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Using Sustainability Criteria for Biomass

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Abstract — This article explores the use of sustainability criteria for biomass as a tool to promote and safeguard sustainability of this product. Much attention is paid to the issues that sustainability criteria for biomass should consider. Among them the priority for food supply and food security, the emission reduction of green house gases (GHG) through the whole production chain, the preservation of areas of high ecological value, the protection of soil and water quality, and the requirements to the use of genetically modified organisms (GMOs) are highlighted.

In general, different issues relevant for sustainable biomass can be outlined and promoted. Their choice might depend on the purpose of using sustainability criteria, the type of biomass and the production processes that are regulated, and on specific local conditions. Variations in how the concept of sustainability is interpreted would also have much influence.

Obstacles towards the use of sustainability criteria for biomass are identified. Among them, there is a difficulty to monitor and manage indirect effects of how sustainability criteria are fulfilled, and the potential conflict with the regulations of the World Trade Organisation (WTO). Even other implementation and enforcement difficulties can limit positive effects of using sustainability criteria for biomass. Further search for solutions should be encouraged.

The article is primarily delimited to the environmental aspects of the concept "sustainability", though the importance of social and economic sustainability issues, as well as their interconnection should not be undermined. Certain issues and sustainability criteria typical for sustainable biomass might correspond to sustainability requirements in the biofuel sector and in other similar industries.

Keywords — sustainability criteria; biomass; biofuels; the EU policy for renewable energy; sustainability

I. Introduction

Interest to renewable sources of energy, which can be used as a promising compliment, or an alternative to traditional fossil fuels [1] is continuously growing in different parts of the world [2]. The idea that renewable energy should also be produced in a sustainable way [3] and in reasonable amounts, which are not damaging for the environment and ecological systems of the planet is gaining much importance. In this light, the research on sustainable biomass and criteria that can be used as a tool to promote its sustainable production [4] has become urgent.

One of the prominent examples of how sustainable renewable energy can be regulated in a legal context is the EU approach developed in Directive 2009/28/EC [5]. This Directive establishes a set of sustainability criteria aimed to promote sustainable production of biofuels for transport and bioliquids used in other sectors, such as electricity, heating and cooling [6], see Article 17.

However, this framework does not formulate sustainability criteria for the production of biomass [7], though biomass has a close connection to the production of biofuels [8]. This can be viewed as an incompleteness of the EU approach. The purpose of this article is to explore why sustainability issues for biomass should be promoted, what issues sustainability criteria for biomass should consider, and to reflect upon several examples of including sustainability issues in lists of sustainability criteria for biomass. The choice of the practical examples has been made on the basis of their relevance for the promotion and safeguard of sustainability of biomass.

The content of the article is primarily delimited to the environmental dimension of the concept "sustainability", though the importance of social and economic sustainability issues, as well as their interconnection should not be undermined.

The research on sustainability criteria for biomass has relevance for better understanding of how sustainability criteria for biofuels and bioliquids should be designed, particularly in the EU legal documents. The major set of sustainability criteria for biomass and challenges that their use may involve would correspond to the critical issues typical for the sustainable production of biofuels and bioliquids [9].

II. Background Information about Biomass

Biomass is an important feedstock for the production of renewable energy and fuels [10]. Worldwide, it is the fourth largest energy resource after coal, oil and natural gas, estimated at about 10 – 14 % of global primary energy [11]. Once processed, biomass can be in a solid, liquid or gaseous form, and used alone or in combination with fossil fuels [12]. The amount of energy obtained from biomass and the form of that energy would vary depending on the production technology [13].

Biomass can be originated from a wide range of organic materials, whether directly from plants or indirectly from plant-derived industrial, commercial or

urban wastes, or agricultural and forestry residues [14]. Kurhania (2012) classified the most commonly used sources for biomass production into four groups:

- agricultural and forestry residues that include silvicultural crops;
- herbaceous crops, which include grasses and weeds;
- aquatic and marine biomass, which includes algae, water hyacinth, aquatic weeds, plants, sea grass beds, kelp and coral reap; and
- various wastes, such as municipal solid waste, municipal sewage sludge, animal waste and industrial waste [15].

According to the purpose of use, biomass for electricity, heating and cooling, and for the use in the transport sector can be named [16]. Solid biomass for electricity, heating and cooling can come from forestry, agriculture and non-eatable energy crops, and from municipal and industrial wastes. Biomass for biofuels and bioliquids used in the transport sector can come from agriculture and non-eatable energy crops, and residues and wastes from agriculture and forestry. Biogas can be produced from agricultural by-products or processed residues and wastes, such as manure and animal fat, as well as from landfill gas, sewage sludge and silage maize [17].

Biomass from residues and wastes is particularly attractive from the environmental point of view [18]. Utilization of biomass residues, which would otherwise be dumped in landfills, such as urban and industrial residues, has the potential to reduce greatly emissions of greenhouse gases (GHG) by preventing the formation of methane [19].

Biomass, especially biomass produced from wood and wood waste for electricity, heating and cooling is considered the biggest source of renewable energy in EU [20]. It is expected to make a dominant contribution to the 20 % EU renewable energy target by 2020 [21].

Directive 2009/28/EC defines biomass as the biodegradable fraction of products, waste and residues from biological origin from agriculture, including vegetal and animal substances, forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste, see Article 2.e [22].

III. Why Sustainability Issues for Biomass Should be Promoted

If produced in an unsustainable way, biomass, similarly to biofuels, can turn into a threat instead of an opportunity [23]. Its increased unsecured production can undermine the environmental advantages of renewable energy [24]. The Biomass Technology Group, BTG (2008) noted that without ensuring that biomass is sustainable, its wide use can encounter strong opposition from the public opinion, pressure groups from non-governmental organizations (NGOs) and developing countries. This can hinder the development of the biomass sector [25]. Sustainable biomass, on the contrary, would help to create a green image for this industry [26] and benefit the environment.

Potential advantages of setting sustainability requirements for biomass are many. Among the environmental winnings, there are GHG emission savings [27], avoidance of unacceptable competition with food [28] and protection of local environment. The last issue includes protection of biodiversity, for example high conservation forests and wildlife habitats, control of soil and water conditions [29], as well as restrictions on using chemical fertilizers and pesticides [30], and genetically modified organisms (GMOs) [31].

If biomass production takes place in a State with an emission reduction target under the Kyoto Protocol, the fulfillment of sustainability criteria for biomass will add to the achievement of this target [32]. It can also contribute to the improved quality of Kyoto-type projects [33].

Taking the EU approach to sustainable renewable energy as an example, the EU Council in December 2012 acknowledged the need to consider sustainability of the use of biomass resources [34]. This was done in connection to the 2012 EU Commission's Communication on renewable energy [35]. In January 2014, in its Communication "A policy framework for climate and energy in the period from 2020 to 2030" [36], the EU Commission underlined that "(a)n improved biomass policy will also be necessary to maximise the resource efficient use of biomass in order to deliver robust and verifiable greenhouse gas savings and to allow for fair competition between the various uses of biomass resources in the construction sector, paper and pulp industries and biochemical and energy production. This should also encompass the sustainable use of land, the sustainable management of forests in line with the EU's forest strategy and address indirect land use effects as with biofuels" [37].

IV. Issues that Sustainability Criteria for Biomass Should Consider

To add to the environmental issues, which are most essential for the production of biomass, such as GHG emission savings, protection of the existing eco-systems and biodiversity, preservation of soil and water quality, the Biomass Technology Group, BTG underlined in its report (2008) that sustainability of biomass could not be separated from aspects like competition for land for food [38], materials and energy [39]. This research group stressed that biomass should not be originated from unsustainable sources, for example illegal harvesting [40]. Similarly to the situation with biofuels, sustainability criteria for biomass have to take into account different local conditions [41].

Sustainability criteria for biomass should be explicitly tailored to the task they are to fulfill. This

implies that the purpose of sustainability criteria should be clearly defined. An opinion was expressed that sustainability criteria for biomass should ensure an equivalence of the existing and emerging legal frameworks and voluntary sustainability standards, rather than establish equal requirements [42].

Implementation and enforcement difficulties can limit positive effects of sustainability criteria for biomass [43]. For example, sustainability criteria can hardly control the effects of biomass production on competition with food and indirect land use changes [44]. Solutions need to be found to deal with this. Compensations to owners of areas of high conservation value for protecting and not using the areas for other purposes, maintaining biodiversity, wildlife and carbon stocks can be considered. In some cases, when land use changes apparently lead to environmental problems, any farming activities in the area should be prohibited [45]. If environmental targets for renewable energy result in unacceptable impacts regarding such issues as competition with food and land use, it should be discussed whether these targets should be changed. Other possibilities should also be considered, because changes of the targets may have an adverse effect on the development of renewable energy [46].

Another important issue that should be taken into account is that sustainability criteria for a product have to comply with the WTO rules [47]. Legal frameworks and voluntary sustainability standards used in an international setting run the risk of being abused by certain interest groups in the importing country as a non-tariff trade barrier, if their sustainability criteria do not apply to all providers of biomass [48].

In contrast to legal frameworks, voluntary sustainability standards do not usually suffer all the WTO-limitations. This makes it easier to introduce stricter sustainability criteria, for example those related to biodiversity and local environmental effects, in voluntary sustainability standards. A minimum list of mandatory sustainability criteria can, therefore, be presented in a legal framework and then completed with more elaborated voluntary sustainability standards. By doing so, it will be possible to address issues that due to different reasons cannot be included as binding sustainability criteria in a legal framework [49]. As an example, EU recommended to promote and support the development of voluntary sustainability standards in addition to legal regulations for biofuels [50], though this approach is not without challenges and complications.

Some NGOs support the development of legal frameworks and voluntary sustainability standards for biomass as a means to promote and safeguard sustainability of this product and its production methods. Other involved actors are more skeptical about the efficiency of this approach [51], though they accept that sustainability criteria for biomass related to biodiversity conservation, local environmental impacts and social aspects may be formulated.

Sustainability criteria, as well as legal frameworks and voluntary sustainability standards for biomass can be integrated with the Clean Development Mechanism (CDM) and the Joint Implementation (JI) approach, regulated under the Kyoto Protocol. Within CDM a distinction was made between renewable and non-renewable biomass [52]. In EU, this type of sustainability should be related to the broader GHG emission reduction targets formulated within EU, and as a part of the Kyoto obligations and to energy security in EU.

There are expectations that a limited number of legal frameworks and voluntary sustainability standards for biomass would become available, some quite detailed and strict, others only including the minimum list of sustainability criteria. Different sets of sustainability criteria might be developed for different types of biomass. EU has an intention to impose obligatory minimum criteria on the biomass producers, suppliers and distributors [53], and contribute to the promotion of the sustainable quality of this product. Strong governmental policies, top management support and consumer pressure are among the key factors that can foster the development of sustainability criteria for biomass and their use [54].

It is not clear what percent of the involved actors will be interested in following sustainability criteria for biomass. Some biomass producers, suppliers and distributors might switch their interest to less eco-sensitive alternatives [55]. Their unwillingness to be engaged can lead to marginal changes towards sustainability in the biomass sector.

After the introduction of sustainability criteria, certain types of biomass would not be perceived as environmentally sustainable, like the unseparated biodegradable part of urban solid waste, demolition wood and combustion of sewage sludge [56]. These types of biomass might become unavailable, and, therefore, disturb the market development [57].

V. Examples of Including Sustainability Issues in Lists of Sustainability Criteria for Biomass

The World Wildlife Fund (WWF) is an active supporter of voluntary sustainability standards in different fields, including sustainability of biomass. In 2006, the German WWF section published a report on “Sustainability standards for bioenergy” [58], which investigated key environmental concerns for bioenergy, with a particular emphasis on the biomass production. The most important sustainability issues for this product were outlined, and they are rendered below. This list is fully relevant for the sustainable production of biofuels and bioliquids:

- avoidance of negative impacts from bioenergy-driven changes in land use;
- priority for food supply and food security;
- no additional negative biodiversity impacts;
- minimization of GHG emissions;
- minimization of soil erosion and degradations;

- minimization of water use and avoidance of water contamination; and
- avoidance of human health impacts [59].

According to another investigation, made within the project “Clean Energy Network for Europe, CLEAN-E” (2006), it is desirable that sustainability criteria for biomass include the following issues:

- sources for biomass should be eligible;
- sustainability requirements for the cultivation and imports of sources for biomass, for example forestry, should exist;
- the use of GMOs should be prohibited;
- sources of biomass should not be produced on arable land, which was gained by conversion of pasture or grassland;
- biogas plants that use manure and other sources of energy consumption during the production and transportation of biomass need to reduce GHG emissions;
- an overall efficiency of a biomass plant should be at least 60 % [60];
- soil fertility should be maintained. No needles, foliage and roots should be removed; and
- principles of integrated farming should be preserved. Biomass from dedicated cultivation on arable land needs to comply with guidelines for integrated crop protection [61].

It can be seen that the two presented approaches to the sustainability criteria for biomass, the first of WWF and the second of CLEAN-E, preserved the same task, which could be formulated as “to promote and safeguard sustainability of the produced biomass”. The approaches highlighted some common sustainability issues, such as restrictions on land use and protection of soil quality. The approach of WWF was clearly directed at environmental sustainability and major challenges that the industrial production of biomass would imply, i.e. negative impacts on biodiversity and competition with food supply. However, it did not mention the problem of using or prohibiting GMOs. It neither addressed the issue of using chemical fertilizers and pesticides.

The approach of CLEAN-E was more generally formulated. It referred broadly to the “sustainability requirements for the cultivation of biomass sources” and “principles of integrating farming”, without specifying the content of these spacious notions. Besides, the approach of CLEAN-E contained requirements to the process of manufacturing of biomass from biomass feedstocks and its transportation, see the requirements to biomass and biogas plants. This type of requirements could be discussed and regulated separately from the most traditionally used ways of producing biomass feedstocks, such as growing energy crops or gathering forestry sources. Relevance of the given per cent of the overall efficiency of a biomass plant could be questioned. It could also be argued whether a certain amount of needles, foliage and roots could be removed, without damaging environmental conditions.

The research of the Biomass Technology Group, BTG (2008) stressed that soil fertility during the production of biomass of an agricultural origin is an important aspect that should be protected and safeguarded [62]. For farming of soy, which is widely used for biomass production, the water and soil quality are the central sustainability factors, together with biological diversity and responsible use of agro-chemicals [63]. As an illustration, the Basel Criteria for responsible soy, issued by the NGO community in 2004 [64] can be taken.

The researchers Ladanai and Vinterbäck (2010), after analyzing the existing sustainability standards for biomass produced from different sources, outlined the following minimum list of environmental sustainability criteria for biomass:

- the use of chemicals;
- maintenance of biological diversity;
- protection of areas of high ecological value;
- protection of the soil and prevention of erosion;
- protection or enhancement of water quality;
- regeneration following harvesting;
- forest and land monitoring; and
- forest and land management planning [65].

This approach added two important issues, which could lead to much improvement in the sustainability of the produced biomass, and namely forest and land monitoring, and forest and land management planning. Otherwise the approach of Ladanai and Vinterbäck had many similarities with the environmental approach of WWF, though the reduction of GHG emissions, and the problem of using or prohibiting GMOs could be included. The priority for food supply and food security is crucial for the sustainable production of certain types of biomass. That is why, to my mind, a special emphasis should be put on this issue.

It could be speculated whether the order, in which the sustainability issues were presented in the mentioned lists of sustainability criteria, reflected their significance for the promotion and safeguard of sustainability. If this were the case, the issue of using chemicals in the last approach should not perhaps be placed in the very beginning. Protection of areas of high ecological value and maintenance of biological diversity could be prioritized.

VI. Conclusions

In this article, the notion of using sustainability criteria for biomass, particularly with the purpose to promote and safeguard sustainability of this product, has been explored. The general background about different types of biomass has been outlined. It has been researched why sustainability for biomass should be promoted, and what issues sustainability criteria for biomass should primarily consider.

Reflections have been made on three representative examples of including sustainability issues in lists of sustainability criteria for biomass.

It seems to be a prevailing opinion that certain sustainability requirement to the production of biomass should exist, so that biomass does not become a threat to sustainability instead of an opportunity. Among them the priority for food supply and food security, the reduction of GHG emissions through the whole production chain, the preservation of areas of high ecological value, the maintenance of biodiversity, and the protection of soil and water quality can be underlined.

At present there is no universally accepted list of sustainability criteria for biomass. It is questionable whether such a list could and should be created. Different issues relevant for sustainable biomass can be highlighted and promoted. Their choice would depend on the purpose of using sustainability criteria, the type of biomass and the production processes that are regulated, and on specific local conditions. Variations in how the concept of sustainability is interpreted would also have their consequences. According to the personal opinion, the importance to include the issue of GMOs' use cannot be neglected.

Several obstacles towards the use of sustainability criteria for biomass have been identified. Among them, there is a difficulty to monitor and manage indirect effects of how sustainability criteria are fulfilled, for example the influence on the food market and damaging effects of indirect land use changes. Another obstacle is that only a limited number of mandatory sustainability criteria would hold ground in case of a potential WTO conflict. The third obstacle is that if sustainability criteria exclude certain types of biomass as unsustainable, it can distort the situation at the market of biomass and products made of it.

Further research on the use of sustainability criteria for biomass is desirable. Comparative analysis of co-existing sustainability standards for biomass can be recommended, with the purpose to find out what sustainability criteria for biomass and linked implementation, enforcement and control mechanisms are the most appropriate.

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