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A review of key international biomass and bioenergy sustainability frameworks and certification systems and their application and implications in Colombia

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ABSTRACT

This document presents the results of an analysis of the key sustainability certification systems applicable to biomass and bioenergy. A review was made of the state-of-the-art sustainability frameworks at the international level. The improvements that have been made in these standards in recent years to reduce social, environmental and economic impacts were identified. In addition, it was determined how some of the initiatives analyzed were implemented in a country such as Colombia, where the establishment of a bio-based economy is being carried out. It was noted that most of the certification systems analyzed have been updated in the last two years. The main adjustments made to the standards are based on criteria developed by the European Commission through the Renewable Energy Directive (EU2015/1513). For environmental issues, it was found that the key update was the inclusion of the indirect land-use change (ILUC). Another key issue addressed is the obligation to calculate and publish the GHG emissions generated annually. Social issues have increased the focus on food security of the population regarding local areas of influence such as the price of the family food basket and food supply. Regarding economic issues, the requirement for a business plan is highlighted to contribute to the economic viability of a certified company. Colombia is one of the countries in the world where the basic conditions support a future sustainable bio-based products sector. Not only does the country have a large amount of land suitable for cultivation, but the land does not require the forests deforestation. However, it must be borne in mind that in a megadiverse country like Colombia, a joint effort (integration) is required between the application of strict laws for the protection of natural resources and the use of certification systems for sustainable products.

1. Introduction

There is a growing global interest in biomass as a sustainable energy source: the use of biomass for energy and materials is expected to grow over the next 20 years [1,2]. Biomass-generated primary energy is expected to increase to the equivalent of 1827 Mt of oil by 2030 (12% of total world primary energy demand) [3]. The opening of new markets based on biomass (a bio-economy) implies increased investment in research and innovation. These markets can contribute to social development in terms of creating new jobs and food security, however, at the same time, the increase in the use of biofuels and bioenergy, generates new concerns about the use of biomass. These concerns involve indirect land use change (ILUC), negative impacts on biodiversity, greenhouse gas (GHG) emissions, water use, competition between uses of land, and possible pressure on food prices, along with other important socio-economic conditions [4,5]. It is important to note that these concerns are still present, and if not adequately addressed, could become barriers to the development of bioenergy and biofuels.

In order to reduce the concerns about biomass-use mentioned above, a number of organizations and governments have developed certification systems to define indicators that can be used to reduce negative impacts on the environment, society and the economy. One of the major focuses has been the reduction and prevention of impacts to the environment, but greater attention should be given to the social component because there are still concerns that have not been taken into account especially in the area of food security and well-being of employees and the surrounding community [4]. On the other hand, it is understandable that the certified companies expect to receive an economic benefit when marketing sustainable biomass or sustainable bio-based products. In recent years, sustainability criteria and indicators for

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biomass products have been developed and implemented by the European Commission (EC) and also by some private organizations such as Global Bioenergy Partnership (GBEP), International Organization for Standardization (ISO), and others [6–9].

In Latin America, there is considerable experience with generation of bioenergy [10] and Colombia is a key country in Latin America, because Colombia has a potential for agricultural development of biomass as a source of renewable energy. The modern use of bioenergy in the country is currently limited to the production of first-generation biofuels from sugarcane and palm oil, as well as the use of biomass residues to supply own heat and electricity in biofuel production facilities and injecting surplus electricity to the power grid. In 2015, Colombia produced roughly 20 PJ and 8.25 PJ of biodiesel and ethanol, respectively, in addition to 1.85 PJ of surplus bio-electricity [11,12]. These volumes represent minor shares of their respective energy sectors, where the final energy consumption in the road transport sector reached 405 PJ while about 197 PJ of electricity was consumed through the national grid [12]. The theoretical biomass energy potential in Colombia was estimated between 2007 and 2011 in the range of 210–900 PJ. This range included biomass categories from agricultural and forestry residues, biofuels, animal manure and urban waste. By taking into account different factors that may constrain the availability of biomass for energy purposes (e.g. competing uses, ecological and technical constraints), the technical potential was estimated at 36–420 PJ [13].

The future sustainable potential of biomass supply for energy purposes largely depends on the management system of the agricultural and livestock sectors [14]. If Colombia pursues highly efficient and intensified agricultural practices, up to 60 Mha of surplus land could become available for energy purposes compared to a business-as-usual scenario [15]. If one-quarter of this area is allocated to purpose-grown perennial energy crops (e.g. eucalyptus), up to 4600 PJ of technical potential could become available by 2050 from this biomass category. By extrapolating future agricultural production and consumption trends to the future, additional 80–250 PJ of technical potential may become available from agricultural residues by 2050; excluding residues from sugarcane and palm oil sectors [16]. Moreover, forestry residues, animal manure, and urban waste may contribute to the technical potential of about 300 PJ, 27 PJ and 14 PJ by 2030, respectively [13]. Overall, the future technical biomass supply potential in Colombia is significant and may reach up to 5200 PJ within the next four decades, which is 6.5 folds the current total final energy consumption in the country [16].

Since 2001, the Colombian government has adopted a series of laws to promote the production and use of biofuels and bioenergy (Law 693/2001, Law 939/2004, and Law 1715/2014). These laws have encouraged the cultivation of sugar cane and oil palm for the production of bioethanol and biodiesel respectively, as well as the use of biomass for cogeneration. For instance, in 2017, the sugarcane sector had a 1% share in the national electricity generation [17]. Consequently, to continue to expand the use of renewable energy and reduce the fossil fuel use, the government has issued laws (such as Resolution 1283/2016) that provide tax benefits to companies that generate and manage the use of renewable energy in the country [18]. Although Colombia is on the path to sustainability, a route to implement specific criteria and indicators for sustainability in the use of biomass from agricultural crop waste has not yet been defined. This is needed to realize transition from a fossil-based economy to an economy based on biomass [19].

Therefore, in this work, review and analysis of the certification systems available at the international level were carried out to identify the sustainability criteria applicable to crop residues (biomass) and bio-based products. The guideline for this document was the Renewable Energy Directive (RED 2009/28/EC), which is mandatory for the use of renewable energy in Europe. Because this directive was updated in 2015 (Directive (EU) 2015/1513), to add new guidelines for such as reducing ILUC, limiting the use of agricultural land for energy purposes, and increasing the amount of GHG emission savings [20], some voluntary certification systems have also updated their indicators to adjust to the RED.

There were three primary aims of this study. The first was to carry out a state-of-the-art review of key sustainability frameworks for bioenergy at the international level. To meet this goal, their sustainability criteria (social, environmental, and economic) were identified, it assessed their status and improvements over the last five years, and it determined how the sustainability frameworks compare and what their key strengths and weaknesses are. The second aim was to determine how some of the initiatives analyzed have been implemented in Colombia. This is because this country is characterized by an abundance of valuable resources such as natural biodiversity, water, and substantial land available for cultivation. The third aim was to identify drivers of the environment, social and economic issues in the country that could affect the establishment of a bio-based economy. It should be noted that the initiatives analyzed in this report are among the best known and the European Commission has accepted some of them. The paper has the following structure. First, it discusses the selection of certification systems and the criteria for selecting them. Then, it makes a general description of the systems and their content. Subsequently, it analyzes and compares them from the point of view of environmental, social, and economic criteria, as well as procedures for governance.

2. Methodology

To identify and analyze the most relevant certification systems used in the evaluation of products made from biomass (bioenergy, biofuels, biomaterials), a bibliographic review was carried out. First, the list of voluntary certification schemes recognized by the European Commission[1] to meet biofuel sustainability criteria was taken into account. This implies that the standards cover, among others, criteria such as non-use of land with high carbon stock, protection of biodiversity, reduction of GHGs, and protection of water. Following this, the work of several authors who have gathered and evaluated long lists of sustainability initiatives [4,21,22] were reviewed. Third, the initiatives that have been updated in the last five years were identified. Last, the biomass sustainability certifications systems that apply to Colombia were taken into account. Because of the review, eleven certification schemes were selected that includes the use of biomass at the agricultural, biofuel and energy levels (see Table 1).

3. Data/review

This section is divided into four parts. In Section 3.1, the strengths and weaknesses of each of the certification systems shown in Table 1 were identified. In Section 3.2, the certification systems applicable to Colombia were discussed. In Section 3.3, the aspects that should be taken into account when planning sustainable biomass production and use were discussed. Specific attention was paid to the conditions in Colombia, where high biodiversity and specific socioeconomic matters are very prominent. In Section 3.4, the use of Good Governance for both certification systems and national governments were discussed.

3.1. General certifications

Table 1 shows the eleven (11) certification systems for sustainable bio-based products or sustainable biomass evaluated in this document. There are ten (10) international certification systems and one certification system specific to Colombia (Icontec-GTC 213).

3.1.1. Renewable Energy Directive (RED)

One of the main objectives of the Renewable Energy Directive from the European Union (EU) is to ensure a sustainable production of

[1] https://ec.europa.eu/energy/node/74.