APPROACHES TO
THE SUSTAINABILITY OF ALTERNATIVE FUELS IN AVIATION

Disclaimer

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Preamble

This publication compiles information on existing tools to address the sustainability of aviation biofuels. It builds upon various ICAO workshops and the work of the Sustainable Alternative Fuels (SUSTAF) experts group, established in June 2012 to develop recommendations relating to on-going challenges to the development and deployment of sustainable fuels for aviation. This publication has benefited from the exchange of expertise and knowledge within these fora, amongst experts and stakeholders, and in particular through cooperation with UNEP and FAO.

While the main approaches to sustainability in the context of alternative fuels are presented, the analysis of these approaches is not intended to be exhaustive and the inclusion of a specific initiative does not imply its endorsement by ICAO.

The intent is to provide an overview of the elements to take into account when assessing and ensuring sustainability of alternative fuels production and use. The document highlights key elements of the mentioned approaches and standards. For the exact definition of the principles, criterion, indicators and associated guidelines, the reader is invited to consult the official documentation provided by the relevant organizations.

This report is intended to be a living document to be updated with the progress and evolution achieved in the field. Suggestions and contributions to improve it are welcome.

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1 INTRODUCTION

Sustainable alternative fuels have been endorsed as a promising means of reducing aviation greenhouse gas (GHG) emissions and, together with efficiency improvements and market-based measures, they are a key part of the basket of measures under consideration by ICAO Member States to achieve the aspirational goal of stabilizing emissions from international aviation at their 2020 levels.

Along with the motivation to reduce GHG emissions, the aviation community has also demonstrated a strong commitment to the sustainability of the deployment of alternative fuels, in accordance with the environmental, social and economic dimensions of sustainability.

In October 2013, during the 38th Session of the ICAO Assembly, ICAO Member States adopted Resolution A38-18, which requests States to adopt measures to ensure the sustainability of alternative fuels for aviation, building on existing approaches or combination of approaches proposed in the general context of bioenergy and transportation fuels. The Assembly also reaffirmed the role of ICAO in supporting Member States' efforts and facilitating the exchange of information and best practices among States on research, development, demonstration and deployment of sustainable alternative fuels.

Building upon this Resolution, this document aims to provide States and various stakeholders that wish to develop aviation alternative fuels with an introduction to sustainability issues related to such fuels. It does not aim to propose new concepts or introduce new approaches or sustainability standards. Based on recent developments, the purpose of this document is to provide an overview of the components of sustainability and to present the tools available to assess and/or ensure the sustainability of projects, development plans or policies.

After a brief introduction of the concept of sustainability (Chapter 2), the document:

- summarizes the existing approaches to addressing the sustainability of alternative fuels (Chapter 3);
- provides an overview of the different impacts that can be considered in a sustainability assessment (Chapter 4);
- addresses the additional issue of indirect impacts, for which supplementary measures may be required and for which methodological approaches are currently less advanced and call for additional research (Chapter 5).

2 THE CONCEPT OF SUSTAINABILITY

In the context of alternative fuels, sustainability refers to the concept of "sustainable development" for which the United Nations Brundtland Commission provided the following definition in 1987: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"[2].

Although the common definition of sustainability relates largely to the preservation of environmental and natural resources[1], the 2005 World Summit on Social Development agreed on "the three components of sustainable development – economic development, social development and environmental protection – as interdependent and mutually reinforcing pillars" [3], thus introducing the concept of the three pillars of sustainability, which are widely accepted today.

Beyond these concepts, it is difficult to offer a single, commonly shared definition of sustainability. However, in the context of the three pillars of sustainability as applied to alternative fuels, sustainability can be understood as the preservation of a long-term continued production capacity of natural resources, in an economically feasible and socially and environmentally acceptable way.

Rather than being defined, sustainability is generally assessed against principles, criteria and indicators. While initiatives exist to make progress towards converging views[2], there are currently no globally recognized principles or criteria. Sustainability entails some judgement value, evaluated against a selected or user-defined reference. Transparency and multi-stakeholder processes are thus critical for the definition for such a reference.

3 EXISTING APPROACHES TO SUSTAINABILITY

From a general point of view, addressing the sustainability of the production of alternative fuels requires the definition of:

- the impacts and consequences of alternative fuel production that need to be considered for the assessment of sustainability (for example the consequences on the use of water);
- a reference for what is, or is not acceptable for these impacts through a set of principles (e.g. "preservation of water availability and quality") which are further detailed in a set of acceptance criteria (for example "biofuel production should not contribute to the depletion of water resources");
- the indicators and associated thresholds to measure whether a principle or criteria is met (in the example of water depletion, an indicator can be the volume of water drawn from a specific watershed), or other proofs of compliance or implementation of mitigation measures, when no quantitative indicator may be associated with the requirements.

Taken together, the above elements form a "sustainability standard".

However, depending on the context and the purpose, different approaches can be deployed to promote and ensure the sustainable development of alternative fuels.

One approach is the voluntary acceptance of a sustainability standard by fuel producers. This acceptance is often accompanied by voluntary certification by a third party that assesses and guarantees

[1] The Oxford Dictionary defines sustainability as "conserving an ecological balance by avoiding depletion of natural resources".

[2] The Global Bioenergy Partnership (GBEP) should be mentioned as a unique initiative that aimed at building consensus among a wide range of governments (23 partners and 26 observers) and international organisations (14 partners and 11 observers) on the sustainability of bioenergy. It developed a set of themes and indicators regarding the sustainability of bioenergy in all its forms (see chapter 3.2).

compliance with the standard. Many standards have developed "certification schemes" for this purpose (the ensemble consisting of a standard and a certification scheme is henceforth referred to as "voluntary standard and certification scheme").

Another approach, which is more relevant from an aggregate or regional perspective, is the measurement of indicators to assess the consequences of the development of an alternative fuels industry.

A final approach is the implementation of sustainability requirements through regulations at the national level.

These different approaches are detailed in the following Chapters.

3.1 Project-scale approach: voluntary sustainability standards and certification schemes

3.1.1 Overview

The purpose of voluntary sustainability standards and certification schemes that have developed in recent years is the assurance of sustainability of operations at the level of individual production value-chains. They propose a complete set of principles and criteria with the associated required evidence of compliance, against which operators can be certified.

Such standards and certification schemes have been designed to verify and further certify the sustainability of a given value-chain in a voluntary setting. The motivation of the producers (farmer, processor, blender, supplier) which seek recognition of their practices through certification, was originally to obtain competitive advantage among customers or the public that were sensitive to sustainability issues. Additional potential advantages are improvements in efficiency and a proactive attitude toward the evolution of regulatory requirements. In particular, with the development of regulations in some regions of the world, certification can be used to prove compliance with legislation, and thus, can guarantee access to certain markets[3].

Voluntary standards have generally emerged from the agreement of economic sectors to improve their specific practices by the voluntary adoption of defined production standards and accompanying certification. As a consequence, considered impacts, principles, criteria and indicators may vary widely among these different standards in association with the particular aspects taken into account by the various initiative. As no harmonised standard exists, assessing sustainability first mean to choose a referential.

The following are examples of voluntary standard and certification schemes developed for specific feedstock that can potentially be used for biofuel production:

[3] In particular, the European Union has enforced mandatory sustainability requirements on bioenergy, the compliance with which can be demonstrated through voluntary certification schemes (see Chapter 3.3.)

- Bonsucro, established in early 2009 for sugar cane cultivation by the Bonsucro association (formerly known as “Better Sugar Initiative”), gathers sugar retailers, investors, traders and producers, as well as non-governmental organisations (www.bonsucro.com);
- The RTRS standard, was established in 2010 by the Round Table on Responsible Soy Association, an international multi-stakeholder initiative created in 2006 to promote sustainable soy production, processing, trade and use (www.responsiblesoy.org); and
- RSPO, a standard and certification system established by the Round Table on Sustainable Palm-Oil, a non-profit organisation created in 2004, aiming at developing and implementing global standards for sustainable palm oil (www.rspo.org).

Other systems have been developed more generally for biomass and bioenergy production:

- the International Sustainability & Carbon Certification (ISCC) standard was developed through a project started in 2008[4] by the German association ISCC with the objective to develop “an internationally oriented, practical and transparent system for the certification of biomass and bioenergy” (http://www.iscc-system.org);
- NTA 8080 Sustainable Biomass Certification (Netherlands Technical Agreement), is a certification scheme for biomass for energy purposes. It was developed by a diverse group of stakeholders, based on European sustainability criteria and on the work of the Dutch project group “Sustainable production of biomass” established in 2006, also known as the Cramer criteria (www.sustainable-biomass.org); and
- the Round Table on Sustainable Biomaterials (RSB) which was originally developed for biofuels[5], is an international multi-stakeholder initiative established in 2006 by Ecole Polytechnique Fédérale de Lausanne to achieve global consensus around a set of principles and criteria for sustainable biofuels (www.rsb.org).

Beyond these examples, a significant number of standards exist today. The Bioenergy and Food Security (BEFS) project of FAO has compiled 23 existing voluntary certification schemes related to biofuels production, the description of which is available on the BEFS website [4]. Publications from the NL Agency [5] and the Joint Research Centre [6] also provide information on additional certification schemes.

Some certification schemes have adopted a “meta-standard” approach (see box p.11) which allows for the recognition of other systems for the certification of a part of the value-chain if these certification systems comply with their own requirements. Within ISCC or RSB for example, crops can be certified under a third applicable qualifying standard rather than the main standard.

The International Standard Organisation (ISO) has also formed a task force for the definition of a sustainability standard for bioenergy, ISO 13065 “Sustainability Criteria for bioenergy”. This work is to be based on the international work already carried out, in Europe (CEN - European Committee for Standardization[6]), the RSB, the International Biofuels Forum and the Tripartite task force (Brazil, EU,

[4] The project was funded by the German Federal Ministry of Food, Agriculture and Consumer Protection.
[5] RSB was formerly “Round-table on Sustainable Biofuels”
[6] CEN is developing a standard to assist E.U. members States, operators and verifiers to work in a standardized way to comply with E.U. Renewable Energy Directive (RED). This is a standard only, not a voluntary scheme, and it does not demonstrate

USA), among others, in order to obtain a standard that could be globally applicable. It will include principles, criteria and indicators relevant to all economic operators and applicable to all forms of bioenergy. Compared to existing standards, ISO will differ in that it will define criteria and methodologies, but not set thresholds values or limits [7]. Hence, compliance with the standard will not imply sustainability, but rather will provide elements that inform the judgement of external evaluators. Operators applying for certification will provide a response to indicators, resulting in a scorecard on the basis of which customers, end-users or policy-maker can decide whether a sufficient level of sustainability is achieved according to their own threshold values. The standard is expected to be

The Meta-Standard approach

European Governments, along with NGOs, have studied the development of an international harmonised scheme to assure the sustainability of biomass production for bioenergy use. This approach has been referred to as the Meta-Standard approach [8].

The concept of the Meta-Standard is to build on existing standards for sustainable production of biomass. The Meta-Standard defines principles and criteria for the sustainability of biomass production but, instead of requiring producers to be certified to the Meta-Standard directly, compliance can be demonstrated through certification to existing standards which have been recognized to match the Meta-Standard's requirements.

A qualifying standard must meet two requirements:

- The standard must prove that it meets the sustainability requirements of the Meta-standard;
- The standard must have procedures in place to demonstrate that the quality of the auditing and certification process is sufficient to ensure that the criteria of the Meta-Standard are met.

The Meta-Standard concept requires the definition of procedures and norms for benchmarking the sustainability criteria of existing standards against its own criteria. This norm defines whether all Meta-Standard sustainability criteria must be met from the beginning or whether, for pragmatic reasons, a certain number of gap-criteria will be permitted for a limited period of time.

In order to avoid duplication, the Meta-Standard does not develop a whole new standard against which parties need to be certified. By using existing standards, a Meta-Standard automatically supports international harmonization among the several standards. Therefore, companies using a qualifying standard can claim that their product has been produced sustainably (according to the norm set by the Meta-Standard).

An intrinsic feature of the Meta-Standard is that it is likely to cover less criteria than the qualifying standards. The sustainability criteria included in the European Renewable Energy Directive form a kind of meta-standard (see chapter 3.3).

sustainability beyond the RED requirements. Parts 1, 3 & 4 of the standards have been issued (http://www.cen.eu/cen/Sectors/Sectors/UtilitiesAndEnergy/Fuels/Pages/Sustainability.aspx) published by 2015.

To complement this introduction of voluntary standards and certification scheme, the RSB's principles and criteria are given in Appendix A as an example of an existing standard. The RSB was selected as it is supported by a number of aviation organisations, such as IATA or SAFUG, and was specifically designed for biofuels.

3.1.2 How voluntary schemes operate

The operation of a voluntary certification scheme is based on the verification of the compliance of the operator with the sustainability principles and criteria of the scheme.

A typical schematic of the process is depicted on Figure 1.

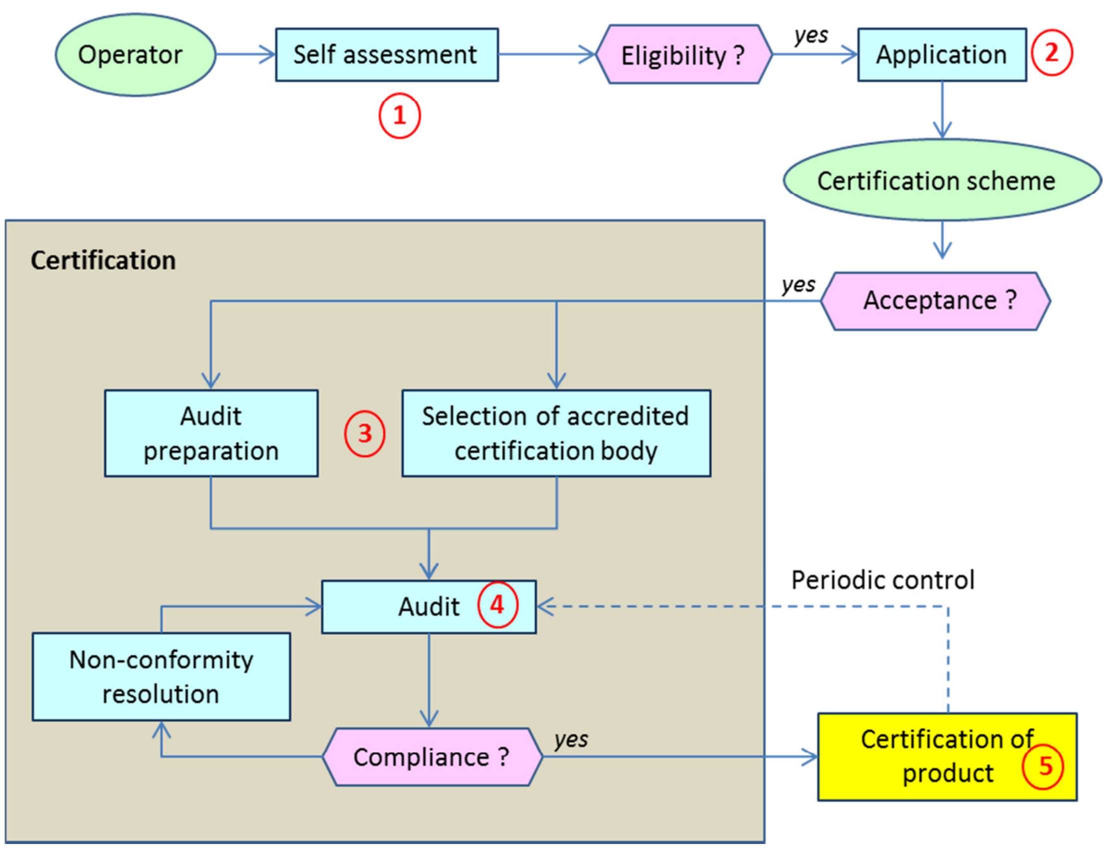


Figure 1: typical steps of certification process

ISEAL: a coalition of sustainability standards

The multiplication of sustainability standards and certification schemes has led to the creation of ISEAL[1], a coalition of standards that aims at defining codes of best practices for the development and implementation of standards and certification schemes. ISEAL is a non-governmental organization open to all multi-stakeholder sustainability standards and accreditation bodies that demonstrate an ability to meet ISEAL's codes of best practices and commit to continuous improvement of their practices. Certification schemes relevant to biofuels that are currently members of ISEAL include Bonsucro, RSPO and RSB.

To date, ISEAL's codes include:

- A Standard-setting Code with requirements on the standards development process, structure and content[1];
- An Impacts Code that requires standards to monitor and evaluate their impact and publicly report on their evaluations;
- An Assurance Code, setting minimum criteria for the implementation of the assurance process.

ISEAL is currently working on Credibility Principles that will provide guidance on what makes a standard credible. Thirteen principles have been submitted for global consultation [9]. They require in particular transparency, multi-stakeholder involvement and local applicability, as well as impartiality and independence of assurance.

It should be noted that ISEAL's codes contain an underlying principle of non-redundancy between standards and of harmonization. It states that a justification study of the need for the standard is an important first step to avoid the development of redundant standards.

In order to apply to a certain scheme, a participating operator must go through the following steps:

(1) The operator must carry out a self-evaluation to determine whether they are in the position to be certified;

(2) If this is the case, the operator must send the application for certification to the certification scheme;

(3) Once it is accepted and registered, the operator must choose an independent accredited verifier;

(4) The accredited verifier carries out the audit;

(5) If the audit is successful, it will result in a certified product or product mix.

These certificates must be renewed periodically, depending on the certification scheme, as well as on the risk level of the participating operator. For example, in the case of RSB, the auditing intervals vary between three and 24 months.

As mentioned before, the auditing process has to be carried out by a qualified auditor who belongs to an accredited company. The participating operator must reach a commercial agreement with the certification body in order to cover the costs of certification. The certification process usually consists of a number of field visits, as well as office audits. During that process, the auditor must ensure that the participating operator complies with the principles and criteria of the certification scheme.

Some participating operators may operate under very specific conditions which can make certification under the common standard's requirements difficult. To accommodate such a situation, some certification schemes[7] have established the possibility to adapt to:

- Crop specific conditions;
- Specific geographic conditions; or
- Specific biomass production standards.

The objective is to allow for flexibility in cases for which the application of the common rules would otherwise not be possible, or would result in an unfair burden for participants, or in negative environmental, social or economic impacts. This flexibility is particularly useful when compliance with the principles of a certification scheme would not achieve the main intent of the scheme, result in the violation of existing legislation, have negative environmental, social or economic impacts, or when there is a need to adapt to specific cultivation methods of a particular crop or environmental conditions.

3.2 Regional and national approaches

Voluntary certification schemes are suitable tools to ensure sustainable practices at a value-chain level. However, not all aspects can be addressed at a company level and, at the regional or national level, assessing and ensuring the sustainability of the development of an alternative fuels industry may require additional tools and measures that go beyond the boundaries of an individual production-chain. In particular, there is a need to assess the cumulative impacts of multiple value-chain developments and to establish a global view. A typical example of a sustainability issue that requires an aggregate view is the preservation of water availability.

The Cramer Committee, set up in 2006 in the Netherlands, to develop a certification system and formulate sustainability criteria for the production and use of biomass in energy, fuels or chemistry, proposed two levels of reporting in sustainability assessment, one at company levels and one at macro-levels [10]. The second, under the responsibility of the Dutch Government, was to report issues that cannot be addressed at company level such as:

- availability and price of food;
- land-use change; and/or
- deforestation.

[7] RSB has issued specific rules for such adaptation. These rules are available on the organization website: http://rsb.org/.

In a similar way, the European RED [11] requires Member States to report on the impacts of biofuels on [11][8]:

- biodiversity;
- water resources;
- water and soil quality;
- net GHG emissions; and
- change in commodity prices and land use associated with the increased use of biomass.

The Global Bioenergy Partnership (GBEP), which represents a unique initiative to build consensus among a wide range of governments and international organisations, has developed a set of indicators that policy-makers and other stakeholders can use to monitor the impact of bioenergy production and use at domestic level, as well as to inform decision-making [12].

Based on consensus, this science-based and technically sound set of relevant measurements and indicators represents a non-prescriptive approach; unlike standards and certification schemes, it does not set principles and thresholds, or compliance requirements. The 24 defined indicators (Table 1) are value-neutral, do not feature direction, thresholds or limits, and are not legally binding. Measured over time, they show progress towards or away from a nationally defined sustainable development path. They also provide agreed themes along which sustainability can be assessed.

Implementing a monitoring policy at State level based on indicators such as those defined by GBEP is thus an additional means, complementary to certification, to address the sustainability of alternative fuels deployment. However, being only measurement tools, these indicators need to be associated with a national policy that defines national targets and driving principles. Monitoring and reporting in themselves do not contribute to limiting of the possible detrimental impact of deploying biofuels.

In addition, monitoring is an assessment of already existing impacts. A key to sustainability is to minimize risks through evidence-based planning, before actual impacts materialize. An assessment of the sustainable bioenergy potential is essential to inform decision-making in the development and implementation of sustainable biofuel policies and strategies. This is a highly multidisciplinary process connected to other renewable energy policies, which calls for multi-sectorial approach from States, coordinating energy, environment, agriculture and transport. It should be accompanied by a dialog among relevant stakeholders as well. Such an assessment should evaluate in particular:

- the potential for sustainable agriculture intensification and residue use;
- the resources available (e.g. land, water) for the sustainable expansion of agriculture and the most suitable areas for its development considering agro-climatic characteristics, logistics and existing infrastructure, as well environmental protection criteria;
- impact on agricultural markets and on the trade balance;
- competing demands for biomass, food, feed and fibre.

[8] RED, Article 22

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 these pillars:		
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. Lifecycle 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

Table 1: The GBEP pillars, themes and 24 indicators for sustainability [12].

A more in-depth description of the processes and tools required to undertake such an assessment and to support decisions in the development of bioenergy is available through the “Bioenergy Decision Support Tool” prepared by UNEP and FAO, under UN Energy [13], or the “BEFS Approach” of FAO [14]. The U.S. CAAFI has also developed an “Environmental Progression” tool to provide guidance on when different environmental analyses might best be performed during the development of a new fuel production process [15] [16].

3.3 Regulatory approach

Beyond voluntary approaches and global monitoring, States may enforce mandatory requirements through regulations to ensure the sustainable development of alternative fuels. Some States or supranational institutions have already defined such regulations. The existing examples do not preclude the production of non-sustainable products, but rather, foster the production of sustainable products by making them eligible to support measures and incentives only if they comply with sustainability requirements, or by allowing only compliant products to qualify for the achievement of national targets for renewable energy development.

Compared to voluntary standards, several examples of regulations that address a reduced scope of sustainability requirements currently exist:

- In Brazil, regulations include a set of environmental and social requirements that are to be applied to domestic biofuel production [17].
- The European Renewable Energy Directive (RED) [11] defines thresholds for GHG emissions reductions and excludes feedstock obtained from lands with high biodiversity or high carbon stocks. RED applies to both domestically produced and imported biofuels. Domestic production is also subject to additional requirements related to the implementation of agricultural practices which comply with the Common Agricultural Policy (CAP). As mentioned, RED introduces an obligation for States to monitor impacts as well as for the European Commission to report on social aspects, impacts on food markets, and other indirect impacts of the biofuel policy.
- The U.S. Renewable Fuel Standard (RFS) [18] [19] sets requirements for GHG emissions reductions in order to qualify for different categories of biofuel and limits the feedstock that can qualify as “renewable biomass” to certain types of biomass harvested on certain types of lands. Like the EU’s RED, it applies to domestically produced and imported biofuels.

Additional information on the provisions included in these regulations is provided in Appendix B.

Sustainability regulations may be subject to constraints that limit their scope, in particular with a view to their application to non-domestic products. Compliance with international trade rules must be considered [20][21]. The 1994 WTO GATT mandates equal treatment of “like” products of WTO members and sustainable or non-sustainable are likely to be “like” products, as sustainability is not a product-related characteristic. Therefore, restrictions related to impacts induced by a product’s production may not be acceptable with regard to the GATT, in particular in the case of local effects and social impacts, which are considered relevant to States' sovereignty. As a result, there is a possibility that a number of requirements considered by voluntary sustainability standards are excluded.

However the GATT lists a number of exceptions that allow for sustainability measures. Among others, these exceptions are justified under the following circumstances:

- when necessary to protect human, animal life or health; or
- when related to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption.

In principle, the GATT allows for distinguishing products on the basis of the global environmental effects, or on the basis of a territorial linkage between the producing country and the country making the distinction from the point of view of the impact. As an example, it is noteworthy that the EU RED only sets requirements about GHG emissions and land with high carbon stocks (two items related to the global issue of climate change), as well as on biodiversity that is covered by international treaties.

Enforcing regulatory sustainability requirements may require associated means to ensure compliance. For instance, RED requires an independent audit of the information provided as proof of compliance. This audit can be conducted either through a national system (relying, for example, on certification of the operator's declaration by organizations such as Bureau Veritas or SGS International Certification Services) or through voluntary sustainability standards and certification schemes, recognized by the European Commission (entailing the fulfilment of a broader scope of sustainability criteria than the ones strictly enforced by EU regulation). For third countries, recognition through bilateral or multilateral agreement concluded with the EU is also offered.

4 SCOPE OF SUSTAINABILITY ASSESSMENT

Although there is some convergence on what the important issues are, there is no single, globally recognized reference against which to assess sustainability. Thus, the scope of the assessment, the level of the thresholds and the implementation depend on the chosen assessment system.

However, examining several well established sustainability standards, together with the GBEP sustainability indicators, which are widely recognized, provides a comprehensive view of the impacts and requirements that may be considered in a sustainability assessment or in a sustainability policy.

The environmental, social and economic pillars of sustainability being well recognized, a sustainability framework includes these three aspects in the definition of its principles or indicators.

In addition to these three considerations, voluntary standards often include additional cross-sectional requirements:

- An overarching principle of legality, which applies to the three pillars of sustainability and requires compliance with national legislation;
- Transparent, consultative and participatory process with stakeholders;
- Continuous improvement of the stakeholders' operational practices.

Regarding compliance with national legislation, it should be noted that following the promulgation of the RED European Directive, many voluntary standards and certification schemes have issued a specific version of their standard for compliance with RED's requirements.

In the following overview, the various relevant impacts to be considered by a sustainability assessment are categorized thematically. Some overlap may exist between categories, with some criteria being relevant for different categories of impacts.

For each category of impacts, the corresponding GBEP indicators are provided as a reference. They are generally presented as national aggregates, but may also often be measured at the level of a specific producer. Indicators are further complemented by a high-level presentation of a range of corresponding criteria and provisions adopted by a number of representative sustainability standards or regulations. The focus is on the general content of the criteria and provisions, not on their detailed definition and implementation, which differ from one standard to another. National or regional interpretations of the criteria may also be state-specific, however, as stated by GBEP, "the basic concept of sustainable development and the broad strategic framework for achieving it should be common".

For the measures proposed by voluntary sustainability standards and certification schemes, the screening is based on the following schemes and associated references[9]:

- Roundtable for Sustainable Biomaterial (RSB) [24];
- International Sustainability & Carbon Certification (ISCC) [25];
- NTA 8080 certification of sustainable biomass [10];
- Bonsucro [26];
- Roundtable on Sustainable Palm Oil (RSPO) [27].

For regulation, unless mentioned, only specific provisions included in bioenergy and biofuels regulations to enforce sustainability are listed. Other States' legislation can be applicable for particular aspects, such as water or air pollution, setting minimum sustainability requirements.

In chapter 3.2, the crucial importance of a sustainability analysis in the planning phase prior to the project or policy development was underlined. The impacts and criteria enumerated in the following paragraphs need to be considered in this preparation phase as well, and a predictive evaluation of indicators will inform decision making.

4.1 Environmental sustainability

The following categories are considered to assess environmental sustainability:

1. GHG emissions;
2. Land use and land-use change;

[9] These schemes have been selected because they are representative and well established, which does not presume the quality of these standards, nor that of other standards.

3. Conservation;
4. Soil and productive capacity of land;
5. Water;
6. Air quality; and
7. Best practices, technology risk and waste management.

1) GHG emissions

a) Scope

Climate change mitigation being a strong driver for the introduction of alternative fuels, measuring GHG emissions associated to their use is a relevant parameter to be considered when assessing sustainability.

The relevant indicator is the total GHG emissions across the whole life cycle of the fuel, obtained through a Life Cycle Assessment (LCA).

Different methodologies exist for life cycle analysis and are used or specified by voluntary certification schemes or regulations (in accordance with the overarching principle to respect national legislation, standards comply with regulations when such regulations include provisions for the assessment of GHG emissions).

Greenhouse gases are not addressed by all voluntary standards and certification schemes, in particular when they were designed to cover biomass for food or materials production. At the contrary, standards related to bioenergy and biofuels include this aspect. With the increasing recognition of the importance of this impact category for other value chains, some convergence can be observed.

The approach also differs in whether to set a threshold for minimum emissions reductions in order for the fuel to be recognized as compliant.

Indicators and criteria related to land use are also relevant to GHG emissions as land use change may generate significant carbon release.

b) Indicators, principles and criteria

GBEP indicators
Life cycle 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' [23].

Sustainability standards and certification schemes
• Compliance with legislative biofuel policy or regulations in force, in which biofuel must meet GHG reduction requirements across its lifecycle to comply with such policy or regulations and/or to qualify for certain incentives (RSB, Bonsucro). • (Standard's) Defined methodology requested for LCA (RSB, Bonsucro, ISCC). • Maximum level of emissions: – Threshold on minimum emission reduction for the biofuel blend relative to fossil baseline: RSB - 50% (each biofuel in the blend shall have lower emission than the fossil baseline); ISCC – 35%; – Absolute maximum level: Bonsucro – 24 g CO_2 eq/MJ_{fuel} (sugar cane ethanol); – Net reduction (> 0%): NTA 8080. • Requirements on type of lands used for biomass cultivation (see also land use and land use change) – no land with high carbon stocks (peatland, certain grassland,…) (ISCC, NTA8080) – no installation of new biomass production in areas in which the loss of above-ground carbon storage cannot be recovered within a period of ten years of biomass production (NTA 8080). • Assessment and monitoring plan to reduce emissions (RSPO).
Regulations
• Minimum reduction threshold relative to fossil reference (EU RED: per date of entry in operation – 60% from 2018, U.S. RFS: per category of biofuels, from 20 to 60%). • Defined LCA methodology (EU RED, U.S. RFS). • Requirements on type of lands allowed for biomass cultivation (EU RED, US RFS).

2) *Land use and land-use change*

a) Scope

Land-use change has emerged as a critical parameter in life cycle analysis and GHG emissions assessment for the production of biofuels. Indeed, significant amounts of carbon may be stored in a given tract of land, both above and underground[10]. A change in land use will affect carbon storage not only through the removal of the vegetation, but also through the oxidation of the soil organic carbon induced by agricultural practices such as tillage. Yet, the change may have either positive or negative

[10] Carbon that may be stored in a land includes above ground carbon contained in the vegetation and underground carbon contained in the vegetation roots, as well as well as soil organic carbon consisting of humus, and charcoal, comprising decomposed plant and animals residues, substances synthesised from the decomposition and living micro-organism and small animals.

Life Cycle Assessment (LCA)

LCA consists of an analytical methodology which accounts for all the impacts generated at each step of the manufacture and use of a product. In the case of a fuel, this includes production (comprising emissions associated to the conversion of the land for cultivation of the crops), transportation and processing of the feedstock, conversion into fuel and distribution of the fuel, and finally the combustion of the fuel. It is based on an inventory of all input and output flows (raw material, chemicals, energy…) at each step of the life cycle, which allows for the assessment of the global environmental impact. LCA can be applied for GHG emissions, as well as to assess energy use, or other impacts such as water use.

Standards for LCA have been issued by the International Standards Organisation (ISO) (ISO 14040 and 14044). They define the following steps for LCA:

- Definition of goal and scope - defines the subject of the analysis, clarifies its assumptions, identifies the system boundaries and the impacts to be assessed;
- Life Cycle Inventory (LCI) - compiles all the inputs and outputs flows at each step of the life cycle;
- Life Cycle Impact Assessment (LCIA) - computes the impacts caused by the flows at each step, for example the summation of GHG emissions associated to each step;
- Interpretation, including discussion of data quality, sensitivity and uncertainties.

Methodological parameters of a LCA

A number of choices have great influence on the results of LCA and their use.

- Choice of the reference system
  LCA is often used to compare the performance of different products and in the case of alternative fuels, to compare emissions with those of fossil fuels. Ideally the reference should be the product most likely to be replaced, which might not always be the same, as oil supply and associated characteristics vary upon geographic area. Average value is a possible option.
- System boundaries
  They define the limits of the system for which the impacts are being computed. Ideally these boundaries should be such that the compared systems deliver the same services. As biofuel production often induces co-products (seed cake, electricity,…), the reference fossil fuel system should include the production of equivalent products, which is referred to as “system expansion”. When expansion is not feasible, the impacts need to be allocated between the biofuel and its co-products according to a given rule. Different allocation methods exist which can significantly impact the results.
- Functional unit
  In case of GHG emissions, the results are generally expressed in grams of CO_2 equivalent. Together with CO_2, methane (CH_4) and nitrous oxide (N_2O) are important GHGs to take into account. They are included in the CO_2 quantity that would generate an equivalent impact on climate. But these emissions have to be normalised to a reference for which different choices are possible:

- Input related functional units: for example kg CO_2 eq / kg of processed biomass, or kg CO_2 eq / ha of crop used;
- Output related functional units: for example kg CO_2 eq / passenger-km, or kg CO_2 eq / energy unit of fuel (MJ).

As the purpose is to compare fuels that are to be used in the same aircraft with no or marginal influence on their efficiency, emissions for aviation fuel are generally expressed in kg CO_2 eq / MJ.

- Allocation methods
  Different methods can be used to allocate emissions between the fuel and its co-products:
  - Partitioning of the emissions pro rata of mass, energy content or economic value of the fuel and co-products;
  - System expansion and use of a substitution or displacement method: when the fuel co-product displaces or substitutes another product, the emissions associated to this product are counted as credit for the co-product and subtracted from the fuel emissions.

    Example: the seed-cake of camelina used to make biofuel can be used as animal feed and replaces for example corn. The emissions associated to the replaced volume of corn are subtracted from the emissions associated to the fuel made from the camelina seeds oil.

- Reference time for emissions accounting
  Emissions such as those associated to the land use change to produce energy crops happen only once in the early stage of the biofuel production. These emissions are generally amortised over a reference duration of biofuel production, for example 20 years.

- Well-to-Wake or Well-to-Tank
  Compared to LCA applied to fossil fuels, the CO_2 uptake during biomass growth has to be accounted for. Two approaches exist:
  - Either a CO_2 uptake is evaluated and included in the cultivation step and combustion CO_2 emissions are also included;
  - Either biomass based-fuel is assumed to be carbon neutral and combustion emissions are not included since they are supposed to be compensated by biomass growth.

  This second approach corresponds to a well to tank approach. It is justified in the case of aviation alternative fuels as the fuel are to be used on the same aircrafts with little or no influence on combustion performance (on an energy content basis).

  Additional climate impacts, non-related to CO_2, can be associated to aviation emissions, in particular contrails radiative forcing. Little science however exits about the possible influence of drop-in alternative fuels on these impacts. They are thus generally not addressed in the LCA of the fuels.

Useful references:

Air Force Research Laboratory [28]; UNEP/FAO/UNIDO [29]; IEA Bioenergy [30] impact; converting a forest into crop land will result in carbon release, while replacing annual crops by perennial crops may result in increased carbon storage in the land.

Beyond GHG emissions, land use and land-use change is fundamental in understanding many of the environmental, social and economic effects of bioenergy production, whether direct or indirect (see Chapter 5 for the indirect impacts of land use and land use change).

The set of indicators developed by GBEP provides a view on the relative importance of the bioenergy sector to national land use, as well on the direct land-use change induced by bioenergy production. If the latter does not measure indirect effects, it can nevertheless provide some indication of the risk of displacing agricultural activities.

When addressed in voluntary standards and certification schemes, land use and land use change is often related to its impact on GHG emissions.

b) Principles, criteria and indicators

GBEP indicators
1. Total area of land for bioenergy feedstock production, and as compared to total national surface and agricultural and managed forest land area. 2. Percentages of bioenergy from yield increases, residues, wastes and degraded or contaminated land. 3. 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.
Sustainability standards and certification schemes
• Biomass shall not be produced on land with high carbon stock (wetlands, continuously forested areas, peatlands, primary forest...) (ISCC, RSPO, NTA 8080). • Soil suitability maps or soil surveys to be used as adequate tool to establish the long-term suitability of land for crop cultivation (RSPO).
Regulations
• Requirements on type of lands allowed for biomass cultivation (E.U. RED, U.S. RFS). • Mapping and zoning of areas entitled for biofuel crops cultivation (Brazil: Agroecological Zoning for Sugarcane and Agroecological Zoning of Oil Palm).

3) *Conservation*

a) Scope

Although preservation of biodiversity is the aspect of conservation most often referred to, conservation in this context covers a much broader scope including in particular the preservation of “wilderness” or “ecosystems services”. Ecosystems services are defined as the benefits people derive from ecosystems. These include provisioning services, such as food and water; regulating services, such as flood and disease control, cultural services, such as spiritual, recreational and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth [31].

The High Conservation Value (HCV) concept [32], originally developed by the Forest Stewardship Council (FSC) for use in forest management certification, is a good example of guidelines to address conservation-related issues, and currently is used by a number of certification schemes. It defines six types of high conservation values areas:

- Areas containing globally, regionally or nationally significant concentrations of biodiversity values;
- Globally, regionally or nationally significant large landscape-level areas where viable populations of most, if not all naturally occurring species exist in natural patterns of distribution and abundance;
- Areas that are in or contain rare, threatened or endangered ecosystems;
- Areas that provide basic ecosystem services in critical situations (e.g. watershed protection, erosion control);
- Areas fundamental to meeting basic needs of local communities (e.g. subsistence, health);
- Areas critical to local communities’ traditional cultural identity (areas of cultural, ecological, economic or religious significance identified in cooperation with such local communities).

Although many aspects of biodiversity are commonly associated with natural and undisturbed ecosystems, many areas that have been converted to agriculture, and especially abandoned lands, may be significant in terms of biodiversity.

While most emphasis is on land-use change related impacts on biodiversity, it is also important to consider the risk associated to invasive species that may be introduced for bioenergy production [33].

There is no consensus on how areas of importance for biodiversity should be defined or identified. A four-step process has been referenced in the FAO/UNEP Bioenergy Decision Support Tool [13], and mapping and zoning methodologies capture conservation goals. The International Biodiversity Assessment Tool (IBAT) has also been proposed by UNEP, IUCN, Birdlife Internationals and Conservation International [34]. In addition, some international agreements exist to protect areas that were designated by countries as protected areas, in particular the Convention on Biological Diversity (CBD), the Ramsar Convention on Wetlands or the UNESCO World Heritage Convention. Additional information and tools are also available at the World Conservation Monitoring Centre of UNEP[11].

b) Principles, criteria and indicators

GBEP indicators
Biodiversity in the landscape 1. Area and percentage of nationally recognized areas of high biodiversity value or critical ecosystems converted to bioenergy production. 2. Area and percentage of the land used for bioenergy production where nationally recognized invasive species, by risk category, are cultivated. 3. Area and percentage of the land used for bioenergy production where nationally recognized conservation methods are used.
Sustainability standards and certification schemes
• Identification of HCV areas, achievement of an impacts assessment, use only if adequate management practices maintain or enhance the identified conservation values, preservation/creation of buffer zones and ecological corridors (to be documented by operator) (RSB, NTA 8080, RSPO). • Biomass shall not be produced on land with high biodiversity value, including forest land, areas designated by law or relevant authority for nature protection, grassland with high biodiversity (ISCC). • Indicator based criteria (Bonsucro). Example: "*Percent of areas defined internationally or nationally as legally protected or classified as High Conservation Value areas (interpreted nationally and officially as described in Appendix 1) planted to sugarcane after the cut-off date of 1 January 2008 = 0*". • Existence of management plan detailing practices for preservation and mitigation plan. • Prevention of invasive species (assessment of invasiveness, interdiction of highly invasive species, agriculture practices preventing dissemination) (RSB).

[11] http://www.unep-wcmc.org/

Regulations
• "Biofuels and bioliquids [...] shall not be made from raw material obtained from land with high biodiversity value, namely land that had one of the following statuses in or after January 2008, whether or not the land continues to have that status : primary forest […], areas designated by law […] for nature protection purposes, for the protection of rare or endangered ecosystems or species by international agreements […], highly biodiverse grassland […]" (European Union's Directive for the Promotion of Renewable Energy [11]). • Renewable biomass definition excludes slash and pre-commercial thinnings from ecologically sensitive forestland (U.S. RFS) *Ecologically sensitive forestland means forestland that meets either of the following criteria:* *(1) An ecological community with a global or state ranking of critically imperiled, imperiled or rare pursuant to a State Natural Heritage Program.* *(2) Old growth or late successional, characterized by trees at least 200 years in age.* • Mapping and zoning of areas entitled for biofuel crops cultivation (Brazil) • Preservation in all rural properties of a percentage of set aside land as legal reserve where native vegetation must be preserved (Brazil: 20% of land for the whole country, 80% of all rural land in the Amazon Tropical forest and Pentanal wetlands).

4) Soil and productive capacity of land and ecosystems

a) Scope

The preservation of the productive capacity of land and ecosystems is a prerequisite for sustainable production.

This includes the preservation of soil quality, which is defined by the Soil Science Society of America as: "the fitness of a specific kind of soil, to function within its capacity and within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation"[12].

Soil quality results from a combination of inherent properties, weakly affected by land use, and dynamic properties that can change in response to land management. These involve physical properties (e.g. soil structure, bulk density), chemical properties (e.g. nutrient content) and biological properties (e.g. organic matter content) which are characterised by indicators. Soil organic matter for example provides information on soil fertility, soil structure, soil stability and nutrient retention. Similarly, plant indicators, such as root depth, can provide information about the bulk density or compaction of the soil.

Figure 2 illustrates the various kinds of land degradation that may result from improper land-use practices.

[12] http://soilquality.org

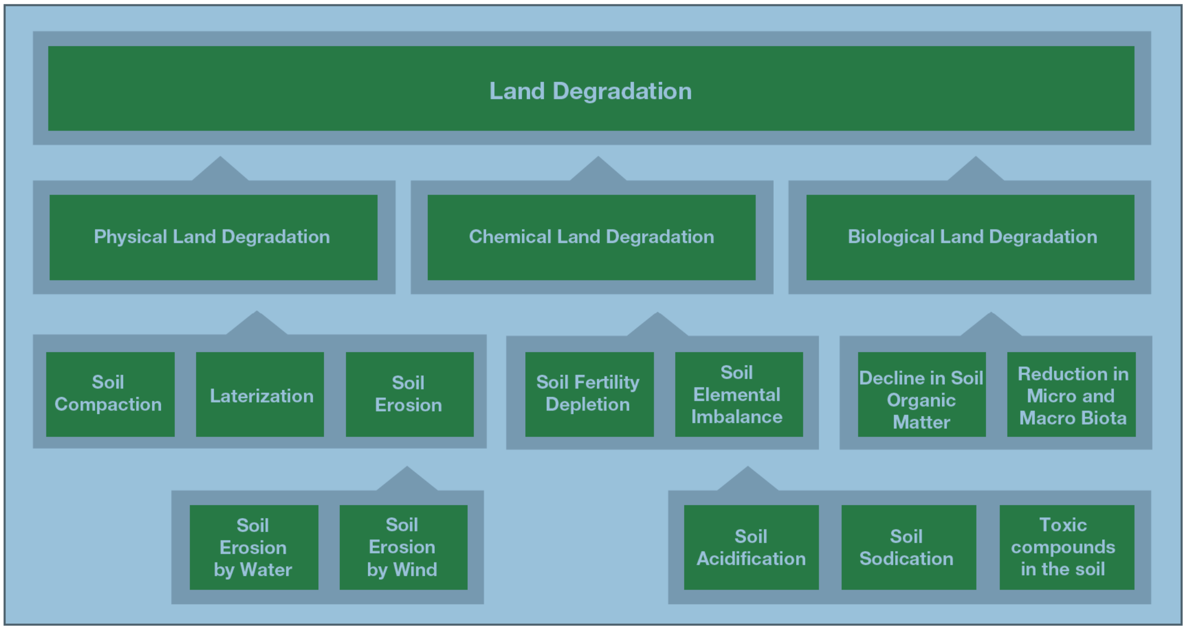


Figure 2: The various types of land degradation processes

(FAO/UNEP/UN-Energy Bioenergy Decision Support Tool)

A reasonable exploitation of land and ecosystem resources is a another aspect of the preservation of productive capacity. In particular for forestry, the annual growth of biomass is a reference for sustainable harvesting practices to preserve wood stocks and associated carbon sequestration.

b) Principles, criteria and indicators

GBEP indicators
• 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. • 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.

Sustainability standards and certification schemes
• Formulation and implementation of practices that maintain or enhance soil physical, chemical and biological condition: preservation of erosion, conservation of nutrient balance and organic matter, prevention of salinization. • The use of agrarian and forestry residual products for feedstock production, including lignocellulosic material, shall not be at the expense of long-term soil stability and organic matter content (RSB, NTA8080, ISCC, Bonsucro). • The residual products of the biomass production and processing must be used optimally (no unnecessary burning or removal) (NTA8080) - Burning as part of the cultivation process or land clearance is not allowed (ISCC). • Continuous improvement of the status of soil and water resources (RSB, Bonsucro) • Indicator based criteria (Bonsucro): *"ground cover of tops or leaves after harvest (> 20%), soil mechanically tilled per year (<20%), Percent fields with samples showing analyses within acceptable limits for pH (> 80%)".*
Regulations
• European Union, Common Agricultural Policy (for domestic production only): Member States requested to set minimum requirements to maintain land in good agricultural and environmental conditions on the basis of a defined framework addressing soil erosion (minimum soil cover and minimum land management reflecting site specific conditions), soil organic matter (arable stubble management), minimum level of maintenance (retention of landscape features, avoidance of encroachment of unwanted vegetation on agricultural land, protection of permanent pasture). • *General law for agriculture may apply, e.g. Brazil: law 6171/88, Soil Conservation in Agriculture.*

5) Water

a) Scope

Water is a major component of biofuels production, both for the growing of the feedstock and for processing this feedstock into fuel.

Sustainability concerns about water can be divided into two categories: the preservation of water availability and the preservation of water quality.

Water availability covers both surface and ground water. It may be affected by biofuel production through direct withdrawal for crop irrigation or feedstock processing at the biofuel factory, but also through rainfed plants' direct use of available water (Figure 3). The water returned to the atmosphere through plants evapotranspiration is subtracted from the water available to replenish groundwater levels or that contributes to river flows. Depending on the crops (e.g. forestry crops used for short rotation coppices), the impact may be significant on local hydrology in the case of large plantations.

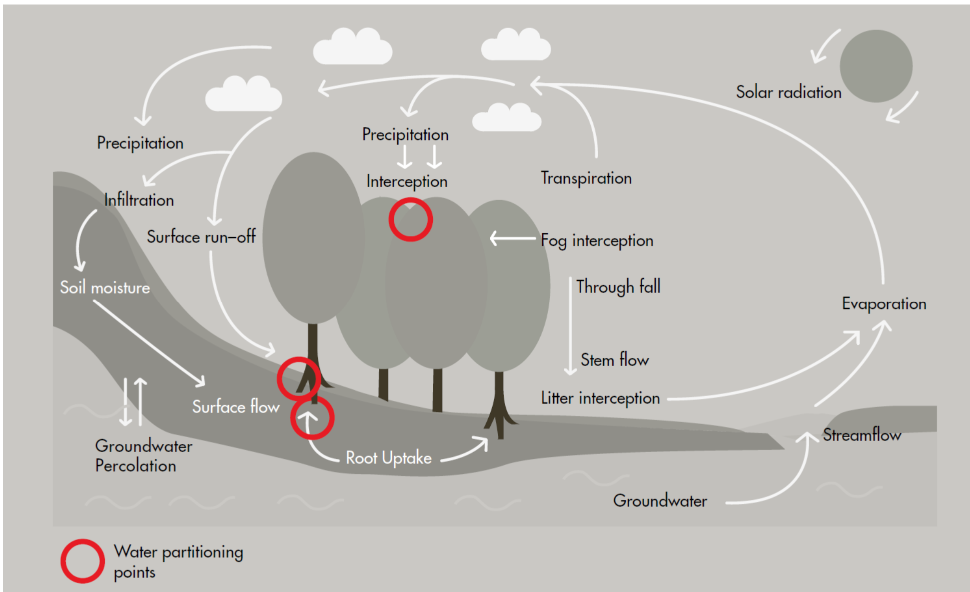


Figure 3: Key water partitioning points in the hydrological cycle affected by biofuel feedstock production [35]

UNEP/Öko-Institut/IEA Bioernergy Task 43 provides a comprehensive analysis of water issues related to bioenergy production [35]. It details a number of indicators pertinent to water use as well as policy instruments for the preservation of water availability and quality . Life cycle analysis can in particular be used to analyse water use for the production and conversion of various feedstock for bioenergy. However, indicators and LCA are not sufficient to represent impacts of water use without an in-depth analysis of local conditions. A conclusion is that water needs to be included in the land use planning for the production of bioenergy, together with economic, agronomic and environmental aspects, in an integrated water resources management.

Biofuel production can impact water quality in particular through:

- Cooling water and effluents releases from processing plants,
- Runoff of pesticides and fertilizers from agriculture, the latter being responsible for hypoxia and degradation of aquatic life due to plant and algae blooms.

While there may be no particular provision related to water quality in bioenergy or biofuels regulations, other States' regulations may be applicable, defining maximum permissible levels of pollutants or physical characteristics.

b) Principles, criteria and indicators

GBEP indicators
1. Water use and efficiency • Water withdrawn from nationally determined watershed(s) for the production and processing of bioenergy feedstock, 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 feedstock per unit of bioenergy output, disaggregated into renewable and non-renewable water sources. ***2. 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 bioenergy processing effluents, and expressed as a percentage of pollutant loadings from total agricultural processing effluents in the watershed.
Sustainability standards and certification schemes
• Implementation of a water management plan for efficiency of water use and preservation of water resources quality (RSB, NTA 8080, ISCC, RSPO). ***Water use and efficiency*** • Biofuel operations shall not contribute to the depletion of surface or groundwater resources beyond replenishment capacities (RSB) – The level of groundwater table is monitored (ISCC). • No use must be made of water from non-renewable sources (NTA 8080, ISCC). • Respect of local or regional water management plan (RSB), share of water resources for biofuels taking into account other users (RSB, RSPO), respect of formal or customary water rights (ISCC). • No withdrawing of water from natural watercourses (e.g. a river) to an extent that modifies its natural trajectory or the physical, chemical and biological equilibrium (RSB, RSPO) – Protection of riparian vegetation (ISCC) and buffer zone (RSPO). • Quantitative indicator (Bonsucro): *net water consumed per unit of product < max value.* **Water quality** • Enhancement or maintaining of the quality of the surface and groundwater resources: – Containment of effluents, chemicals, wastes to avoid contamination of water resources (RSB, ISCC, RSPO);

– buffer zone with water resources (RSB, RSPO); – responsible use of agrochemicals (NTA 8080) – Special care in fertilisers use for no water contamination (distance to river, no runoff), fertilizers with high nitrogen content applied on absorptive soils only (ISCC); – Treatment or recycling of discharge water and effluents (RSB, RSPO).
Regulations
• Reporting requirement for States on water resources and quality (EU RED). • *Other States' regulation may apply (e.g. Water Directive in EU).*

6) Air

a) Scope

Air quality generally refers to non-CO_2 pollutant emissions that, unlike GHG emissions, are generally considered as problematic on a local or regional basis rather than on a global basis (although particulate emissions may have a global impact). This category covers emissions such as carbon monoxide (CO), nitrogen oxide (NOx), sulfur oxide (SOx) or particulate matter (PM). As recognized by the GBEP indicator, impact on air quality should be assessed across all steps of the fuel life cycle, including during its end use (combustion in engine).

However in the approaches to determining the sustainability of alternative fuels, air quality is limited to the production cycle of the fuel. Air quality issues associated to the use of the fuel are addressed in a different context. For aviation, the air quality issue is handled through the emissions standards for engine certification defined in Annex 16, Volume II - *Engine Emissions*, to the *Convention on International Civil Aviation*. This Standard sets maximum values for unburned hydrocarbon, CO and NOx as well as for PM. For the alternative fuels that are currently approved[13] by ASTM, there is no specific issue concerning air quality since these fuels copy conventional fuel, with even better characteristics as they contain lower levels of sulphur and aromatics.

The air quality issues considered in the fuel sustainability assessment are thus those linked to agricultural practices (e.g. use of pesticides, open-air burning) or to the processing of the fuel.

[13] Blends of Jet A-1 with Synthetic Paraffinic Kerosene obtained from hydroprocessed oils and fats (HEFA) or from Fischer-Tropsch synthesis.

b) Principles, criteria and indicators

GBEP indicators
Emissions of non-GHG air pollutants, including air toxics, from bioenergy feedstock production, processing, transport of feedstock, intermediate products and end products, and use; and in comparison with other energy sources.
Sustainability standards and certification schemes
• Identification of air pollution emission sources and implementation of a management plan to minimize pollutant emissions (RSB, NTA 8080, RSPO). • Open-air burning of residues, by-product or waste, shall be avoided and, where possible eliminated (RSB, NAT 8080, ISCC) – Use of fire in the preparation of new plantings avoided (except in specific situation) (RSPO). • Quantitative indicator (Bonsucro): *atmospheric acidification burden per unit mass product < limit value.*
Regulations
States' regulations on air quality may apply.

7) Best practices, technology risk and waste management

a) Scope

There might be some overlaps between this last category of sustainability requirements and the previous categories as a number of best practices are already included in topics such as soil and land productive capability or water. Similarly, waste management impacts some of the previous categories, as some waste related criteria were already included.

b) Principles, criteria and indicators

GBEP indicators
N.A.
Sustainability standards and certification schemes
• Implementation of good practices for the storage, handling, use, and disposal of biofuels and chemicals (RSB, ISCC) – Adequate containment of micro-organisms which represent a risk to environment or people (RSB). • Implementation of Integrated Pest Management (ISCC): evidence of cultivation method that could reduce pest attacks. • Use of selective pesticide applied by qualified persons with proven methods and appropriate material (RSPO). • Fertilizers applied according to soil or leaf analysis, indicators on nitrogen and phosphorous fertilizer as well as on pesticides applied per hectare (Bonsucro). • Minimization of the risk of damages to environment and people from the technologies used in biofuel operations including genetically modified plants, micro-organisms, and algae – improvement of environmental and/or social performance over the long term (RSB). • Procedures and infrastructures ensuring that residues from wastes, and by products from feedstock processing and biofuel production units, do not damage soil, water and air physical, chemical, and biological conditions (RSB). • Waste recycling avoids or reduces wastage and avoids the use of landfill or burning (ISCC).
Regulations
• Environmental licensing required for potentially polluting or environmentally damaging activities (Brazil for processing plants or distilleries).

4.2 Social sustainability

Social sustainability requirements are presented according to the following classification:

1. Land, water and resource rights;
2. Respect of human and labour rights;
3. Rural and social development; and
4. Access to food.

1) Land, water and resource rights

a) Scope

This first category is related to the preservation of the rights of communities pre-existent to the development of biofuels projects.

"Respect for land tenure rights, whether customary rights or rights derived from formal legal mechanisms, is essential to the fair and equitable allocation of land resources" (GBEP). This is particularly important for countries where a subsistence economy based on agriculture, and natural resources represents a significant part of the national economy and where ambiguous or insufficient legal frameworks provide weak recognition of land tenure rights. The development of industrial production of energy crops pushes for the mobilisation of large contiguous areas and may lead to small holders' expropriation.

This principle may be extended to access to other necessary resources, such as water.

b) Principles, criteria and indicators

GBEP indicators
Allocation and tenure of land for new bioenergy production Percentage of land – total and by land-use type – used for new bioenergy production where: 1. a legal instrument or domestic authority establishes title and procedures for change of title; and 2. the current domestic legal system and/or socially accepted practices provide due process and the established procedures are followed for determining legal title.
Sustainability standards and certification schemes
Land • Identification and documentation of lands rights and use (both formal and informal or customary) prior to the project. No start-up of the project before right to use the land is established. (RSB, NTA 8080, ISCC, Bonsucro). • Free, Prior, and Informed Consent of original users (RSB, NTA 8080, RSPO). • Fair, equitable and timely compensation for land acquisition of voluntary relinquishment (RSB, RSPO) - Appropriate balancing measures needed to preserve the ability of the persons concerned to sustain their livelihoods in an autonomous and dignified manner (RSB). • In any negotiations concerning compensation for loss of legal or customary rights, implementation of a documented system that enables indigenous peoples, local communities and other stakeholders to express their views through their own representative institutions (RSPO).

Water *(some measures included in the chapter "water" are also applicable)* • Respect of the existing water rights of local and indigenous communities (RSB, ISCC).
Regulations
• Reporting (*by European Commission*) on respect of land use rights in countries supplying significant amount of raw material for biofuel (Member States and third countries) (E.U. RED[14]).

2) Respect for human and labour rights

a) Scope

This category groups all sustainability requirements related to human rights, namely:

– Civic and social rights;

– Labour rights, conditions and wages; and

– Occupational health and safety.

The International Labour Organization (ILO), in its "Declaration on Fundamental Principle and Rights at Work" (1998), affirms the fundamental and immutable nature of the following four principles [36]:

– freedom of association and the effective recognition of the right to collective bargaining;

– the elimination of all forms of forced or compulsory labour;

– the effective abolition of child labour; and

– the elimination of discrimination in respect of employment and occupation.

These principles are generally reflected in sustainability standards (RSB, ISCC, NTA 8080, BSI, etc.).

b) Principles, criteria and indicators

GBEP indicators
1. 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. 2. Incidences of occupational injury, illness and fatalities in the production of bioenergy in relation to comparable sectors.

[14] Article 17 (7)

Sustainability standards and certification schemes
• Workers shall enjoy freedom of association, the right to organize, and the right to collectively bargain. (RSB, ISCC, BSI…). • No slave labor or forced labor shall occur. (RSB, ISCC, Bonsucro…). • No child labor shall occur, except on family farms and then only when work does not interfere with the child's schooling and does not put his or her health at risk (RSB) – Minimum age of 18 for hazardous work and 15 for non-hazardous work (Bonsucro). • Workers shall be free of discrimination of any kind, whether in employment or opportunity, with respect to gender, wages, working conditions, and social benefits (RSB. ISCC). • Respect of applicable minimum wage in a given country (RSB, ISCC) or industry minimum standards (ISCC), and when non applicable, negotiation and agreement of wage with the worker (RSB). • Maximum working hours do not exceed 48h/week (RSB, ISCC). • Self-declaration on good social practice regarding human rights communicated to employees – fair legal contracts with employee and farmers (ISCC, Bonsucro). • Qualified management regarding safety and good social practices (ISCC). • Minimum social dialogue and existence of a freely and democratically elected workers representation to the management (ISCC). • Implementation of internationally-recognized standards for workers' health and safety. (RSB). • Written health, safety and hygiene procedures – identification of hazards (ISCC). • Adequate equipment and training for workers (ISCC, Bonsucro). • Application of human rights and labor standards to subcontractors (RSB, Bonsucro) and suppliers (Bonsucro) – Percentage of contractors and suppliers having demonstrated compliance > 95% (Bonsucro).
Regulations
• Reporting (by European Commission) on ratification and implementation by countries supplying significant amount of raw material for biofuel (Member States and third countries) of conventions of the International Labour Organisation (E.U. RED15).

[15] Article 17 (7)

3) Rural and social development

a) Scope

This section deals with the global benefits of the development of alternative fuels production for local communities and society as a whole. This includes the improvement of wealth and well-being improvement, increased access to energy or benefit to public health.

b) Principles, criteria and indicators

GBEP indicators
1. 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 feedstock, by self-employed households/individuals. 2. Net job creation as a result of bioenergy production and use, total and disaggregated (if possible) as follows: – skilled/unskilled, – temporary/indefinite. 3. 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. 4. 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. 5. Total number and percentage of households and businesses using bioenergy, disaggregated into modern bioenergy and traditional use of biomass. 6. 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.
Sustainability standards and certification schemes
• In region of poverty, the socioeconomic status of local stakeholders impacted by biofuel operations shall be improved (RSB). – Optimization of job creation potential, promotion of permanent local labor, reemployment of existing workers in mechanised processes. – Measurement of improvement and review every 3 years. – Implementation of at least one measure to significantly optimize the benefits to local stakeholders.

• Special measures to encourage participation of women, youth, indigenous communities and vulnerable people (RSB). • Demonstrable contributions to local development that are based on the results of consultation with local communities (RSPO). • All children living on the farm have access to quality primary school education (ISCC).
Regulations
• Reporting (*by European Commission*) on social sustainability in countries supplying significant amount of raw material for biofuel (Member States and third countries) (E.U. RED[16]). • Support to smallholders and family farming: "Social Fuel Stamp" (Brazil). 80% of the biodiesel market is reserved to producers purchasing a minimum percentage of feedstock from family farmers.

4) Access to food

a) Scope

The potential competition with food and fodder is a major concern in the development of bioenergy. This is a complex, multi-faceted issue, with possible indirect effects, that cannot be fully addressed on a local scale or within the boundary of a value-chain certification (the issue of food security and bioenergy development is more comprehensively addressed in Section 5.2). However, a number of certification schemes include provisions related to access to food which reflect local perspectives and circumstances. In addition, food security is addressed in GBEP's indicators.

As stated in the GEBP report on bioenergy indicators, even if one indicator was specifically defined for food security (the price and supply of a national food basket), several other GBEP indicators are relevant to food security: land use and land use change, allocation and tenure of land, change in income, access to modern energy and infrastructure and logistics for distribution of bioenergy.

In a similar way, certification schemes' provisions related to preservation of water, soil and productive capacity of land are also applicable to the maintenance of food security.

[16] Article 17 (7)

b) Principles, criteria and indicators

GBEP indicators
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.
Sustainability standards and certification schemes
• Biofuel operations shall assess risks to food security in the region and locality and shall mitigate any negative impacts that result from biofuel operations. (RSB) • In food insecure regions, biofuel operations shall enhance the local food security of the directly affected stakeholders (by, for instance, setting aside land for food growing, increasing yields, providing opportunities for workers to carry out household-level food production, sponsoring agricultural support programs and activities, and/or making value-added food by-products available to the local market) (RSB) • Reporting on change of land use and change of food price (NTA 8080) • Biomass production shall not replace staple crops and does not impair the local food security. Local food prices do not rise as a direct effect of biomass production. (ISCC)
Regulations
• Reporting (*by the European Commission*) on the availability of foodstuffs at affordable prices countries supplying significant amount of raw material for biofuel (Member States and third countries) (E.U. RED[17])

[17] Article 17 (7)

4.3 Economic sustainability

a) Scope

The GBEP has established a set of eight indicators related to the economic sustainability of bioenergy:

- The productivity of bioenergy production, which focuses on the productivity of land use, as well as on the overall efficiency of the bioenergy production, is crucial for both environmental and economic sustainability and can help to determine whether local bioenergy is economically viable and competitive at the national level;
- The energy balance (energy ratio of the bioenergy value chain as compared to other energy sources) provides a basis for identifying the most energy efficient ways to produce bioenergy among a given set of options and may be used to select appropriate feedstock, technologies and practices;
- The gross added value per unit of bioenergy allows for comparison with other forms of energy;
- The change in the consumption of fossil fuels and traditional uses of biomass measures a transition from fossil fuel to bioenergy which is likely to produce favourable trade balance and increase energy security; in addition this change is a measure of socio-economic development;
- Training and requalification of the workforce (also strongly related to social and rural development) facilitate the adoption of new technologies and provide an enabling environment for the deployment of such technologies in a country (the indicator applies largely to States where bioenergy has been modernised);
- Energy diversity increases the level of energy security;
- Infrastructure and logistics for distribution of bioenergy, when safe, reliable, cost-effective, appropriate and available, help ensure adequate and secure energy supplies that facilitate sustainable development; and
- Capacity and flexibility of the use of bioenergy provides useful information on the capability of the demand side to rapidly increase or diminish fuel or feedstock consumption and therefore its ability to respond to unexpected shortages of bioenergy and/or bioenergy feedstock or to rapidly increase bioenergy consumption under favourable economic conditions.

This economic component proves to be less developed in the voluntary standards and certification schemes. Under such schemes, the only economic component considered is the long term viability of the project.

b) Principles, criteria and indicators

GBEP indicators
1. Productivity – Productivity of bioenergy feedstock 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. **2. 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. **3. Gross value added** Gross value added per unit of bioenergy produced and as a percentage of gross domestic product. **4. 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. **5. Training and requalification 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 (due for example to mechanization of harvesting). **6. Energy diversity** Change in diversity of total primary energy supply due to bioenergy. **7. 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. **8. 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.

Sustainability standards and certification schemes
• Implementation of a business / management plan that reflects a commitment to and aims at long-term economic viability (RSB, RSPO). • Quantitative indicator for the promotion of economic sustainability (BSI) : *value added / tonne cane > defined minimum value.*
Regulations
N.A.

5 ADDITIONAL ISSUES TO ADDRESS

As described in Chapter 2, the various existing tools respond to distinct types of needs and objectives. Ensuring sustainability requires combining these tools, for example by ensuring sustainable practices at value-chain level through certification while assessing cumulative impacts by monitoring at a national level in the frame of a general biofuel policy defining sustainability targets.

Additional impacts should however be considered in the commercial scale deployment of alternative fuels. In particular, deployment may induce indirect effects that are not directly observable and are more difficult to address. In particular, the impact on prices of increased demand for biomass may have consequences on food markets and consequently on food security. In addition, deployment of energy biomass crops in one locale may induce land-use change in a different geographic area due to the displacement of previously existing crops. This phenomena is referred to as Indirect Land Use Change (ILUC) and is recognized to potentially creating GHG emissions. These indirect impacts cannot fully addressed through the approaches presented in Chapter 2 and require additional measures and policies. In addition, the assessment and management of these impacts is currently not fully mature and require additional research and methodological work.

5.1 Indirect land use change (ILUC)

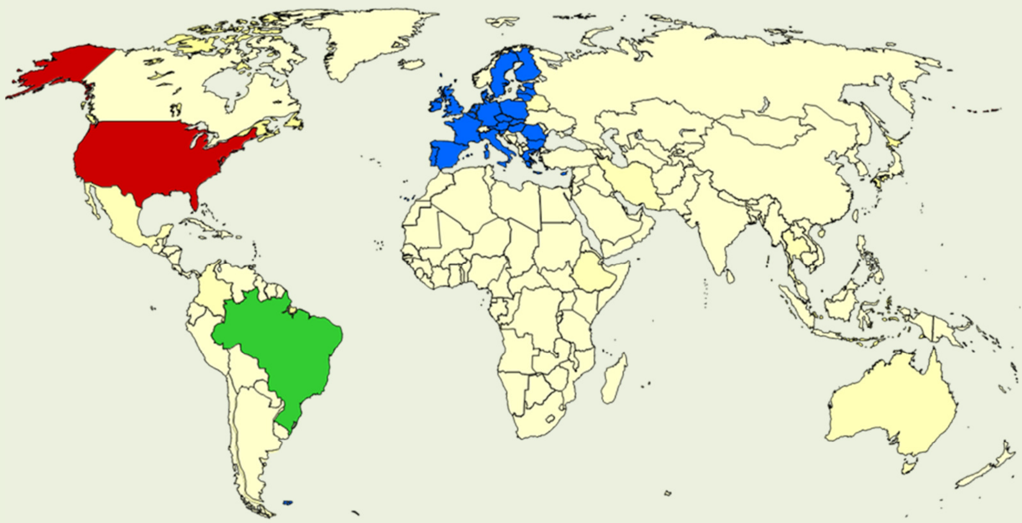
5.1.1 ILUC mechanism and impacts

At first sight, ILUC can be seen as the need to replace food (or feed or fiber) production on existing arable land that has been newly appropriated to produce biomass for biofuels.

Practically, the general mechanism of land use change is more subtle [37]. It starts from the increased demand for agricultural product. This demand translates in an adjustment of prices, the increase of which encourages an increase in production and a decrease in consumers' demand, along with other market modifications, until a new equilibrium is reached. This new equilibrium is the result of a number of coexisting mechanisms which include the impact of the biofuel's co-products on other markets

Indicative coverage of existing regulations per impact category

Comparison with GBEP and existing bioenergy sustainability standards



Category	Impact	Brazil	E.U	U.S.A.	GBEP	RSB	ISCC	NTA8080
Environment	GHG		✓	✓	✓	✓	✓	✓
	Land use	✓	✓	✓	✓		✓	✓
	Conservation	✓	✓	✓	✓	✓	✓	✓
	Soil				✓	✓	✓	✓
	Water		*Reporting*		✓	✓	✓	✓
	Air quality				✓	✓	✓	✓
	Practices	✓				✓	✓	✓
Social	Land rights		*Reporting*		✓	✓	✓	✓
	Human rights		*Reporting*		✓	✓	✓	✓
	Rural development	✓	*Reporting*		✓	✓	✓	✓
	Food security		*Reporting*		✓	✓	✓	✓
Economic					✓	✓		

Note:

- this table only refers to regulations specifically addressing biofuels; some impact categories may be covered by other general regulations;
- The table indicates existence of provisions related to the impact category not their completeness.

such as feed, the possible substitution to the biofuel feedstock, the manner through which the increased demand is satisfied and the adjustment of international trades. Land use change occurs if an increase of the production is the result of an increased use of land. It can be direct land-use change (LUC) when the use of a land is modified to produce biomass for biofuel, or ILUC when the market mechanisms induce change of use on other lands to produce biomass for uses other than biofuels.

The latter is more difficult to identify as it results from complex market mechanisms and from various actors' decision in terms of land use. The associated price adjustments and actors' decisions do not only occur in the biofuels feedstock market, nor in a single country. In addition, assessing land use change requires monitoring of land use over time and it is often not necessarily possible to isolate the effect of biofuels.

As it is impossible to identify iLUC as a result of biofuels from historical data, the main means to evaluate ILUC are based on economic simulations which compare situations with and without biofuel deployment. They use either partial equilibrium models, that describe the agriculture sector including the behaviour of demand depending on prices, the substitution mechanisms between products and the impact of policy and external parameters, or general equilibrium models which also describe the other sectors of the economy (e.g. energy and transport) and their interactions with the agricultural sector. Such models are complex and are not easily accessible to non-specialists. It should be noted that these simulations generally do not allow for distinguishing between LUC and ILUC, and provide a global evaluation of land use change emissions for a given scenario of deployment of biofuels.

An alternative to economic simulation are causal-descriptive approaches which aim at describing all the mechanism involved in land-use change and which use statistical analysis of historical trends together with experts' view to quantify the market response to an increase of demand [38]. In these approaches, prices are not explicitly considered but are contained in projections based on historical trends and experts' opinion.

As for LUC, the consequences in terms of GHG emissions highly depend on the nature of the converted lands. Most of these emissions occur over a relatively short period as the loss of standing biomass and soil carbon occurs within a few years after land conversion. For accounting purpose, emissions resulting from land use change are generally combined with life cycle emissions through amortisation over a given period (typically 20 years). In relation to the unit of energy of the fuel produced, this provides the ILUC factor (though as already mentioned this also often includes LUC emissions) that is to be added to the LCA emissions of the fuel.

Recent studies and literature reviews [37][38][39][40][41] tend to show an increase in biofuel GHG emissions when taking into account land use change. However studies show a large variation in the evaluations originating from significant uncertainties in data, models, scenarios and assumptions. There is currently no consensus on ILUC emissions, nor on the way to address ILUC issue, though some regulations such as the U.S RFS or the Californian Low Carbon Fuel Standard already include ILUC factors in LCA emissions associated to biofuels.

5.1.2 Mitigation measures and proposed approaches

Generally, three types of mitigation measures can be considered to prevent or minimise unwanted impacts of bioenergy production [42]:

1) Prevent unwanted direct land use change, globally and for all sectors (the ILUC of a given activity being the direct LUC of another activity), through land use monitoring and land use planning, which requires global action across all land-intensive sectors;
2) Reduce the need for additional lands from agriculture as a whole by increasing efficiency across all the value-chain steps (e.g. production yields, supply chain efficiency, reduction of waste);
3) Use production models that prevent indirect impacts at project level by implementing measures such as increasing efficiency, integrating food and fuel production, developing unused or underused land (e.g. marginal lands, set aside land or degraded lands) and use of end-of-life products that would otherwise be incinerated or sent to the landfill.

Category 1) of the measures clearly requires policy actions from States that also have the potential to promote category 2), in particular through R&D policy actions and support to agricultural development. These categories of measures would also certainly benefit from international coordination and cooperation considering the global nature of ILUC. For categories 2) and 3), attention should be paid to the possible impacts of intensified agricultural practices and to the possibility of developing agriculture on underused categories of land (such as marginal land), in particular for economic consideration.

Recently, Ecofys, EPFL and WWF International have proposed the Low Indirect Impact Biofuel (LIIB) methodology, which can be included in existing voluntary certification schemes[18] to distinguish biofuels with a low risk of causing indirect impacts [42]. It recognizes the implementation of the “conservation” category of mitigation measures in the production of biofuels. The overarching principle is to produce biofuel without displacing previous productive functions or provisioning service of land. Ideally, the methodology would request that the feedstock production be “additional”, meaning that such production should not have occurred in the absence of demand for biofuel. Thus, projects submitted are accepted for a given period only, as after a certain duration the project may no longer be considered “additional”. The certification is only delivered for a given volume of fuel determined from the actual performance of the project, for example the achieved yield increase for a project based on yield increases.

However, the proponents of the LIIB methodology do not believe that project-level action alone is effective to mitigate global land use change.

5.2 Bioenergy and food security

As stated in the 1996 World Food Summit Plan of Action, “food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”.

[18] RSB has recently decided to propose the LIIB as an optional complementary module in its certification (RSB Newsletter – July 2013)

Food security encompasses four dimensions: availability, access, utilization and stability, as well as a variety of determinants. Availability addresses the ”supply side” of food security and is determined by domestic food production plus imports and excluding exports. Variations in food stocks should be taken into account as well. Access refers to people’s ability to acquire appropriate foods for a nutritious diet, and is determined mainly by the income level of individuals, as well as by the price of food. Utilization is commonly understood as the way the body makes the most of various nutrients in the food. This dimension of food security is affected by a range of factors, including the health status of individuals, their access to clean water, and the way food is prepared, in addition to its nutritional value. Finally, stability refers to the availability of - and access to - adequate food at all times.

Modern bioenergy development can both positively and negatively affect the four dimensions of food security. The nature and magnitude of the impacts of modern bioenergy development on food security will depend on a number of factors, including:

- local environmental and socio-economic conditions and interaction between bioenergy and other sectors;
- the regional, national and local policy environment, especially in the areas of energy, agriculture, food security and environmental protection;
- the types of feedstocks, processing technologies and biofuels;
- the scale and ownership of production;
- the types of business models along the bioenergy supply chain; and
- the way production is managed and the extent to which sound environmental and socio-economic practices are implemented by operators.

Depending on these factors, modern bioenergy development could lead to any combination of the impacts on the four dimensions of food security described below.

5.2.1 *Availability*

On the one hand, the demand for bioenergy can lead to the diversion of certain crops from the food and feed markets to the energy market. This can be mitigated, at least in part, by the supply of livestock feed as biofuel co-product, which can free up crops and land for food. Even if non edible crops are used as bioenergy feedstocks, bioenergy production can still compete with food production by diverting resources and inputs such as land, water and fertilizers from the latter to the former . Furthermore, the demand for bioenergy can exacerbate pressures on natural resources and biodiversity (e.g. through land use changes), contributing to the loss or degradation of key ecosystem services supporting food production.

On the other hand, the increased demand for certain agricultural commodities for bioenergy production can stimulate new investments in agriculture, leading to an expansion of agricultural land and/or an increase in productivity. In addition, the demand for bioenergy can stimulate investments in agricultural Research and Development, with the introduction of improved seed varieties, inputs and management practices. Investments can also be triggered in infrastructure and logistics for the processing, transportation, storage and distribution of bioenergy products, with positive spillover effects on the agricultural and food sectors. Furthermore, modern bioenergy development can lead to an increase in fuel/energy availability for crop production, processing, storage and distribution, as well as for pumping irrigation water, including in remote rural areas.

5.2.2 Access

The increase in the global demand for certain agricultural commodities for bioenergy production can contribute to an increase in the international price of such commodities . This tends to have positive effects on net-exporting countries and negative effects on net-importing countries. This price increase is then transmitted from the international market to domestic markets . On average, an increase in the domestic price of agricultural commodities tends to have positive effects on net-producing households and negative effects on net-consuming households , especially on the poorest among the latter .

Beyond these immediate effects, however, behavioural responses by consumers, who can switch to less costly foods, can mitigate the negative welfare impacts on net-consuming households. In addition, in the long-run, the food price increase due to bioenergy can be mitigated or even reversed if an adequate supply response takes place through agricultural land expansion and/or productivity increases.

At the same time, the demand for bioenergy can create new employment opportunities along the supply chain, with positive effects on people’s income and access to food. A critical issue in measuring the impact of bioenergy production on employment and food security is the relative labour intensity of this production and the extent to which the employment generated is targeted at the poor. At a farm level, for instance, it is crucial to understand the labour requirements of the bioenergy feedstock per unit of area-time (e.g. per hectare per year) compared to the labour requirements of the crops planted previously. The labour intensity of alternative land uses should be considered as well. On average, small scale bioenergy production seems likely to generate more employment for the poor than large scale bioenergy production, which tends to be more capital intensive and less labour intensive. By opening up new markets for agricultural products (including residues) and services, the demand for bioenergy can also foster enterprise development and contribute to the diversification of farm income, especially if integrated food-energy systems are implemented. This can have positive effects on access to food by farmers, including smallholders.

5.2.3 Utilization

On the one hand, the demand for bioenergy can exacerbate pressures on water resources, leading to a reduction in water availability and potability. In addition, local sources of fuel-wood for cooking can be displaced (e.g. through land use changes).

On the other hand, if the reliance on fuel-wood and charcoal is reduced and access to modern energy services is improved, modern bioenergy development can lead to a decrease in indoor pollution and in the time spent collecting traditional fuels, with positive effects on human health. Increased access to modern energy services through bioenergy development can also lead to improved food storage and preparation, as well as increased potential for pumping water for household use, with additional health benefits.

5.2.4 Stability

On the one hand, the global demand for bioenergy can strengthen the linkages between energy markets and agricultural markets, contributing to an increase in the volatility of food prices, which net-importing low-income, food-deficit countries are particularly vulnerable to.

On the other hand, modern bioenergy development can contribute to the diversification of a country's energy mix . This can lead to a reduction in the dependence on fossil fuels and in the vulnerability of the domestic economy and agricultural sector to fluctuations in oil prices, with positive effects on food stability.

The demand for bioenergy can also affect the vulnerability of the agricultural supply to both climatic and market shocks, depending on the diversity of the agricultural systems that are established for the production of bioenergy and of those that are displaced.

6 CONCLUSION

This document aimed to provide a consolidated view of the various components of sustainability in the context of biofuel development and of the approaches developed to date to promote and ensure the sustainable development of bioenergy and biofuels.

It highlighted the different approaches that are relevant to the different levels of actors, from producers to States, answering to different needs in the development of sustainable alternative fuels. Considering the broad scope of possible impacts of the development of bioenergy at both the local and global scale, these different levels of approaches have complementary roles and need to be combined in order to achieve sustainable deployment. Integrating sustainability into policies, projects planning and decision-making is also essential. A solid foundation of measures and tools is available to States and stakeholders to develop their respective policies and strategies to successfully and sustainably engage in biofuels.

Sustainability is an area that continues to be defined and some issues need further elaboration and development.

In particular, indirect impacts of bioenergy development are still difficult to address. They require additional methodological work and would benefit from international cooperation.

This document also highlighted the differences in requirements among existing voluntary standards and also among emerging national or regional regulations. As often raised in debates about sustainability, an increased convergence would yield benefits from the general point of view of feedstock producers supplying different final-products markets or fuel producers selling in different countries. The meta-standard approach, recognizing other sectorial standards, can be seen as a step in this direction. As underlined by the SUSTAF experts group, for a fully international sector of activity like commercial aviation where aircraft operate daily over multiple geographic areas, the coexistence of disparate regulations and procedures could be even more burdensome. While challenging to achieve, greater harmonisation between national policies and/or the definition of mechanisms for mutual recognition would significantly facilitate the deployment of sustainable alternative fuels in aviation.

Last, as the importance of integrating sustainability in the planning and decision-making process was emphasized, the general context of the development of alternative fuels in aviation should also be mentioned. In light of the growing demand for biomass resources for various uses in the context of a growing population, increasing scarcity of fossil resources, and the pressure of climate change, an integrated “system thinking” across the various sectors of the economy is desirable to address aviation alternative fuels in the global context of energy demand.

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APPENDIX A: THE ROUNDTABLE ON SUSTAINABLE BIOMATERIALS

An example of voluntary standard and certification scheme

The Round Table for Sustainable Biofuels (RSB, www.rsb.org) is presented here as an example of an existing voluntary standard and certification scheme as it is the only scheme that was specifically designed for biofuel value chains. In addition, this scheme has also received the support of aviation organizations, such as SAFUG or IATA, who are members of the RSB.

The RSB presents a detailed framework covering a broad scope of sustainability aspects with key as well as a complete set of instruments:

- the principles and criteria are commented in a guidance document;
- they are completed by a precise set of more than 250 indicators of compliance; and
- several guidelines documents have been published in association with the 12 principles, providing a detailed approach to improve the sustainability of any biofuel.

The following tables present the principles and associated criteria considered for biofuel production certification under the RSB voluntary certification scheme.

Principles	**Criterion**	**Sub-criteria**
Legality	Biofuel operations shall follow all applicable laws and regulations.	Biofuel operations shall comply with all applicable laws and regulations of the country in which the operation occurs and with relevant international laws and agreements.
Greenhouse gas emissions	Biofuels shall contribute to climate change mitigation by significantly reducing life cycle GHG emissions as compared to fossil fuels.	In geographic areas with legislative biofuel policy or regulations in force, in which biofuel must meet GHG reduction requirements across its life cycle to comply with such policy or regulations and/or to qualify for certain incentives, biofuel operations subject to such policy or regulations shall comply with such policy and regulations and/or qualify for the applicable incentives.
		Life cycle GHG emissions of biofuel shall be calculated using the RSB life cycle GHG emission calculation methodology.
		Biofuel blends shall have on average 50% lower life cycle greenhouse gas emissions relative to the fossil fuel baseline. Each biofuel in the blend shall have lower life cycle GHG emissions than the fossil fuel baseline.
Conservation	Biofuel operations shall avoid negative impacts on biodiversity, ecosystems, and other conservation values	Conservation values within the potential or existing area of operations shall be identified through a land-use planning process. Conservation values of local, regional or global importance within the potential or existing area of operation shall be maintained or enhanced
		Ecosystem functions and services that are directly affected by biofuel operations shall be maintained or enhanced
		Biofuel operations shall protect, restore or create buffer zones
		Ecological corridors shall be protected, restored or created to minimize fragmentation of habitats
		Biofuel operations shall prevent invasive species from invading areas outside the operation site.
Soil	Biofuel operations shall implement practices that seek to reverse soil degradation and/or maintain soil health	Operators shall implement a soil management plan designed to maintain or enhance soil physical, chemical, and biological conditions

Principles	**Criterion**	**Sub-criteria**
Water	Biofuel operations shall maintain or enhance the quality and quantity of surface and ground water resources, and respect prior formal or customary water rights	Biofuel operations shall respect the existing water rights of local and indigenous communities.
		Biofuel operations shall include a water management plan which aims to use water efficiently and to maintain or enhance the quality of the water resources that are used for biofuel operations
		Biofuel operations shall not contribute to the depletion of surface or groundwater resources beyond replenishment capacities
		Biofuel operations shall contribute to the enhancement or maintaining of the quality of the surface and groundwater resources
Air	Air pollution from biofuel operations shall be minimized along the supply chain	Air pollution emission sources from biofuel operations shall be identified, and air pollutant emissions minimized through an air management plan.
		Biofuel operations shall avoid and, where possible, eliminate open-air burning of residues, wastes or by-products
Use of Technology, Inputs, and Management of Waste	The use of technologies in biofuel operations shall seek to maximize production efficiency and social and environmental performance, and minimize the risk of damages to the environment and people.	Information on the use of technologies in biofuel operations shall be fully available, unless limited by national law or international agreements on intellectual property
		The technologies used in biofuel operations including genetically modified: plants, micro-organisms, and algae, shall minimize the risk of damages to environment and people, and improve environmental and/or social performance over the long term.
		Micro-organisms used in biofuel operations which may represent a risk to the environment or people shall be adequately contained to prevent release into the environment
		Good practices shall be implemented for the storage, handling, use, and disposal of biofuels and chemicals
		Residues, wastes and by-products from feedstock processing and biofuel production units shall be managed such that soil, water and air physical, chemical, and biological conditions are not damaged

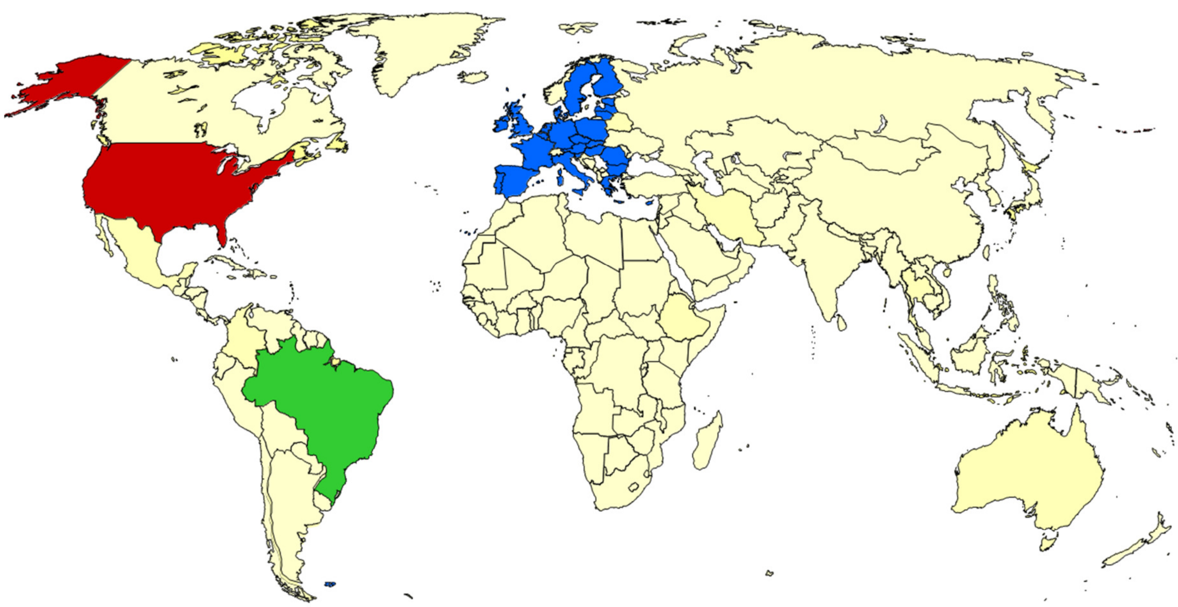
Principles	Criterion	Sub-criteria
Human and labour rights	Biofuel operations shall not violate human rights or labor rights, and shall promote decent work and the well-being of workers	Workers shall enjoy freedom of association, the right to organize, and the right to collectively bargain.
		No slave labor or forced labor shall occur.
		No child labor shall occur, except on family farms and then only when work does not interfere with the child's schooling and does not put his or her health at risk
		Workers shall be free of discrimination of any kind, whether in employment or opportunity, with respect to gender, wages, working conditions, and social benefits
		Workers' wages and working conditions shall respect all applicable laws and international conventions, as well as all relevant collective agreements. Where a government regulated minimum wage is in place in a given country, this shall be observed. Where a minimum wage is absent, the wage paid for a particular activity shall be negotiated and agreed on an annual basis with the worker. Men and women shall receive equal remuneration for work of equal value.
		Conditions of occupational safety and health for workers shall follow internationally-recognized standards.
		Operators shall implement a mechanism to ensure the human rights and labor rights outlined in this principle apply equally when labor is contracted through third parties
Rural and social development	In regions of poverty, biofuel operations shall contribute to the social and economic development of local, rural and indigenous people and communities.	In regions of poverty, the socioeconomic status of local stakeholders impacted by biofuel operations shall be improved
		In regions of poverty, special measures that benefit and encourage the participation of women, youth, indigenous communities and the vulnerable in biofuel operations shall be designed and implemented

Principles	Criterion	Sub-criteria
Land rights	Biofuel operations shall respect land rights and land use rights	Existing land rights and land use rights, both formal and informal, shall be assessed, documented, and established. The right to use land for biofuel operations shall be established only when these rights are determined
		Free, Prior, and Informed Consent shall form the basis for all negotiated agreements for any compensation, acquisition, or voluntary relinquishment of rights by land users or owners for biofuel operations
Planning, monitoring and continuous improvement	Sustainable biofuel operations shall be planned, implemented, and continuously improved through an open, transparent, and consultative Environmental and Social Impact Assessment (ESIA) and an economic viability analysis.	Biofuel operations shall undertake an Environmental and Social Impact Assessment (ESIA) to assess impacts and risks and ensure sustainability through the development of effective and efficient implementation, mitigation, monitoring and evaluation plans.
		Free, Prior & Informed Consent (FPIC) shall form the basis for the process to be followed during all stakeholder consultation, which shall be gender sensitive and result in consensus-driven negotiated agreements.
		Biofuel operators shall implement a business plan that reflects a commitment to long-term economic viability.

APPENDIX B: ADDITIONAL INFORMATION ON EXISTING EXAMPLES OF SUSTAINABILITY REGULATIONS

Note:

This appendix is only intended to provide more insight in existing regulations. The purpose is not to provide an exhaustive analysis of these regulations, nor any interpretation of them. For implementation of these regulations, the reader should refer to the official texts provided by relevant regional or national administrations.



1. BRAZIL

Sustainability requirements in Brazil are addressed in a variety of national regulations and policies. They are focused mainly on land-use restrictions. Brazil also has a specific policy for incentivizing the social benefits of biofuels production.

In order to protect its enormous carbon sinks from possible impacts linked with the expansion of biofuel production, the Brazilian National Policy on Climate Change addresses the need to preserve environmental resources, with particular attention to the major natural biomass reserves considered as national heritage.

As part of its National Policy, Brazil presented in 2010, during COP 10 on Biodiversity, the "*Amazon Region Protected Areas*" (ARPA) program, which established, on its first phase, 44 conservation units in the Brazilian Amazon and implemented 62 other protected areas. ARPA aims to be one the main national regulatory tools to achieve climate change goals and protect biodiversity.

Another key land-use related regulation is the Brazilian Forest Code: it established that at least 20% of individual farms land (increasing it between 50% and 80% in the Amazon region) must be set aside in order to protect natural resources, including water and biodiversity. In addition, stretches of land along water bodies as well as those with slopes above 45° are Areas of Permanent Preservation and cannot legally be converted to production.

Additionally, Brazil has created the "Social Fuel Stamp” which is an identification granted by the Ministry of Agrarian Development to producers of biodiesel that promote social inclusion and regional development through job generation and income for community farmers. It is adjusted according to the criteria of Pronaf (*Programa Nacional de Fortalecimento da Agricultura Familiar*), a program to enhance family farming.

The stamp is granted only to the producers of biodiesel that meet the following three criteria.

1. Buying raw material from community agriculture in a minimal percentage of:
   – 50% Northeast region and Semi-arid region,
   – 10% Northern region and Center-Western region; and
   – 30% South-east region and South region.
2. Executing agreements negotiated with community farmers, making evident at least:
   – The contractual term;
   – The value of purchase and criteria of contracted price adjustment;
   – The conditions of delivery of raw material;
   – The safeguards of each part; and
   – The identification and agreement of a representative of farmers who have participated to the negotiations.
3. Secure presence and technical education to communitarian farmers.

2. EUROPEAN UNION: EU RED DIRECTIVE

The regulatory framework for biofuels in the European Union is defined by the Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources (usually referred to as the Renewable Energy Directive, RED).

The primary purpose of RED is to set binding targets at the European level for the introduction of renewable energy by 2020, including:

– at least 20 % of the European Union’s gross final consumption of energy should come from renewable energies;

– the share of energy from renewable sources in all forms of transport should be at least 10 % of the final consumption of energy in transport.

No specific quota is defined for aviation but consumption of biofuels in aviation can contribute to the achievement of the 10% target.

The Directive establishes a specific goal for each EU Member States and requests the development of a mandatory National Action Plan which outlines goals for 2020 in transport, electricity, heating and cooling, and includes strategies for the development of biomass and mobilization of new biomass resources. The Directive also set rules for guarantee of origin, administrative procedures and connection to the electricity grid, and also defines environmental sustainability criteria for biofuels.

RED is also complemented by the Directive 2009/30/CE, the “Fuel Quality Directive”, which enjoins suppliers to reduce up to 10% by 2020 the GHG emissions from fuel and energy supplied.

In order to guarantee the beneficial effects of the use of renewable energy, biofuels[19] and bioliquids[20] consumed in the EU must meet sustainability criteria based on maximum levels of GHG emissions, land use (and associated carbon stocks), biodiversity and environmental requirements for agriculture. Biofuels that do not meet the criteria will not count in meeting the objectives of the EU and will not benefit from tax exemptions or other type of fiscal benefits.

Sustainability criteria for biofuels and bioliquids

RED provides a set of sustainability requirements for biomass based fuels. They apply to biofuels produced in the EU or imported in the EU. Members States are responsible for making sure these criteria are met when (and only when) biofuels:

– are counted for compliance with national targets set by the Directive or for compliance with renewable energy obligations;

– receive financial support for their consumption.

The same sustainability criteria apply for fuel counted towards the target of the Fuel Quality Directive for reducing greenhouse gas emissions.

Three articles of the Directive are expressly dealing with sustainability criteria for biofuels:

– Article 17 on the “Sustainability criteria for biofuels and bioliquids”;

– Article 18 on the “Verification of compliance with the sustainability criteria for biofuels and bioliquids”;

– Article 19 about the “Calculation of the greenhouse gas impact of biofuels and bioliquids”.

Article 17 (sustainability criteria for biofuels and bioliquids) focuses on 3 major aspects:

[19] Liquid and gaseous fuels used in transportation
[20] Liquid fuels used to generate heat and electricity

1. Greenhouse gas emission net reduction from the use of biofuels shall be at least 35%. For biofuels produced in installations in operation from January 2008, this obligation shall apply from 1 April 2013. From January 2017 the net reduction shall be at least 50%, and 60% from January 2018 in facilities that are operated from 2017.

   This criterion is the only one applying for biofuels and bioliquids produced from waste and residues, other than agricultural, aquaculture, fisheries and forestry residues.

   The RED comes with binding guidelines for the calculation of land carbon stocks.

2. Raw material shall not be obtained from land with high value: high biodiversity value (paragraph 3), high carbon stock (paragraph 4) or peat land (paragraph 5), apart from very few exceptions;

3. Agricultural raw materials cultivated in the Community and used for the production of biofuels shall be obtained in accordance with the requirements and standards applying for direct support schemes for farmers under the common agricultural policy and in accordance with the minimum requirements for good agricultural and environmental conditions defined in that Regulation (1782/2003 - cross-compliance with good agricultural practices and environmental practices). This requirement applies only for raw materials originating in the EU.

In addition to these requirements, the European Commission must report (paragraph 7):

- every two years about the national measures taken to respect sustainability criteria;
- every two years about the societal impacts and in particular about the availability of food at an affordable price especially for people living in developing countries;
- about the implementation of major international conventions at members States and third countries level.

Sustainability criteria are harmonized at Community level. Member States should not set additional criteria.

Verification of compliance with sustainability criteria

Member states must assure that biofuels comply with E.U. sustainability requirements. They shall take measures to ensure that producers submit reliable and clear information to prove that their operations are fulfilling the different criteria set up by the European Commission.. Audits may be conducted to verify that the systems used are accurate, reliable and resistant to fraud, to evaluate the frequency and sampling methodology and the robustness of the data. These obligations apply whether the biofuels and other bioliquids are produced in the EU or imported.

Operators have to use a mass balance system which allows consignments of raw material or biofuel with differing sustainability characteristics to be mixed.

In June 2010, the European Commission complemented the RED by two Communications for the implementation of sustainability rules[21]. Three possibilities are in particular proposed for operators to demonstrate their compliance with sustainability requirements:

1. by providing the relevant national authorities with data in compliance with requirements that the Member State has laid down ("national system", all Member States must provide one);
2. by using one of the voluntary schemes recognized by the Commission;
3. in accordance with the terms of bilateral or multilateral agreement concluded by the Union with third countries.

Since 19 July 2011, the EC has recognized 14 voluntary schemes that apply directly in 27 EU Member States[22].

Calculation of GHG emissions

To demonstrate compliance with the GHG reduction thresholds, operators can use default values provided by the RED for 22 biofuel production pathways in order to reduce the administrative burden on economic operators. The default values are available to producers who want to use them without having to perform a Life Cycle Analysis (LCA) of their product. For other production pathways operators have to do their own calculations according to a given methodology described in the RED.

These default values are set at a conservative level to make it unlikely for economic operators to claim values that are better than their actual value. For example, the published default values for the biodiesel pathways from rapeseed and soybean do not pass the 35% minimum GHG saving and palm oil only passes with methane captured at the mill.

The Directive also provides counting rules for particular biofuel cases:

- For fuel consisting only partly of biofuels, the contribution of each source is to be taken into account on the basis of its energy content - for the purposes of compliance with the sustainability criterion on greenhouse gas savings, the biomass-derived part of fuels has to meet the appropriate threshold;
- Biofuels produced from wastes and residues count double for demonstrating compliance with the 10 % target for the share of energy in all forms of transport in 2020.

Waste and residues are not defined by the directive. Waste can be understood as any substance or object which the holder discards or intends or is required to discard. Residues can include agricultural, aquaculture, fisheries and forestry residues, and processing residues (a processing residue is a substance that is not the end product(s) that a production process directly seeks to produce. It is not a primary aim of the production process and the process has not been deliberately modified to produce it).

[21] Communication 2010/C 160/02 - Communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels – and 2010/C 160/01 - Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme

[22] List is available at http://ec.europa.eu/energy/renewables/biofuels/sustainability_schemes_en.htm

3. UNITED STATES OF AMERICA: RENEWABLE FUEL STANDARD

The RFS program was created under the Energy Policy Act (EPAct) of 2005. Amending the Clean Air Act (section 211), it established a renewable fuel mandate that requires transportation fuel sold in the U.S. to contain a minimum volume of renewable fuels.

For the original program (RFS1), the objective was to reach 7.5 billion gallons of renewable fuel to be blended into gasoline by 2012. Under the Energy Independence and Security Act (EISA) of 2007, the objectives were expanded in order to include other renewable fuel categories and increase the volume of renewable fuel required to be blended into transportation fuel from 9 billion gallons in 2008 to 36 billion gallons by 2022. The 2007 ESIA also included the requirement to apply lifecycle greenhouse gas performance threshold to ensure that renewable fuels emit fewer greenhouse gases than the fossil fuel it replaces.

A unique feature of the RFS2 is to include quotas per category of biofuels: renewable biofuel, cellulosic biofuel, biomass based diesel and advanced biofuels (Table 2). These categories are defined as follows, the GHG emissions performance being a criteria to qualify for a category of biofuel.

- Renewable Biofuel: Any fuel derived from starch feedstocks. This category covers mainly corn ethanol. Renewable biofuels produced in plants built after 2007 must demonstrate a 20% reduction in life cycle GHG emissions compared to the baseline.
- Biomass-Based Diesel: A diesel fuel substitute made from renewable feedstocks, including biodiesel and nonester renewable diesel. It cannot be co-processed with petroleum (such fuels fall under an undifferentiated advanced biofuels category). This category must have life cycle GHG emissions at least 50% lower than the baseline.
- Cellulosic Biofuel: Any fuel derived from cellulose, hemicellulose, or lignin—nonfood-based renewable feedstocks. This category must have life cycle GHG emissions at least 60% lower than the baseline.
- Advanced Biofuel: Any fuel derived from renewable feedstocks. This may include sugarcane or sugar beet-based fuels; renewable diesel co-processed with petroleum; and other biofuels that may exist in the future. Both biomass-based diesel and cellulosic biofuel that exceeds volumes in their respective categories may be used to meet this category. Fuels in this category must demonstrate life cycle GHG emissions reductions of 50% compared to the baseline.

EISA Renewable Fuel Volume Requirements (billion gallons)

Year	Cellulosic biofuel requirement	Biomass-based diesel requirement	Total Advanced biofuel requirement	Total renewable fuel requirement
2008	n/a	n/a	n/a	**9.0**
2009	n/a	0.5	0.6	**11.1**
2010	0.1	0.65	0.95	**12.95**
2011	0.25	0.80	1.35	**13.95**
2012	0.5	1.0	2.0	**15.2**
2013	1.0	a	2.75	**16.55**
2014	1.75	a	3.75	**18.15**
2015	3.0	a	5.5	**20.5**
2016	4.25	a	7.25	**22.25**
2017	5.5	a	9.0	**24.0**
2018	7.0	a	11.0	**26.0**
2019	8.5	a	13.0	**28.0**
2020	10.5	a	15.0	**30.0**
2021	13.5	a	18.0	**33.0**
2022	16.0	a	21.0	**36.0**
2023+	b	b	b	**b**

[a] *To be determined by EPA through a future rulemaking, but no less than 1.0 billion gallons.*

[b] *To be determined by EPA through a future rulemaking.*

Table 2: EISA Renewable Fuel Requirements

Another noticeable feature of the RFS is to include land use change (both direct and indirect) in the thresholds on life cycle emissions.

The RFS program regulations specify the types of renewable fuels eligible to participate in the program and the procedures by which renewable fuel producers and importers may qualify for the ESIA objectives through approved fuel pathways. Environmental Protection Agency (EPA) establishes the volume requirements for each category based on legislated volumes and fuel availability.

EPA has promulgated a credit trading program, allowing obligated parties to generate or acquire credits to demonstrate compliance with their annual renewable fuel volume obligations. Credits can also be used by an obligated party to meet its requirements in the following year, or traded for use by another obligated party. RINs, Renewable Identification Numbers, form the basic currency for the RFS. A RIN must be generated for all renewable fuel produced or imported into the United States, and RINs must be acquired by obligated parties for use in demonstrating compliance with the RFS annual requirements. EPA’s program requires RINs to be transferred with renewable fuel until the point at which the renewable fuel is either: (a) purchased by an obligated party, or (b) blended into gasoline or diesel fuel by a blender. At such time, RINs are “separated” from the volumes. RINs have a monetary value and can then be traded on the market independently from the volume to which it had originally been assigned. In order to generate RINs, the fuel must comply with the RFS2 definition of renewable fuel.

For fuels to be qualified as renewable, the EISA requires them to be made from feedstock that qualify as “renewable biomass”. EISA's definition of the term "renewable biomass" limits the types of biomass as well as the types of land from which the biomass may be harvested. The term "renewable biomass" means each of the following[23]:

(i) Planted crops and crop residue harvested from agricultural land cleared or cultivated at any time prior to the enactment of this sentence that is either actively managed or fallow, and nonforested.

(ii) Planted trees and tree residues from actively managed tree plantations on non-federal land cleared at any time prior to enactment of this sentence, including land belonging to an Indian tribe or an Indian individual, that is held in trust by the United States or subject to a restriction against alienation imposed by the United States.

(iii) Animal waste material and animal by-products.

(iv) Slash and pre-commercial thinnings that are from non-federal forestlands, including forestlands belonging to an Indian tribe …, but not forests or forestlands that are ecological communities with a global or State ranking of critically imperiled, imperiled, or rare pursuant to a State Natural Heritage Program, old growth forest, or late successional forest.

(v) Biomass obtained from the immediate vicinity of buildings and other areas regularly occupied by people, or of public infrastructure, at risk from wildfire.

(vi) Algae.

(vii) Separated yard waste or food waste, including recycled cooking and trap grease.

RFS2 places the same duties on foreign producers of renewable fuels as domestic ones including the registration with EPA and the possibility of independent inspection.

[23] Energy Independence and Security Act (EISA) of 2007, Title II, subtitle A – Renewable Fuel Standard.