ANALYSIS OF CRITERIA FOR THE SUSTAINABLE DEVELOPMENT OF BIOENERGY

UABio Position Paper N 17

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Introduction

Position Paper 17 by the Bioenergy Association of Ukraine covers general concept of the sustainable development, presents existing binding and recommended sustainability requirements for biofuels in the European Union, analyses the situation in Ukraine and suggests relevant recommendations.

Concept of sustainability

Concept of *sustainable development* originates from the environmental movement of 1960s that linked economic growth and worsening of the environmental state. One of the first applications of the term *sustainable* in the current sense can be found in the first report by the Club of Rome called «The limits to growth»[1] (1972). In 1980, the International Union for Conservation of Nature and Natural Resources published World Conservation Strategy[2], which includes one of the first references to sustainability as a global priority and introduces the term of ***"sustainable development"***.

The Earth Summit held in Rio de Janeiro in 1992 drew attention to the sustainable development of society in general sense of this idea (protection of the environment and people health, replacement of fossil fuels by alternative energy sources, access to water and other). Principal themes of this United Nations Conference were environment and sustainable development. The Conference resulted in the development of a number of documents (the Statement of Forest Principles, the United Nations Convention on Biological Diversity and other) and establishment of several international commissions on sustainability issues.

In the materials of the Earth Summit and similar documents, one can find the following definition and principles of sustainable development[3]:

- As a general guiding principle, ***sustainable development*** is a process of technological progress and social organization that meets the needs of society (and particularly those of the poor) in a manner that does not damage the environment to the extent that future generations cannot meet their own needs. Sustainable development implies social equity between generations and within each generation. Social equity and eradication of poverty are essential to sustainable development.

  It should be mentioned that the definition given by the World Commission on Environment and Development (the Brundtland Commission) in its report on «Our Common Future»[4] is cited most often:

[1] "The limits to growth" http://www.clubofrome.org/report/the-limits-to-growth/
[2] "World Conservation Strategy. Living Resource Conservation for Sustainable Development" https://portals.iucn.org/library/efiles/edocs/WCS-004.pdf
[3] The Global Bioenergy Partnership. Sustainability Indicators for Bioenergy, December 2011 http://www.globalbioenergy.org/fileadmin/user_upload/gbep/docs/Indicators/The_GBEP_Sustainability_Indicators_for_Bioenergy_FINAL.pdf
[4] Report of the World Commission on Environment and Development: Our Common Future, March 1987 http://www.un-documents.net/our-common-future.pdf

*"**Sustainable development** is development which meets the needs of current generations without compromising the ability of future generations to meet their own needs".*

- There are *three* components of sustainable development: ***economic development, social development and environmental protection***[5] (**Fig. 1**). Sustainable development means the integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations[6].
- The basic concept of sustainable development and the broad strategic framework for achieving it should be common, though interpretations will vary among countries, taking into account their unique social, physical, economic and political characteristics.

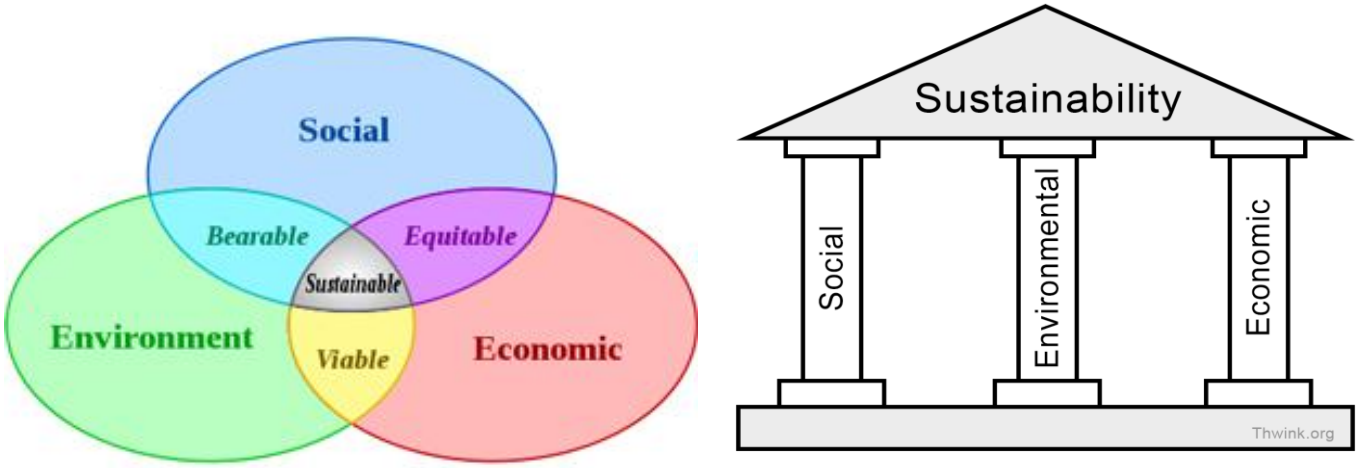

Fig. 1. Three pillars of sustainability – economic, social, and environmental[7]

Sustainability requirements for liquid and gaseous motor biofuels. Voluntary certification schemes

Sustainable development of bioenergy is an integrated part of the general sustainable development of society. The European Commission pays big attention to the issues focusing on sustainable production of biomass and bioenergy. Some of the sustainability requirements are binding for the EU countries (production of biofuels and bioliquids), the others are still recommended (solid and gaseous biomass used for electricity, heating and cooling). General trend is toughening of the sustainability requirements.

Now the sustainability requirements for biofuels and bioliquids in the EU are determined by

[5] Plan of Implementation of the World Summit on Sustainable Development http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl.pdf
[6] Johannesburg Plan of Implementation, 2003 http://www.cooperazioneallosviluppo.esteri.it/pdgcs/documentazione/AttiConvegni/2003-01-01_JohannesburgPlanImplementation.pdf
[7] http://www.thwink.org/sustain/glossary/ThreePillarsOfSustainability.htm

Directive 2009/28/EC on the promotion of the use of energy from renewable sources[8] and ***Directive 2009/30/EC***[9] ***regarding the quality of transport fuels***.

Directive 2009/28/EC sets a mandatory **10%** minimum target to be achieved by all Member States for the share of RES in transport sector by 2020. At that the proportion of biofuels from food crops that can be counted towards the 2020 renewable energy targets is limited to **7%** of the final energy consumption on transport[10], and the contribution made by biofuels produced from wastes, residues, non-food cellulosic material and lingo-cellulosic material shall be considered to be twice that made by other biofuels. It is also noted that biofuel[11] production should be *sustainable*. Biofuels used for compliance with the targets laid down in this Directive, and those that benefit from national support schemes, should therefore be required to fulfil ***sustainability criteria***. These criteria are[12]:

- The greenhouse gas emission saving from the use of biofuels and bioliquids[13] shall be at least **35%** until 31.12.2017 and at least **50%** from 01.01.2018 for biofuels and bioliquids produced in installations in which production started *before 05.10.2015*. Biofuels produced in new installations (that is production started *after 05.10.2015)* must achieve GHG emission savings of at least **60%** in comparison with fossil fuels.
  It should be noted that the requirements are ***new***, they were included in Directive 2009/28/EC by Directive (EU) 2015/1513 of the European Parliament and of the Council[10] in September 2015 and they are more strict than the original ones of 2009.
  For comparison, *the previous variant* of the requirements is presented below:
  The greenhouse gas emission saving from the use of biofuels and bioliquids shall be at least 35%. With effect from 01.01.2017 the GHG emission saving shall be at least 50%, and from 01.01.2018 it shall be at least 60% for biofuels and bioliquids produced in installations in which production started on or after 01.01.2017.
- Biofuels and bioliquids *shall not be made* from raw material obtained from land with high biodiversity value, namely land that had one of following statutes in or after January 2008, whether or not the land continues to have that status: primary forest, areas designated for nature protection purposes, and grassland.
- Biofuels and bioliquids *shall not be made* from raw material obtained from:
  - Land with high carbon stock, namely land that had one of the following statutes in January 2008 and no longer has that status: wetlands, continuously forested areas.
  - Land that was peat land in January 2008.

[8] Directive 2009/28/EC on the promotion of the use of energy from renewable sources
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN
[9] Directive 2009/30/EC http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0030&from=EN
[10] Directive (EU) 2015/1513 of the European Parliament and of the Council of 9 September 2015
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2015:239:FULL&from=EN
[11] In Directive 2009/28/EC, "biofuels" means liquid or gaseous fuel for transport produced from biomass.
[12] The same mandatory sustainability criteria (as in the original version of Directive 2009/28/EC) were introduced by Directive 2009/30/EC for liquid biofuels, the use of which can be taken into account for achieving EU's target on GHG emission reduction.
[13] In Directive 2009/28/EC, "bioliquids" means liquid fuel for energy purposes other than for transport, including electricity and heating and cooling, produced from biomass.

- Biofuels and bioliquids produced from waste and residues, other than agricultural and forestry residues, need only fulfil the sustainability criteria as for GHG emission saving.

Economic operators must show Member States that the sustainability criteria have been met in three ways[14]:

а) By providing the relevant national authority with *data*, in compliance with requirements that the Member State has laid down (a 'national system');

б) By using a '*voluntary scheme*' that the Commission has recognised for the purpose;

в) In accordance with the terms of a *bilateral or multilateral agreement* concluded by the Union with third countries and which the Commission has recognised for the purpose.

At present, the use of ***voluntary schemes*** recognized by the European Commission is the most common way of demonstrating compliance with sustainability criteria. For a voluntary scheme to be recognized by the Commission, it must fulfil criteria such as (any changes in the schemes must be notified to the Commission so that to be assessed and the Commission be able to establish whether the schemes still adequately cover the sustainability criteria):

- feedstock producers comply with the sustainability criteria;
- information on the sustainability characteristics can be traced to the origin of the feedstock;
- all information is well documented;
- companies are audited before they start to participate in the scheme and retroactive audits take place regularly;
- the auditors are external and independent;
- the auditors have both the generic and specific auditing skills needed with regards to the scheme's criteria.

The European Commission has recognized **19 voluntary schemes[15],** and recognition can last for a period of five years:

1. ISCC (International Sustainability and Carbon Certification.
2. Bonsucro EU.
3. RTRS EU RED (Round Table on Responsible Soy EU RED).
4. RSB EU RED (Roundtable of Sustainable Biofuels EU RED).
5. 2BSvs (Biomass Biofuels voluntary scheme).
6. RBSA (Abengoa RED Bioenergy Sustainability Assurance).
7. Greenergy (Greenergy Brazilian Bioethanol verification programme).
8. Ensus (voluntary scheme under RED for Ensus bioethanol production).
9. Red Tractor (Red Tractor Farm Assurance Combinable Crops & Sugar Beet Scheme).
10. SQC (Scottish Quality Farm Assured Combinable Crops (SQC) scheme).
11. Red Cert.

[14] Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme (2010/C 160/01) http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52010XC0619(01)&from=EN

[15] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes

12. NTA 8080.
13. RSPO RED (Roundtable on Sustainable Palm Oil RED).
14. Biograce GHG calculation tool.
15. HVO Renewable Diesel Scheme for Verification of Compliance with the RED sustainability criteria for biofuels.
16. Gafta Trade Assurance Scheme.
17. KZR INIG System.
18. Trade Assurance Scheme for Combinable Crops.
19. Universal Feed Assurance Scheme.

Generally speaking, one can say that there are three types of certification schemes[16]:

1. **Round table initiatives** (e.g., Bonsucro EU, RSB EU RED) are coalitions of a big number of companies, nongovernmental organizations, research institutes, international organizations. In a report prepared by Natural Resources Defense Council in 2014, RSB EU RED was defined as the most environmentally friendly scheme[17].
2. **Industrial schemes** (e.g., Greenergy, 2BSvs) focus on feedstock supply chains.
3. **Schemes financed by government** (e.g., ISCC, Biograce). ISCC is an initiative of many stakeholders that is supported mostly by German government through the Agency for Renewable Energy (FNR). ISCC is a well-known and comparatively cheap scheme, that is why it is most often used in the EU for the certification of biofuels.

Main characteristics of voluntary schemes are presented in **Annex 1.** Comparative analysis of the most widely used schemes can be found in «Methodical recommendations for determining sustainability criteria for biomass production»[18] on website of the Ministry of Agrarian Policy and Food of Ukraine. All the voluntary schemes have their own features, advantages and disadvantages, and that is why the choice of an optimal scheme requires an individual approach in every case.

European standard CEN 16214-1:2012: Sustainability criteria for the production of biofuels and bioliquids for energy applications – principles, criteria, indicators and verifiers[19] was adopted in 2012. The Standard consists of four parts: 1 – Terminology, 2 – Conformity assessment including chain of custody and mass balance (the part was updated in 2014[20]), 3 – Biodiversity and

[16] Brian Denvir (E4tech). Sustainability criteria for biofuels. Presentation at the seminar at SAEE on 09.12.2014, Kyiv.
[17] NRDC (Natural Resources Defense Council) Report, July 2014
https://www.nrdc.org/sites/default/files/biofuels-sustainability-certification-report.pdf
[18] http://minagro.gov.ua/node/17694
[19] Standard CEN – EN 16214-1
http://standards.globalspec.com/standards/detail?familyId=ZYGPGDAAAAAAAAAA
[20] Standard CEN/TS 16214-2
http://standards.globalspec.com/standards/detail?familyId=EMSFHFAAAAAAAAAA

environmental aspects related to nature protection purposes, 4 – Calculation methods of the greenhouse gas emission balance using a life cycle analysis approach.

Sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling

While sustainability requirements for transport biofuel and bioliquids are ***mandatory,*** for solid and gaseous biomass sources used for the production of electricity, heating and cooling they are still just ***recommended***.

Following requirements of Directive 2009/28/ЄС[8], the European Commission prepared ***Report on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling***[21] (2010). It is stated in the Report that in Europe, sustainable agricultural production is regulated through the environmental cross-compliance requirements in the Common Agricultural Policy (CAP[22]). Forest management is regulated at national level, with policy guidance through the EU Forestry Strategy[23] and international processes such as the Ministerial Conference for the Protection of Forests in Europe (MCPFE[24]). However, a common sustainability scheme for biomass in needed in order to limit intra-EU cross-border barriers in setting up bioenergy projects.

The Report by the European Commission determines four aspects of sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling:

- ***Sustainability in production (land management, cultivation and harvesting).*** Sustainability related to biomass production concerns inter alia the protection of highly biodiverse ecosystems and of carbon stocks, such as those in forests. In the EU, as most biomass comes from European forest residues and by-products of other industries (processing residues), and as forest management governance structures are strong, the current sustainability risks are considered to be low. However, the expected increase of demand for domestic and non-EU biomass feedstock warrants vigilance in how far and in what way the expected expansion will impact on carbon stocks in forests and agricultural land and soils.
- ***Land use, land use change and forestry (LULUCF) accounting.*** Accounting methods for LULUCF-related carbon emissions need to be improved.

[21] Report on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling COM(2010)11 final, 25.2.2010 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52010DC0011&from=EN
[22] The Common Agriculture Policy http://ec.europa.eu/agriculture/cap-overview/2012_en.pdf
[23] EU Forestry Strategy http://eur-lex.europa.eu/resource.html?uri=cellar:21b27c38-21fb-11e3-8d1c-01aa75ed71a1.0022.01/DOC_1&format=PDF
[24] http://www.foresteurope.org/ministerial_conferences/ministerial_conferences

- ***Life cycle GHG performance.*** Life Cycle Assessment (LCA[25]) is considered to be the appropriate method to evaluate the GHG performance of bio-energy compared to that of fossil alternatives. There is no single LCA methodology. Methodological choices for LCA will have an effect on the measurement of the GHG performance of bio-energy. The LCA methodology for biofuels and bioliquids laid down in the Renewable Energy Directive[8] was based on a careful analysis and has been endorsed by the legislator. For consistency, it would make sense to use the same methodology for all types of bio-energy. To assess the GHG performance of biomass, the LCA methodology should be extended so that conversion of the biomass fuel to electricity, heating or cooling is included in the GHG emissions calculations. That was done in 2014[26].

  Where forest or agricultural residues are used, the greenhouse gas savings of European feedstocks are high, generally **above 80%** savings compared to the fossil alternative. The risk of not achieving high GHG savings is thus lower than the risks identified for biofuels used in transport, because the typical processing steps (e.g. pelletisation) generally consume less energy than the processes required to make transport biofuels.
- ***Energy conversion efficiency***. Reducing energy consumption and increasing the efficiency of energy production are among the main energy goals of the Community. The energy conversion efficiencies of household biomass stoves and boilers vary from around 10-95%. Cogeneration (producing electricity and heat) and district heating plants can achieve between 80-90% efficiency, while large scale power and waste incineration with energy recovery achieve between 10-35% efficiency. There is therefore significant potential for reducing energy consumption through increasing efficiency. Considerations for energy efficiency criteria for bio-energy installations have to take account of the wide range of energy conversion efficiencies which are significantly influenced by size, feedstocks, technology and end-use. For feedstock where different conversion processes are available, it is particularly important to encourage the more efficient conversion processes.

The European Commission is analysing results of consultations that were conducted within the framework of preparation of sustainable bioenergy policy for the period after 2020[27]. During the consultations, target groups, inter alia, were questioned as for ***necessity*** to implement the current sustainability policy for solid/gaseous biomass ***at the European level***. In other words, the question is whether the sustainability criteria should be ***mandatory***.

The Commission recommends that Member States that either have, or who introduce, national sustainability schemes for solid and gaseous biomass used in electricity, heating and cooling, ensure that these in almost all respects are the same as those laid down in the Renewable Energy

[25] ISO/TC 207/SC 5 – Life cycle assessment
http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=54854
[26] Commission staff working document. State of play on the sustainability of solid and gaseous biomass used for electricity, heating and cooling in the EU, Brussels, 28.7.2014
http://ec.europa.eu/energy/sites/ener/files/2014_biomass_state_of_play_.pdf
[27] Preparation of a sustainable bioenergy policy for the period after 2020
https://ec.europa.eu/energy/en/consultations/preparation-sustainable-bioenergy-policy-period-after-2020

Directive. Due to the characteristics of the production and use of solid and gaseous biomass used in electricity, heating and cooling, the following differences are appropriate[21]:

- According to Article 17(1) of the Renewable Energy Directive, wastes and certain residues should only be required to fulfil the requirements of Article 17(2), i.e. the greenhouse gas performance criteria. It is challenging to set greenhouse gas default values for the wide range of possible feedstocks such as wastes, or common default values to cover a range of similar feedstocks or a mixture of feedstocks. It is also difficult to justify imposing obligations and additional costs for proving compliance with greenhouse gas performance criteria, for sectors which routinely achieve high greenhouse gas savings such as by using wastes. It is recommended that the greenhouse gas performance criterion is not applied to wastes, but to the products for which default greenhouse gas emission values have been calculated as listed in **Annex 2**.
- The methodology for the calculation of greenhouse gas emissions should be extended, resulting in the methodological rules described in Annex I of the Report[21] and the Accompanying document[28]. The recommended methodology in Annex I would require that the default value is divided by the actual energy conversion efficiency value of the electricity or heating/cooling installation to obtain a value for total greenhouse gas emissions.

  Typical values for GHG emission reduction while using solid and gaseous biopmass are presented in **Annex 3**. Given the above analysis, it is considered to be good practice for existing bioenergy installations to achieve GHG savings of at least **70%** compared to the fossil fuels comparators. This equates to lifecycle emissions of less than or equal to 86 kg CO_2 equivalent per MWh of biomass heat generated, to 201 kg CO_2 equivalent per MWh of biomass electricity, and 78 kg CO_2 equivalent per MWh of biomethane injected into the grid.
- To stimulate higher energy conversion efficiency, Member States should in their support schemes for electricity, heating and cooling installations differentiate in favour of installations that achieve high energy conversion efficiencies, such as high efficiency cogeneration plants as defined under the Cogeneration Directive[29].

The biomass sector is fragmented and there are numerous small-scale users of biomass. It is recommended that sustainability schemes apply only to larger energy producers of **1 MW** thermal or **1 MW** electrical capacity **or above**. Placing requirements on small-scale producers to prove sustainability would create undue administrative burden, although higher performance and efficiency should be encouraged.

[28] Commission Staff Working Document. Impact Assessment. Accompanying document to the Report from the Commission to the Council and the European Parliament on Sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling. SEC (2010) 65 final 25.2.2010 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52010SC0065&from=EN

[29] Directive 2004/08/EC http://www.seai.ie/Renewables/Renewable_Energy_Policy/EC_Directives/9_CHP_Directive.pdf

National and European statistics have large knowledge gaps concerning the amount of biomass used for energy purposes. In order to improve data on biomass use, it is recommended that Member States keep records of the origin of primary biomass used in electricity, heating and cooling installations of 1 MW or above, helping to improve statistics on biomass use and to monitor the effects of biomass use on the areas of origin. Member States are also encouraged to monitor small-scale (mainly household) biomass use through surveys and strive to improve the availability and quality of data.

While about half of the Member States have adopted regulations promoting higher efficiency of bioenergy production (i.e. efficient CHP), only few Member States (Belgium, Italy, UK) have adopted greenhouse gas (GHG) saving criteria for biomass used in electricity/heating, which appear broadly in line the Commission recommendations (**Table 1**). Other Member States (Belgium, Hungary, and UK) have introduced specific sustainable forest management (SFM) criteria for forest biomass and land criteria for agricultural biomass (UK).

Table 1. Selected national sustainability criteria for biomass used in heat and electricity[26].

Country	Status	Energy specific sustainability criteria
Belgium	Adopted in 2007	Financial incentives linked to GHG savings, SFM requirements for forest biomass
Hungary	Adopted in 2010	SFM requirements for forest biomass
Italy	Adopted in 2012	Minimum GHG saving threshold for forest biomass
UK	Adopted in 2013	Minimum GHG saving threshold for solid and gaseous biomass (minimum 60% for power production[30]), land use criteria for agricultural biomass (restricted use of biomass originating from lands with high biodiversity and high carbon stock[30]), timber standard for wood fuel for heat and electricity
The Netherlands	Adopted in 2015[31]	GHG saving performance, forest carbon stock and ILUC impacts

A number of countries have introduced regulations aimed at addressing potential competition with existing biomass uses. In Belgium, for example, woody feedstocks suitable for the wood-processing industry are not eligible for the Flemish Green Power Certificates. Moreover, Poland has adopted a policy increasingly excluding the use of stem wood (with a diameter above a certain size) from being eligible for national financial incentives for renewables.

[30] E. Otazu, B. de Ulibarri. European solid biomass sustainability scheme approach https://issuu.com/besustainablemagazine/docs/issue_5_high_2705
[31] http://english.rvo.nl/sites/default/files/2015/04/SDE%2B%20sustainability%20requirements%20for%20co-firing%20and%20large%20scale%20heat%20production.pdf

In 2013, seven of major European utilities that use biomass, mostly in the form of wood pellets, in large thermal power plants have funded the Sustainable Biomass Partnership (**SBP**[32]) with the aim to develop sustainability standards & processes. SBP recognises fully the credibility of existing and well proven forest certification schemes, the Forest Stewardship Council (**FSC**[33]) and the Programme for Endorsement of Forest Certification (**PEFC**[34]) schemes, and does not wish to compete with or replicate them. However, there is limited uptake of certification in some key forest source areas and the aforementioned schemes do not yet cover all the key requirements of biomass users. Therefore, SBP is working to develop solutions, short term and long term, to address these issues and is in discussion with both FSC and PEFC to determine how these challenges might be overcome.

By the end of March 2016, 15 SBP certificates had been issued and a further 70 applications for certification received. SBP consists of *six* Framework Standards (feedstock compliance; verification of SBP-compliant feedstock; requirements for certification bodies; chain of custody; collection and communication of data; energy and carbon balance calculation); and each of them includes a number of sustainability principles and criteria.

Example of principles and criteria related to Framework Standard 1: Feedstock compliance[35]*:*

Biomass feedstock is legally sources. There are 6 criteria for checking including the following: The forest owner and manager hold legal use rights to the forest. There is compliance with the requirements of local, national and applicable international laws, and the laws applicable to Forest Management. Harvesting does not violate traditional or civil rights.

Biomass feedstock is sustainably sources. There are 10 criteria for checking including the following: Management of the forest ensures that productivity and ecosystem function is maintained. The basic labour rights of forest workers are safeguarded. Genetically modified trees are not used.

At EU level, the EU Timber Regulation[36], which entered into force in March 2013, addresses the risk that forest biomass (for all uses, not just energy) has been harvested in contravention of the legislation applicable in the country of harvest. This measure prohibits the placing on the EU market of illegally harvested timber or timber products.

[32] Sustainable Biomass Partnership (SBP) http://www.sustainablebiomasspartnership.org/about-us
[33] Forest Stewardship Council (FSC) https://us.fsc.org/en-us/certification/become-certified
[34] Programme for Endorsement of Forest Certification (PEFC) http://www.pefc.org/certification-services/overview
[35] SBP Framework Standard 1: Feedstock Compliance Standard
http://www.sustainablebiomasspartnership.org/docs/2015-03/sbp-standard-1-feedstock-compliance-standard-v1-0.pdf
[36] EU Timber Regulation (No 995/2010 of 20.10.2010) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:295:0023:0034:EN:PDF

In September 2013, the Commission adopted a new EU Forest Strategy[37] with the view to address in a holistic way the overall increasing demands put on forests by many end-uses, including bioenergy. The 2020 objective of this strategy is to ensure and demonstrate by 2020 that all EU forests are managed according to the principle of sustainable forest management.

In Europe, the Common Agriculture Policy (CAP[22]) and applicable environmental legislation are aimed to reduce the environmental impact of agricultural production. The CAP has been recently reformed for the period of 2014-2020 and substantial changes have been introduced concerning environmental protection[38]. For example, 30% of direct payments to farmers will be subject to compliance with a new set of environmental "greening" measures. Furthermore, environmental protection, including climate change aspects and the production of renewable energy has been strengthened in the Rural Development Policy[39]. In each Member State, 30% of rural development funds have to be spent on measures beneficial to the environment or climate change.

EU policy supports the sustainable supply and cascading use of forest and agriculture biomass. The idea of biomass cascading[26] is that the same biomass should be used more than once, starting with material uses (e.g. high-grade wood for the construction sector), followed by the subsequent use of the recovered/recycled material in applications where lower grades are acceptable, such as particle board and other agglomerated materials. While in principle energy conversion would typically be the last step in this broad hierarchy, in reality in several markets energy conversion may result the only economically valuable or available option for the use of biomass resources.

The Global Bioenergy Partnership sustainability indicators

The Global Bioenergy Partnership (GBEP) was launched in 2006. One of its main purposes is to promote sustainable development of bioenergy, especially in developing countries. Today GBEP and its Partners comprise 23 countries (including Argentina, Brazil, Canada, China, United States of America, Germany, Sweden, United Kingdom) and 14 international organizations and institutions (including FAO, IRENA, UNDP, UNIDO). A further 27 countries and 12 International Organizations and institutions are participating as observers.

The GBEP task force on sustainability established in 2008[40]. Task force under the leadership of the United Kingdom and led by Sweden has developed scientifically grounded *set of sustainability indicators* for bioenergy with **24** indicators. These indicators are evenly grouped in three areas:

[37] A new EU Forest Strategy: for forests and the forest-based sector http://eur-lex.europa.eu/resource.html?uri=cellar:21b27c38-21fb-11e3-8d1c-01aa75ed71a1.0022.01/DOC_1&format=PDF
[38] Regulation (EU) No 1305/2013 of 17.12.2013 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:EN:PDF
[39] Rural development 2014-2020 http://ec.europa.eu/agriculture/rural-development-2014-2020/index_en.htm
[40] Global Bioenergy Partnership (GBEP): Task Force on Sustainability http://www.globalbioenergy.org/programmeofwork/task-force-on-sustainability/en/

environmental, social, economic (**Table 2**). For each indicator a description[41] and detailed methodology for its evaluation is provided.

Table 2. GBEP sustainability indicators for bioenergy[42]

PILLARS GBEP's work on sustainability indicators was developed under the following three pillars, noting interlinkages between them:		
Environmental	**Social**	**Economic**
THEMES GBEP considers the following themes relevant, and these guided the development of indicators under this pillar:		
Greenhouse gas emissions, Productive capacity of the land and ecosystems, Air quality, Water availability, use efficiency and quality, Biological diversity, Land-use change, including indirect effects	Price and supply of a national food basket, Access to land, water and other natural resources, Labour conditions, Rural and social development, Access to energy, Human health and safety.	Resource availability and use efficiencies in bioenergy production, conversion, distribution and end-use, Economic development, Economic viability and competitiveness of bioenergy, Access to technology and technological capabilities, Energy security/Diversification of sources and supply, Energy security/Infrastructure and logistics for distribution and use.
INDICATORS		
1. Life-cycle GHG emissions	9. Allocation and tenure of land for new bioenergy production	17. Productivity
2. Soil quality	10. Price and supply of a national food basket	18. Net energy balance
3. Harvest levels of wood resources	11. Change in income	19. Gross value added
4. Emissions of non-GHG air pollutants, including air toxics	12. Jobs in the bioenergy sector	20. Change in consumption of fossil fuels and traditional use of biomass
5. Water use and efficiency	13. Change in unpaid time spent by women and children collecting biomass	21. Training and re-qualification of the workforce
6. Water quality	14. Bioenergy used to expand access to modern energy services	22. Energy diversity
7. Biological diversity in the landscape	15. Change in mortality and burden of disease attributable to indoor smoke	23. Infrastructure and logistics for distribution of bioenergy
8. Land use and land-use change related to bioenergy feedstock production	16. Incidence of occupational injury, illness and fatalities	24. Capacity and flexibility of use of bioenergy

[41] A description of GBEP sustainability indicators are provided in **Annex 4**.
[42] http://www.globalbioenergy.org/fileadmin/templates/gbep/images/Ylenia/Summary_table_website_12-11.pdf

The authors note that the GBEP sustainability indicators do not give answers to all possible questions about sustainability and do not give specific values for the indicators. Instead, the indicators are intended to guide any analysis undertaken of bioenergy at the domestic level with a view to informing decision making and facilitating the sustainable development of bioenergy in a manner consistent with multilateral trade obligations. Each country has to take an individual approach to assessing GBEP sustainability indicators with taking into account their national legal and socio-economic factors. For example, when analysing the implementation of GBEP sustainability indicators in Germany, experts excluded from consideration GBEP indicators with numbers 13-15, 21, 23 (**Table 2**) because they are not relevant to the conditions of the country[43].

The EU policy as for bioenergy sustainability for the period after 2020

In September 2015, the European Commission announced that a ***new directive on renewable energy (REDII)***[44], which will include targets for all EU member countries for the period 2020-2030, will be issued by early 2017. The aim is to reduce greenhouse gas emissions in the EU by 40% compared to 2005 and to achieve a minimum of 27% of renewable energy in the EU energy balance by 2030, and to introduce, among other things, ***"bioenergy sustainability policy"*** [45].

According to the European Commission, the improved policy on biomass will maximize the resource-efficient use of biomass raw material to provide reliable GHG emission reductions, which can be verified, and ensure fair competition between different ways of the use of biomass resources in the construction sector, pulp and paper industry, biochemicals and energy production.

In the frame of the consultations of the European Commission[46], held in February and May 2016, the European Biomass Association (AEBIOM), which unites 29 national associations and 90 companies from all over Europe, prepared its recommendations on policy frameworks for the sustainable bioenergy. These recommendations include six key points[47]:

1) Define sustainability rules based on biomass types and categories but not on the ways of its use. For example, the same woodchips can be used to produce heat, electricity and 2nd generation biofuels.

2) To set GHG emissions reduction at 60% level for the whole bioenergy sector.

In order to provide certainty to investors, the calculation methodologies should be the ones already endorsed by the European Commission and should be set for the period 2020-2030: for liquid biofuels – existing methodology of Directive 2009/28/EC, and for heat, electricity and cold

[43] Implementing the GBEP Indicators for Sustainable Bioenergy in Germany http://www.iinas.org/tl_files/iinas/downloads/bio/IFEU_IINAS_2014_GBEP_Application_indicators_in_Germany.pdf
[44] https://ec.europa.eu/energy/en/consultations/preparation-new-renewable-energy-directive-period-after-2020
[45] http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568329/EPRS_BRI%282015%29568329_EN.pdf
[46] https://ec.europa.eu/energy/en/consultations/preparation-sustainable-bioenergy-policy-period-after-2020
[47] AEBIOM position on "A sustainable bioenergy policy for the period after 2020", http://www.aebiom.org/wp-content/uploads/2016/05/AEBIOM-position-on-a-sustainable-bioenergy-policy-for-the-period-after-2020-10.05.16.pdf

generation from solid/gaseous biofuels – the methodology proposed by the European Commission in 2010[21] and approved in 2014[26].

3) To extend the criteria for sustainable land use for all primary biomass of agricultural origin, irrespective of their final energy use (such criteria is established by the Directive 2009/2008/EC only for agricultural biomass used for the production of liquid biofuels/bioliquids).

4) To take into consideration Risks connected with the use of forest biomass.
To ensure that forest biomass used for energy purposes does not lead to environmental concerns, AEBIOM proposes the European Commission the Risk Based Approach (**RBA**[48]). Such approach is already used in the legislation of such countries as Great Britain, Denmark, Belgium and in the existing voluntary certification schemes (e.g. Sustainable Biomass Partnership, SBP).
The RBA approach takes into consideration risks related to forest resources, carbon in forests and forest ecosystems (biodiversity, soil, water, etc.) not at the planting level but at the macrolevel (national/regional). By using this approach it will be able to create a registry of potential risks, which will also include the results of risks monitoring, description of tools for their reduction and assessment of the effectiveness of the use of these tools.

5) To set the capacity level for bioenergy units that have to prove sustainability criteria. This includes installations that produce heat and/or electricity from solid biofuels. Conducted by AEBIOM studies show that although only 14.8% of all energy units in the EU have > 20 MW capacity, they cover 73.7% of the total consumption of wood chips and 75.8% of the total consumption of pellets. Therefore it is recommended to set the capacity level of **20 MW** (equivalent to about 6 MW_e and 17 MW_{th}), i.e. sustainability criteria only apply to installations ≥20 MW. This does not apply to biogas energy units (for which capacity level should be lower) and liquid biofuels (for which sustainability criteria need to be verified in all cases).

6) To recognize the voluntary certification schemes for solid biomass if they meet the requirements of the EU similarly to the voluntary certification schemes for liquid biofuels. In particular, it is recommended to use the existing VCS Sustainable Forest Management (SFM[49]), such as PEFC/SFI, FSC. For countries in which it is difficult to apply such certification systems because of certain features of the economy of forestry and forest ownership structure, it is proposed to apply the certification schemes based on the risk based approach, such as the SBP system (Sustainable Energy Partnership).

Situation in Ukraine

In Ukraine, the issue of sustainable bioenergy development is still at a relatively early stage of discussion, understanding and implementation. Moreover, the sector of liquid biofuels generally develops very slowly. But the issue of sustainability criteria may become urgent in the case of exports of biofuels or raw materials for their production in the EU and in the further process of

[48] SUSTAINABLE FOREST MANAGEMENT CRITERIA & INDICATORS
http://ec.europa.eu/agriculture/forest/publications/pdf/sfcci-report_en.pdf
[49] Sustainable Forest Management (SFM) http://www.fao.org/forestry/sfm/en/

European integration. In Ukraine, there are even organizations authorized to perform certification of biofuels on voluntary systems, recognized by the European Commission, for checking compliance with European requirements of sustainability.

In 2014 in Ukraine, as a member of the Energy Community, an Action Plan for the implementation of Directive 2009/28/EC was developed and approved. Among others it includes the following items[50]:

- To develop and ensure publication of *calculation procedures* of the *reduction of greenhouse gas emissions* indicators for biofuels and bioliquids on the official websites of the Ministry of Environment, State Environmental Investment Agency of Ukraine and State Agency on Energy Efficiency and Energy Saving of Ukraine.
- To develop *technical requirements* for production and use of biofuels and bioliquids with the reduction of greenhouse gas emissions no less than 50% starting from 01.01.2017 and at least 60% from 01.01.2018 for biofuels and bioliquids produced in installations put into operation after 1 January 2017.
- ***To develop sustainability criteria*** for liquid and gaseous fuels produced from biomass and used for transport, and liquid fuels produced from biomass and aimed for the energy use (excluding transport), including the electricity, heat and cooling production.

At present, there is no information that Ukraine has already developed sustainability criteria for liquid and gaseous fuels and bioliquids, although according to the above mentioned Action Plan this would be done by the end of 2014.

We consider it necessary:

1. Significantly *accelerate* the work on the implementation of all points of the Action Plan for the implementation of Directive 2009/28/EC relating to aspects of sustainability of bioenergy.
2. To develop a *national* biofuels verification system on compliance them with sustainability criteria or *accept (adapted)* one of the existing systems of voluntary certification recognized by the European Commission for its use in Ukraine.
3. To monitor EU policies on sustainable bioenergy development by the competent authorities, to publish information on their official websites and quickly respond by developing appropriate regulations in Ukraine.

Conclusions

The concept of *sustainable development* is originated from the environmental movement of the 1960s that began to pay attention to the link between economic growth and development and environmental degradation. Special attention to the issue of sustainable development in the broadest sense (protection of the environment and human health, replacing fossil fuels with alternative energy sources, access to water, etc.) was paid after the so-called the Earth Summit in 1992 year in Rio de Janeiro, Brazil.

[50] Ordinance of CMU of 03.09.2014 №791-p "On approval of the action plan for the implementation of the European Parliament and Council 2009/28/EC" (in Ukrainian) http://zakon0.rada.gov.ua/laws/show/791-2014-%D1%80

Sustainable development is a development that meets the needs of the present without harmful effect on the ability for the future generations to meet their own needs. It has three components: economic development, social development and environmental protection.

Sustainable bioenergy development is an integral part of the process of the society sustainable development. The European Commission pays great attention to the issue with a focus on sustainable biomass to obtain raw materials for biofuels and energy. Some requirements that are mandatory for the EU Members (the production of liquid biofuels and bioliquids), others still are recommendatory (production of electricity, heat and cold from solid and gaseous biomass). Generally there is a trend of gradual tightening of requirements to fulfil sustainability criteria.

Currently, Directive 2009/28/EC on the promotion of the use of energy from renewable sources and Fuel quality Directive 2009/30/EC provide the frame of sustainability criteria for liquid biofuels and bioliquids at the EU level. Compliance with sustainability requirements can be brought EU countries in several ways. Today, the most common option is the use of voluntary certification systems recognized by the European Commission.

Regarding agricultural biomass, the basic principles of sustainability and reduction of the negative impact on the environment is reflected in the Common agricultural policy of the EU. The European Commission recommends the so called cascade (streaming) principle of the use of wood and agricultural biomass. Now, the issue of mandatory implementation of pan-European sustainability criteria for solid biofuels is under discussion.

In September 2015, the European Commission announced that a new directive on renewable energy will be issued by early 2017, which includes targets for all EU members for the period 2020-2030. The aim is to reduce greenhouse gas emissions in the EU by 40% compared to 2005 and to achieve a minimum of 27% of renewable energy in the EU energy balance by 2030, and to introduce, among other things, “bioenergy sustainability policy”.

In Ukraine, the issue of sustainable bioenergy development is still at a relatively early stage of discussion, understanding and implementation. In 2014 in Ukraine, as a member of the Energy Community, the Action Plan for the implementation of Directive 2009/28/EC was developed and approved. At present, there is no information that Ukraine has already developed sustainability criteria for liquid and gaseous fuels and bioliquids, although according to the above mentioned Action Plan this would be done by the end of 2014.

We consider it necessary to significantly accelerate work on the implementation of all points of the Action Plan for the implementation of Directive 2009/28/EC relating to aspects of sustainability of bioenergy.

Annex 1. Voluntary certification schemes approved by the European Commission

Scope						Demonstrates compliance with Articles:				
Name	**Date Commission Decision**	**Feedstock type**	**Feedstock origin**	**Biofuel production geography**	**Extent of supply chain covered**	**17(2) GHG through**	**17(3) High biodiversity value**	**17(4) High Carbon Stock**	**17(5) Peatlands**	**18(1) mass balance system**
1. **ISCC** (International Sustainability and Carbon Certification) http://www.iscc-system.org/en/	19 July 2011	Wide range of feedstocks	Global	Global	Full supply chain	Default or actual	Yes	Yes	Yes	Yes
2. **Bonsucro EU** http://www.bonsucro.com/	19 July 2011	Sugar cane	Global	Global	Full supply chain	Default or actual	Yes, except 17(3)(c)[5]	Yes	Yes	Yes
3. **RTRS EU RED** (Round Table on Responsible Soy EU RED) http://www.responsiblesoy.org/?lang=en	19 July 2011	Soy	Global	Global	Full supply chain	Default or actual	Yes	Yes	Yes	Yes
4. **RSB EU RED** (Roundtable of Sustainable Biofuels EU RED) http://rsb.org/	19 July 2011	Wide range of feedstocks	Global	Global	Full supply chain	Default or actual	Yes	Yes	Yes	Yes
5. **2BSvs** (Biomass Biofuels voluntary scheme) http://www.2bsvs.org/	19 July 2011	Wide range of feedstocks	Global	Global	Full supply chain	Default or actual	Yes, except 17(3)(c)[5]	Yes	Yes	Yes
6. **RBSA** (Abengoa RED Bioenergy Sustainability Assurance) http://www.abengoabioenergy.com/web/es/rbsa/contact/	19 July 2011	Wide range of feedstocks	Global	Global	Full supply chain	Default or actual	Yes	Yes	Yes	Yes
7. **Greenergy** (Greenergy Brazilian Bioethanol verification programme)	19 July 2011	Sugar cane	Brazil	Brazil	Full supply chain	Default only	Yes, except 17(3)(c)	Yes	Yes	Yes
8. **Ensus (**voluntary scheme under RED for Ensus bioethanol production) http://www.ensus.co.uk/Bioethanol/Ensus_VS/	23 April 2012	Feed wheat	EU	Ensus One plant	From the 1st feedstock delivery point to the Ensus One bioethanol storage	Actual or combination	Yes[1]	Yes	Yes	Yes
9. **Red Tractor** (Red Tractor Farm Assurance Combinable Crops & Sugar Beet Scheme)	16 July 2012	Cereals, oilseeds, sugar beet	UK	n/a	Until the first feedstock delivery point	n/a[2]	Yes	Yes	Yes	Yes
10. **SQC** (Scottish Quality Farm Assured Combinable Crops (SQC) scheme) http://www.sqcrops.co.uk/	9 June 2015	All cereals and oilseeds	North Great Britain	n/a	Until the first feedstock delivery point	n/a[2]	Yes	Yes	Yes	Yes

11. **Red Cert** http://www.redcert.org/index.php?lang=de	23 November 2012	Palm oil	Global	Global	Full supply chain	Default; or actual following recognised tool	Yes	Yes	Yes	Yes
12. **NTA 8080**	24 July 2012	Wide range of feedstocks	Europe	Europe	Full supply chain	Default or actual	Yes	Yes	Yes	Yes
13. **RSPO RED** (Roundtable on Sustainable Palm Oil RED) http://www.rspo.org/	31 July 2012	Wide range of feedstocks	Global	Global	Full supply chain	Default or actual	Yes, except 17(3)(c)	Yes	Yes	Yes
14. **Biograce GHG calculation tool** http://www.biograce.net/	30 May 2013	Wide range of feedstocks	Global	Global	Supply chain not covered	Actual[3]	No	No	No	No
15. **HVO** Renewable Diesel Scheme for Verification of Compliance with the RED sustainability criteria for biofuels	09 January 2014	All feedstocks suitable for HVO-type biodiesel	Global	Global	From the producer of HVO- type renewable diesel	Default or actual	Yes[1]	Yes[1]	Yes[1]	Yes
16. **Gafta Trade Assurance Scheme** http://www.gafta.com/	03 June 2014	Wide range of feedstocks	Global	n/a	Covers chain of custody from farm gate to first processor	n/a[4]	Yes[1]	Yes[1]	Yes[1]	Yes
17. **KZR INIG System** http://www.kzr.inig.eu/	03 June 2014	Wide range of feedstocks	Europe	Europe	Full supply chain	Default or actual	Yes	Yes	Yes	Yes
18. **Trade Assurance Scheme for Combinable Crops** https://www.agindustries.org.uk/home/	17 September 2014	Combinable crops, such as cereals, oilseeds and sugar beet	United Kingdom	n/a	Covers chain of custody from farm gate to first processor	n/a[4]	Yes[1]	Yes[1]	Yes[1]	Yes
19. **Universal Feed Assurance Scheme** https://www.agindustries.org.uk/home/	17 September 2014	Feed ingredients and compound feeds as well as combinable crops	United Kingdom	n/a	Covers chain of custody from farm gate to first processor	n/a[4]	Yes[1]	Yes[1]	Yes[1]	Yes

1) The scheme relies for this on other recognised schemes.
2) Only recognised for accurate data that land use change emissions (e_i) referred to in point 1 of part C of Annex V are equal to zero, and on the appropriate geographic area referred to in point 6 of part C of Annex V (NUTS-2 region).
3) The scheme is a non-typical voluntary scheme that covers only assessment of greenhouse gas savings. Voluntary schemes using the tool need to ensure that it is applied appropriately and that adequate standards of reliability, transparency and independent auditing are met.
4) The scheme ensures that all relevant information on GHG emissions is transferred from economic operators upstream the chain of custody to the economic operators downstream the chain of custody.
5) The scheme is not formally recognised by the Commission for demonstrating compliance with Article 17(3)(c) but has taken measures

Source: https://ec.europa.eu/energy/sites/ener/files/documents/voluntary%20schemes%20overview%20table%20to%20publish.pdf

Annex 2. Typical and default values for solid and gaseous biomass if produced with no net carbon emission from land use change

Primary solid and gaseous biomass pathways	Typical greenhouse gas emissions (gCO_{2eq}/MJ)	Default greenhouse gas emissions (gCO_{2eq}/MJ)
Wood chips from forest residues (European temperate continental forest)	1	1
Wood chips from forest residues (tropical and subtropical forest)	21	25
Wood chips from short rotation forestry (European temperate continental forest)	3	4
Wood chips short rotation forestry (tropical and subtropical e.g. eucalyptus)	24	28
Wood briquettes or pellets from forest residues (European temperate continental forest) - using wood as process fuel	2	2
Wood briquettes or pellets from forest residues (tropical or subtropical forest) - using natural gas as process fuel	17	20
Wood briquettes or pellets from forest residues (tropical or subtropical forest) - using wood as process fuel	15	17
Wood briquettes or pellets from forest residues (European temperate continental forest) - using natural gas as process fuel	30	35
Wood briquettes or pellets from short rotation forestry (European temperate continental forest) - using wood as process fuel	4	4
Wood briquettes or pellets from short rotation forestry (European temperate continental forest) - using natural gas as process fuel	19	22
Wood briquettes or pellets from short rotation forestry (tropical and sub-tropical e.g. eucalyptus) - wood as process fuel	18	22
Wood briquettes or pellets from short rotation forestry (tropical and sub-tropical e.g. eucalyptus) - natural gas as process fuel	33	40
Charcoal from forest residues (European temperate continental forest)	34	41
Charcoal from forest residues (tropical and sub-tropical forest)	41	50

Charcoal from short rotation forestry (European temperate continental forest)	38	46
Charcoal from short rotation forestry (tropical and subtropical e.g. eucalyptus)	47	57
Wheat straw	2	2
Bagasse briquettes - wood as process fuel	14	17
Bagasse briquettes - natural gas as process fuel	29	35
Bagasse bales	17	20
Palm kernel	22	27
Rice husk briquettes	24	28
Miscanthus bales	6	7
Biogas from wet manure	7	8
Biogas from dry manure	6	7
Biogas from wheat and straw (wheat whole plant)	18	21
Biogas from maize as whole plant (maize as main crop)	28	34
Biogas from maize as whole plant (maize as main crop) - organic agriculture	16	19

Source: Annex II of Report from the Commission to the Council and European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling[21].

Annex 3. Default GHG saving performance of solid and gaseous biomass

In **Fig. A3.1,** the default values of GHG emission reductions when using solid biomass for heat and electricity production are shown. The reduction of the electricity production is **10-88%** and heat energy production – **39-92%** (depending on the type of biomass and transportation distance).

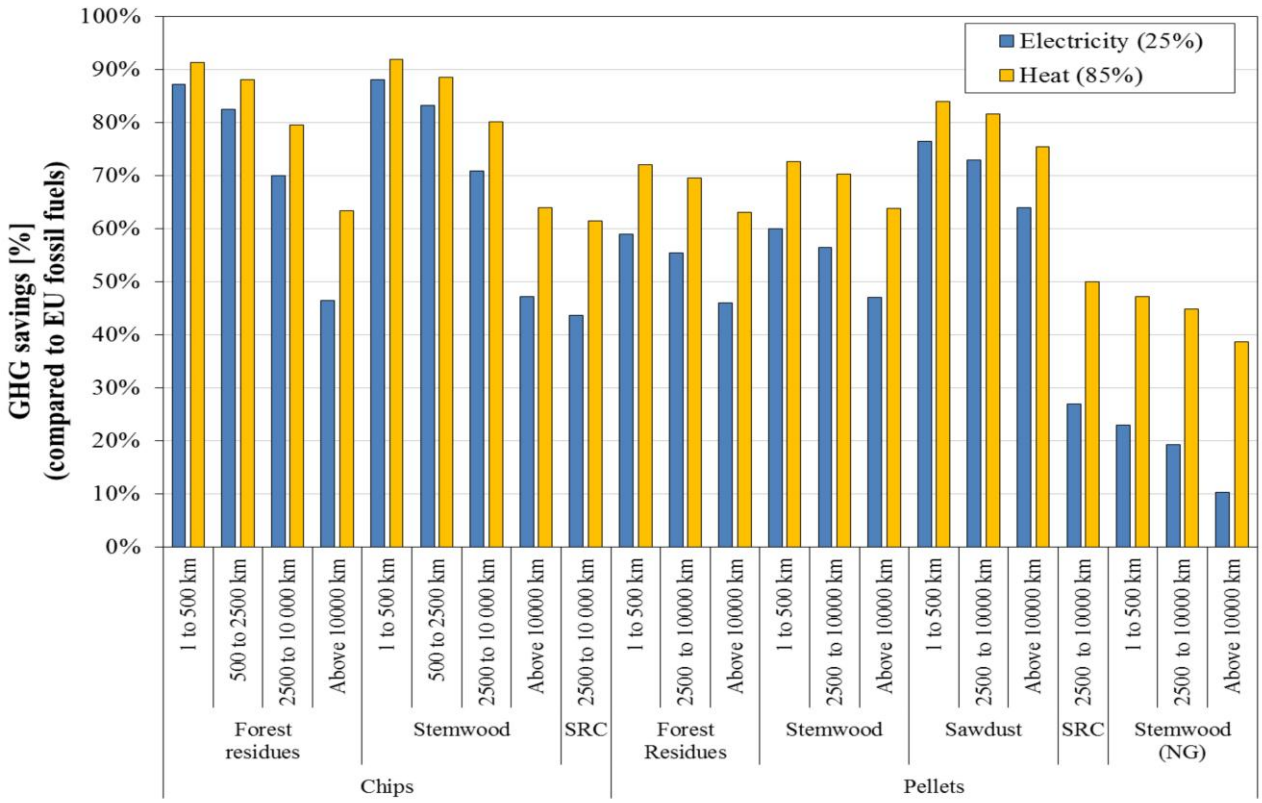

Figure A3.1. Default GHG saving performance of solid biomass[26]:

Notes:

- Default GHG values are obtained applying a standard electrical efficiency of 25% and a standard thermal efficiency of 85%.
- SRC = Short Rotation Coppice. The calculations are based on GHG data from eucalyptus cultivation in tropical areas.
- Stem wood (NG) = pellets produced using natural gas as process fuel, all the other pathways are based on wood as process fuel.
- Distances refer to the following regions: 1-500 km = intra-EU trade, 500-2500 km = imports from Russia and Baltic countries, 2500-10000 km = imports from South East USA and South America, >10000 km = imports from Western Canada.

In **Fig. A3.2,** the default values of GHG emission reductions when using biogas and biomethane are shown. This reduction has a very large range depending on the type of biomass and features of biomass technologies. Calculations are performed by the Joint Research Centre (JRS).

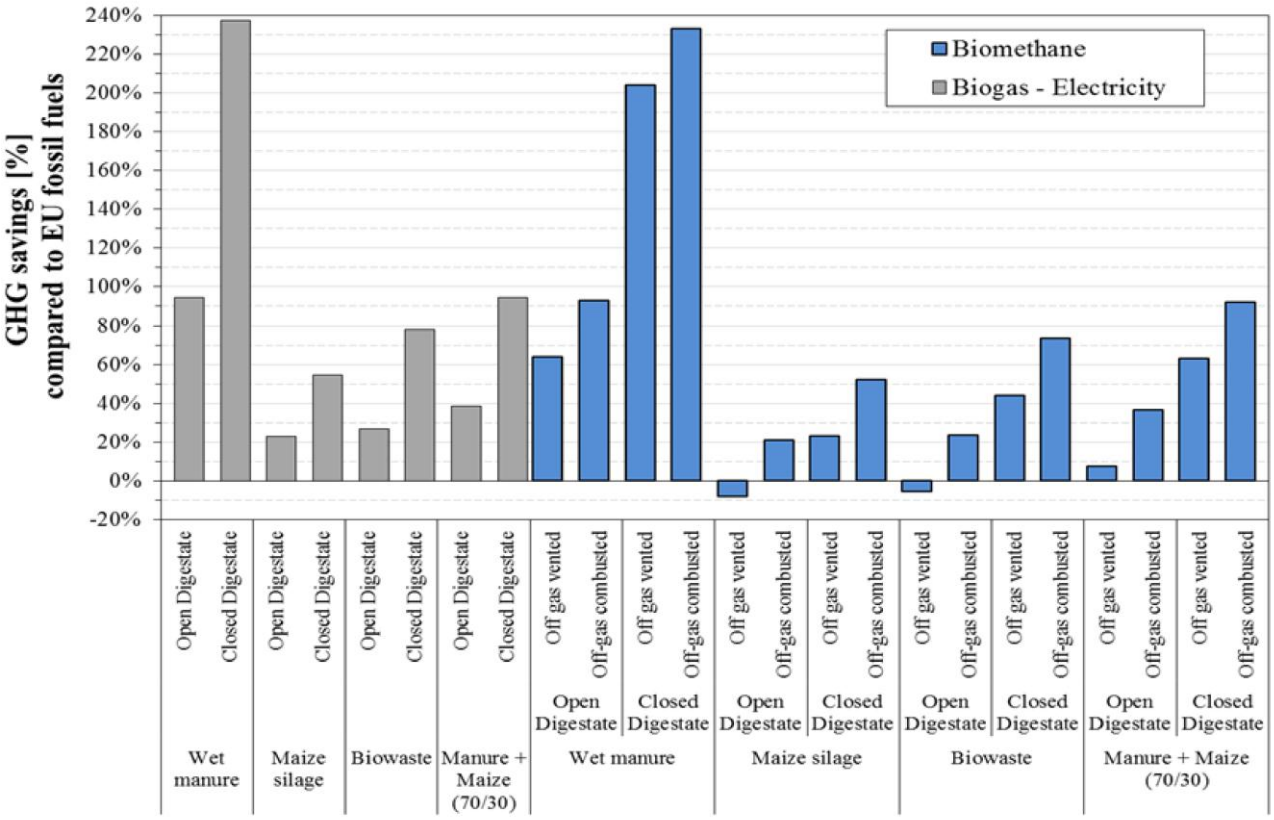

Figure A3.2. Default greenhouse gas saving performance of biogas and biomethane in EU in comparison with fossil fuels[26]

Annex 4. Description of the Global Bioenergy Partnership Sustainability Indicators

ENVIRONMENTAL PILLAR	
THEMES GBEP considers the following themes relevant, and these guided the development of indicators under this pillar: Greenhouse gas emissions, Productive capacity of the land and ecosystems, Air quality, Water availability, use efficiency and quality, Biological diversity, Land-use change, including indirect effects[51]	
INDICATOR NAME	**INDICATOR DESCRIPTION**
1. Lifecycle GHG emissions	Lifecycle greenhouse gas emissions from bioenergy production and use, as per the methodology chosen nationally or at community level, and reported using the GBEP Common Methodological Framework for GHG Lifecycle Analysis of Bioenergy 'Version One'
2. Soil quality	Percentage of land for which soil quality, in particular in terms of soil organic carbon, is maintained or improved out of total land on which bioenergy feedstock is cultivated or harvested
3. Harvest levels of wood resources	Annual harvest of wood resources by volume and as a percentage of net growth or sustained yield, and the percentage of the annual harvest used for bioenergy
4. Emissions of non-GHG air pollutants, including air toxics	Emissions of non-GHG air pollutants, including air toxics, from bioenergy feedstock production, processing, transport of feedstocks, intermediate products and end products, and use; and in comparison with other energy sources
5. Water use and efficiency	Water withdrawn from nationally determined watershed(s) for the production and processing of bioenergy feedstocks, expressed as the percentage of total actual renewable water resources (TARWR) and as the percentage of total annual water withdrawals (TAWW), disaggregated into renewable and non-renewable water sources Volume of water withdrawn from nationally determined watershed(s) used for the production and processing of bioenergy feedstocks per unit of bioenergy output, disaggregated into renewable and non-renewable water sources
6. Water quality	Pollutant loadings to waterways and bodies of water attributable to fertilizer and pesticide application for bioenergy feedstock cultivation, and expressed as a percentage of pollutant loadings from total agricultural production in the watershed Pollutant loadings to waterways and bodies of water attributable to

[51] In light of discussions on the issue and considering the state of the science on quantifying possible indirect land-use change (ILUC) impacts of bioenergy, it has not yet been possible to include an indicator on ILUC. GBEP notes that further work is required to improve our understanding of and ability to measure indirect effects of bioenergy such as ILUC and indirect impacts on prices of agricultural commodities. GBEP will continue to work in order to consolidate and discuss the implications of the current science on these indirect effects, develop a transparent, science-based framework for their measurement, and identify and discuss options for policy responses to mitigate potential negative and promote potential positive indirect effects of bioenergy.

	bioenergy processing effluents, and expressed as a percentage of pollutant loadings from total agricultural processing effluents in the watershed
7. Biological diversity in the landscape	Area and percentage of nationally recognized areas of high biodiversity value or critical ecosystems converted to bioenergy production Area and percentage of the land used for bioenergy production where nationally recognized invasive species, by risk category, are cultivated Area and percentage of the land used for bioenergy production where nationally recognized conservation methods are used
8. Land use and land-use change related to bioenergy feedstock production	Total area of land for bioenergy feedstock production, and as compared to total national surface and agricultural and managed forest land area Percentages of bioenergy from yield increases, residues, wastes and degraded or contaminated land. Net annual rates of conversion between land-use types caused directly by bioenergy feedstock production, including the following (amongst others): - arable land and permanent crops, permanent meadows and pastures, and managed forests; - natural forests and grasslands (including savannah, excluding natural permanent meadows and pastures), peatlands, and wetlands.

SOCIAL PILLAR	
THEMES GBEP considers the following themes relevant, and these guided the development of indicators under this pillar: Price and supply of a national food basket, Access to land, water and other natural resources, Labour conditions, Rural and social development, Access to energy, Human health and safety	
INDICATOR NAME	**INDICATOR DESCRIPTION**
9. Allocation and tenure of land for new bioenergy production	Percentage of land - total and by land-use type - used for new bioenergy production where: ▪ a legal instrument or domestic authority establishes title and procedures for change of title; and ▪ the current domestic legal system and/or socially accepted practices provide due process and the established procedures are followed for determining legal title
10. Price and supply of a national food basket	Effects of bioenergy use and domestic production on the price and supply of a food basket, which is a nationally defined collection of representative foodstuffs, including main staple crops, measured at the national, regional, and/or household level, taking into consideration: ▪ changes in demand for foodstuffs for food, feed and fibre; ▪ changes in the import and export of foodstuffs; ▪ changes in agricultural production due to weather conditions;

	▪ changes in agricultural costs from petroleum and other energy prices; and ▪ the impact of price volatility and price inflation of foodstuffs on the national, regional, and/or household welfare level, as nationally determined
11. Change in income	Contribution of the following to change in income due to bioenergy production: ▪ wages paid for employment in the bioenergy sector in relation to comparable sectors ▪ net income from the sale, barter and/or own consumption of bioenergy products, including feedstocks, by self-employed households/individuals
12. Jobs in the bioenergy sector	Net job creation as a result of bioenergy production and use, total and disaggregated (if possible) as follows: - skilled/unskilled - temporary/indefinite Total number of jobs in the bioenergy sector and percentage adhering to nationally recognized labour standards consistent with the principles enumerated in the ILO Declaration on Fundamental Principles and Rights at Work, in relation to comparable sectors
13. Change in unpaid time spent by women and children collecting biomass	Change in average unpaid time spent by women and children collecting biomass as a result of switching from traditional use of biomass to modern bioenergy services
14. Bioenergy used to expand access to modern energy services	Total amount and percentage of increased access to modern energy services gained through modern bioenergy (disaggregated by bioenergy type), measured in terms of energy and numbers of households and businesses Total number and percentage of households and businesses using bioenergy, disaggregated into modern bioenergy and traditional use of biomass
15. Change in mortality and burden of disease attributable to indoor smoke	Change in mortality and burden of disease attributable to indoor smoke from solid fuel use, and changes in these as a result of the increased deployment of modern bioenergy services, including improved biomass-based cook stoves
Incidence of occupational injury, illness and fatalities	Incidences of occupational injury, illness and fatalities in the production of bioenergy in relation to comparable sectors

ECONOMIC PILLAR
THEMES GBEP considers the following themes relevant, and these guided the development of indicators under this pillar: Resource availability and use efficiencies in bioenergy production, conversion, distribution and

end-use, Economic development, Economic viability and competitiveness of bioenergy, Access to technology and technological capabilities, Energy security/Diversification of sources and supply, Energy security/Infrastructure and logistics for distribution and use	
INDICATOR NAME	**INDICATOR DESCRIPTION**
17. Productivity	Productivity of bioenergy feedstocks by feedstock or by farm/plantation Processing efficiencies by technology and feedstock Amount of bioenergy end product by mass, volume or energy content per hectare per year Production cost per unit of bioenergy
18. Net energy balance	Energy ratio of the bioenergy value chain with comparison with other energy sources, including energy ratios of feedstock production, processing of feedstock into bioenergy, bioenergy use; and/or lifecycle analysis
19. Gross value added	Gross value added per unit of bioenergy produced and as a percentage of gross domestic product
20. Change in the consumption of fossil fuels and traditional use of biomass	▪ Substitution of fossil fuels with domestic bioenergy measured by energy content and in annual savings of convertible currency from reduced purchases of fossil fuels ▪ Substitution of traditional use of biomass with modern domestic bioenergy measured by energy content
21. Training and re-qualification of the workforce	Percentage of trained workers in the bioenergy sector out of total bioenergy workforce, and percentage of re-qualified workers out of the total number of jobs lost in the bioenergy sector
22. Energy diversity	Change in diversity of total primary energy supply due to bioenergy
23. Infrastructure and logistics for distribution of bioenergy	Number and capacity of routes for critical distribution systems, along with an assessment of the proportion of the bioenergy associated with each
24. Capacity and flexibility of use of bioenergy	▪ Ratio of capacity for using bioenergy compared with actual use for each significant utilization route ▪ Ratio of flexible capacity which can use either bioenergy or other fuel sources to total capacity

Source: The Global Bioenergy Partnership Sustainability Indicators for Bioenergy, 2011
http://www.globalbioenergy.org/fileadmin/user_upload/gbep/docs/Indicators/The_GBEP_Sustainability_Indicators_for_Bioenergy_FINAL.pdf

Abbreviations

CAP – Common Agricultural Policy
CHP – combined heat and power
GHG – greenhouse gas
ILUC – indirect land use change
RED – Renewable Energy Directive
SFM – sustainable forest management

Previous publications by UABio

http://www.uabio.org/activity/uabio-analytics

1. *Position Paper N 1* (2012) "Position of bioenergy in the draft updated energy strategy of Ukraine till 2030".
2. *Position Paper N 2* (2013) "Analysis of the Law of Ukraine "On amending the Law of Ukraine «On Electricity" No5485-VI of 20.11.2012".
3. *Position Paper N 3* (2013) "Barriers to the development of bioenergy in Ukraine".
4. *Position Paper N 4* (2013) "Prospects of biogas production and use in Ukraine".
5. *Position Paper N 5* (2013) "Prospects for the electricity generation from biomass in Ukraine"
6. *Position Paper N 6* (2013) "Prospects for heat production from biomass in Ukraine"
7. *Position Paper N 7* (2014) "Prospects for the use of agricultural residues for energy production in Ukraine".
8. *Position Paper N 8* (2014) "Energy and environmental analysis of bioenergy technologies"
9. *Position paper N 9* (2014) "State of the art and prospects for bioenergy development in Ukraine"
10. *Position paper N 10* (2014) "Prospects for the growing and use of energy crops in Ukraine"
11. *Position paper N 11* (2014) "Prospects of biomethane production and use in Ukraine"
12. *Position paper N 12* (2015) "Prospects for the development of bioenergy as an instrument for natural gas replacement in Ukraine"
13. *Position paper N 13* (2015) "Analysis of energy strategies of the EU and world countries and the role of renewables in their energy systems".
14. *Position paper N 14* (2016) "Analysis of tariff setting in the district heating sector of EU countries".
15. *Position paper N 15* (2016) "Analysis of additional sources of wood fuel in Ukraine".
16. *Position paper N 16* (2016) "Opportunities for harvesting by-products of grain corn for energy production in Ukraine".

Civic union "Bioenergy Association of Ukraine" (UABio) was established to create a common platform for cooperation on bioenergy market in Ukraine, as well as to provide the most favorable business environment, accelerated and sustainable development of bioenergy. General constituent assembly of UABio was held on September, 25, 2012 in Kyiv. The Association was officially registered on 8 April 2013. Among UABio members there are over 10 leading companies and over 20 recognized experts working in the field of bioenergy.
http://uabio.org

Bioenergy Association of Ukraine