ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/305621884

Examining Sustainability Certification of Bioenergy

Technical Report · February 2013

DOI: 10.13140/RG.2.1.2427.2884

CITATIONS
5

READS
218

12 authors, including:

Luc Pelkmans
CAPREA Sustainable Solutions
70 PUBLICATIONS **947** CITATIONS

SEE PROFILE

Chun Sheng Goh
Harvard University
33 PUBLICATIONS **870** CITATIONS

SEE PROFILE

Jamie Joudrey
Ontario Ministry of the Environment
6 PUBLICATIONS **27** CITATIONS

SEE PROFILE

Helena Chum
National Renewable Energy Laboratory
172 PUBLICATIONS **3,085** CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:

Project — Optimising lignocellulosic energy crop cultivation in terms of socioeconomic and environmental sustainability View project

Project — Forest carbon pool development over 35 years in a balsam fir-red spruce forest in northern Maine View project

All content following this page was uploaded by Oskar Englund on 25 July 2016.

The user has requested enhancement of the downloaded file.

IEA Bioenergy

Strategic Intertask Study (Task 40/43/38):
Monitoring Sustainabiility Certification of Bioenergy

Examining Sustainability Certification of Bioenergy

IEA Bioenergy

Strategic Inter-Task Study:
Monitoring Sustainability Certification of Bioenergy

A cooperation between IEA Bioenergy Task 40, Task 43 and Task 38

Task 1: Examining Sustainability Certification of Bioenergy

A study commissioned by IEA Bioenergy

February, 2013

Liesbet Goovaerts, VITO, Belgium
Luc Pelkmans, VITO, Belgium
Chun Sheng Goh, Utrecht University, the Netherlands
Martin Junginger, Utrecht University, the Netherlands
Jamie Joudrey, University of Toronto, Canada
Helena Chum, National Renewable Energy Laboratory, USA
C.T. (Tat) Smith, University of Toronto, Canada
Inge Stupak, University of Copenhagen, Denmark
Annette Cowie, University of New England, Australia
Lena Dahlman, Swedish Bioenergy Association, Sweden
Oskar Englund, Chalmers University of Technology, Sweden
Alison Goss Eng, US Department of Energy, USA

Strategic Inter-Task Study:
Monitoring Sustainability Certification of Bioenergy

At present numerous biomass and biofuel sustainability certification schemes are being developed or implemented by a variety of private and public organisations. Schemes are applicable to different feedstock production sectors (forests, agricultural crops), different bioenergy products (wood chips, pellets, ethanol, biodiesel, electricity), and whole or segments of supply chains. There are multiple challenges associated with the current status of sustainability certification, i.e. the proliferation of schemes has lead to – to name a few – confusion among actors involved, market distortion and trade barriers, an increase of commodity costs, questions on the adequacy of systems in place and how to develop systems that are effective and cost-efficient.

Within IEA Bioenergy a strategic study was initiated among Tasks 40, 43 and 38 to monitor the actual implementation process of sustainability certification of bioenergy. The study was executed between January 2012 and February 2013. Its main goals were to evaluate how stakeholders are affected by certification initiatives, quantify the anticipated impact on worldwide bioenergy trade, assess the level of coordination among schemes, and make recommendations to remove barriers which may depress markets and reduce sustainable trade. A worldwide survey was launched to investigate the operational experiences of people actively involved with any aspects of bioenergy production systems, including those engaged in biomass feedstock production, conversion into primary and secondary biofuel and bioenergy products, markets and trade. The survey placed a particular focus on the input of stakeholders on how systems can be improved to be more effective. Many people have responded - we have received over 200 survey responses, from all over the world.

The study has produced four reports, which are available on-line on the IEA Bioenergy website, and the sites of the participating tasks*:

- Task 1: Examining sustainability certification of bioenergy
- Task 2: Survey on governance and certification of sustainable biomass and bioenergy
- Task 3: Impacts of sustainability certification on bioenergy markets
- Task 4: Recommendations for improvement of sustainability certified markets

On Tuesday 12 March 2013 the main outcomes of the study were presented in a workshop, in connection to the World Biofuels Markets in Rotterdam.

* www.ieabioenergy.com
www.bioenergytrade.org *(Task 40, Sustainable Bioenergy Trade)*
www.ieabioenergytask43.org *(Task 43, Biomass Feedstocks for Energy Markets)*
http://www.ieabioenergy-task38.org *(Task 38, Climate Change Impacts)*

The authors would like to gratefully acknowledge the IEA Bioenergy Executive Committee for providing funding to make the project possible. We would especially like to thank the interviewees and the respondents of the survey, for providing thoughtful and engaging answers, and helping to move the discussion beyond the identification of problems, toward solutions.

Table of Contents

1 Introduction 5
2 Approach 7
3 Current regulatory sustainability requirements 8
3.1 European Union 8
The European Renewable Energy Directive (RED - Directive 2009/28/EC) 8
EU Member States – selected examples 10
3.2 United States 11
US Renewable Fuel Standard (RFS-2) 11
The California Low Carbon Fuel Standard (LCFS) 12
4 Introduction to voluntary certification systems 13
5 Selecting certification schemes for further analysis 16
6 Characteristics of selected voluntary schemes 18
6.1 Standard setting and governance mechanism 18
6.2 Chain of Custody standard 27
6.3 Information handling 30
6.4 Assessment procedures 31
6.5 Relation with policies and other schemes 33
7. Key conclusions 37
List of literature 39
List of abbreviations 44

Disclaimer

This report was written for IEA Bioenergy. The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the IEA or the members of the IEA Bioenergy Implementing agreement. IEA Bioenergy has reviewed and approved this report, but is not responsible for any use that may be made of the information or opinions contained therein.

1 Introduction

In recent years the bioenergy market has increased in importance, and international trading of biomass feedstocks and biofuels has expanded. There is also an increased awareness of the importance that the production of biomass feedstock and biofuels be sustainable. In order to ensure that bioenergy is developed in an environmentally, economically and socially sustainable way, a range of policy instruments can be used to require or promote good practices throughout the supply chain.

Establishing certification schemes is one of the strategies to ensure that bioenergy is produced in a sustainable manner and is often thought to be the most suitable instrument for the development of sustainable bioenergy systems (Ladanai S., Vinterbäck J., 2010). At present, numerous sustainability certification systems have been developed, on national and international level. These certification systems differ in many ways: not only are they developed by different organisations, they have also developed to serve many different feedstocks (e.g. forests, agricultural crops), bioenergy products (e.g. relatively unprocessed forest residues, ethanol, biodiesel, electricity), and to apply to whole or segments of the supply chain (e.g. production system, chain of custody from growers to energy consumers).

Recently several articles and reports have examined and compared a number of existing sustainability initiatives and policies. The overview of sustainability standards and biomass and bioenergy certification systems prepared by Van Dam et al. (2010) shows the wide range of initiatives that exist, and indicates differences and similarities between selected initiatives (EC-RED, US-RFS, RTRS, RSPO, BSI, RSB, ISCC, NTA8080, RTFO, SAN, FSC, GlobalGAP and CERTFOR) with regard to the sustainability principles, and how verification and monitoring is included anno 2009 (i.e. GHG calculation methodologies). Scarlat and Dallemand (2011) have also assessed the main roundtable initiatives (RSPO, RTRS, Bonsucro, RSB, CSBP, GBEP and ISO) and EU sustainability requirements for biofuels and bioenergy certification (EU-RED, UK-RTFO, Cramer criteria, ISCC and CEN) by comparing sustainability principles covered and chain-of-custody systems in place or under development (anno 2009). In a study from DG Energy (2011) a comparative analysis has been made of the sustainability criteria in national regulations from EU Member States that link with the use of biomass for bioenergy, 4 voluntary schemes (NTA8080, Laborelec, DRAX, GGL and Swan) and the Renewable Energy Directive (RED). Stupak et al. (2011) presents an overview of existing sustainable forest management processes and certification schemes (FSC and PEFC), and reviews how they are developed and address sustainable production of forest fuels. The FAO project Bioenergy and Food Security Criteria and Indicators (BEFSCI) provides a series of papers and studies. A recent "Compilation of Tools and Methodologies to Assess the Sustainability of Modern Bioenergy" is a good source of tools and methods, from a global viewpoint, for environmental and socioeconomic dimensions (FAO, 2012). The BEFSCI web site lists more examples of government frameworks, voluntary standards, and scorecards for bioenergy sustainability. Another review of existing frameworks and activities on bioenergy sustainability was prepared as the Global Bioenergy Partnership (GBEP) with 23 partner countries and 13 international organizations participants, along with 23 observer countries and 11 observer international organizations as they reached consensus on globally acceptable principles and 24 indicators for sustainability regarding the production and use of broadly defined modern bioenergy, including biofuels. GBEP-developed indicators provide policy-makers and other stakeholders with a set of analytical tools that can inform the development of national bioenergy policies and programs, and provide tools for monitoring the impact of these policies and programs, which are expected to be rolled up to the country level. The indicators are being shared with developing countries envisioning the development of biofuels and bioenergy (Working Group on Capacity Building) so that this knowledge can guide the development of their

programs along with the understanding of the measuring tools to assess these programs in the future and set possible course corrections. (http://www.globalbioenergy.org/).

These recent reports give an overview of the variety of certification schemes that exist and how they address the sustainability of biomass feedstocks and bioenergy production. They all conclude that to evolve to a sustainable bioenergy production the harmonisation of definitions and calculation methodology is needed, and that a unified framework of ecological, social and economic criteria is recommended.

To ensure sustainable biomass, biofuel and bioenergy production also effective and efficient implementation and verification systems need to be in place, e.g. management, tracking and auditing procedures. The reports mentioned above did not elaborate deeply on these aspects as for some of the initiatives these procedures were not yet in place. They do however indicate that implementation and verification of sustainability standards is complicated and not straightforward considering the differences in definitions, criteria and indicators and calculation methodologies. Also standard setting and governance mechanisms are covered less comprehensively in the literature.

Within this context, the overall objective of this task is to elaborate further on the standard setting, implementation and verification of these sustainability certification initiatives. We will examine the various approaches of selected sustainability schemes for agriculture, forestry, biomass, biofuels and bioenergy and their practical applicability; what type of tracking procedures are in place (Chain-of Custody standards), how do they ensure sustainability.

This task focuses on initiatives which are having, or are expected to have, an important impact on the bioenergy market. Major initiatives are for example those approved by EU, national systems in countries with high bioenergy use, or relatively high imports or exports of biomass and biofuels. The schemes mentioned in this report are among the best known, but many other exist. The comparisons presented here are not intended to be comprehensive but rather provide illustrative examples of how existing schemes and initiatives have been and are being implemented. This should to provide the reader with an overview and a clearer picture of how these schemes work, and how they are similar or different, and how they are interlinked. In addition, most of these systems have continuous improvement practices built in and evolve over time.

2 Approach

The work is built upon global reviews of certification developments published by Task 40 (van Dam et al. 2010), Task 43 (FAO 2010, Lattimore et al. 2009, Stupak et al. 2011), and updated where necessary with insights from Task 40, Task 43 and Task 38 experts. Similar assessments and evaluations have been performed by other institutes, i.e. most recently by NL Agency (May 2011, March 2012). Our analysis does not go into detail on the sustainability criteria as such, since this has already been dealt with in just mentioned reports and articles, but our work examines and refines the analysis and compares the results with findings in the mentioned studies (see § 1). Information on the Americas was built on the work of the U.S. Department of Energy sustainability analysis and bilateral activities with Brazil, and significant global publications including this topic. [1]

The work was approached in the following steps:

1. Discussion of legislative frameworks (see § 3);
2. An introduction to voluntary certification systems (see §4);
3. Selecting specific certification schemes for analysis (§5):
4. Detailed analysis of selected schemes using a structured template to identify general aspects (§6):
    - Standard-setting and governance
    - Chain of Custody
    - Information handling along the supply chain
    - Assessment procedures
    - Relation with policies and other schemes
5. Discussion of key conclusions based on the review of the characteristics and relationship of the selected certification schemes (§7).

[1] See, for instance, http://www.obpreview2011.govtools.us/analysis/ sustainability activities; REN21. Renewables 2012 Global Status Report. Paris: REN21 Secretariat, 2012; Chum, H.; Faaij, A.; Moreira, J.; Berndes, G.; Dhamija, P.; Dong, H.; Gabrielle, B.; Goss Eng, A.; Lucht, W.; Mapako, M.; Masera Cerutti, O.; McIntyre, T.; Minowa, T.; Pingoud, K. "2011: Bioenergy." In O. Edenhofer et al. eds. IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Cambridge, UK, and New York, NY: Cambridge University Press; Global Energy Assessment. 2012:—Toward a Sustainable Future. Cambridge, UK, and New York, NY: Cambridge University Press; and the International Institute for Applied Systems Analysis, Laxenburg, Austria, 2012.

3 Current regulatory sustainability requirements

The interest in biofuels and bioenergy production and investment has been largely driven by the policies of national governments, both in developed and developing countries, designed to reduce greenhouse gas (GHG) emissions. The intense debate on 'food versus fuel' and on the environmental impact of large scale production of biofuels has triggered the development of schemes to account for and monitor sustainability issues intended to reduce the negative unintended consequences of GHG related policies.

A number of countries have already been actively engaged in the development of sustainable biomass, biofuels and bioenergy standards, including e.g. Belgium, the Netherlands, Germany, the United Kingdom, Switzerland, US, Canada, Australia, New Zealand, Korea, Japan, Brazil, India, China, Thailand, Argentina, Philippines, and South Africa. A comprehensive overview of these initiatives can be found in the publication of Scarlat and Dallemand (2011) and van Dam et al. (2010). These countries have adopted policies that encourage the production and use of bioenergy, mostly related to biofuels, and have set sustainability requirements for production, processing and trade of biofuels, bio-liquids and/or solid biomass which must be fulfilled in order to meet present national targets and/or to be eligible for financial support.

The most important policies are those developed by the European Commission and US as these have the greatest impact on large international bioenergy market.

3.1 European Union

The European Renewable Energy Directive (RED - Directive 2009/28/EC)

The main legislative driving force for sustainability of biofuels and bioenergy in the European Union is the Renewable Energy Directive (2009/28/EC). The aim of this legislative act is to achieve by 2020 a 20% share of energy from renewable sources in the EU's final consumption of energy and a 10% share of energy from renewable sources in each member state's transport energy consumption. To achieve these objectives, the directive established, for each member state, a mandatory national target for the overall share of energy from renewable sources in gross final consumption of energy. This target was set on the basis of the different starting points of the various countries. The 10% target for the transport sector was set at the same level for each member state, in order to ensure consistency in transport fuel specifications and availability.

The RED has set specific minimum sustainability standards for biofuels (for transport) and bioliquids (for electricity and heat production) and requirements for their verification that should be met in order to receive government support or count towards the mandatory national renewable energy targets. The sustainability criteria are:

- Minimum greenhouse gas (GHG) savings of at least 35% compared to fossil fuel (to be increased up to 50% from 2017 and 60% for new installations from 2018),
- no raw material from land with high biodiversity value, such as primary forest, nature protection areas, highly biodiverse grasslands (unless it can be shown that biomass extraction is part of management regime compatible with - or a requirement for - high biodiversity),
- no raw material obtained from converted[2] high carbon stock land (continuously forested areas, wetlands or peatlands),

[2] Converted, according to the RED = land that had the status of continuously forested areas, wetlands or peatlands in January 2008 and no longer has that status.

- Cross compliance: raw materials in EU must be cultivated in accordance with the EU Common Agricultural Policy (with subsidies for producers for biofuels feedstocks).

The compliance to these biofuel sustainability requirements needs to be checked by Member States or through voluntary schemes which have been approved by the European Commission (EC)[3]. The EU Member States must also report to the EC on biannual basis on the impact of biofuels and bioliquids on biodiversity, water resources, water and soil quality, GHG emission reduction and changes in commodity prices and land use associated with biomass production. The RED in itself did not include any definite set of definitions, criteria and indicators related to terms such as "primary forest" and "highly biodiverse grasslands" requiring that these be further examined and defined as part of a comitology process at EU level.

On 17 October 2012, the EC published a proposal to limit global land conversion for biofuel production, and raise the climate benefits of biofuels used in the EU[4]. The proposal contains four major changes:

- Incorporation of biofuels produced from food crops (cereals, sugar and vegetable oil) would be limited to 5% in terms of energy content out of the target of 10% of renewable energy in transport by 2020,
- New biofuel plants (post 1st July 2014) should deliver minimum greenhouse gas savings at 60 % compared to fossil fuels emissions,
- Additional support is introduced for "advanced" biofuels produced from non-food feedstocks, such as waste, straw and non-food crops, by weighting more favourably their contribution towards the 10% renewable energy target,
- The estimated GHG emissions associated with indirect land use changes (iLUC) needs to be reported by Member States and fuel suppliers based on using fixed factors[5]. The high iLUC value for oil crop biofuels puts a high constraint on the role of biodiesel from oil crops after 2020.

The EC also expresses the view that in the period after 2020 biofuels produced from food and feed crops, which do not lead to substantial greenhouse gas savings (when iLUC emissions are included), should not be subsidised.

So far the RED sustainability requirements do not apply for **solid or gaseous biomass** used for electricity or heat production. However, feedstocks used for the production of solid and gaseous bio-energy carriers (notably lignocellulosic biomass) are expected to also be used for the production of '2nd generation biofuels', which will have to comply with the requirements set for biofuels and bioliquids. It is therefore expected that common requirements or some form of harmonization will be needed.

In February 2010, the EC published a Communication[6] stating that for the moment, there would be no binding criteria at the European level. However, the EC provided a number of recommendations for Member States in order to ensure greater consistency and to avoid unwarranted discrimination in

---

[3] Since 19 July 2011, the EC has recognised voluntary schemes for biofuels, applying directly in the 27 EU Member States: ISCC, Bonsucro, RTRS, RSB, 2BSvs, RBSA, Greenergy, Ensus, Red Tractor, SQC, Red Cert, NTA8080, RSPO. http://ec.europa.eu/energy/renewables/biofuels/sustainability_schemes_en.htm

[4] COM(2012)595, Proposal for a Directive of the European Parliament and of the Council amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources. October 2012.

[5] Current iLUC emission factors are 12 g CO2eq/MJ for cereals, 13 g CO2eq/MJ for sugars and 55 g CO2eq/MJ for oil crops (for reference, the fossil fuel comparator is 83.8 g CO2eq/MJ). Biofuels made from feedstocks that do not lead to additional demand for land, such as those from waste feedstocks, should be assigned a zero emissions factor.

[6] COM(2010)11, Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling. February 2010.

the use of raw materials. Basically, it recommended the use of a similar methodology as that for biofuels for installations larger than 1MW, with the same sustainability requirements on biodiversity and high carbon stock land and a common GHG calculation (with adapted reference as the end use needs to be included as well). The EC is in the process of assessing the implementation of its recommendations to Member States, and the opportunity to have binding EU-wide criteria for solid and gaseous biomass. EC recommendations are expected to be released in 2013.

EU Member States – selected examples

In 2006, the **German** Ministry launched a project aimed at defining the basis for sustainability requirements for biofuels. The result was the proposed Biomass Sustainability Regulation (BSR). The draft BSR was released in late 2007, but with the RED in development at EU level, the initiative was abolished. Nevertheless, in the early stages Germany decided to follow the RED requirements and it was the first country to implement the sustainability requirements of the RED in their own legislation. Germany also supported the development of a scheme called ISCC (International Sustainability and Carbon Certification). This system was the first to be recognized at the national level to fulfil the RED requirements (in 2010). A second system, the REDcert, was also recognized later in Germany (Lieback, 2011). In 2015 Germany will change from volume quota to CO_2-quota for biofuels. This will put higher emphasis on the GHG balance of biofuels (to be certified), with important economic impact.

Belgian authorities (at regional level) introduced sustainability criteria into their supporting scheme for renewable electricity in 2006. In the Flemish region, certain biomass streams (e.g. wood (waste) that is still suitable for recycling in board or pulp and paper industry) are not entitled to receive green power certificates as a feedstock for the production of renewable electricity. Also, the energy used for transporting and pre-treatment of the biomass, is deducted from the green power certificates. In the Brussels and Walloon regions, a greenhouse gas balance and reduction compared to the best available natural gas system is calculated to determine the amount of green certificates. All calculations must be validated through an audit by an independent organisation.

Since April 2008, under the ***UK*** RTFO (Renewable Transport Fuel Obligation), the Renewable Fuels Agency (RFA) requests fuel suppliers to report on the specific type and origin of biofuels, the compliance of biofuel crops with existing environmental and social sustainability criteria, and the greenhouse gas emission reductions achieved by using biofuels. While there are no strict consequences of not meeting the sustainability criteria, public disclosure may be an important driver for the reporting commercial companies. A similar procedure was implemented for renewable electricity in 2011. From 2011, a well-founded report on the RED sustainability criteria is required for installations larger than 50kWe; from 2013, generators of 1MWe and above will need to actually satisfy the sustainability criteria. This staged approach will also be considered by the Renewable Heat Incentive (RHI).

The ***Netherlands*** examined sustainability criteria for all forms and applications of biomass. In 2007, the Cramer Commission published a list of sustainability principles for the use of biomass for energy (fuels, liquids, solid and gaseous). These principles are partially covered in the RED sustainability criteria. The Netherlands are building further on their experience with the Corbey Commission. Based on the 'Cramer' principles, the Dutch normalisation institute NEN, developed standards NTA 8080 and 8081 for sustainable biomass for energy purposes. This is a voluntary system and already used by commercial actors to demonstrate the sustainability of their biomass. The NTA 8080/81 was recently approved by the European Commission as a voluntary system for biofuels and bioliquids.

In October 2012, large Dutch biomass users have signed a "Green Deal". The participating companies will report annually to the government the amounts of biomass they use and how sustainability is demonstrated via certification or verification systems.

3.2 United States

US Renewable Fuel Standard (RFS-2)

The US Renewable Fuel Standard (RFS) uses a different approach. The RFS-2 defines the volume of different biofuels that have to be blended with conventional fuel between 2006 and 2022 according to the U.S. Energy Independence and Security Act of 2007. The total volume of biofuels mandated in the Renewable Fuels Standard increases biofuel use in the US to 36 billion gallons (136 billion litres) by 2022. Although the law has prescribed volumes up to 2022 totalling 36 billion of renewable fuels, the law sets a limit of 15 billion gallons for conventional renewable fuel, and 21 billion of advanced biofuels including 1 billion gallons of biomass-based diesel, 4 billion of non-cellulosic advanced fuel (e.g., Brazilian sugarcane ethanol), and 16 billion of cellulosic biofuels (60% GHG emission reduction). On a yearly basis, the EPA has the ability to waive the volumes of the advanced biofuels based on the market ability to produce them. Only a quarter of these advanced biofuels can be made from food crops, and the rest, 16 billion of 21 billion gallons, must be cellulosic biofuels made from agricultural waste, fast-growing woody species and herbaceous grasses, and other sources of waste biomass. This transition away from food-based fuels is essential to managing the conflict between food and fuel, and it is why the success of the RFS is so critically tied to the commercialization of cellulosic non-food biofuels. The first commercial cellulosic biofuel facilities are coming on line in 2012, with larger ones following in 2013 and 2014[7].

The RFS2 requires that each category of renewable fuel emits fewer greenhouse gases than the petroleum fuel it replaces, and sets restrictions on the type of feedstock used and the types of land that can be used to grow and harvest the feedstock. It sets restrictions on GHG emissions which must be less than the lifecycle GHG emissions of 2005 baseline average gasoline or diesel fuel that it replaces. Each year, obligated parties such as refiners and importers of gasoline and diesel and blenders are required to meet these volumetric targets for four broad categories of biofuels: (1) conventional renewable fuels, (2) bio-based diesels, (3) advanced biofuels, and (4) cellulosic biofuels. These biofuels categories are defined based on the nature of feedstock/technology used in production and minimum GHG reduction thresholds obtained. The minimum GHG reduction thresholds that must be reached to qualify as conventional renewable fuel (or grandfathered), non-cellulosic advanced biofuels, biomass-based diesel and cellulosic biofuel are 20%, 50%, 50% and 60%, respectively. These requirements favour the development of highly efficient biofuel technologies, including second-generation biofuels. The definition (requirements) of 'renewable biomass' limits the types of biomass as well as the type of land from which biomass may be harvested to produce compliant renewable fuels.

[7] http://www.triplepundit.com/2012/08/renewable-fuels-standard-biofuel-technology-drought/

US renewable fuel producers have reporting obligations based on default values established per feedstock. EPA established these default values based on feedstock and processing pathways (including waste and residue streams), so-called specific fuel pathways. Assessment of lifecycle GHG emissions is necessary to determine which fuel pathways meet the GHG reduction thresholds under RFS2 for the four required renewable fuel categories. Classifications of approved fuel pathways are specified in the RFS2 regulations. Three critical components of a fuel pathway are listed: (1) fuel type, (2) feedstock, and (3) production process. Each specific combination of the three components, or fuel pathway, is assigned a RIN D code designating the renewable fuel category (renewable fuel, biomass-based diesel, advanced biofuel, cellulosic biofuel) for which it qualifies. For example, biodiesel is assigned a RIN D Code of 4, which qualifies the fuel for compliance with the biomass-based diesel category.

The US has hence adopted a direct legislative approach not relying on voluntary certification schemes. At the same time, US legislation confirms the global trend of increasing importance of sustainability in the biofuel market (Agency NL, May 2011).

The California Low Carbon Fuel Standard (LCFS)

State-level legislation in the US, such as the California's Low Carbon Fuel Standard, is also largely based upon reporting requirements using default carbon intensity values established per type of biofuel. The California Low Carbon Fuel Standard (LCFS) is a standard which aims to reduce GHG emissions from the transportation sector in California by at least 10 percent by 2020, using a technology-independent "lifecycle" approach. So liquid and gaseous fuels, electric and hybrid vehicles, and other combinations can be used to reach the legislated reductions. Fuel producers and fuel purchasers (bundlers for resale) require that the fuel pathway be register and can mix a variety of sources to reach a needed level. Carbon intensity (CI) is a calculated for specific categories of transportation fuels and its substitutes (such as biofuels using a modified for California GREET methodology with data provided by the fuel producer) that takes into account the lifecycle greenhouse gas emissions (GHGs), including indirect emissions associated with production and transportation. The California Air Resources Board (CARB) calculates current carbon intensities of various fuel pathways and sub-pathways as listed in tables - called lookup tables - and each additional facility and pathway approved is then found in the registered facility information (http://www.arb.ca.gov/fuels/lcfs/reportingtool/registeredfacilityinfo.htm), which is added to other already registered fuels. The LCFS convened a working group relative to the iLUC factor and this factor will be modified in legislation in the future. (http://www.arb.ca.gov/fuels/lcfs/lcfs.htm).

In general these (supra)national regulations focus on the environmental and ecological issues related to biofuel production, such as:

- the climate change mitigation potential of biofuels by requiring a certain percentage in reduction of lifecycle GHG emissions compared to a fossil-based fuel, and;
- preservation of existing organic carbon stores and biodiversity by stating that biofuels cannot be made from feedstock obtained from land with high carbon stock or high biodiversity value.

The advantage of these national/regional standards is that they are well tailored to local/regional issues. However, these initiatives are not comparable with regards to the overall structure, definitions used, specific sustainability requirements, reporting methodology and reporting requirements; for example there are differences in the type of biomass/biofuel/bioliquids included, time frame, GHG emission reduction requirements, the GHG emission reduction calculation methodology and the way ILUC is incorporated. As a result, this situation can be confusing to actors in the marketplace and lead to barriers for international trade.

4 Introduction to voluntary certification systems

Voluntary standards and certification systems have existed for decades to affirm product safety, quality, and production practices. In the 1990s, forest certification became one of the first large-scale applications addressing a number of global social, economic, and environmental challenges.

With the increase in production and use of biofuels and bioenergy in response to, among other things, climate change mitigation, sustainable development and security of energy supply, there has been a dramatic increase in the number of sustainability initiatives developing worldwide. Sustainability certification exists for a wide range of products. Such systems set standards for sustainable or responsible management practices and generally include a number of principles, criteria and indicators against which compliance is verified.

In recent years, mandated targets and financial incentives for biofuels and bioenergy have been set at international and national levels to provide certainty and some economic security for investors. This has driven the rapid industry expansion globally. The rapid scaling up of the bioenergy industry has led to a public debate in the past years on the potential unsustainable consequences of biomass use for energy. This has triggered many countries, international organisations and industry bodies to develop bioenergy sustainability systems. These groups adopted governance systems as known from forestry certification systems: standard-setting by representatives of social, environmental, and economic interests, third party certification and auditing by accredited certification bodies, that issue certificates when the standards had been met. One of the goals of the advent of bioenergy certification schemes was to generate enough demand for standards-compliant products so that certification would become a de facto condition for market access.

At the core of each certification system is the standard - a defined set of social, environmental, and/or economic principles. Standards systems determine who has a voice in setting the standard, how it evolves over time, who audits, verifies and certifies compliance, who accredits the certifiers, and how compliance is demonstrated, with corresponding effects on legitimacy and credibility, costs and benefits, and effectiveness to achieve goals.

These certification systems are in many ways similar with regard to the sustainability issues/principles they cover, but there is a variation in the way these principles are measured, i.e. different criteria and indicator systems and different monitoring procedures exist to guarantee sustainability.

Although there are many variations in the structure of standards and certification systems, most systems include the same basic components carried out by a similar set of organizations (Figure 1

illustrates this model) (Steering Committee of the State-of-Knowledge Assessment of Standards and Certification, 2012).

- The standard setter is responsible for setting the standard and often has responsibility for the management of the standards system. A variety of stakeholders are often engaged directly in the governance of the standard setter.
- A certification body is responsible for making decisions about compliance based on the results of audits, i.e., reviews or assessments to confirm whether the practices or services established to meet the standard are being implemented. Auditors often work for certification bodies and are responsible for carrying out the audits. There are normally two types of audits; the first audits leading to issuing of the certificate, and the subsequent annual audits to maintain the certificate. Usually, the certificate must be renewed after some years, resulting in a new major audit to renew the certificate.
- The accreditation body is responsible for evaluating the competence of the certification body and the auditors.

Figure 1. *General model of a certification system (Steering Committee of the State-of-Knowledge Assessment of Standards and Certification, 2012)*

A variety of schemes has become operational for the production, processing and trade of biomass, with the most prominent ones relevant for bioenergy markets being:

- ***Forest certification systems***: The first implemented forest certification scheme was the Forest Stewardship Council (FSC). The FSC sets international principles for sustainable forest management, and local stakeholders develop region-specific standards. Other schemes followed, with PEFC as one of the larger recognised international certification organizations endorsing national-level schemes based in more than 30 countries. In general, each of these PEFC schemes differs in how sustainable forest management is defined, but our review indicates they seem to have somewhat similar chain-of-custody standards, although some differences can be found. The PEFC has not mandated one set of international principles but does have a mechanism for evaluating if schemes seeking PEFC endorsement are in compliance with a 'harmonized' set of standards. While FSC and PEFC schemes are used to certify the sustainable management of forests from which bioenergy feedstocks are harvested, neither were originally developed for biofuels/bioenergy applications. These schemes also do not include binding limits for GHG emissions, nor do they include the complete production chain or quality of air issues. They do address water and soil quality/conservation, and include biodiversity and workers and land rights.
- ***Agricultural certification systems***: Most of these systems are designed for the certification of organic products to be used for a wide range of end-uses (food, feed, energy), like SAN/RA and GlobalGAP. Some focus on a specific crop, like RTRS (soy), RSPO (palm oil) and Bonsucro (sugar cane). As for forestry certification, these agricultural schemes include environmental, economic and social aspects; soil conservation is addressed in all schemes; and air quality is only covered in RSPO and social aspects (workers' rights and land rights) are not included in GlobalGAP. The crop specific schemes, RTRS, RSPO and Bonsucro, have recently been extended to also include specific biofuels or bioenergy related issues, i.e. GHG emissions and carbon conservation, so that they are recognized as voluntary scheme for biofuels by the European Commission.
- ***General biofuel/bioliquids certification systems***: A number of dedicated certification schemes for biofuels/bioliquids exist (e.g. ISCC, RSB, REDCert, 2BSvs). Most of them have been developed to show compliance with the European RED requirements. These are more generic standards which cover a wide range of feedstocks to be used for biofuels or bioliquids. They cover the same aspects as the crop dedicated agricultural schemes, although the approach differs; for example, these schemes require a specific GHG reduction target compared to fossil fuel instead of general GHG improvement requirements. On the other hand they generally exclude requirements on e.g. fertilizer applications, tillage, labour conditions and so on.
- *Wood pellet certification systems*: The first private standards for wood pellets for energy production included the Green Gold Label (GGL) and the Laborelec system, which were developed to comply with (anticipated) national legislation and customers demand. These are mainly Chain-of-Custody (CoC) standards for product verification. They allow the use of other schemes to comply with the sustainability criteria set out in the standard (e.g. FSC, PEFC, including e.g. CSA, SFI). Currently a consortium of large pellets buyers have formed an initiative called 'International Wood Pellet Buyers' (IWPB) to streamline their quality and sustainability requirements to facilitate trade within the sector.

5 Selecting certification schemes for further analysis

This chapter focuses on a selection of the most relevant voluntary certification schemes and initiatives to address sustainable biomass, biofuels and bioenergy. It examines how these schemes work/or are supposed to work in practice and identify similarities and differences between them to develop an understanding of the benefits and opportunities that exist among the systems. Our criteria for relevance were schemes having, or potentially having, an important impact on the biomass, biofuel or bioenergy market. The list of certification schemes were selected in consultation with the IEA Bioenergy Task 40, 43 and 38 members involved in this project. To select the schemes, a comprehensive spreadsheet with information on all known existing relevant systems and initiatives was compiled. We included existing schemes and schemes under development to guarantee the sustainability of forestry, agricultural production, biofuels and bioenergy. The following aspects were taken into account when selecting the most relevant schemes:

- the amount and type of traded feedstock/commodities for energy, covering different supply regions and demand regions, and different types of feedstock.
- the international importance of schemes in the production of these feedstocks.

The most important feedstocks in terms of trade flows for energy are:

- *Sugarcane* for ethanol:
    - supply region: Brazil
    - demand regions: Brazil, US, EU
- *Soy* for biodiesel
    - Supply regions: Argentina, Brazil, US
    - Demand regions: Brazil, US, EU
- *Palm oil* for biodiesel
    - Supply regions: South-East Asia (Malaysia, Indonesia)
    - Demand: EU
- *Rapeseed* for biodiesel
    - Supply regions: EU, Canada
    - Demand: EU
- *Wood* for pellets, wood chips
    - Supply regions: Canada, US, Russia, EU, potentially also South-America and Africa
    - Demand regions for energy: EU, North-America, East Asia (China, Japan, Korea)

Based on this analysis, the following schemes are selected:

- FSC (forestry) with focus on differences by region
- PEFC endorsed schemes (forestry):
    - SFI, CSA, ATFS in North-America
    - PEFC Finland, Sweden, Germany or France in the EU
    - CertFor (Chile), CerFlor (Brazil) in South America
    - FCR (Russia)
- GlobalGAP (several agricultural crops)
- SAN/RA (several agricultural crops)
- CSPB (agricultural biomass)
- Bonsucro (sugar cane)
- RSPO (palm oil)
- RTRS (soy)
- 2BSvs (biofuels)

- ISCC (biofuels)
- RSB (biofuels)
- IWPB (International Wood pellet Buyers consortium), which also covers a discussion on the systems of Electrabel (Laborelec) and Essent (GGL).

To allow for comparison of these schemes a detailed factsheet was produced for each scheme.

6 Characteristics of selected voluntary schemes

The selected schemes are analysed and discussed with regards to four topic areas:

- Standard setting and governance mechanism;
- Chain of Custody standard;
- Information handling;
- Assessment procedures;
- Relation with policies and other schemes.

Where appropriate, the results are organised in tables allowing for a quick and easy comparison of the different schemes against each other.

6.1 Standard setting and governance mechanism

Standard setting involves consultation processes and participation of interested stakeholders to decide on the content (e.g. which ecological, social and economic principles and criteria to include) and structure (e.g. whether standard sets performance requirements or management practices) of the standard. The content of the certification schemes is dependent on the interests and motivation of the actors involved, their values and the balance between them.

Generally two types of governance structures are used: a membership-elected governance body or an appointed, representative governance body. Both types have strengths and limitations. The election of governance bodies by members is the most democratic, and all stakeholders are represented in the process if no limits exist on becoming a member. The appointed governance structure can include representation from key stakeholders, but sometimes not all stakeholders have the feeling of being involved or having a voice in the process. Besides a core governing body most standards have technical working groups or committees that are responsible to work on specific themes or issues related to the implementation of the standard.

In the development of schemes and standards for forestry certification three types of stakeholder are generally involved: organizations or persons, who represent mainly environmental, social or economic values. Their motivations to develop certification systems could typically be concern for natural resources and human beings dependent on or involved in managing them, and access to green markets. These schemes provide the opportunity for the public to participate in the standard setting procedure, where any person can submit comments to the new or revised standard. Members of the governance bodies are elected, ensuring a balance between the major stakeholder groups.

GlobalGAP standards are developed by Sector Committees. Any member of GlobalGAP can apply to be a Member of the Sector Committee that is constituted by six GlobalGAP suppliers and six GlobalGAP retailers elected by members. Similarly to forest certification systems, public consultations take place, with standards being revised according to the received comments as decided by the Sector Committee. SAN standards are set by an independent International Standard Setting Committee that is composed by stakeholder from different groups (producer, industry, NGO, academic, government). The Committee Members are elected for 2 years by consensus by SAN's board of directors, which are again members elected for a three year period by the General Assembly.

The crop specific schemes, Bonsucro, RSPO and RTRS, are multi-stakeholder initiatives dedicated to reducing environmental and social impacts of the production and processing of the specific crops - sugar cane, palm oil and soy- and promote sustainable growth and use. In general three stakeholder

groups are involved: producers, industry and trade. Bonsucro and RSPO also involve NGO's. The initiatives are governed by an Executive Board which is elected by the General Assembly, or participating members, to ensure a balanced representation of stakeholders involved. In general, the technical working groups are at the heart of the standard setting. They draft proposals which are commented and reviewed by the stakeholders involved. RTRS and RSPO invite any interested stakeholder to provide input to the standard.

The development of the biofuel standards ISCC and RSB started through the involvement and cooperation of a range of stakeholders representing the entire supply chain from producers to logistics and traders, including NGO's, environment and climate change policy organisations, intergovernmental organisations, consultants and research institutes. Their aim is to ensure that biofuels deliver their promises of climate change mitigation, economic development and energy security without causing environmental or social damage. In general, both standards are governed by a Steering Board, or Association in case of ISCC, equally representing each stakeholder group by election of representatives of each group. These standards are developed through an intensive stakeholder consultation process. The 2BSvs is also a biofuel schemes, but differs from the other two general biofuel standards in governance and aim. The 2BSvs scheme focuses only on the compliance with RED, and provides management, verification and audit procedures to demonstrate compliance. It is governed by a Steering Committee that is formed by members of the founding associations of French biofuel industry and the technical advisor (Bureau Veritas). No information is provided on whether other stakeholders are involved in the managing and decision-making processes.

The industrial standards, GGL, Laborelec and IWPB, are initiated by utility companies. The Green Gold Label (GGL) also invites other stakeholder groups (producers, traders, end-users and NGO's) to join. The aim is to develop a sustainability scheme for solid (with focus on pellets) biomass in power plants, GLL is also applicable for chemical purposes. These schemes have different governance structures and standard-setting approach. The GGL scheme is governed by an Executive Board. The board members are elected by existing members representing at least stakeholders from primary producers, traders, end users and NGOs. Standard-setting is done through working groups representing all stakeholders involved. Laborelec is governed by Suez/Electrabel, together with Laborelec and SGS. They do not involve other stakeholders in the standard-setting. The IWPB initiative was also initiated by Suez to bring together all major biomass-firing power plants, trying to establish a common certification schemes for power production to enable the trading of industrial wood pellets among the partnering companies. The IWPB is still under developments and proposed to use the governance structure of GGL.

Many sustainability standards use ISEAL Alliance's standards-setting code of good practice as a guideline for setting standards (Table 1). ISEAL guarantees that the development of criteria and indicators by its members are undertaken through a multi stakeholder, consensus-based process.

Table 1. *Overview stakeholder representation, involvement in governance and standard-setting (plus indication of number of certificates issued dated end of February 2012)*

Scheme	***Operational date***	***Relation to ISEAL***	***Stakeholders involved***	***Governance***	***Stakeholder consultation in standard-setting***	***Number of certificates (status end Feb 2012)***	***Remarks***
2BSvs	2011	No info	The steering committee is formed by members from professional associations representing the biofuel industry in France, and Bureau Veritas as technical advisor	Steering committee is in charge of the scheme and all decisions	No, only French biofuel industry involved	*427*	Members are mainly French companies (92%) focus on EU, with worldwide import
ISCC	2010	Affiliate member	The ISCC association. The association is open to all interested stakeholders (agriculture, conversion, trade, logistics, end-users, NGO's and other).	Governance takes place through general assembly, a board and executive board, which form the ISCC Association. Stakeholders can become a member of the association and/or contribute through technical committees and working groups.	The standard is developed via stakeholder consultation	*961*	250 stakeholders worldwide(45 countries)
RSB	2011	Full member of ISEAL	different type of biofuel stakeholder as follows: 1. Farmers and growers 2. Industrial biofuel producers 3. Retailers/blenders & the transportation industry	Steering Board with members from the chambers who are elected by each of the individual chambers. Each chamber represent a different type of biofuel stakeholder	The standard is developed via stakeholder consultation	*1*	130 members worldwide (30 countries)

Scheme	*Operational date*	*Relation to ISEAL*	*Stakeholders involved*	*Governance*	*Stakeholder consultation in standard-setting*	*Number of certificates (status end Feb 2012)*	*Remarks*
			4. Banks/investors 5. Rights-based NGOs 6. Rural development and food security organizations 7. Environment and conservation organizations 8. Climate change and policy organizations 9. Trade unions 10. Smallholder farmer organizations and indigenous peoples' organizations/ community-based civil society organizations 11. Intergovernmental organizations (IGOs), governments, standard-setters, specialist advisory agencies, certification agencies, and consultant experts.				
Bonsucro	2010	Associate member	Representatives of consumer companies, commodity traders, NGO's, national and local	Board is elected by the members, reflecting and represent the stakeholders of the organisation.	Technical working groups, consisting of members and non-members, develop	*15 (12 mills, 3 Chain of Custody*	57 members, mainly Latin America ,S-E-Asia, Australia

Scheme	*Operational date*	*Relation to ISEAL*	*Stakeholders involved*	*Governance*	*Stakeholder consultation in standard-setting*	*Number of certificates (status end Feb 2012)*	*Remarks*
			producers and oil companies.		standard. These are commented and reviewed by all stakeholders involved.	*certificates)*	
RSPO	2008	Follow ISEAL	Growers, processors or traders, consumer goods manufacturers, retailers, banks and NGO's.	Executive board consist of 16 members, designated by the General Assembly (representing sectors involved) for period of 2 years. Allocation of seats is equally divided between the different sectors involved.	Any interested stakeholder can provide input into the criteria.	*46*	796 members worldwide (48 countries) 11% of crude palm oil certified
RTRS	2011	Follow ISEAL procedures	3 stakeholder groups/ constituencies: NGOs, producers, industry and trade and finance.	General assembly of representatives from 3 constituencies, plus observing members from governments, consultancy and academia. They elect the Board consisting of 15 members, 5 from each constituency (NGO's, producers, trade/industry/ finance).	Standard setting by specific RTRS working group comprising members of all three constituencies, with public consultation on RTRS standard.	*16*	150 members mainly in Latin America, NL and UK
IWPB	not yet	No information	Working panel group of major EU utilities firing wood pellets and certifying companies.	Not defined yet. Proposed to use GGL governance structure	Stakeholders will be involved in standard setting.	-	focus on EU
GGL	2002	No	Growers, suppliers, traders,	The Green Gold Label Foundation, with its board and technical committee,	GGL foundation establishes different	*25 producers/tr*	5 million tonnes

Scheme	*Operational date*	*Relation to ISEAL*	*Stakeholders involved*	*Governance*	*Stakeholder consultation in standard-setting*	*Number of certificates (status end Feb 2012)*	*Remarks*
		information	processors and NGO's.	represent the different stakeholders involved. The board members are elected by existing members representing at least stakeholders from primary producers, traders, end users and NGOs.	working groups. Stakeholders are involved in working groups, which are responsible for standard setting and procedures	*aders*	certified worldwide focus on EU/NL, will be replaced by IWPB
Laborelec	2006	No information	SGS Belgium and Laborelec, under request of GDF-SUEZ/Electrabel	GDF-Suez/Electrabel, together with Laborelec and SGS	No. SGS and Laborelec develop standard;	*not available*	only applicable in Belgium will be replaced by IWPB
GlobalGAP (GG)	1997	follow ISEAL's basic requirements	GG engages with different stakeholders around the globe, and is open to any organization.	Board constitutes an equal number of elected producer and retailer representatives and is chaired by an independent chairperson.	GG increases local involvement by establishing National Technical Working Groups (NTWG). Sector specific issues are discussed within technical committees, all having 50% retailer and 50%	*112 000 producers*	Worldwide and across all sectors (> 100 countries)

Scheme	*Operational date*	*Relation to ISEAL*	*Stakeholders involved*	*Governance*	*Stakeholder consultation in standard-setting*	*Number of certificates (status end Feb 2012)*	*Remarks*
					producer/supplier representation. NTWGs develop National Interpretation Guidelines, address identified specific local adaptation and implementation challenges. Stakeholders are invited to comment on drafts.		
SAN/RA	SAN 1994 RA 1992	Full member	Coalition of independent non-profit conservation organisation, together with participating members ranging from small agriculture producers, agricultural industry and civil society organisations.	General assembly composed of one member of each member organisation. The Board of Directors is currently composed of max. 12 conservation professionals elected by general assembly.	Technical working group (so-called International Standards Committee, composed of 12 experts from a range of countries) provide input. Standard-setting is open to public consultation	*> 250 000 RA certified farms* *> 800 certificates*	>1 million ha in 33 countries and 30 crops
FSC	1993	Full member	FSC is an international association of members from of a diverse group, with people	The General Assembly of FSC Members is the highest decision-making body in FSC and is made up of the three	FSC provides opportunities for the public to participate in	*1096 combined forest*	149,85 million ha

Scheme	*Operational date*	*Relation to ISEAL*	*Stakeholders involved*	*Governance*	*Stakeholder consultation in standard-setting*	*Number of certificates (status end Feb 2012)*	*Remarks*
			representing environmental, social and economic values. These include representatives from the timber trade and the forestry profession, indigenous people's organizations, responsible corporations, community forestry groups, forest product certification organizations and individuals from around the world. Participation is open.	membership chambers: Environmental, Social and Economic, which are further split into sub-chambers North and South. The purpose of the chamber structure is to maintain the balance of voting power between different interests without having to limit the number of members. The FSC Board of Directors is accountable to the FSC members. It is made up of nine individuals who are elected from each of the chambers for a three-year term.	processes related to scheme management, standard-setting and assessments.	*management /CoC certificates* *16 controlled wood certificates* *22466 CoC certificates*	
PEFC	2000	No	PEFC is an international membership association. The members of PEFC international are national PEFC schemes (one representative each), and international stakeholder organisations (sometimes also called extraordinary members, one representative each).	The General Assembly is the highest authority of PEFC international. It elects the Board of Directors. The Board members are chosen to ensure a balance between the major stakeholders supporting PEFC, the different interests and different geographical distribution of members, annual cutting categories, and gender,	Much of PEFC's work concerning the development or revision of international or national standards is carried out in independent Working Groups comprised of representatives from a	*483957 forest owners FM certified (under a smaller number of certificates, due to group*	245 million ha

Scheme	Operational date	Relation to ISEAL	Stakeholders involved	Governance	Stakeholder consultation in standard-setting	Number of certificates (status end Feb 2012)	Remarks
			International stakeholder members can be e.g. industry, forestry, or land owner associations). Initiated by the forestry sector. Members of national schemes can be representatives from all types of organisations with interest in sustainable forest management, but at least for some schemes forestry and industry involvement dominates. National members may be divided into different groups, e.g. "Forestry", "Industry", and "Others, including environmental and social interests".	with reference to the nine major groups as defined by Agenda 21 of the 1992 United Nations Conference on Environment and Development in Rio de Janeiro. National schemes are governed by the national General Assembly, which elects the Board of the national scheme, with representatives from forestry and forest industry companies and other organisation representatives.	wide range of invited stakeholder groups, including NGO. Public consultations are an integrate part of the standard development process.	*certification* *8797 companies CoC certified (under a smaller number of certificates, due to group certification)*	

6.2 Chain of Custody standard

In the field of biofuels and bioenergy, proof of the sustainable production must be provided in order to be able to claim a tax relief or to credit the biofuels to the biofuels targets. This requires for all operators in the supply chain to have valid certificates confirming that the requirements as to the sustainability criteria (e.g. GHG emissions) have been fulfilled and traceability back to the time of cultivation of the biomass is ensured by a traceability system.

A certification scheme typically includes 2 types of standards: i) a land management standard (forestry schemes) or product standards (agricultural schemes and crop schemes, biofuel schemes) and ii) a Chain-of-Custody standard.

i) The land management or product standard defines the specific requirements that need to be fulfilled for certification, consisting of a number of measurable principles and criteria, improvement options, pass or fail levels, etc. Typically, a set of indicators and verifiers are used to define the type of information and data that needs to be measured and reported to complete the assessment. These criteria and indicators can include management rules and guidelines, describing how the sustainable biomass feedstock needs to be produced and what measures or practices are allowed or prohibited (e.g. use of fertilisers). The differences and similarities of principles, criteria and indicators defined in the different sustainability schemes available are already intensively discussed in other reports and articles, as mentioned in the introduction, and will not be discussed in this report.

ii) The Chain-of-Custody (CoC) system is the chronological physical or electronic documentation and/or paper trail —showing the acceptance, purchase, custody, control, transfer and disposition of a product and its associated sustainability attributes. It enables to effectively control the flow of the biomass/biofuel product through the supply chain and inform their respective customers about the origin and characteristics of the material(s) in their products. The standards generally list the requirements for acquiring, handling and forwarding certified biomass/biofuel products. It provides a range of options for tracking biomass/biofuel product characteristics throughout the whole supply chain, e.g. GHG emissions which have so far been incurred during cultivation, transport and processing up. It requires establishing, maintaining and keeping updated documentation of all products acquired and/or handled and/or forwarded.

There are 4 types of traceability methods that can be used: the physical segregation system, mass balance system and the book-and-claim system. A summary of each of these systems is listed below starting with the most demanding and proceeding to less demanding systems (Dehue et.al, 2007).:

- *Identity preserved:* Certified products are physically separated and the identity of the biomass producer is preserved through the chain of custody.

- *Physical segregation (also referred to as track-and-trace):* Certified products are physically separated from non-certified products throughout the supply chain. The main goal is to ensure that certified and non-certified products are not mixed in the supply chain. It does not aim to provide traceability back to the origin of the product (individual farm or plantation). All companies in the supply chain are fully CoC certified. Some minimum mix is sometimes allowed, if it is technically unavoidable (e.g. RSPO).

- *Mass balance systems*: In this system there is an administrative segregation of certified from non-certified biomass. The physical product is sold together with the sustainability

information. Mixing certified and non-certified raw material during the production or trading process is allowed. However the percentage of the certified raw material must be known and communicated to the company's customers (usually as a percentage).

- *Book-and-Claim systems*: The trade in physical products is completely decoupled from the trade in sustainable certificates. Only the farmer or forester is certified. This system creates a trade in certificates for each specific commodity (e.g. biomass product, biomass oil and biodiesel): the farm gets a certificate for each unit of sustainable biomass it adds to the market from an 'issuing body'. The certificate includes information on the sustainability of the farm and GHG data. The farm sells this certificate direct to fuel supplier, or this is can be done successively from biomass processor to biofuel producer and then to the supplier. The biomass processor and fuel producers convert the certificates into oil or biodiesel certificates via the issuing body. The suppliers that bring in a certain amount of 'sustainable' biofuel on the market have to submit these certificates to the issuing body. There is no physical segregation of sustainable biomass from non-sustainable biomass throughout the supply chain. Electricity markets, for example, have adopted this model. The book-and-claim system is not allowed under RED, because the direct link between physical product flows and sustainability is absent.

The physical segregation, mass balance and book-and-claim systems thus differ in purpose (Dehue et al. 2008):
- book-and-claim guarantees the *production,*
- identity preserved, physical segregation and mass-balance systems guarantee the *consumption* of sustainable feedstock.

Mass balance and book-and-claim systems are more suitable for large volumes and a wide range of feedstock types and sources as they do not require that the certified products are physically separated from non-certified products. However, in the food sector there is a drive towards the segregation method (Agency NL, March 2012). The identity preserved and segregation method cannot be used for transport and logistics in cases where biofuels/bioliquids are blended with conventional fuels.

All the sustainability certification initiatives have developed a Chain-of-Custody standard, or intend to develop one (i.e. IWPB), but differ in which methodology should be applied and which parts of the chain are covered by the CoC certificate. All schemes provide procedures and guidelines on the specific requirements to comply with the CoC standards. Some schemes outline specific requirements for different actors within the supply chain, e.g. GGL defining CoC standard for producers and traders, transport and processing in a separate standard.

The CoC systems used and the coverage of the system of the selected voluntary schemes are summarised in table 2. The results for the biofuel schemes are verified with the related recent report from Agency NL (March 2012).

The most flexible schemes are RSB and RSPO, allowing the use of all 4 systems. The RTRS schemes can not apply the identity preserved system, and ISCC and SAN/RA do not allow the use of the book-and-claim option. All schemes use the mass balance system in some way, 3 schemes exclusively (2BSvs, Bonsucro, GGL). GGL, GlobalGAP, FSC and PEFC are also prepared for the use of the segregation methodology.

The physical segregation system and the mass balance system are the most commonly used CoC systems. These are also regarded as less prone to error and favoured by regulators because they

provide direct incentives for fuel providers to ensure that the fuels they purchase and deliver meet sustainability requirements (Dehue et al. 2008).

Regarding the coverage of the CoC standards, Table 2 shows that all general biofuel/bioliquid schemes (ISCC, RSB, 2BSvs) and crop-specific schemes (except for Bonsucro) refer to the tracking of sustainably produced products along the whole supply chain. All other certification schemes have partial CoC systems, excluding farmers or biomass production and only include the operators handling or processing the certified product (wood products in case of GGL, Laborelec, FSC and PEFC, agricultural products in case of GlobalGAP and SAN/RA).

***Table 2**. Chain of Custody system utilized in the selected schemes*

	Parts of the chain covered under CoC standard	***Identity preserved***	***Physical separation***	***Mass balance system***	***Book-and-claim***	***Remark***
2BSvs	All actors after 1st gathering point (FGP), FGP as group manager of farmers			X		
ISCC	Farms/plantation, FGP, conversion units, traders, warehouses	X	X	X		*if farmer and FGP are under same legal owner
RSB	From farmer to final retailer	X	X	X	X	
Bonsucro	All actors after the mill			X		
RSPO	From farmer and mill to all processers and users downstream, last operator to be certified is the manufacturer of end-product	X	X*	X	X	*The system should guarantee the minimum standard of 95 % segregated physical material. Physical intermixing of two product flows (certified and conventional oil) in the refinery equipment is technically unavoidable.
RTRS	From farmer to all processers and users downstream, up until the product is delivered to the market		X	X	X	*If farmer and FGP are under same legal owner
IWPB	To be developed, proposal to use GGL CoC standard					Under development
GGL	Partial CoC in place for production and trading, transport and storage, use at the power plant		X	X		
Laborelec	From primary resources to final product, excludes production of biomass		X	X		
GlobalGAP	All actors handling or processing certified product		X	X*		*In case of parallel production or parallel ownership.
SAN/RA	All actors handling or processing certified product	X	X	X*		*can be used if permission is obtained from the Rainforest Alliance. However, products on the list of permitted mass balance products do not require special permission. Currently these include palm oil and sugar cane.

	Parts of the chain covered under CoC standard	*Identity preserved*	*Physical separation*	*Mass balance system*	*Book-and-claim*	*Remark*
FSC	All manufacturers and traders, except forest and retailers selling to end-users		X	X		
PEFC endorsed schemes	All actors except forest/biomass production		X	X		Several national schemes directly use the PEFC international CoC standard, but for example SFI has its own CoC standard, with the PEFC international CoC standard being one of the normative documents.

6.3 Information handling

The chain of custody tracking is based on continuous information about each stage of the trail taken by products from primary production at the forest, farm or crop site to the final user. It includes each stage of processing, conversion, transformation, manufacturing, trading and distribution where progress to the next stage of the supply chain involves a change of legal and/or physical control to ensure transparent transfer and traceability of certified feedstock/biofuel.

In general this information includes the volume, source of feedstock, type of feedstock and applicable certification number, together with sustainability data. Most CoC systems focus on the sustainability of feedstock production, and for biofuels all GHG emissions along the entire production chain must be included.

But how is all of this information handled and passed along the supply chain?

Quick review of the CoC procedures of the crop and biofuel certification schemes indicates that all economic operators who participate in the handling, processing and trading of a certified product under the CoC system are certified based on their ability to manage and record data, implement a material accounting system and present documentation on all processed involved from buying to selling of the certified product.

The analysis shows that in some schemes certification information and documents are passed through the chain using an online/electronic centralised database (i.e. 2BSvS, ISCC and RSB) or traceability system (RSPO) allowing access to detailed information regarding the origin, validity of certification and other relevant data of all operators involved. The Bonsucro CoC standard requires that each batch gets a unique identification number, generated by the accounting system. Documents that are passed to the next operator in the chain must specify properties, sustainability characteristics and GHG data. The RTRS certified products are supplied with an RTRS claim on their sales documents and transport documents, also information on the content of the certificate is provided (certification number and CoC system used). Under the RTRS CoC system only the last operator needs to calculate GHG emissions from cultivation, land use change, transportation and processing.

6.4 Assessment procedures

In order to be accepted and recognised as a reputable scheme, an auditing system is essential. In all schemes, each participating economic operator must be certified by a regularly accredited certifying body, and is subjected to an annual audit by an (independent) third party auditor. During desk audits and field visits, the auditors check for compliance with the standard. However there are differences in the way this third party verification is conducted among schemes. Audits can be performed through:

- field visits, evaluating the performance and compliance of the company on-site;
- desk-audits, examining the documents and check the existence of the required management plan, procedures, bookkeeping, data recording etc. taking place away from the place of action.

Multi-site Chain of Custody certification has been developed to facilitate Chain of Custody certification for larger companies that have a number of sites at which fundamentally the same functions, methods or procedures are carried out. Group certification is permitted for the producers of raw material. For other economic operators in the supply chain it is not allowed. Group auditing can be applied in particular for smallholder farmers, producer organisations and cooperatives. The administrative requirements, plus communication with the certification body, are carried out by a designated 'central part' of the organisation or group manager
Multi-site and group certification allows certification bodies to evaluate those organizations based on common, centrally administered and monitored control and reporting systems. In addition to this standard, the central part or group manager must ensure that all 'participating sites and operators' comply with the relevant Chain of Custody certification requirements. In those cases the 'central part' or group manager shall have a declaration, questionnaire, form or other document signed by all operators involved demonstrating their commitment to ensure that the biomass declared as sustainable has been produced in compliance with the requirements of the standard. It is based on the concept that an extensive part of the inspections required is carried out by internal auditors. These 'self-declarations' are easy (and cheaper), but do not increase credibility. The external certification body assesses and evaluates the effectiveness of the internal audit system, carries out an audit of a sample (referred to as sample-based auditing), and certifies the group as a whole.

Based on the analyses presented in the table above, the following conclusions can be made:

- At first glance, all audit procedures are quite similar, but there may be significant differences depending on the role that self-assessment, desk audits and field visits play respectively.
- All certification schemes require field visits; however, in certain cases of multi-site or group certification only a sample of the entities involved in the certification are visited to verify that all conditions are met.
- Some schemes, such as 2BSvs and RSB, mention the use of desk audits. The auditor determines whether it is necessary to perform a field or a desk audit. RSB provides the option for a desk audit only under restricted conditions.
- All schemes require at least a yearly surveillance audit, but as mentioned before in case of the use of sample-based auditing not all producers are audited annually.
- The duration of most certificates varies from 1 to 5 years, after which the operation must be fully re-certified.

***Table 3**. Characteristics of the assessment procedures of certification schemes*

	Audit requirements: desk audit, field visit	**Use of sample based auditing**	**Frequency of verification audits**	**Validity of certificate**
2BSvs	desk audit for all sites and field visits for FGP and selected sites managed by the FGP (see sample auditing)	Yes. Only a sample of the biomass producers is audited every year (square root of the total number of producers). Units for audits are partly selected randomly (25%) and partly based on a risk analysis (75%)	annual	5 years
ISCC	field visits	Yes for biomass product, no for CoC Sampling based on self-risk assessment	at least annual	1 year
RSB	desk audit and field visit	Yes. Based on risk class	depending on risk class, operators conduct self-risk assessment to determine risk class	3 to 24 months
Bonsucro	field visits	Sampling based on volume provided to the mill	annual	3 years
RSPO	field visits	Yes	At least annually	5 years
RTRS	field visits	Yes, based on risk assessment	annual	5 years
IWPB	N/A - will work with a list of recognised meta-standards			
GGL	field visits	N/A	annual	16 months
Laborelec	Desk audit, field visits not required at initial assessment	N/A	per load	per load
GlobalGAP	field visits and internal self assessment	Yes	annual	
SAN/RA	field visits	Yes	annual	3 years
FSC	Desk audit and field visit	Yes, under group certificates. The minimum number of units to be visited depends on the type of group (Classic group types, at least 10%)	annual	5 years
PEFC endorsed schemes	Field visits		annual	3-5 years

6.5 Relation with policies and other schemes

Links between voluntary certification schemes and legislation

One of the driving forces for the implementation of especially newer biomass certification schemes is that it provides proof of compliance with the legal requirements of EU RED (currently 12 voluntary schemes has been approved as eligible to show compliance), national regulations formulating sustainability requirements and reporting obligations or can be used to comply with the reporting obligation of illegal logging legislation (e.g. US Lacey Act, the EU FLEGT Regulation and the EU Timber Regulation).

Examples of some of the regulatory frameworks by subnational, national, supranational, regional governments are illustrated in Figure 2 (dashed boxes). Some of the certification systems derived explicitly from such government activities (e.g. The Netherlands and Germany). Others initiated in the private sector, with multiple stakeholders from associations, and non-governmental environmental organizations, industry, etc. (full boxes) can apply, or be modified to apply, to specific regulations. In 2007, SEKAB provided an example of a two-country effort (Sweden and Brazil) addressing verification of the supply chain for ethanol. Others were developed over time and many are recognized as global. Many of them share practices such as the ISEAL Alliance, the global association for sustainability standards. Implementing entities often can work in multiple sustainability standards as is common in other areas of standardization. The figure also displays scorecards used by multilateral banking organizations. Finally, under development is the ISO standard for Sustainability Criteria for Bioenergy.

Recognition among voluntary certification schemes

Standards often apply to similar or overlapping sectors, and for producers simultaneous certification to more than one scheme can be an advantage. However, the costs of going through multiple audits can often be prohibitive for producers whose resources are limited. Thus, many standards have begun exploring ways to coordinate certification, thereby reducing the economic and administrative burden for economic operators. Improved consistency and collaboration for standards that are overlapping in either content or functions can lead to increased efficiency for standards themselves and it can help scale up the use of certification generally, by making standards more available[8].

An additional advantage of mutual recognition is that by recognising non-energy related schemes, such as FSC and PEFC, these schemes become available for bioenergy production. Furthermore, for operators who want to claim e.g. EU RED certified biofuel, mutual recognition of other schemes allows the total certified supply base to be extended to products from other certified systems as well.
More information on the advantages and disadvantages of mutual recognition can be found in the publication of Agency NL (March 2012 p. 40).

Some systems have already recognised other schemes: 2BSvs, ISCC, GGL and Laborelec. ISCC and 2BSvs accept certificates from all systems which are EC recognised after gap-analysis.
Other certification schemes (e.g. RSPO, RTRS, and Bonsucro) do not seem to have any formal procedures or information on how to handle other standards. RTRS and RSB are currently

[8] http://www.isealalliance.org/online-community/blogs/what-makes-a-standard-credible-an-interview-with-rsbs-s%C3%A9bastien-haye-on-efficiency-with

discussing collaboration (RSB) with or mutual recognition of other standards (RTRS). Table 4 gives an overview of the link with policies and other schemes.

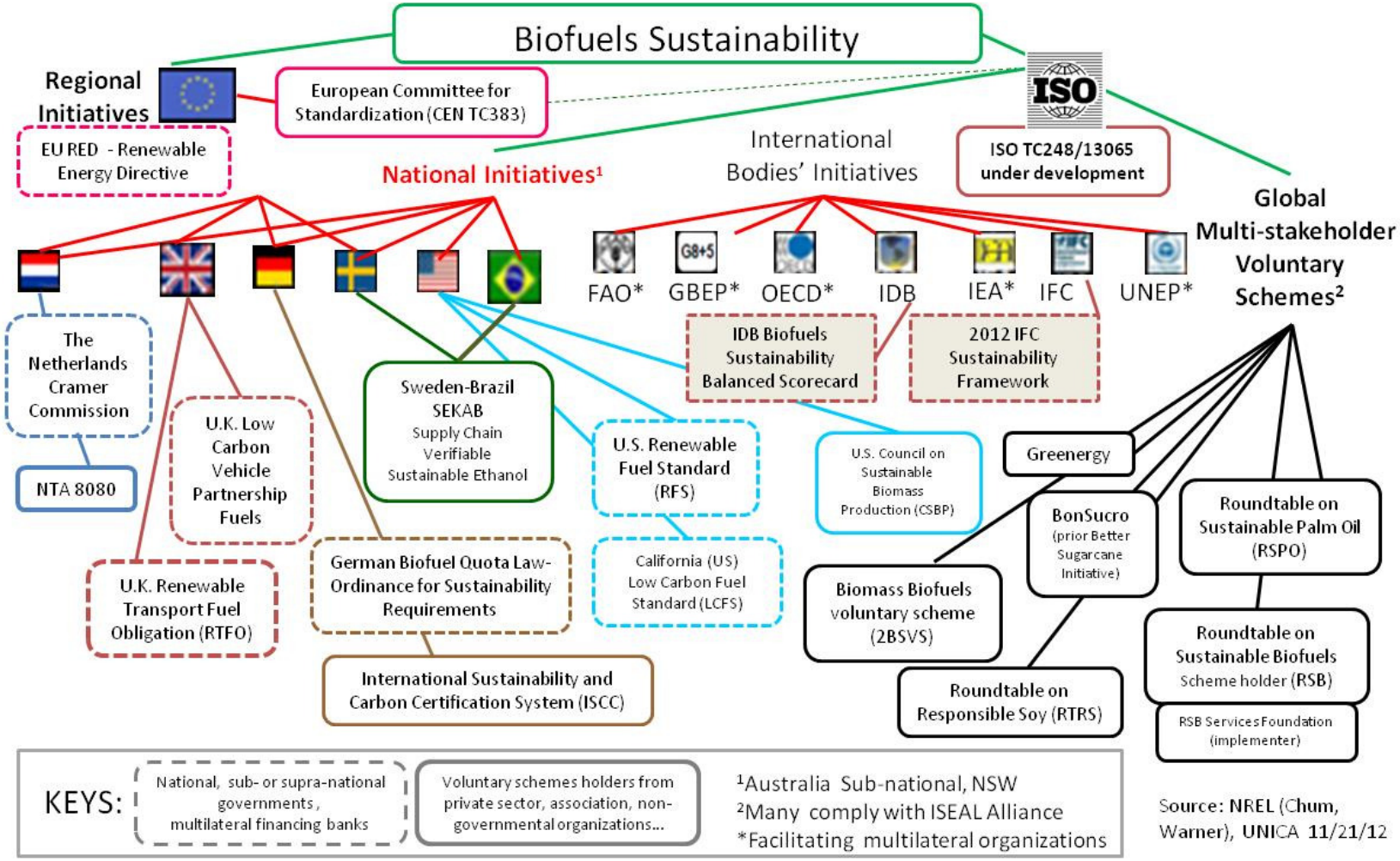

Figure 2. *Illustration of some government led initiatives at various levels (in dashed boxes) and of sustainability standards that were developed over time by a variety of entities (full boxes). Many are organized through voluntary schemes by multiple stakeholders. Others, not displayed, exist for forestry and agriculture specifically. Scorecards are also used to provide check lists of project submissions to financing by multilateral organizations.*

***Table 4**. Overview of link with policies and other schemes*

	Recognised EU RED	*Recognition by national regulators*	*Recognition by / acceptance of other schemes*	*Remarks*
2BSvs	x			Recognised RED scheme
ISCC	x	X	x	Recognised by Germany and RED, recognised by RED Cert. Accepts FSC and PEFC certificates as proof of sustainable wood production.
RSB	x	X	x	Recognised RED scheme, recognised by Germany and UK
Bonsucro	x			Recognised RED scheme
RSPO	x	X		Recognised by Dutch regulators, allows for national interpretation
RTRS	x	X	x	Cooperation with FEMAS scheme, possibility for national interpretation for soy producing countries
IWPB	x		x	A larger number of schemes and international conventions are considered for assessing IWPB sustainability principles.
GGL	x	X	x	Recognised by UK and Dutch regulators. Accepts FSC and PEFC certificates as proof of sustainable wood production, and GlobalGAP and all programmes that certify organics as per EU, Japanese and/or US regulations as proof of sustainable agricultural biomass
Laborelec	x	X		Developed for Belgium end-use market, and required by law to obtain financial incentives Accepts FSC, PEFC, GGLS5 and approved pre-scope certificates of one of the endorsed forest management verification systems (with the intention of full verification) as proof of sustainable wood production Accepts RSPO, GlobalGAP, GGLS2, and agricultural products grown in the EU as proof of sustainable agricultural biomass.
GlobalGAP			x	Accepted by GGL and Laborelec
SAN/RA			x	
FSC			x	Accepted by ISCC, IWPB and GGL
PEFC endorsed schemes: e.g.				All PEFC schemes recognized by UK CPET, and accepted by ISCC, IWPB and GGL
SFI			x	PEFC endorsed, recognise other North American schemes endorsed by PEFC, i.e. ATFS and CSA
CSA			x	PEFC endorsed
ATSF			x	PEFC endorsed, a source for CoC programmes of PEFC endorsed schemes

7. Key conclusions

The large-scale expansion of biofuel production is putting a certain pressure on agricultural land and water, and may potentially result in large negative social and environmental problems such as rising food prices, deforestation and the depletion of water resources in the absence of careful management.

One important method to avoid these problems is the certification of bioenergy according to principles and criteria aiming at a sustainable production. During the past few years many schemes for the certification of sustainable biomass/biofuels have arisen. All of these have been developed with different intentions (e.g. general or specific markets) and sustainability issues may be addressed differently among schemes.

The rise in number of schemes developed over the years and The EU RED acceptance of voluntary certification to show compliance with legislative requirements implies that certification is considered valuable, and that there is a perceived need to tailor schemes to suit particular producers and markets. Forestry and some agricultural schemes have existed for decades, and are growing in impact around the world. Also many newer schemes have already a big impact.

Governance and stakeholder involvement are crucial to ensure good certification schemes. Most schemes are developed through a multi-stakeholder process, except for Laborelec, and are governed by a Board of Members, which (at first sight) equally represents all stakeholder groups. Although the general approach of these initiatives is very similar, the schemes differ in the way specific issues are dealt with and how they operate. The systems differ in:

- *Chain-of-custody systems*: All certification schemes include or can feed into a chain of custody standard to make sure that the certified product can be traced all the way through the supply chain. However the approach is different among schemes. All schemes can feed into the mass balance and segregation system in some way, except for 3 schemes which only include the mass balance option i.e.2BSvs, Bonsucro, GGL. These are the traceability systems that are regarded as less prone to error and favoured by regulators because they provide direct incentives for fuel providers to ensure that the fuels they purchase and deliver meet sustainability requirements (Dehue et al. 2008).
  All general biofuel/bioliquid (2BsvS, ICSS, RSB) and crop-specific schemes (except for Bonsucro) refer to the tracking of sustainable produced products along the whole supply chain. All other certification schemes have partial CoC systems, excluding the farmer or biomass production and only include the operators handling or processing the certified product (wood products in case of GGL, Laborelec, FSC and PEFC, agricultural products in case of GlobalGAP and SAN/RA).

- *Information handling*: The analysis further showed information on certificates and sustainability characteristics is transferred via online or electronic systems (i.e. 2BSvS, ISCC, RSB, RSPO) or through product declarations documents that are passed to the next operator in the supply chain (e.g. Bonsucro).

- *Assessment procedures*: All audit procedures seem quite similar, but there may be large differences depending on the role that sample-auditing, desk audits and field visits play respectively. For example, in certain cases of multi-site or group certification where

sampling-auditing is allowed not all entities involved in the certification are visited to verify that all conditions are met. The duration of most certificates varies from 1 to 5 years, after which the operation must be fully re-certified.

- *Recognition*: Many schemes are recognised by another scheme(s) or EU Member State, and especially forestry and agricultural schemes are accepted by other biomass schemes as proof of sustainable wood production and agricultural biomass production. Recognition by other schemes, and especially by governments or the European Commission contributes to the credibility and assurance of a scheme

In general it can be concluded that the voluntary sustainability schemes examined tend to bring more credibility, accountability and transparency to the supply chain. They all address sustainability issues although they differ in the way these issues are addressed, e.g. differences in coverage of the supply chain, methodologies, audit requirements and level of transparency. However, it must be noted that his complexity may create marketplace confusion and trade barriers.

The analysis also shows that it is difficult to get a clear picture of the differences between the standards. Not at the level of general approaches and procedures, but differences may only appear when comparing these in full detail. Auditing manuals are rarely available from homepages of certification schemes or certification bodies, and may in some cases be the auditor's personal manual. Also, clear information, for example on the actual role of stakeholders in the development and governance of initiatives is in many cases not readily available[9].

Overall, we recommend that certification schemes continue to explore ways to increase coordination and mutual recognition, to enable broader benefits – such as shared audits and accreditation and decrease confusion. Experiences regarding the management, measurement, monitoring and control systems could beneficially be shared across the different certification schemes to create a more harmonised and efficient approach, allowing challenges to be overcome within the sector more broadly.

[9] Similar conclusion as report from Dutch Soy Coalition (2011) Key characteristics and comparison of voluntary soy standards, Crem BV, The Netherlands

List of literature

Auld, G., L. Gulbrandsen, and C. McDermott. “Certification Schemes and the Impacts on Forests and Forestry.” Annual R. of Environmental Resources 33 (2008): 187-211.

Bioenergy and Food Security Criteria and Indicators (BEFSCI) project: http://www.fao.org/bioenergy/foodsecurity/befsci/en/

Stephen Bass, Kirsti Thornber, Matthew Markopoulos, Sarah Roberts, Maryanne Grieg-Gran. Certification’s impacts on forests, stakeholders and supply chains. A report of the IIED project: Instruments for sustainable private sector forestry. (May 2001).

Buytaert V, Muys B, Devriendt N, Pelkmans L, Kretzschmar JG, Samson R. Towards integrated sustainability assessment for energetic use of biomass: A review of state of the art evaluation of assessment tools. Renewable and Sustainable Energy Reviews (2011): 15:3918-3933.

Carter, D. and F. Merry. “The Nature and Status of Certification in the United States.” Forest Products Journal48.2 (1998): 23-28.

Cashore, B., G. Van Kooten, I. Vertinsky, Auld, and J. Affolderbach. “Private or self -regulation? A comparative study of forest certification choices in Canada, the United States, and Germany.” Forest Policy and Economics7 (2005): 53-69.

Chalmers J., Emily Kunen, Nancy Harris, John Kadyszewski. Draft Assessment and Monitoring Framework for Biofuels and Bioenergy Sustainability. Winrock International Arlington VA (April 2012).

G. Cornelis van Kooten, Harry W. Nelson, Ilan Vertinsky (2005). Certification of sustainable forest management practices: a global perspective on why countries certify. Forest Policy and Economics 7 (2005) 857– 867

Dehue, B., Meyer, S., Hamelinck, C. (2007). Towards a Harmonized Sustainable Biomass Certification Scheme. Ecofys, Utrecht.

B. Dehue, C. Hamelinck, G. Reece, S. de Lint, R. Archer, E. Garcia (2008). Sustainability reporting within the RTFO: Framework Report. Ecofys BV January 2008.

Durst PB, McKenzie PJ, Brown CL, Appanah S. Challenges facing certification and eco-labelling of forest products in developing countries. Inter for Rev 2006;8(2):193e200. doi:10.1505/ifor.8.2.193.

Dutch Soy Coalition. Key characteristics and comparison of voluntary soy standards. Crem BV, The Netherlands (July 2011)

Elbakidze M., Per Angelstam, Kjell Andersson, Mats Nordberg, Yurij Pautov (2011) How does forest certification contribute to boreal biodiversity conservation? Standards and outcomes in Sweden and NW Russia. Forest Ecology and Management 262 (2011) 1983–1995.

Evans, AM, RT Perschel and BA Kittler. April 2010. Revised Assessment of Biomass Harvesting Guidelines. Forest Guild.

http://www.forestguild.org/publications/research/2009/biomass_guidelines.pdf

FAO. Criteria and indicators for sustainable wood fuels. FAO Forestry Paper 160. Food and Agriculture Organization of the United Nations, Rome (2010).

FAO. Environment and Natural Resources Working Paper No.51 118 pp.. ISBN 978-92-5-107150-2. Rome (2012) (http://www.fao.org/docrep/015/i2598e/i2598e.pdf).

Fernholz K., et al. (2010). Forest certification: a status report. Dovetail partners inc. Minneapolis March 2010.

Gale, F. and C. Burda. "The Pitfalls Potential of Eco Certification as a Market Incentive for Sustainable Forest Management." The Wealth of Forests: Markets, Regulation, and Sustainable Forestry. Ed. Chris Tollefson. Vancouver: UBC Press (2000): 278 -293.

Garrelts, H. and M. Flitner. "Governance issues in the ecosystem approach: what lessons from the Forest Stewardship Council?" European Journal of Forest Research130 (2011): 395-405.

German, R. and P. Penfield. "The Potential Certified Wood Supply Chain Bottleneck and Its Impact on Leadership in Energy and Environmental Design Construction Projects in New York State." Forest Products Journal 60.2 (2010): 114 -118.

GBEP (2011) "Global Bioenergy Partnership Sustainability Indicators for Bioenergy. First Edition." http://www.globalbioenergy.org/fileadmin/user_upload/gbep/docs/Indicators/The_GBEP_Sustainability_Indicators_for_Bioenergy_FINAL.pdf

Hironori, T (2006). Biomass material certification (biomass mark) system. Idemitsu Technical Report. Vol 49, no. 2, 187-290.

Holvoet B, Muys B. Sustainable forest management worldwide: a comparative assessment of standards. Int for Rev 2004;6(2):99e122. doi:10.1505/ifor.6.2.99.38388.

ICCT (2012). International Council on Clean Transportation, Policy Updates: United States Low Carbon Fuel Policies. Policy update Number 12. April 2012.

IPIECA (2010). Chain of custody options for sustainable biofuels – operations and fuels 2010.

Siry J.P., Frederick W. Cubbage, Miyan Rukunuddin Ahmed (2005) Sustainable forest management: global trends and opportunities. Forest Policy and Economics 7 (2005) 551– 561.

Jensen, K., P. Jakus, B. English, and J. Menard. "Market participation and willingness to pay for environmentally certified products." Forest Science 49.4 (2003): 632-641.

Dan Klooster (2005) Environmental certification of forests: The evolution of environmental governance in a commodity network. Journal of Rural Studies 21 (2005) 403–417.

Kaphengst T., Mandy S. Ma, Stephanie Schlegel. At a tipping point? How the debate on biofuel standards sparks innovative ideas for the general future of standardisation and certification schemes. Journal of Cleaner Production 17 (2009) S99–S101.

Ladanai, S & Vinterbäck, J (2010) Certification criteria for sustainable biomass for energy. Dept of Energy & Technology. Report 026. Swed. Univ. of Agric. Sci. 38 pp

Lattimore, B., C.T. Smith, B.D. Titus, I, Stupak, G. Egnell. Environmental factors in woodfuel production: risks, and criteria and indicators for sustainable practices. Biomass & Bioenergy 33(10): 1321-1342 (2009).

Lieback J. and Kapsa K.. Sustainable biomass in the light of certification and assessment schemes. 19th European Biomass Conference. June 2011. Berlin.

Lewis K.A., Andrew Green, John Tzilivakis and Douglas J. Warner. The contribution of UK farm assurance schemes towards desirable environmental policy outcomes. International Journal of Agricultural Sustainability 8(4) 2010, 237–249.

Magar SB, Pelkonen P, Tahvanainen L, Toivonen R, Toppinen A (2011). Growing trade of bioenergy in the EU: Public acceptability, policy harmonization, European standards and certification needs.

Merger E, and Till Pistorius (2011). Effectiveness and legitimacy of forest carbon standards in the OTC voluntary carbon market. Carbon Balance and Management 2011, 6:4, 1-12. http://www.cbmjournal.com/content/6/1/4

Newsom D, Volker Bahn, Benjamin Cashore (2006). Does forest certification matter? An analysis of operation-level changes required during the SmartWood certification process in the United States. Forest Policy and Economics 9:197– 208.

NL Agency. Selecting a biomass certification scheme – a benchmark on level of assurance, costs and benefits. Netherlands Programmes Sustainable Biomass, Utrecht (March 2012).

NL Agency. Benchmark of sustainable forestry management systems against the requirements of the Biomass Protocol, Utrecht (16 February 2012).

NL Agency. Sustainability requirements for biofuels and biomass for energy in EU and US regulatory frameworks. Utrecht (May 2011).

OECD/IEA. Sustainable Production of Second-Generation biofuels. Potential and perspectives in major economies and developing countries. Paris (February 2010).

O'Connell D , Braid A, Raison J, Handberg K, Cowie A, Rodriguez L and George B (2009). Sustainable production of bioenergy: A review of global bioenergy sustainability frameworks and assessment systems. Rural Industries Research and Development Corporation (Australia) 134pp.

Owari, T., H. Juslin, A. Rummakainen, and T. Yoshimura. "Strategies, functions, benefits of forest certification in wood products marketing: perspectives Finnish suppliers." Forest Policy and Economics9 (2006): 380-391. The International Council on Clean Transportation. Policy Updates: United States Low Carbon Fuel Policies. Policy Update Number 12.(April 2011).

Owari T., Heikki Juslin, Arto Rummukainen, Tetsuhiko Yoshimura (2006). Strategies, functions and benefits of forest certification in wood products marketing: Perspectives of Finnish suppliers. Forest Policy and Economics 9 (2006) 380– 391.

Partzsch L.. The legitimacy of biofuel certification. Agric Hum Values (2011) 28:413–425. DOI 10.1007/s10460-009-9235-4.

Philip Peck, Göran Berndes, Bo Hektor. Mobilising Global Bioenergy Supply Chains, Keys to

unlocking the potential of bioenergy. Report for the Swedish Energy Agency - IIIEE Report 2011:02

Quesnel, J. “Government calls for mandatory certification.” Northern Ontario Business . 24 Oct 2004: 11.

Andrea, R, and Cadoni Paola. Policy Instruments to promote good practices in bioenergy feedstock production, Food and Agriculture organisation of the United Nations, Bioenergy and Food Security Criteria and Indicators (BEFSCI) project (GCP/INT/081/GER) (2012).

Scarlat N., Jean-Francois Dallemand (2011): Recent developments of biofuels/bioenergy sustainability certification: A global overview. Energy Policy 39(2011), 1630–1646.

Scarlat N., Jean-Francois Dallemand. Status of the implementation of biofuels and bioenergy certification systems Major implications, reporting constraints and implementation controls. JRC Scientific and Technical Reports (2011).

Solidaridad Network (Gert van der Bijl). Overview of Bonsucro, RSPO and RTRS. Presentation on Workshop on Sustainable biofuels regulations, standards and certification. Brussels, 18 September 2012

Steering Committee of the State-of-Knowledge Assessment of Standards and Certification. (2012). Toward sustainability: The roles and limitations of certification. (Executive summary.) Washington, DC: RESOLVE, Inc.

Stupak, I, Brenna Lattimore, Brian D. Titus, C. Tattersall Smith. Criteria and indicators for sustainable forest fuel production and harvesting: a review of current standards for sustainable forest management. Biomass &Bioenergy 35 (8): 3287-3308 (August 2011).

Stupak I, Asikainen, A, Jonsell, M, Karltun, E, Lunnan, A, Mizaraite, D et al. (2007). Sustainable utilisation of forest biomass for energy - possibilities and problems: policy, legislation, certification, and recommendations and guidelines in the Nordic, Baltic, and other European countries. Biomass & Bioenergy , 31(10):666-684.

Upham P., Hauke Riesch, Julia Tomei, Patricia Thornley. The sustainability of forestry biomass supply for EU bioenergy: A post-normal approach to environmental risk and uncertainty. Environmental Science & Policy 14 (2011) 510–518.

van Dam J, Junginger M (2011) Striving to further harmonization of sustainability criteria for bioenergy in Europe: Recommendations from a stakeholder questionnaire. Energy Policy, 39:4051-4066.

van Dam, J., M. Junginger, A.P.C. Faaij, From the global efforts on certification of bioenergy towards an integrated approach based on sustainable land use planning. Renewable and Sustainable Energy Reviews 14(9): 2445-2472 (Dec 2010).
http://ec.europa.eu/energy/renewables/biofuels/sustainability_schemes_en.htm

van Dam, J. (2010). Update: Initiatives in the field of biomass and bioenergy certification. Available at www.bioenergytrade.org.

van Dam J, Junginger M, Faaij A, Jurgens I, Best G, Fritsche U. Overview of recent developments in sustainable biomass certification. Biomass Bioenergy 2008;32(8):749e80. doi:10.1016/j.biombioe. 2008.01.018.

Verhaegen K , Leonardo Meeus, Ronnie Belmans. Towards an international tradable green certificate system — The challenging example of Belgium. Renewable and Sustainable Energy Reviews 13 (2009) 208–215.

Visseren-Hamakers IJ, Glasbergen P. Partnerships in forest governance. Glob Environ Change 2007;17(3e4):408e19.doi:10.1016/j.gloenvcha.2006.11.003.

Vogelpohl T. and Bernd Hirschl (2010) Voluntary bioenergy certification: a legitimate approach to account for social aspects in environmental governance?, Institute for Ecological Economy Research (IÖW) Germany

Woods J. and Diaz Chavez R.. The environmental certification of biofuels, Discussion paper No. 2007-6. Imperial College, London (2007).

http://www.epa.gov/otaq/fuels/renewablefuels/index.htm

http://www.theicct.org/sites/default/files/publications/ICCTpolicyupdate12_USLCFS_2011.pdf

http://www.arb.ca.gov/fuels/lcfs/lcfs.htm,

http://www.epa.gov/otaq/fuels/renewablefuels/compliancehelp/rfs2-aq.htm

http://www.globalbioenergy.org/

List of abbreviations

2BSvs, Biomass Biofuels voluntary scheme
BEFSCI, The Bioenergy and Food Security (BEFS) Approach of FAO
BSI, BonSucro / Better Sugarcane Initiative
CARB, California Air Resources Board
CEN TC383 / EN 16214 Sustainably produced biomass for energy applications (biofuels and bioliquids)
CERTFOR, Chilean System for Sustainable Forest Management Certification (PEFC)
CI, Carbon Intensity
CSBP, Council on sustainable biomass production
EC, European Commission
EPA, Environmental Protection Agency
EU RED, EU Renewable Energy Directive
FAO, Food and Agriculture Organisation of the United Nations
FSC, Forest Stewardship Council
GBEP, Global Bioenergy Partnership
GGL, Green Gold Label (RWE-Essent)
GHG, greenhouse gas
GlobalGAP, Global Good Agricultural Practices
iLUC, indirect land use change
ISCC, International Sustainability and Carbon Certification
ISO TC248/ ISO 13065 Sustainability criteria for bioenergy
IWPB, Initiative for Wood Pellet Buyers
LBE, Laborelec / Electrabel
LCFS, California Low-Carbon Fuel Standard
MS, European Member State
NEN, Dutch Normalisation Institute
NTA8080, Dutch Technical Norm for sustainable biomass for energy
PEFC, Programme for the Endorsement of Forest Certification Schemes
RFA, Renewable Fuels Agency
RFS2, USA Renewable Fuel Standard
RHI, Renewable Heat Incentive
RSB, Roundtable on sustainable biofuels
RSPO, Roundtable on sustainable palm oil
RTFO, the Renewable Transport Fuel Obligation
RTRS, Roundtable on responsible soy
SAN/RA, Sustainable Agricultural Network / Rainforest Alliance

View publication stats