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Editorial

Contribution of Agroforestry Biomass Valorisation to Energy and Environmental Sustainability

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1. Introduction

According to data provided by the International Energy Agency, buildings consume more than one-third of the energy produced globally and represent a major source of carbon dioxide-related emissions [1]. In fact, it is expected that without measures to improve the energy efficiency of the sector, energy consumption will increase to more than 50% by 2050. Buildings in the European Union account for 40% of total primary energy consumption and 36% of total CO_2 emissions. A large share of buildings' energy demand (up to 70%) is for heating and cooling, of which 75% is covered by fossil fuels and only 18% is covered by renewable sources [1]. Despite this low rate of usage, the frequency of using renewable energies in buildings, according to the Energy Progress Report, has been increasing by 5 percent year-on-year since 2019 [2]. The most utilised renewable energies are hydropower remains, followed by wind and then solar PV, which is usually the last one installed in buildings. Additionally, the consumption of electricity in buildings, mainly for cooling or heating, has increased by 26.2% in recent years [3] due to atmospheric modifications in the weather promoted by climate change [4].

With the historic Paris Agreement (2015), world leaders at the United Nations Climate Change Conference (COP21) in Paris made a breakthrough on climate change and its negative aspects.

The goals set with this agreement are to substantially reduce greenhouse gas emissions to limit the global temperature increase this century to 2 °C and to strive to limit this increase to even more than just 1.5 °C; review countries' commitments every five years; and provide funding to developing countries to enable them to mitigate climate change, strengthen resilience, and improve their capacity to adapt to the impacts of climate change [5].

To promote energy saving measures and reduce energy consumption for heating and cooling in European buildings, the European Commission (EU) launched a commitment strategy to reduce the enormous amount of energy used for heating and cooling. This is in line with the Energy Efficiency Directive (EED-2012/27/EU), through which a common framework was established to promote energy efficiency in Member States [6,7].

In addition, near-zero energy consumption has been a legal requirement in building construction since the end of 2018. Near-zero energy buildings (NZEB) should not be the buildings of the future, but of the present. In this sense, the European Directive 2010/31/EU determined that from 31 December 2018, all new public buildings had to be NZEB, and that old buildings had to be NZEB by 2020 [8–10]. An NZEB is a very energy efficient building, so the near-zero or minimum amount of energy demanded must be largely met by clean energy sources that are either produced on site or in the surrounding environment [11].

At the end of 2015, the European Union announced the Circular Economy Action Plan to advance the transition to a circular economy in the EU.

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One of the pillars on which a circular economy system is based is bio-based products. In order to find alternatives to petroleum products and other traditional forms of energy, this option seems to be one of the most sustainable. In 2020, the EU adopted a new Circular Economy Action Plan, which was one of the main elements included in the European Green Deal, Europe's new agenda for sustainable growth [12].

The Spanish Circular Economy Strategy, "Spain 2030" (EEEC), approved by Agreement of the Council of Ministers on 2 June 2020, lays the foundations for promoting a new model of production and consumption in which the value of products, materials, and resources is retained in the economy for as long as possible, in which waste generation is minimised and the waste that cannot be avoided is used to the greatest possible extent. The EEEC thus contributes to Spain's efforts to achieve a sustainable, decarbonised, resource-efficient, and competitive economy. The strategy sets the following targets for the year 2030 [13]:

- To reduce the national consumption of materials in relation to the GDP by 30% and taking 2010 as a reference year.
- To reduce waste generation by 15 % compared to 2010.
- To reduce food waste generation throughout the food chain: 50% reduction per capita at the household and retail consumption levels and 20% reduction in production and supply chains from 2020 onwards, thus contributing to the SDGs.
- To increase reuse and prepare for the reuse of 10% of the municipal waste generated.
- To reduce greenhouse gas emissions to below 10 million tonnes CO_2eq.

To increase the share of renewables in the energy mix, as well as energy efficiency, new innovative sources of renewable energy should be researched and promoted. Biomass is a clean source of high energy that has experienced a high degree of sustainable growth due to its carbon-neutral status and high availability worldwide, as it can be obtained from a wide variety of agro-industrial and livestock wastes. It accounts for 9–14% of total primary energy consumption in industrialised countries, while in developing countries, bioenergy accounts for approximately one-fifth to one-third of total consumption. However, despite its potential as an environmentally friendly energy source, biomass is largely discarded without any energy use. New sources of energy from waste biomass are currently being studied for use as a heat source [14,15].

2. Worldwide Research Trends on Bioenergy from Waste

In this study the Scopus database was used to analyse the worldwide research advances in the production of bioenergy from waste using bibliometric techniques.

In this research, the following research equation was used to obtain documents regarding advances in the production of bioenergy from waste: (TITLE-ABS-KEY (bioenergy) AND TITLE-ABS-KEY (waste)).

Currently, there are about 6254 documents on the production of bioenergy from waste.

The top country with the highest scientific output is China (1304) followed by the United States (989), India (853), the United Kingdom (413), Brazil (321), Italy (292), South Korea (291), Spain (255), Malaysia (247), and Australia (241). Figure 1 shows the scientific output of the top 10 countries.

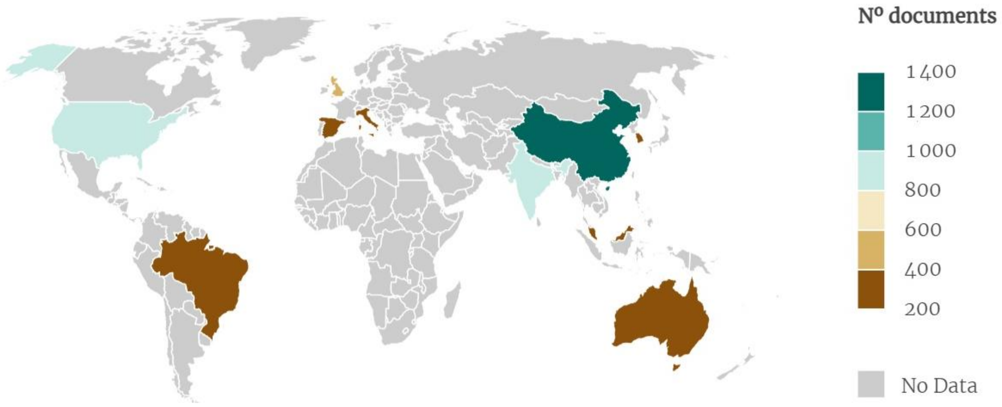

Figure 1. Top 10 countries conducting research on bioenergy production from waste.

Such results match the latest reports that have indicated a switch in Asia, Europe, and other South American countries regarding the production and storage of renewable energy. Additionally, these reports have indicated how larger countries are further incorporating bioenergy, with a 2.1 percent increase between 2018 and 2019 across industry and the building sector [16–18].

In order to identify existing worldwide collaborations on "bioenergy from waste" between authors, Vosviewer® software version 1.6.18 was used. The size of the circle shows the importance of the country based on the number of publications, and the lines represent the collaboration in scientific documents between the different countries. Figure 2 and Table 1 show the existing scientific collaborations between the main countries involved in research on bioenergy production from waste.

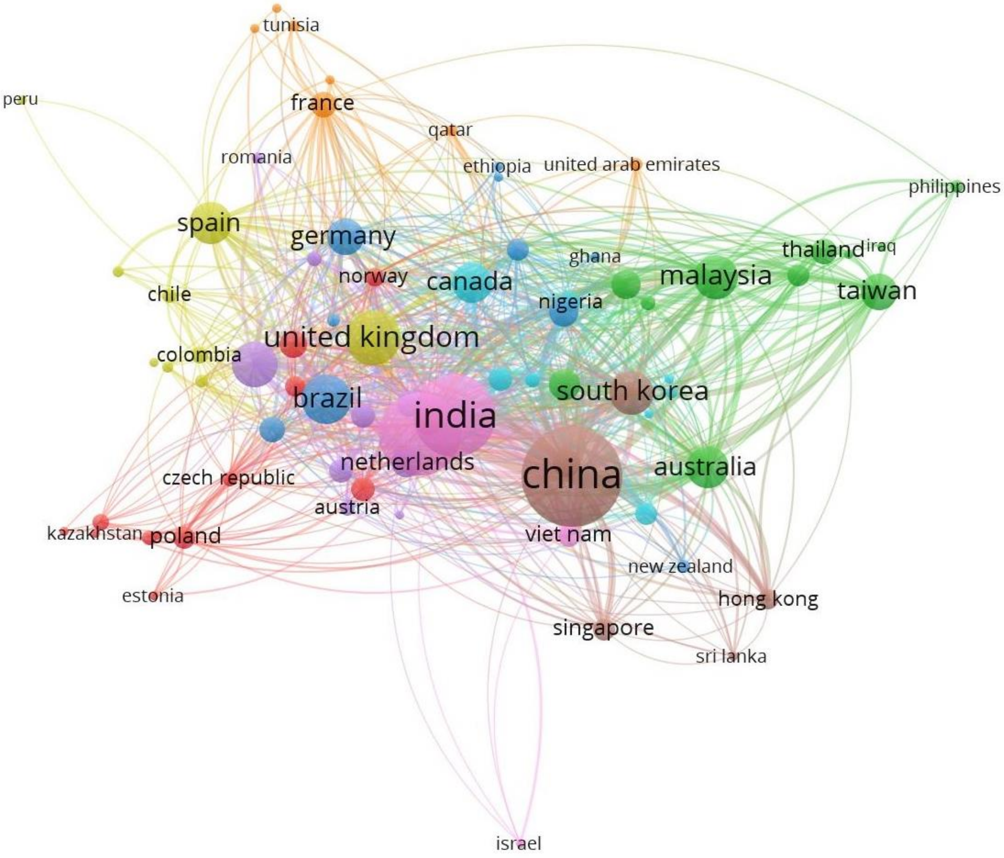

Figure 2. Scientific collaborations between the main countries involved in research on bioenergy production from waste.

Table 1. Main clusters obtained in co-word analysis for the topic of bioenergy from waste.

Cluster	Color	Countries
1	Red	Czech Republic, Estonia, Finland, Greece, Kazakhstan, Norway, Poland, Russian Federation, Saudi Arabia, Serbia, Slovakia, Turkey, Ukraine.
2	Green	Australia, Bangladesh, Indonesia, Iraq, Japan, Malaysia, Pakistan, Philippines, Taiwan, Thailand.
3	Blue	Argentina, Brazil, Denmark, Ethiopia, Germany, Ghana, Mexico, New Zealand, South Africa, Tanzania.
4	Yellow	Chile, Colombia, Ecuador, Hungary, Latvia, Lithuania, Peru, Spain, United Kingdom.
5	Purple	Austria, Belgium, Italy, Kenya, Netherlands, Portugal, Romania, Sweden, Switzerland.
6	Turquoise blue	Bulgaria, Canada, Croatia, Egypt, Ireland, Nigeria, Oman, Slovenia.
7	Orange	Algeria, Costa Rica, France, Morocco, Qatar, Tunisia, United Arab Emirates.
8	Brown	China, Hong Kong, Iran, Singapore, South Korea, Sri Lanka.
9	Pink	India, Israel, United States, Viet Nam.

These connections between countries are in sync with the use of bioenergy, materials, and the industries involved, indicating similarities in the energy consumption between Nordic countries or the application of standardised laws such as the Renewable Energy Directive [19].

Moreover, Vosviewer® software version 1.6.18 was also used in this study to represent the keyword clusters that are coincident in the different scientific papers that have been published on bioenergy production from waste. Figure 3 shows such a representation in which five groups of words are shown.

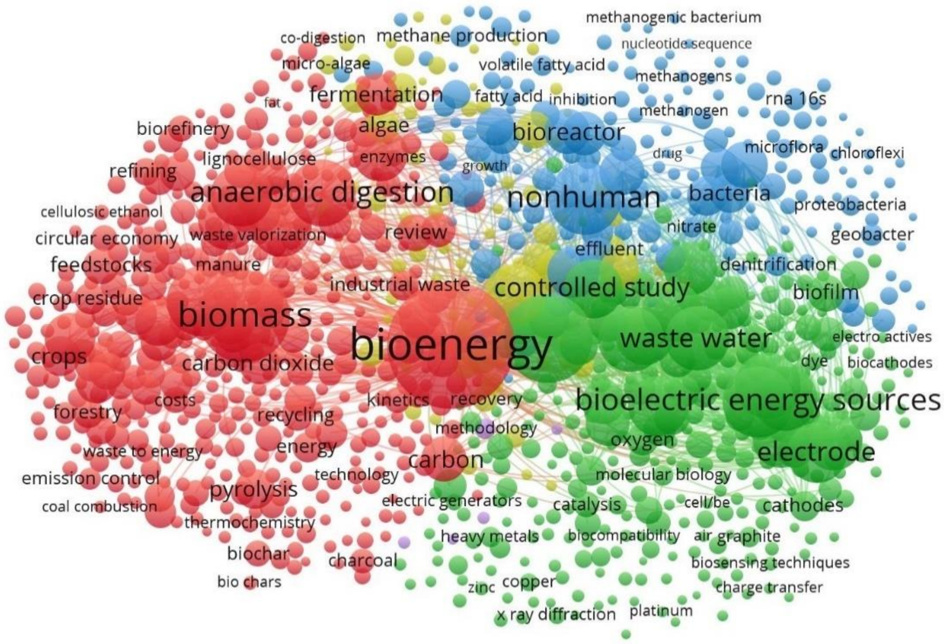

Figure 3. Keyword clusters on bioenergy from waste.

The top ten journals that have published the highest number of articles on Optimizing Wind Turbine Efficiency are shown in Figure 4. It is worth highlighting the relevant position of the journal *Energies* at number 7.

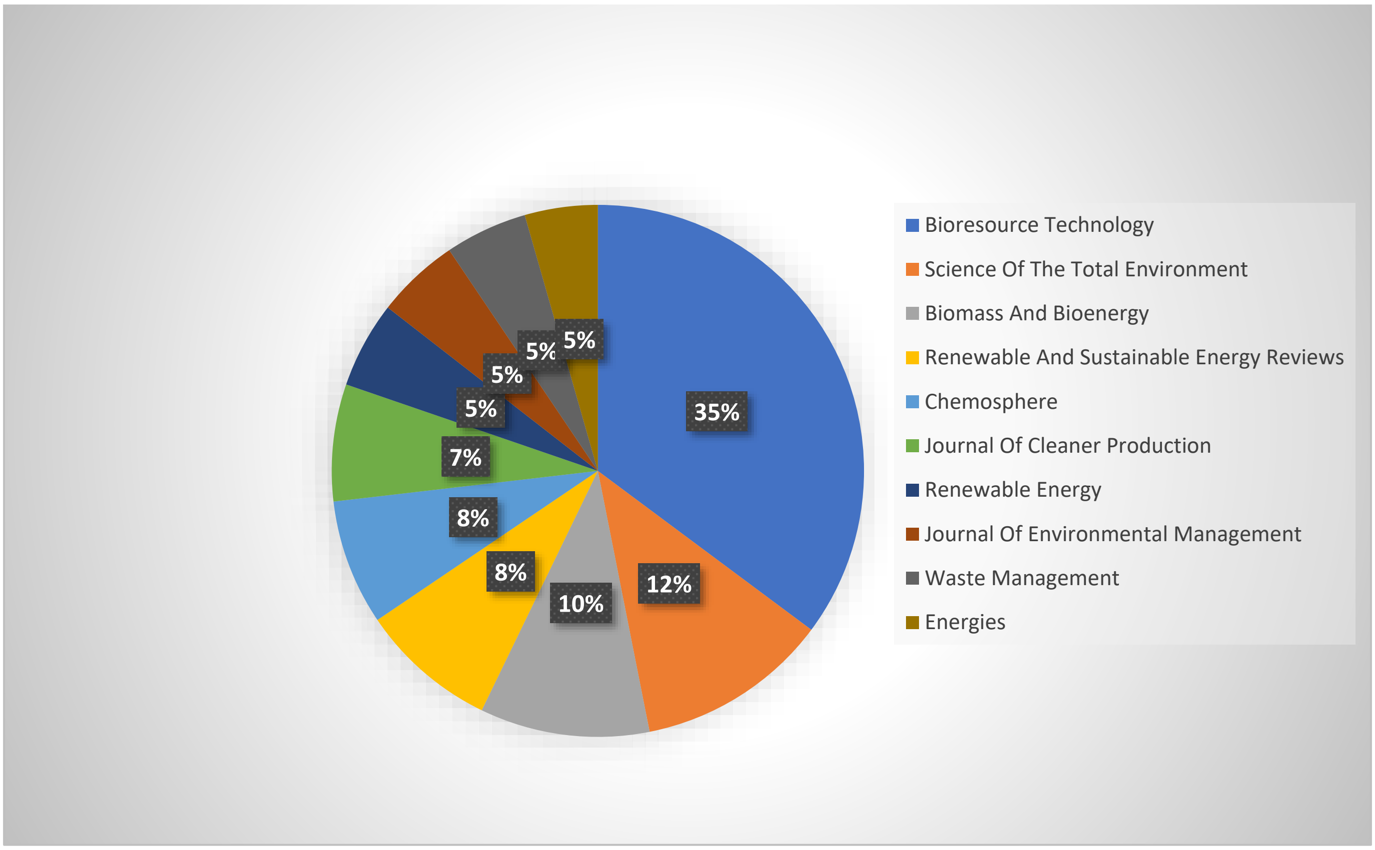

Figure 4. Worldwide top ten journals publishing research on bioenergy from waste.

3. Most Cited Articles in *Energies* on Bioenergy from Waste

Eftaxias et al. proposed using forest residues from a forest in Northern Greece as a source of biogas production. They sampled pine needles, pine branches, and pine bark, which were digested in reactors under mesophilic conditions after the pre-treatment of the samples. The best yield of volatile solids was obtained from pine needles followed by pine branches and lastly by the pine bark. The authors, based on the yield obtained and on the surface density of the pine needles accumulated on the roadside where the samples were taken, estimated methane production of more than 500 $Nm^3\ km^{-1}$ [20].

Uddin et al. studied a new biogas production system using anaerobic digestion and the co-digestion of olive waste. Analysis of the hard olive pomace sample showed that it was a good source of electricity production: 769 kWh/t due to the high number of volatile solids present [21].

Almeida et al. studied the use of three tomato crop residues as a source of biogas: ripe rotten tomato (RT), green (unripe) tomato (GT), and tomato branches including leaves and stems (TB). For a better assessment of these residues, using only ripe rotten tomato (RT), a two-level fractional factorial design with resolution V was performed to determine which factors improve biochemical methane potential (BMP) during anaerobic digestion. The substrate to inoculum ratio (SIR) was the most important factor. The authors, knowing this factor, carried out several experiments with the three residues separately and in combination with each other. The highest biochemical methane potential (BMP) was obtained with a mixture of 63% RT + 20% GT + 17% TB [22].

Hamawand et al. reviewed both by-products and residues as well as their impact on the environment and the existing methods for transforming sugarcane crop by-products and residues into biofuels by considering the economic calculation of each. The residues and by-products considered were molasses, bagasse, and a mixture of milling sludge and boiler ash. Additionally, the products obtained from them ranged from the production of ethanol, furfural, and butanol to hydrogen or paper, among others. They concluded that although the amount of stanol or biogas is lower than the rest of the products obtained from the different uses of waste and by-products, they are the ones with which a greater amount of income can be obtained [23].

Ximenes et al. valorised waste from the local fishing, shrimp, and fruit and vegetable industries through the production of biogas and biofertilisers, estimating it to be economically viable, as it had a positive NPV in year 11 from the start of the investment and an IRR of 6% [24].

Szymaida et al. evaluated the use of cow dung as a fuel to make pellets for use in direct combustion facilities. The manure showed high compaction properties and good moisture as well as a promising calorific value per kg (16.34 MJ-kg^{-1}) [25].

Frankowski et al. proposed the use of wastes from the flower industry, namely stems, the remains of roses, and sunflowers and chrysanthemums as a source and for the production of biogas. They also established the calorific value of the waste. Biogas production was carried out by fermentation, which was tested under mesophilic and thermophilic temperature conditions, and the results showed that the best waste was chrysanthemum straw under mesophilic conditions. In addition, neural modelling was carried out to contrast the research carried out in this study [26].

Obeng et al. proposed the use of coconut waste as a sustainable fuel. To this end, they quantified the proportion of waste, the calorific value, and the emissions generated. For this, one part of the sample taken was carbonised, and the other was not, and it was shown that the calorific value of the carbonised waste was 42% higher than that measured in the non-carbonised waste. Together with the measured air quality parameters, it was concluded that the biocharing process was better than the open burning of the same waste [27].

Enes et al. characterised forest and agricultural biomass in northern Portugal to determine whether or not it should be considered as a source for bioenergy production and to thus meet governmental targets. The higher calorific value and chemical composition of agricultural, forest, and shrub residues were measured. The calorific value of the shrub samples presented higher and statistically different levels compared to those measured in the agricultural forestry residues [28].

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