SUSTAINABILITY STANDARDS FOR BIOFUELS: ANALYSES OF THE CURRENT STANDARDS AND RECOMMENDATIONS ON THE FUTURE DIRECTION

by

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Abstract

Past decades have seen development and expansion of biofuels industry around the world thanks to the environmental and economic contribution that biofuels have promised. As more and more people became concerned about the real benefits of biofuels in comparison to the conventional fossil-based options, the need for ensuring sustainability of biofuels has emerged, which, in turn, led to the development of numerous sustainability standards for biofuels over the last decade.

This work analyzes and compares a selected set of nine standards developed by organizations with different scales and characteristics. Based on this analysis, major weaknesses and limitations of the standards are presented and possible recommendations addressing those weaknesses are provided.

It was concluded that one of the major limitations of the nine standards is the lack of harmonization. Many standards deal with different feedstock, products, and scopes of supply chain among others. Therefore, it is suggested that international organizations, particularly the ISO, CEN, RSB, GBEP and FAO take the lead in providing the fundamental common grounds for harmonization of standards. In addition, the inclusion of technological sustainability area is recommended in order to properly address issues that are strongly dependent on the nature of current technologies used.

Thesis Supervisor: Nazli Choucri, Professor of Political Science

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LIST OF ACRONYMS

CBD	Convention on Biological Diversity
COD	Chemical oxygen demand
EC	European Commission
EMEP	European Monitoring and Evaluation Programme
FAO	Food and Agriculture Organization of the United Nations
GBEP	Global Bioenergy Partnership
GHG	Greenhouse Gas
GIS	Geographic Information System
ILO	International Labour Organization
ILUC	Indirect Land Use Change
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LCA	Lifecycle Analysis
LUC	Land Use Change
RSB	Roundtable on Sustainable Biofuels
UNEP	United Nations Environment Programme
UNICA	União da Indústria de Cana-de-açúcar
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture

CHAPTER 1. INTRODUCTION

1.1. BACKGROUND AND PREVIOUS WORK

Past decades have seen the development and expansion of biofuels industry around the world. This was driven by a mixture of motivations; countries were pursuing higher levels of energy independence, development of agricultural economies and reduction on GHG emissions. Over time, concerns about possible negative impacts of biofuels grew, and there was a need for ensuring sustainability of biofuels.

Consequently, a number of sustainability standards for biofuels emerged in the last decade. The majority of the standards address environmental and social sustainability areas while some deal with economic sustainability area and some other issues. Due to this proliferation of standards, it has become necessary to comprehensively figure out both the desirable and undesirable features of the current standards and to make recommendtions for improvement so that future standards can better achieve their goals.

Studies in this field started relatively recently. Dam et al. reviewed over 60 sustainable biomass certification schems that had been published by the end of 2009 and presented the limitations of the standards with recommendations on their future direction.[1] A year later, Scarlat and Dallemand provided a work of similar interest with a stonger emphasis on the significance of indirect land use change.[2] Both studies included major international standards such as those by EU, GBEP or RSB, but the complete set of standards reviewed was not identical. In 2013, IEA Bioenergy released a study, which focused more on the perspective of individual stakeholders.[3] Finally, a publication by FAO in 2013 presented a summary of a comprehensive set of related issues including 'sustainability issues for biofuels', 'initiatives on bioenergy sustainability' , and 'a review of biofuel certification schems'.[4] The publication also provided some simple comparison tables of five different sustainability standards.

Thanks to these studies, numerous standards were systemically categorized and reviewed. However, there were areas that had not been covered by these studies or those that required further updates.

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[1] 'From the global efforts on certification of bioenergy towards an integrated approach based on sustainable land use planning' J. van Dam, M. Junginger, A.P.C. Faaij, Renewable and Sustainable Energy Reviews, 2010

[2] 'Recent developments of biofuels/bioenergy sustainability certification: A global overview', Nicolae Scarlat n, Jean-Franc- ois Dallemand, Energy Policy, January 2011

[3] Task 4: Recommendations for improvement of sustainability certified markets, Pelkmans et al., IEA Bioenergy, February, 2013

[4] 'Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and related feedstocks', Aziz Elbehri et al., FAO, 2013

First, there was a need to include some of the most recently released standards and other relevant publications into the analysis. For example, the Global Bioenergy Partnership (GBEP) published its final version of the sustainability standard in December 2011, and both the European Commission and the Roundtable on Sustainable Biofuels (RSB) released follow-up documents on topics such as indirect land use change and environemtnal impact assessment over the past years. These works has not been thoroughly reviewed by the previous studies.

Second, there were several standards with notable characteristics that had not been analyzed previously. For example, standards specializing in the second generation biofuel or biodiesel, or a standard that was specially designed for the bilateral trade of biofuels between countries had not been reviewed thoroughly.

Third, specific principles and criteria in different standards had not been directly compared from a sentence to a sentence. Although some previous studies have presented comparison tables, many of them summarized characteristics of standards either with simbols or as short descriptions. Furthermore, topic areas used for comparison were limited. Many studies focused on the most critical areas such as GHG emissions, biodiversity, and labor rights, but not on the other areas such as methodologies included, use of agrochemicals, cropping system, etc. Therefore, more comprehensive and direct comparison among standards deemed necessary.

Finally, there was a need for re-suggesting or re-confirming recommendations for future direction of sustainability standards, taking into account all of the aspects mentioned above.

To summarize, the purpose of this thesis was to make contribution to all of these areas.

1.2. THESIS OVERVIEW

The study begins with chapter 2 with reviewing the major types of biofuels currently consumed and the current trend of the global biofuels trade market. Then the concept of sustainability and sustainable development proposed by internationally-recognized organizations are introduced and analyzed. Finally, some of the most important sustainability issues relevant to the use of biofuels are described at the end of chapter 2.

Then, chapter 3 analyzes and compares the selected set of nine sustainability standards for biofuels currently available around the world. The chosen set contains standards developed by international, regional, national, and private organizations and initiatives.

In chapter 4, comprehensive comparison tables in general, environmental, social, and economic areas will be presented. At the end of each area, key findings from comparative analyses will be provided.

Chapter 5 presents major weaknesses or limitations of the standards based on the observation made in chapter 4. Subsequently, recommendations for improvement of standards will be presented in chapter 6 to guide the future direction of further development of the standards.

To specify, this thesis made the following contributions.

First, the final version of the GBEP's standard was thoroughly analyzed and the EC's follow-up document on its position on indirect land use change was analyzed.

Second, the standard by the Council on Sustainable Biomass Production (CSBP) was analyzed as the US's first standard dedicated to the second generation biofuels. Likewise, the standard by the Sustainable Biodiesel Alliance (SBA) was reviewed as a standard specializing in biodiesel use in the US. Furthermore, as a unique example of a bilateral sustainability standard for bioethanol between Sweden and Brazil, SEKAB's standard was thoroughly analyzed. Finally, as an example of a national standard as well as a forestry standard, Australian Forestry Standard was reviewed.

Third, highly detailed direct comparison tables were produced among standards in four different areas: general, environmental, social and economic sustainability. The tables facilitate direct comparison of the original clauses of the standards in many different topics.

Fourth, this study points out the lack of coverage of the technological area of sustainability in the current standards. It is argued that technological sustainability is essential for the sustainability discussion of biofuels and technological sustainability-related topics with the greatest importance are suggested.

CHAPTER 2. BIOFUELS AND SUSTAINABILITY

The purpose of this chapter is to provide a brief introduction to 1) the trend of global biofuels market, 2) the concept of sustainability and sustainable development, and 3) some key sustainability issues with the use of biofuels. Getting familiar with these topics will facilitate the understanding of the next chapter (chapter 3), which will directly review sustainability principles and criteria for biofuels proposed by many different groups.

2.1. BIOFUELS AND GLOBAL BIOFUELS MARKET

Bioenergy is renewable energy made from materials derived from biological sources. In a broad sense, biological sources include different materials from sugarcane to wood waste. In a narrow and more conventional sense, bioenergy is synonymous to biofuel.

Currently, there are two major types of biofuels consumed in the world: ethanol and biodiesel. Ethanol is produced from 1) sugars or starches or 2) cellulose through the process of fermentation by microorganisms.

Biodiesel is an esterified fuel produced from vegetable oil or animal fat. It is important to note that ethanol is the name for a chemical composition whereas biodiesel refers to any liquid diesel fuel that can be used in a typical diesel engine. Therefore, bioethanol is the same as ethanol but biodiesel can refer to multiple chemical structures.

The first generation biofuels, or conventional biofuels, are fuels that are derived from sources such as starch, sugar, animal fats and vegetable oil. The second generation biofuels refer to biofuels produced from cellulosic feedstock. And the third generation biofuels refer to fuels produced from algae.

Figure 2-1 shows a general life cycle of biofuels. Biofuels are produced by feedstock production and processing. Then biofuels are distributed to end users.

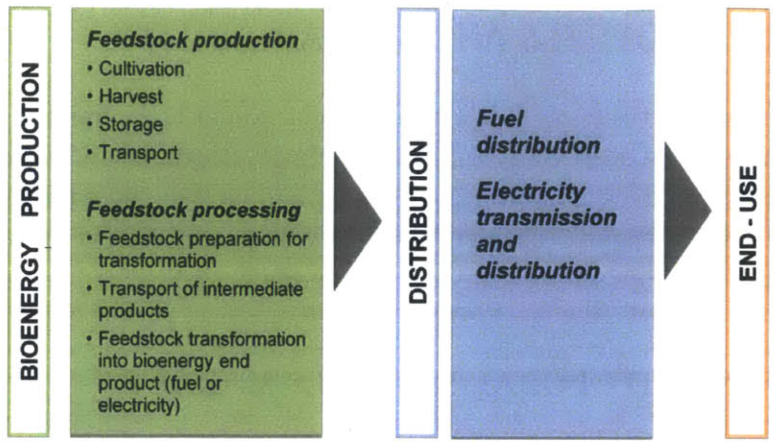


FIGURE 2-1 BIOENERGY LIFECYCLE

Source: 'The Global Bioenergy Partnership Sustainability Indicators for Bioenergy', First edition, Global Bioenergy Partnership, December 2011

The size of global production and trade of biofuels is still modest. It is shown in Figure 2-2 that the world's biofuels production has been growing at a slow rate. In 2012, the world produced about 22 billion gallons of ethanol, which corresponds to about two percent of total global fuel consumption (Figure 2-3).

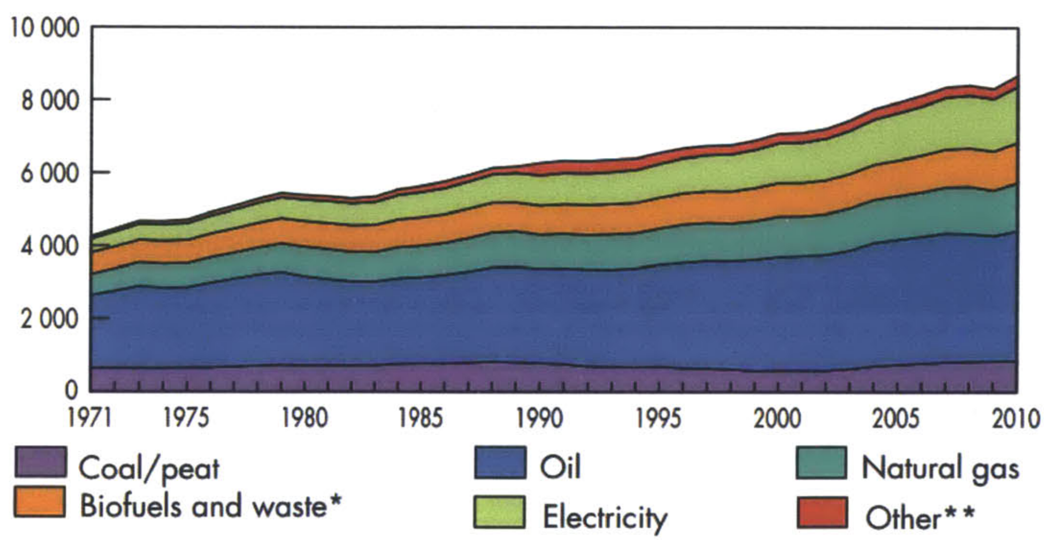


FIGURE 2-2 WORLD TOTAL FINAL ENERGY CONSUMPTION FROM 1971 TO 2010 BY FUEL (MTOE)

Source: Key World Energy Statistics 2012, International Energy Agency

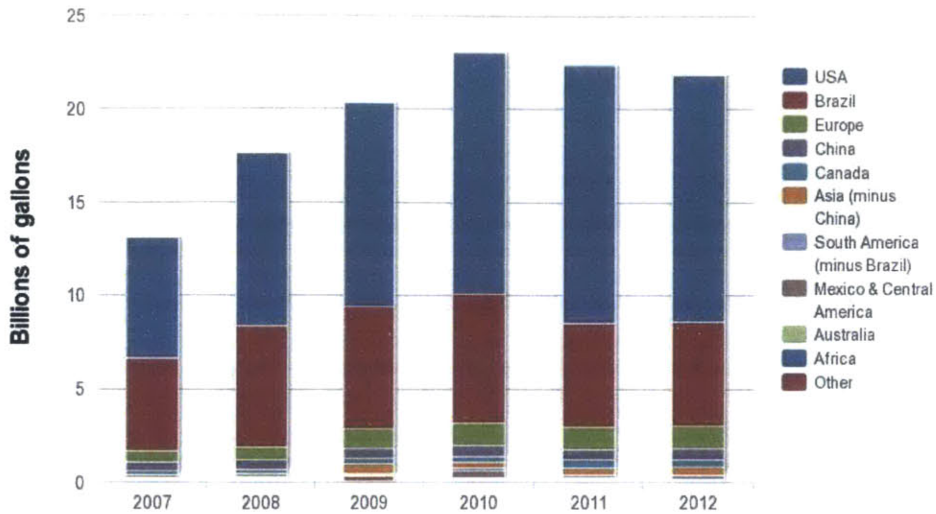


FIGURE 2-3 GLOBAL ETHANOL PRODUCTION

Source: Alternative Fuels Data Center, US Department of Energy, Available at http://www.afdc.energy.gov/data/10331, accessed on May 21, 2013
Original Source: F.O. Licht, cited in Renewable Fuels Association, Ethanol Industry Outlook 2008-2013 reports

However, the global production of both ethanol and biodiesel is on the rise. According to a study by OECD and FAO, the production of both ethanol and biodiesel is expected to grow at steady rates (Figure 2-4 and Figure 2-5). In 2020, world ethanol production would reach at around 155 Bnl, twice the amount produced in 2007. World biodiesel production would grow even faster, reaching at 42 Bnl (four times the amount produced in 2007).

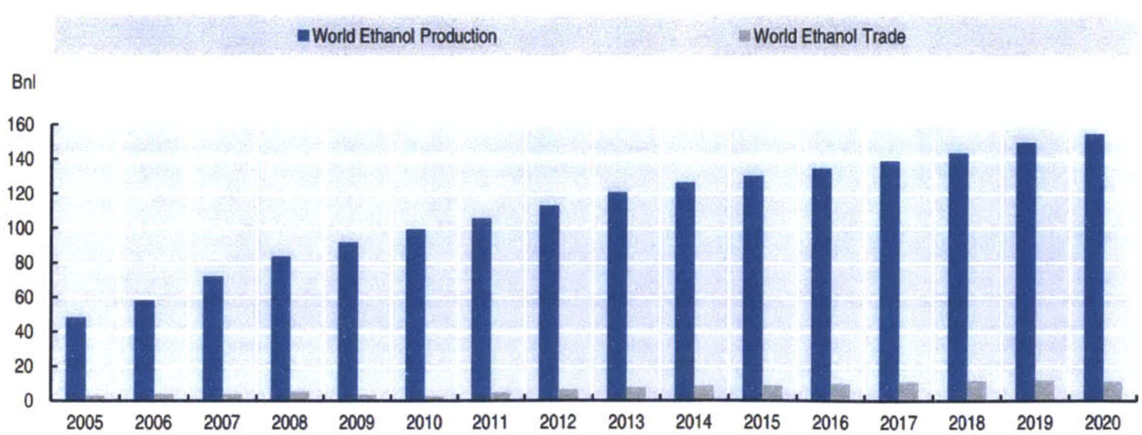


FIGURE 2-4 DEVELOPMENT OF THE WORLD ETHANOL MARKET

Source: OECD-FAO Agricultural Outlook 2011-2020, OECD/FAO, 2011

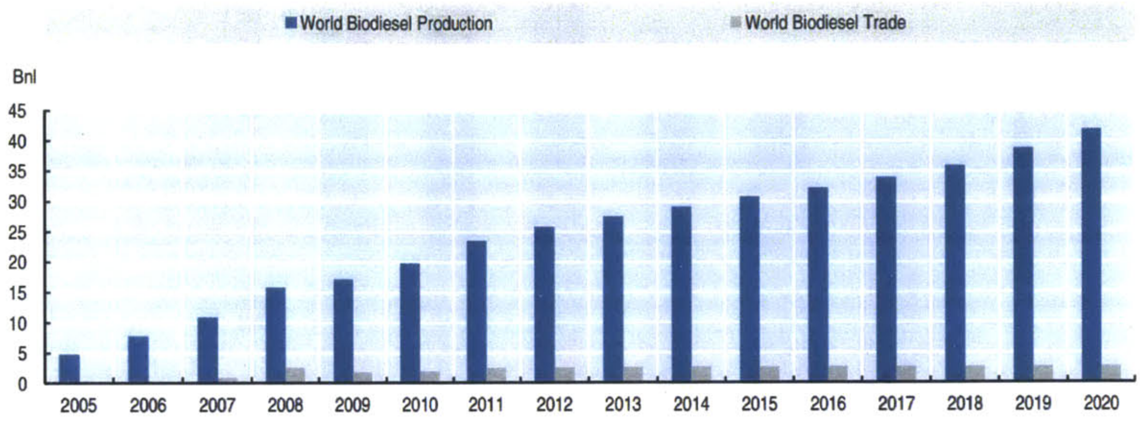


FIGURE 2-5 DEVELOPMENT OF THE WORLD BIODIESEL MARKET

Source: OECD-FAO Agricultural Outlook 2011-2020, OECD/FAO, 2011

As production of biofuels increases, so does the amount of feedstocks used. Figure 2-6 and Figure 2-7 show the types of feedstocks used for the projected production of biofuels from 2008 to 2020. For ethanol production, increase in both sugar cane and biomass-based feedstock is noticeable while use of other feedstocks is expected to grow slowly. For biodiesel production, vegetable oil would remain as the main feedstock while growing at a steady rate. However, the use of biomass-based feedstock would grow fast from around 2016.

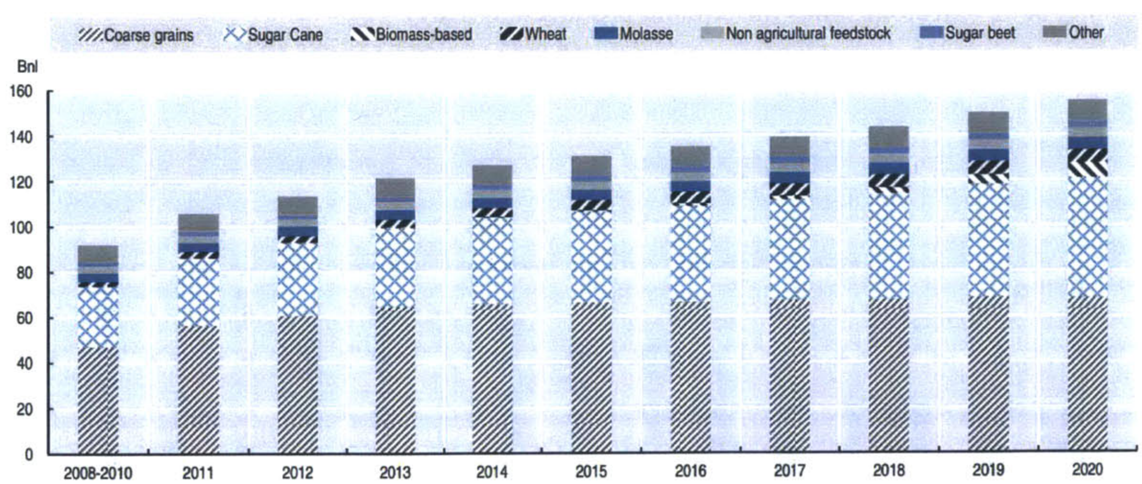


FIGURE 2-6 EVOLUTION OF GLOBAL ETHANOL PRODUCTION BY FEEDSTOCKS USED

Source: OECD-FAO Agricultural Outlook 2011-2020, OECD/FAO, 2011

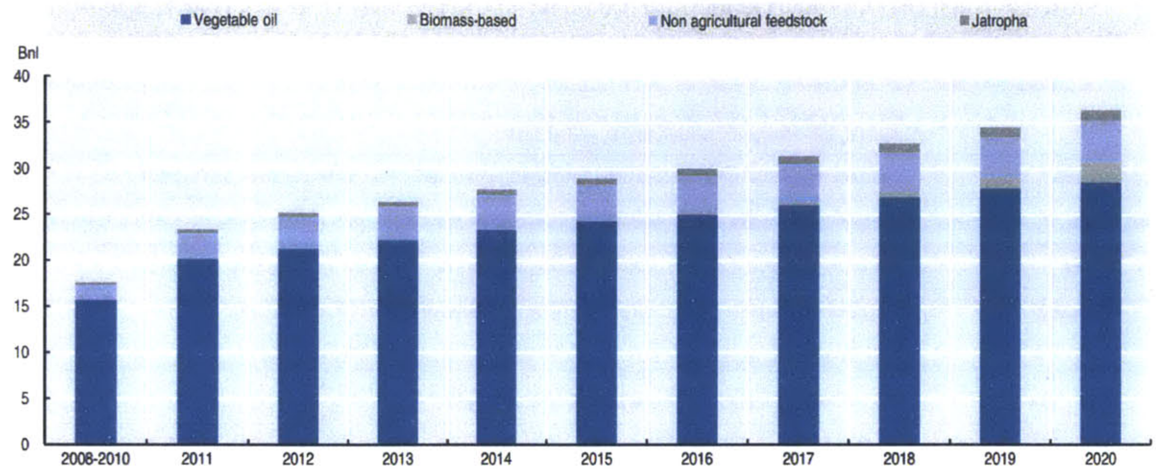


FIGURE 2-7 EVOLUTION OF GLOBAL BIODIESEL PRODUCTION BY FEEDSTOCKS USED
Source: OECD-FAO Agricultural Outlook 2011-2020, OECD/FAO, 2011

This rising demand for biofuels is partly driven by the expansion of fuel-blending requirements around the world. For example, Brazil mandated the blending of ethanol with conventional gasoline up to 20-25% by volume decades ago. Recently, more countries have set or strengthened similar blending requirements either on a mandatory or voluntary basis. Table 2-1 summarizes the blending targets of some of the countries.

TABLE 2-1 VOLUNTARY AND MANDATORY BIOFUELS BLENDING TARGETS FOR TRANSPORT

COUNTRY/COUNTRY GROUPING	TARGETS[1]
Brazil	Mandatory blend of 20–25 percent anhydrous ethanol with petrol; minimum blending of 3 percent biodiesel to diesel by July 2008 and 5 percent (B5) by end of 2010
Canada	5 percent renewable content in petrol by 2010 and 2 percent renewable content in diesel fuel by 2012
China	15 percent of transport energy needs through use of biofuels by 2020
France	5.75 percent by 2008, 7 percent by 2010, 10 percent by 2015 (V), 10 percent by 2020 (M = EU target)
Germany	6.75 percent by 2010, set to rise to 8 percent by 2015, 10 percent by 2020 (M = EU target)
India	Proposed blending mandates of 5–10 percent for ethanol and 20 percent for biodiesel
Italy	5.75 percent by 2010 (M), 10 percent by 2020 (M = EU target)
Japan	500 000 kilolitres, as converted to crude oil, by 2010 (V)
Mexico	Targets under consideration
Russian Federation	No targets
South Africa	Up to 8 percent by 2006 (V) (10 percent target under consideration)
United Kingdom	5 percent biofuels by 2010 (M), 10 percent by 2020 (M = EU target)
United States of America	9 billion gallons by 2008, rising to 36 billion by 2022 (M). Of the 36 billion gallons, 21 billion to be from advanced biofuels (of which 16 billion from cellulosic biofuels)
European Union	10 percent by 2020 (M proposed by EU Commission in January 2008)

Source: The State of Food and Agriculture 2008, Food and Agriculture Organization, Rome, 2008
Note: M= mandatory, V= voluntary

In terms of the countries of production, the US is the world's biggest producer of ethanol accounting for about a half of the global production. Brazil is the second-largest ethanol producer accounting for 37% of the global ethanol production. On the other hand, the EU topped global biodiesel production, accounting for 60% of the global biodiesel production. Some major biofuel-producing countries and their production in 2007 are shown in the table below.

TABLE 2-2 BIOFUELS PRODUCTION BY COUNTRY, 2007

COUNTRY/COUNTRY GROUPING	ETHANOL		BIODIESEL		TOTAL	
	(Million litres)	*(Mtoe)*	*(Million litres)*	*(Mtoe)*	*(Million litres)*	*(Mtoe)*
Brazil	19 000	10.44	227	0.17	19 227	10.60
Canada	1 000	0.55	97	0.07	1 097	0.62
China	1 840	1.01	114	0.08	1 954	1.09
India	400	0.22	45	0.03	445	0.25
Indonesia	0	0.00	409	0.30	409	0.30
Malaysia	0	0.00	330	0.24	330	0.24
United States of America	26 500	14.55	1 688	1.25	28 188	15.80
European Union	2 253	1.24	6 109	4.52	8 361	5.76
Others	1 017	0.56	1 186	0.88	2 203	1.44
World	52 009	28.57	10 204	7.56	62 213	36.12

Source: The State of Food and Agriculture 2008, Food and Agriculture Organization, Rome, 2008
Note: Data presented are subject to rounding

To summarize, first generation biofuels, in particular ethanol and biodiesel are the ones that are traded in the biggest scale in the global market, and the market is expected to grow steadily in the following decades. The expansion of fuel-blending requirements by national governments around the world is one of the drivers of the increased demand for biofuels.

In the next section, the history of the development of the concept of sustainable development will be reviewed, before moving on to the following section (2.3), where some sustainability issues related to biofuels are explained.

2.2. CONCEPT OF SUSTAINABLE DEVELOPMENT

The concept of sustainable development first appeared at the UN Conference on the Human Environment held in Stockholm in 1972. The term 'sustainable development' was not explicitly used but it was agreed by participating members that development and the environment should be managed together in a beneficial way.

The World Conservation Strategy published by the International Union for the Conservation of Natural Resources in 1980 stressed the interdependence of conservation and development. For example, conservation of nature cannot be maintained without development to alleviate poverty;

and development depends on fertility and productivity of the Earth.[5]

The Brundtland Report published by the United Nations in 1987 presented what is now the most widely recognized definition of sustainable development:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

The Global Bioenergy Partnership proposed a similar but slightly different definition focusing on the environmental damage that is passed on to the future generations:

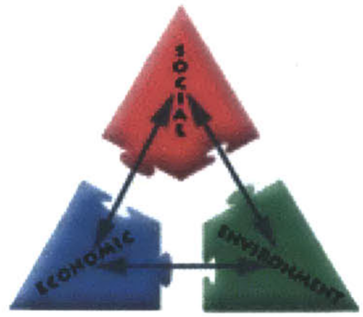
"Sustainable development is a process of technological progress and social organization that meets the needs of society (and particularly those of the poor) in a manner that does not damage the environment to the extent that future generations cannot meet their own needs."[6]

GBEP describes that the environmental damage limit is not a pre-fixed condition; however, it is affected by technological innovation and social organization.

In addition to the concept of sustainable development, it is widely agreed by the international community that the 'three components' or 'three pillars' of sustainable development should be met simultaneously: environmental, social and economic areas. The Johannesburg Plan of Implementation proposed economic development, social development and environmental protection as three components of sustainable development. It explained that they were interdependent and mutually reinforcing. Furthermore, a diagram on the three components by the World Bank describes some of the key issues present in each area of sustainability (Figure 2-8).

[5] The History of Sustainable Development in the United Nations, http://www.uncsd2012.org/history.html, accessed on March 7, 2013

[6] 'The Global Bioenergy Partnership Sustainability Indicators for Bioenergy', First edition, Global Bioenergy Partnership, December 2011



Services	Equity	Biodiversity
Household Needs	Participation	Natural Resources
Industrial Growth	Empowerment	Carrying Capacity
Agricultural Growth	Social Mobility	Ecosystem Integrity
Efficient Use of Labor	Cultural Preservation	Clean Air and Water

FIGURE 2-8 THREE COMPONENTS OF SUSTAINABLE DEVELOPMENT

Source: What is Sustainable Development, The World Bank, available at http://www.worldbank.org/depweb/english/sd.html, Accessed on April 23, 2013

However, many of the issues in an area may seem to conflict with issues in another area. For example, local development may compromise conservation of natural resources in the region in the short term. However, the fundamental motivation for the development of the concept was that long-term and sustained development of humankind can only be ensured by this 'three-pillar' approach. Therefore, in the short term, trade-offs may be made among different elements of sustainability, but in the long term, the goals proposed by these three areas should be achieved simultaneously. The selection of the optimal balancing point is affected by various factors including social, natural and political contexts.

In sum, the concept of sustainable development proposed by the Brundtland Report in 1987 is generally considered as the most-widely agreed definition of the concept. In addition, the so-called 'three-pillar' approach is widely adapted, at least by some of the renowned international organizations such as the World Bank, FAO and UNEP.

2.3. KEY SUSTAINABILITY ISSUES WITH BIOFUELS

This section presents three important issues that are critically related to the discussion of sustainable biofuels. Understanding of these issues will facilitate in-depth understanding of the sustainability standards that will be reviewed in the next chapter.

First, the so-called 'food vs. fuel' debate concerns the possibility that the increased production of biofuels will unintentionally drive up the price of food, impoverishing the poor even more. This is an important issue since the argument has been a major criticism to the expanded use of biofuels. Second, the greenhouse gas emissions reduction also merits attention. The reduction of GHG emissions through the use of biofuels instead of conventional fuels has been one of the strongest motivations for the use of biofuel. Lastly, impact on fossil-derived fuel prices is an important topic as well, since achieving higher energy security by introducing a serious competitor to the fossil energy market has been an important motivation for the expanded use of biofuels for many countries including the US.

2.3.1. FOOD VS. FUEL DEBATE

The 'Food vs. Fuel' is a debate concerning the risk that increase in biofuels production may contribute to the price increase in agricultural products consumed as food. The rationale of the supporters of the argument is that 1) food and biofuels compete for the same resources 2) increase in biofuels production reduces or negatively affects food production and 3) food prices increase due to the decrease in supply. The debate reached at a global scale during the 2007-2008 world food price crisis (Figure 2-9). There are varying degrees of supporting and opposing arguments and they disagree about whether this is really happening, how serious the impacts are, what the causes are, and what things can be done to remedy the situation.

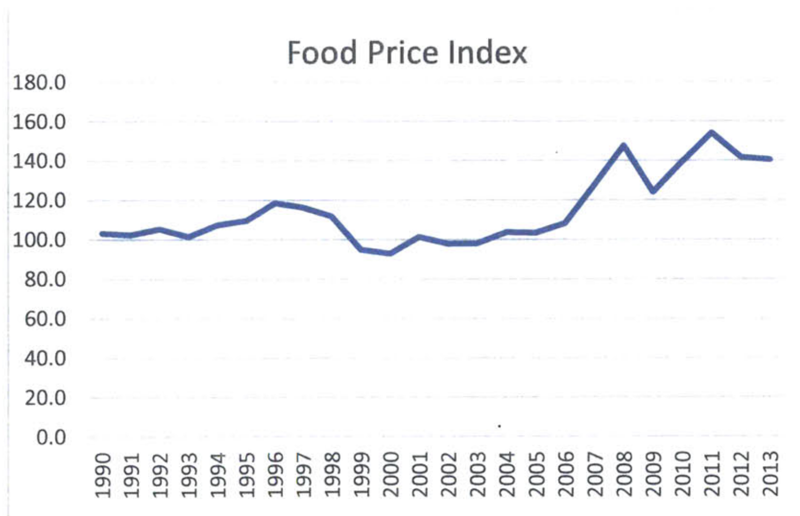


FIGURE 2-9 FAO FOOD PRICE INDEX

Source: based on data by FAO, available at http://www.fao.org/worldfoodsituation/foodpricesindex/en/, accessed on April 2, 2013

A recent study by the International Centre for Trade and Sustainable Development (ICTSD)[7] concluded that the market-driven expansion of ethanol in the US had large effects on the US maize price. It argued that if US ethanol production level did not go beyond than the levels in 2004, the prices of maize wheat, and soybean in 2009 would have been about 21%, 9%, and 5% lower, respectively.

A World Bank policy research working paper "A note on Rising Food Crisis"[8] concluded that large increase of biofuels production in US and Europe are major contributions to the steep rise in global food prices. However, a report published by the World Bank in 2010[9] argued that the conclusion from the previous study may have overestimated the results; the report maintains that the effects by biofuels were not as large as originally expected.

Several causes were proposed that explain the contribution of biofuels on food price increases. One of them is the generous subsidies on biofuels production around the world. For example, the EU has spent up to 3,372 euros as subsidies to ethanol and up to 7,280 euros as subsidies to biodiesel in 2011[10]. Likewise, the US government has been encouraging ethanol production from corn while providing subsidies for decades. Another possible contribution is government mandates. Many countries including Brazil, China, Canada, Sweden, and India have mandated or plan to mandate minimum blending targets of ethanol and/or biodiesel for transport fuels (Table 2-1). For example, in Brazil, 20-25 percent of anhydrous ethanol by volume should be blended with gasoline for any passenger vehicle.

In addition, some cite oil price increase as an important driver of increase of biofuels production. There is economic arbitrage from switching energy consumption from oil to biofuels especially when the oil price is high. A World Bank report argues that oil price increases and weak dollar can explain about 25-30% of food price increases during January 2002 until June 2008.[11]

One of the most well-known proposals to remedy the situation is to move toward the production of second generation biofuels. Since second generation biofuels use lignocellulosic feedstock, which cannot be used for food, it is expected that it will not have an influence on the food supply as much as first generation biofuels. Furthermore, third generation biofuels such as biofuels produced from algae are also proposed as a solution. However, opponents of the idea argue that second generation biofuels still have negative impacts on food production; they still require common resources such as land and water and they may also contribute to both direct and

[7] The Impact of US Biofuel Policies on Agricultural Price Levels and Volatility, Bruce A. Babcock, International Centre for Trade and Sustainable Development, June 2011
[8] A note on Rising Food Crisis, The World Bank, July 2008
[9] Placing the 2006/08 Commodity Price Boom into Perspective The World Bank, July 2010
[10] 'Biofuels-At What Cost? A review of costs and benefits of EU biofuel policies', Global Subsidies Initiative & International Institute for Sustainable Development, April 2013
[11] A note on Rising Food Crisis, The World Bank, July 2008

indirect land use change.

2.3.2. GREENHOUSE GAS EMISSIONS REDUCTION

It is generally known that one of the most important advantages of using biofuels is its carbon neutrality. The rationale is simple; since every carbon released from the use of biofuels was originally absorbed from nature during plant growth, the net carbon emission is zero. However, carbon neutrality is rarely achieved in practice due to other production processes involved such as pre-harvest, waste burning, or transport of feedstock or biofuels.

Normally, carbon emissions are calculated using the Life Cycle Analysis (LCA). The approach calculates the total emission of GHGs from the planting of seeds until the end use of biofuels. Some calculations have shown that first generation biofuels reduce considerable amount of GHG emissions compared to fossil fuels although the exact amounts depend on each type of feedstock. In general, it is known that second generation biofuels reduce even more amount of GHG emissions. Figure 2-10 summarizes the GHG emissions saving from several feedstocks compared to fossil fuels. High saving is observed from production of ethanol from sugar cane.

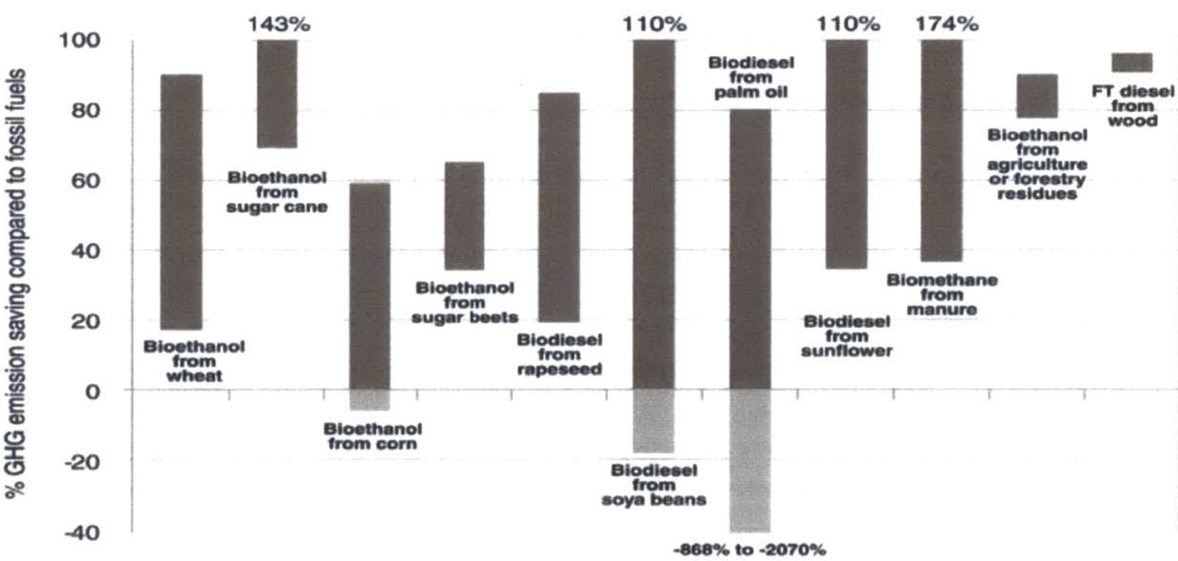


FIGURE 2-10 GREENHOUSE GAS SAVINGS OF BIOFUELS COMPARED TO FOSSIL FUELS
Source: Assessing Biofuels, United Nations Environment Programme, 2009

However, calculating the amount of GHGs emitted is regarded as an inexact process, since many calculation methodologies so far have produced widely differing results because they significantly depend on the methods and assumptions used[12]. One important factor is the consideration of land use change.

2.3.3. IMPACT ON FOSSIL FUEL PRICES

One of the most important motivations for expanding biofuels use is to achieve higher energy security. Specifically, countries try to be less dependent on the volatile global oil and gas prices. The World Energy Outlook of 2006 by the International Energy Agency suggested that biofuels may offer a viable alternative.

However, it is not yet clear whether biofuels can actually have an impact on lowering fossil fuel prices. And even if it is the case, it is controversial how much price changes of fossil fuels they can induce. Recently, at a symposium on the prospects of bi-fuel and tri-flexible vehicles organized by MIT Energy Initiative, participants discussed the conditions that should be met for alternative fuels to have impacts on the gasoline price. Figure 2-11 summarizes major points of the discussion.

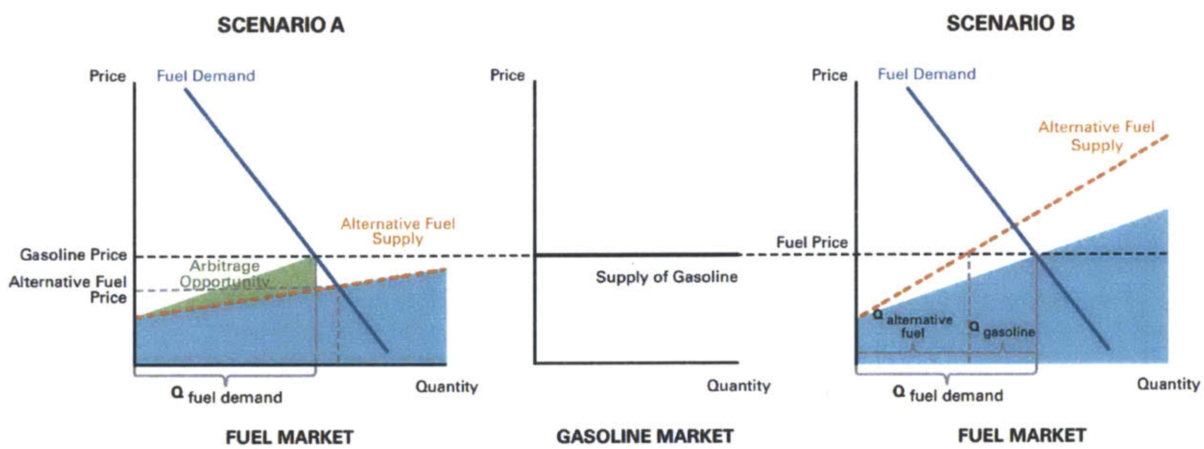


FIGURE 2-11 SCENARIOS FOR PRICING OF ALTERNATIVE FUELS RELATIVE TO GASOLINE
Source: Prospects for Bi-Fuel and Flex-Fuel Light-Duty Vehicles, MIT Energy Initiative, 2013

According to MIT Energy Initiative, scenario A corresponds to a market where supply of an alternative fuel that satisfies the current fuel demand can be produced at a cost less than the price of gasoline. In this case, consumers can arbitrage the price differences of the two fuels (gasoline

[12] Aziz Elbehri et al., Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and relatdate wased feedstocks, FAO, 2013, p68

and alternative fuel) in the short term. The green triangular area represents the amount of benefit for consumers from this arbitrage. In the long term, however, the existence of alternative fuel puts a downward pressure on the price of gasoline and ultimately the prices of the two fuels may converge. In sum, the gasoline price may decrease in the long term in this scenario.

In contrast, scenario B represents a market where supply of an alternative fuel cannot be supplied at a cost lower than the price of gasoline. There would be only one fuel price and this will be set by the marginal fuel or gasoline. Alternative fuel will be produced in the market but up to the amount where the supply line and the gasoline price line intersect. In sum, the alternative fuel cannot put a downward pressure on the price of gasoline.

Therefore there may be certain conditions to be met in order to reduce reliance on fossil fuel prices. Identification of such conditions and assessing whether they can be satisfied for a given market with given conditions, e.g. US transportation fuels market, deserve further study.

To wrap up, the food vs. fuel debate, reduction of GHG emissions and impact on fossil fuel prices are some of the most important issues related to the sustainable use of biofuels. The following chapter will give introduction to some of the current sustainability standards for biofuels with distinct characteristics.

CHAPTER 3. CURRENT STANDARDS ON BIOFUELS SUSTAINABILITY

The purpose of this chapter is to give a brief introduction to a selected set of nine sustainability standards for biofuels (standards from 2 international organizations, 1 regional group, 3 national governments, and 3 private groups) and to present their notable characteristics. Based on the contents of this chapter, the next chapter will comparatively analyze distinct characteristics of the chosen standards.

This chapter begins with presenting definitions of a standard, a sustainability standard, a criterion and an indicator in section 3.1., and it will explain the selection criteria for the nine standards in section 3.2.

3.1. SUSTAINABILITY STANDARDS OF BIOFUELS

What is a standard? Several organizations and researchers proposed definitions of a standard, which is summarized in Table 3-1 below. International Organization of Standardization (ISO) defines a standard as a documentation that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose.

Other definitions show slight differences in specific expressions, but the general concept of the term is that it is a set of principles that guarantee that products, methods, and processes are acceptable so as to ensure acceptable levels of quality, performance and safety.

TABLE 3-1 SEVERAL DEFINITIONS OF A STANDARD

Definer	Definition of a Standard
ISO[13]	a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose.
Dankers, C. [14]	a set of principles and criteria aiming to guarantee that products and production processes were acceptable.
Australian[15]	accepted specifications that define materials, methods, processes and practices

[13] International Organization for Standardization, available at http://www.iso.org/iso/home.htm, accessed on April 18, 2013

[14] Environmental and Social Standards, Certification and Labelling for Cash Crops. Food and Agricultural Organization of the United Nations Rome, 2003

Forestry Standard	that, when effectively implemented, ensure consistent and acceptable levels of quality, performance, safety and reliability are achieved.
Elbehri et al.[16]	a rule for the measure of value or quality that ensures desirable characteristics of products and services – such as environmental friendliness, safety, reliability, efficiency and interchangeability – and at an economical cost.

More specifically, Bioenergy Wiki[17] provides a definition of a sustainability standard for bioenergy; it is a set of agreed criteria by which the production, transportation and processing of particular bioenergy sources can be assessed for environmental, social and other values. Essentially, the definition is an application of the general idea of a standard into biofuels production and use.

Often, a standard contains both a set of criteria and indicators. According to Elbehri et al.(2013), a criterion is a measurable quality characteristic to which a standard conforms and an indicator is a measurement that determines whether the criterion has been met in reality. For example, regarding the principle of soil conservation, a criterion could be 'soil erosion' and an indicator for that criterion could be a specific value obtained from a specific measurement of soil erosion above or below which one can decide whether the degree of soil erosion is acceptable or not[18].

Currently there are number of sustainability standard for biofuels and they differ by types of feedstock used (wood, agricultural crops, etc.), types of products (ethanol, biodiesel, etc.), the scopes of supply chains (Figure 3-1)[19] and purposes of standards (environmental concerns, fair trade, international development, etc.). The next section explains the selection criteria for the nine standards that were chosen for analysis for this study.

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[15] 'The Australian Forestry Standard: Forest management—Economic, social, environmental and cultural criteria and requirements for wood production', Australian Forestry Standard Limited, 2007

[16] Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and related feedstocks, Aziz Elbehri et al., FAO, 2013

[17] Bioenergy Wiki is as an open forum for the promotion of bioenergy use. It was hosted by the National Wildlife Federation and and developed with the CURES network. Webpage: http://www.bioenergywiki.net

[18] Aziz Elbehri et al., Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and relatdate wased feedstocks, FAO, 2013, p54

[19] Goovaerts et al.,Task 1: Examining Sustainability Certification of Bioenergy, IEA Bioenergy, February, 2013

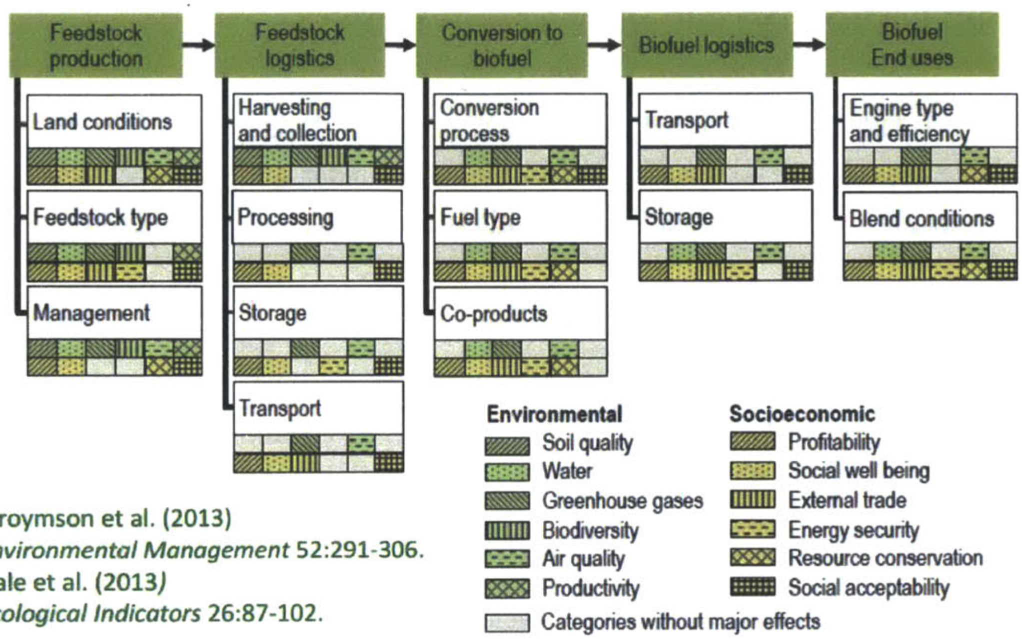

FIGURE 3-1 SUSTAINABILITY INDICATORS AT EACH STAGE OF SUPPLY CHAIN OF BIOFUELS

Source: Biofuels- Lessons Learned, at the Joint workshop on Biofuels and Sustainability, Helena L. Chum, NREL, February, 2013, available at http://www.fapesp.br/eventos/2013/02/BIOEN-BIOTA/Helena.pdf

Original Source: Efroymson et al. (2013). Environmental Management 52:291-306, Dale et al. (2013) Ecological Indicators 26:87-102

3.2. SELECTION OF THE NINE STANDARDS

Over the last decade, there has been a great rise in the number of sustainability standards and they can be categorized into several different groups depending on the scales of the standard developers: international, regional, national, subnational[20]. Figure 3-2 illustrates both the proliferation of standards and the complex relationship among them.

In this thesis, nine different sustainability standards were selected and analyzed. Standards that meet one or more of the following conditions were chosen:

1) Standards by well-known international organizations with public confidence[21]

2) Standards with notable characteristics[22]

3) Standards that were not sufficiently covered by previous studies[23]

Standards from the four kinds of standard-developers - international, regional, national and private- were selected.

[20] For example, Low Carbon Fuel Standard by the State of California of the US belongs to this group.

[21] For example, Inter-America Development Bank, Global Bioenergy Partnership, Roundtable on Sustainable Biofuels

[22] For example, the US's Renewable Fuel Standard is special in that its overall format is unlike the other standards and that it only focuses on the GHG emissions reduction. Australian Forestry Standard was chosen to represent the area of forestry. The standard by SEKAB of Sweden is unique since it is the only bilateral sustainability standard between Sweden and Brazil

[23] Australian Forestry Standard, Council on Sustainable Biomass Production, and Sustainable Biodiesel Alliance

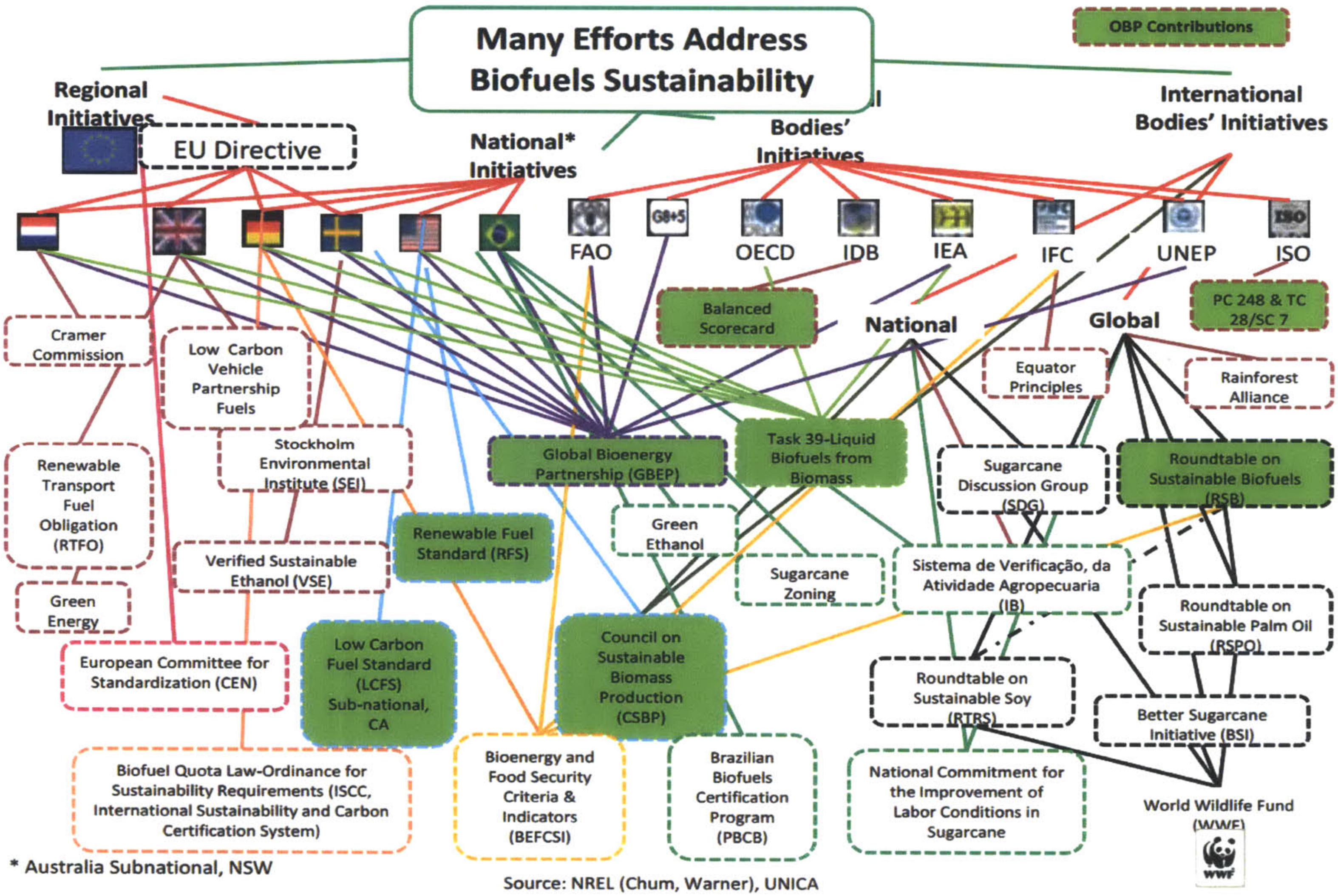

Figure 3-2 Illustration of some government-led initiatives at various levels

Source: Task 1: Examining Sustainability Certification of Bioenergy, Goovaerts et al., IEA Bioenergy, February 2013
Original Source: National Renewable Energy Laboratory (Chum, Warner), UNICA, 2012

Figure 3-2 represents both the proliferation of standards and the complex relationship among standards. Note that this complexity does not cover all of the existing standards.

The following section will review the notable characteristics of the chosen standards.

3.3. INTERNATIONAL STANDARDS

Among standards developed by international bodies, two standards were selected for analyses. The first one is by the Global Bioenergy Partnership and the other one is by the Inter-American Development Bank.

3.3.1. GLOBAL BIOENERGY PARTNERSHIP (GBEP) – THE GBEP SUSTAINABILITY INDICATORS FOR BIOENERGY

The establishment of the Global Bioenergy Partnership (GBEP) was first discussed in the July 2005 Gleneagles Plan of Action by the G8 countries with 5 other countries (Brazil, China, India, Mexico and South Africa). The goal of the partnership was to promote the continued support for wider, cost-effective biomass and biofuels deployment, particularly in developing countries. During the Ministerial Segment of the 14h session of the Commission on Sustainable Development (CSD14) on 11 May 2006, the GBEP was launched.

Currently GBEP is comprised of 23 countries and 14 international organizations[24]. Furthermore, it has 26 countries and 11 international organizations as observers. Figure 3-3 geographically shows the major partner and observer organizations.

[24] Argentina, Brazil, Canada, China, Colombia, Fiji Islands, France, Germany, Ghana, Italy, Japan, Mauritania, Mexico, Netherlands, Paraguay, Russian Federation, Spain, Sudan, Sweden, Switzerland, Tanzania, United Kingdom, United States of America, Economic Community of West African States (ECOWAS), European Commission, Food and Agriculture Organization of the United Nations (FAO), Inter-American Development Bank (IDB), International Energy Agency (IEA), International Renewable Energy Agency (IRENA), United Nations Conference on Trade and Development (UNCTAD), United Nations Department of Economic and Social Affairs (UN/DESA), United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), United Nations Industrial Development Organization (UNIDO), United Nations Foundation, World Council for Renewable Energy (WCRE) and European Biomass Industry Association (EUBIA)

FIGURE 3-3 GBEP'S PARTNER AND OBSERVER COUNTRIES AND INTERNATIONAL ORGANIZATIONS
Source: Global Bioenergy Partnership, available at http://www.globalbioenergy.org/aboutgbep/partners-membership/en/, accessed on June 18, 2013

While the primary focus of the Partnership is on the use of bioenergy, GBEP has three strategic areas of interest: sustainable development, climate change, and food and energy security. For these areas, GBEP has launched two Task Forces: Task Force on GHG Methodologies in 2007 and Task Force on Sustainability in 2008. GBEP's sustainability indicators for biofuels are the result of the second task force.

During the development of the indicators, all partner and observer governments and international organizations were invited for their contribution. The indicators are categorized as environmental, social or economic sustainability-related. With the initial leadership of the United Kingdom and then of Sweden, the Task Force collaborated with other organizations to develop the indicators; the environmental indicators were co-led by Germany and UNEP, the social indicators were led by FAO and the economic indicators were co-led by IEA and UN Foundation. The indicators were adopted by consensus among its Partners.

THE GBEP SUSTAINABILITY INDICATORS FOR BIOENERGY

The most important feature of GBEP Sustainability Indicators is that it is currently the only set of indicators taken by consensus of a number of governments and major international organizations.

GBEP's indicators are applicable to all forms of bioenergy. There are 24 indicators in total and each of the three sustainability pillars (environmental, social and economic) provides 8 indicators.

Indicators were selected according to three major criteria: relevance (to sustainability), practicality and scientific basis. In addition, it was taken into consideration whether the complete set of indicators was well-balanced and sufficiently comprehensive.[25] GBEP acknowledges that although the degree of relevance of each indicator can differ from countries to countries depending on each country's situation, they have developed as much universally relevant indicators as possible. Regarding practicality of indicators, GBEP tried to choose identical or similar indicators that are already in use by other standards so that the practicality of the indicators can be enhanced.

GBEP's work on indicators does not contain any standard or principle regarding sustainable use of bioenergy; rather, it provides detailed analysis of a number of indicators for measuring sustainable use of bioenergy. Moreover, these are voluntary indicators and are not legally-binding. In fact, the indicators were developed in order to provide a comprehensive tool for informed decision-makings regarding the sustainable development of bioenergy for any government or organization.

The three tables below show summaries of the 24 indicators in each pillar[26].

TABLE 3-2 GBEP SUSTAINABILITY INDICATORS - ENVIRONMENTAL PILLAR

ENVIRONMENTAL PILLAR

[25] Detailed descriptions on each indicator's relevance, practicality and scientific basis are found in the 'Methodology Sheets' part of the document 'The GBEP Sustainability Indicators for Bioenergy', 2011.

[26] For the complete analysis of each indicator according to the structure of the Methodology Sheet, please refer to 'The Global Bioenergy Partnership Sustainability Indicators for Bioenergy', First edition, Global Bioenergy Partnership, December 2011.

THEMES

GBEP considers the following themes relevant, and these guided the development of indicators under this pillar: Greenhouse gas emissions, Productive capacity of the land and ecosystems, Air quality, Water availability, use efficiency and quality, Biological diversity, Land-use change, including indirect effects[9]

INDICATOR NAME	INDICATOR DESCRIPTION
1. Lifecycle GHG emissions	Lifecycle greenhouse gas emissions from bioenergy production and use, as per the methodology chosen nationally or at community level, and reported using the GBEP Common Methodological Framework for GHG Lifecycle Analysis of Bioenergy 'Version One'
2. Soil quality	Percentage of land for which soil quality, in particular in terms of soil organic carbon, is maintained or improved out of total land on which bioenergy feedstock is cultivated or harvested
3. Harvest levels of wood resources	Annual harvest of wood resources by volume and as a percentage of net growth or sustained yield, and the percentage of the annual harvest used for bioenergy
4. Emissions of non-GHG air pollutants, including air toxics	Emissions of non-GHG air pollutants, including air toxics, from bioenergy feedstock production, processing, transport of feedstocks, intermediate products and end products, and use; and in comparison with other energy sources
5. Water use and efficiency	▪ Water withdrawn from nationally-determined watershed(s) for the production and processing of bioenergy feedstocks, expressed as the percentage of total actual renewable water resources (TARWR) and as the percentage of total annual water withdrawals (TAWW), disaggregated into renewable and non-renewable water sources ▪ Volume of water withdrawn from nationally-determined watershed(s) used for the production and processing of bioenergy feedstocks per unit of bioenergy output, disaggregated into renewable and non-renewable water sources
6. Water quality	▪ Pollutant loadings to waterways and bodies of water attributable to fertilizer and pesticide application for bioenergy feedstock cultivation, and expressed as a percentage of pollutant loadings from total agricultural production in the watershed ▪ Pollutant loadings to waterways and bodies of water attributable to bioenergy processing effluents, and expressed as a percentage of pollutant loadings from total agricultural processing effluents in the watershed
7. Biological diversity in the landscape	▪ Area and percentage of nationally recognized areas of high biodiversity value or critical ecosystems converted to bioenergy production ▪ Area and percentage of the land used for bioenergy production where nationally recognized invasive species, by risk category, are cultivated ▪ Area and percentage of the land used for bioenergy production where nationally recognized conservation methods are used
8. Land use and land-use change related to bioenergy feedstock production	▪ Total area of land for bioenergy feedstock production, and as compared to total national surface and agricultural and managed forest land area ▪ Percentages of bioenergy from yield increases, residues, wastes and degraded or contaminated land ▪ Net annual rates of conversion between land-use types caused directly by bioenergy feedstock production, including the following (amongst others): o arable land and permanent crops, permanent meadows and pastures, and managed forests; o natural forests and grasslands (including savannah, excluding natural permanent meadows and pastures), peatlands, and wetlands

Source: 'The Global Bioenergy Partnership Sustainability Indicators for Bioenergy', First edition, Global Bioenergy Partnership, December 2011

TABLE 3-3 GBEP SUSTAINABILITY INDICATORS - SOCIAL PILLAR

SOCIAL PILLAR

THEMES

GBEP considers the following themes relevant, and these guided the development of indicators under this pillar: Price and supply of a national food basket, Access to land, water and other natural resources, Labour conditions, Rural and social development, Access to energy, Human health and safety

INDICATOR NAME	INDICATOR DESCRIPTION
9. Allocation and tenure of land for new bioenergy production	Percentage of land – total and by land-use type – used for new bioenergy production where: ▪ a legal instrument or domestic authority establishes title and procedures for change of title; and ▪ the current domestic legal system and/or socially accepted practices provide due process and the established procedures are followed for determining legal title
10. Price and supply of a national food basket	Effects of bioenergy use and domestic production on the price and supply of a food basket, which is a nationally-defined collection of representative foodstuffs, including main staple crops, measured at the national, regional, and/or household level, taking into consideration: ▪ changes in demand for foodstuffs for food, feed, and fibre; ▪ changes in the import and export of foodstuffs; ▪ changes in agricultural production due to weather conditions; ▪ changes in agricultural costs from petroleum and other energy prices; and ▪ the impact of price volatility and price inflation of foodstuffs on the national, regional, and/or household welfare level, as nationally-determined
11. Change in income	Contribution of the following to change in income due to bioenergy production: ▪ wages paid for employment in the bioenergy sector in relation to comparable sectors ▪ net income from the sale, barter and/or own-consumption of bioenergy products, including feedstocks, by self-employed households/individuals
12. Jobs in the bioenergy sector	▪ Net job creation as a result of bioenergy production and use, total and disaggregated (if possible) as follows: o skilled/unskilled o temporary/indefinite ▪ Total number of jobs in the bioenergy sector and percentage adhering to nationally recognized labour standards consistent with the principles enumerated in the ILO Declaration on Fundamental Principles and Rights at Work, in relation to comparable sectors
13. Change in unpaid time spent by women and children collecting biomass	Change in average unpaid time spent by women and children collecting biomass as a result of switching from traditional use of biomass to modern bioenergy services
14. Bioenergy used to expand access to modern energy services	▪ Total amount and percentage of increased access to modern energy services gained through modern bioenergy (disaggregated by bioenergy type), measured in terms of energy and numbers of households and businesses ▪ Total number and percentage of households and businesses using bioenergy, disaggregated into modern bioenergy and traditional use of biomass

15. Change in mortality and burden of disease attributable to indoor smoke	Change in mortality and burden of disease attributable to indoor smoke from solid fuel use, and changes in these as a result of the increased deployment of modern bioenergy services, including improved biomass-based cookstoves
16. Incidence of occupational injury, illness and fatalities	Incidences of occupational injury, illness and fatalities in the production of bioenergy in relation to comparable sectors

Source: 'The Global Bioenergy Partnership Sustainability Indicators for Bioenergy', First edition, Global Bioenergy Partnership, December 2011

TABLE 3-4 GBEP SUSTAINABILITY INDICATORS - ECONOMIC PILLAR

ECONOMIC PILLAR

THEMES

GBEP considers the following themes relevant, and these guided the development of indicators under this pillar: Resource availability and use efficiencies in bioenergy production, conversion, distribution and end-use, Economic development, Economic viability and competitiveness of bioenergy, Access to technology and technological capabilities, Energy security/Diversification of sources and supply, Energy security/Infrastructure and logistics for distribution and use

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

24. Capacity and flexibility of use of bioenergy	▪ Ratio of capacity for using bioenergy compared with actual use for each significant utilization route ▪ Ratio of flexible capacity which can use either bioenergy or other fuel sources to total capacity Countries that have a limited or inflexible bioenergy capacity risk supply interruptions.	

Source: 'The Global Bioenergy Partnership Sustainability Indicators for Bioenergy', First edition, Global Bioenergy Partnership, December 2011

Another important feature of GBEP's indicators is that each indicator follows the same structure provided by its Methodology Sheet. A methodology sheet contains a comprehensive list of sections including the relevance to sustainability, method of measurement, anticipated limitations and relevant international processes, among other things. Especially, the Sheet contains sections that explain each indicator's relevance, practicality and scientific basis.

The Sheet also addresses the issue of uncertainty when measuring the degree of sustainability by providing sections for 'Anticipated limitations' and 'Known data gaps'. Finally, the sections on 'Relevant international processes' and 'References' facilitate future cooperation with other sustainability standard developers and international organizations.

TABLE 3-5 STRUCTURE OF A METHODOLOGY SHEET OF AN INDICATOR BY GBEP

Section	Description
Indicator name	A short name is used for ease of communication
Description	This is what the indicator actually measures
Measurement unit	SI units are suggested, though countries may use other units, depending on national data availability
Application of the indicator	Here it is stated whether the indicator applies to the production and/or use phases and whether it applies to all bioenergy feedstocks, end-uses and pathways or just some specified categories
Relation to themes	Here it is stated how the indicator is related to the sustainability themes selected by GBEP, trends in aspects of which the indicator is intended to measure
How the indicator will help assess the sustainability of bioenergy at the national level	Here it is explained how the indicator values should be interpreted in order to assess the sustainability of bioenergy and inform national-level decision-making
Comparison with other energy options	While the indicators can be used to assess the sustainability of bioenergy (including comparison of different types of bioenergy used within a country) without reference to other energy sources, it is also deemed extremely useful to be able to relate the GBEP Global

	Bioenergy Partnership26contribution (positive or negative) of bioenergy to sustainable development to that of the fossil fuels or other energy sources they might displace or compete with
Methodological approach	this section includes a description of how the methodological approach allows one to determine the impact of bioenergy production and/or use, separate it from other possible impacts, and build an aggregate national level indicator
Anticipated limitations	A key part of science is knowing the main sources of uncertainties in a methodology – some possible means to reduce these uncertainties are also suggested in some cases
Data requirements	These are the basic data that are required to build the indicator, in accordance with the methodological approach described above
Data sources (international and national)	A non-exhaustive list of available sources of the data required for the indicator
Known data gaps	Known data gaps and suggested strategies for filling these gaps are highlighted
Relevant international processes	International processes that involve similar measurements could mean that data is being collected or that new data collection would serve more than the GBEP indicators and could also imply a broader policy relevance
References	A non-exhaustive list of useful references, some of which might be essential to a full understanding of the methodological approach suggested

Source: adapted from 'The Global Bioenergy Partnership Sustainability Indicators for Bioenergy', First edition, Global Bioenergy Partnership, December 2011

3.3.2. INTER-AMERICAN DEVELOPMENT BANK (IDB) – IDB BIOFUELS SUSTAINABILITY SCORECARD

The 'Sustainable and Climate Change Initiative (SECCI)' and the 'Structured and Corporate Finance Department (SCF)' of the Inter-American Development Bank developed the 'IDB Biofuels Sustainability Scorecard' in 2009. It is a web-based scorecard and any individual with an internet access can use the interactive and real-time sustainability scorecard to evaluate the degree of sustainability of a bioenergy business.

The primary objective of the development of the Scorecard is to provide an easy-to-use tool to measure the level of sustainability for any bioenergy project. The Scorecard provides both criteria and indicators and they are categorized as environmental, social, or cross-cutting sustainability areas.

Although the scorecard was developed for users in the private sector, it can be used for any user as a conceptual tool. According to the IDB, the scorecard can be useful for project developers of all stages of production, financial institutions, private investors, and environmental and social safeguard reviewers. Figure 3-4 is a screenshot of the scorecard in the environmental sustainability area.

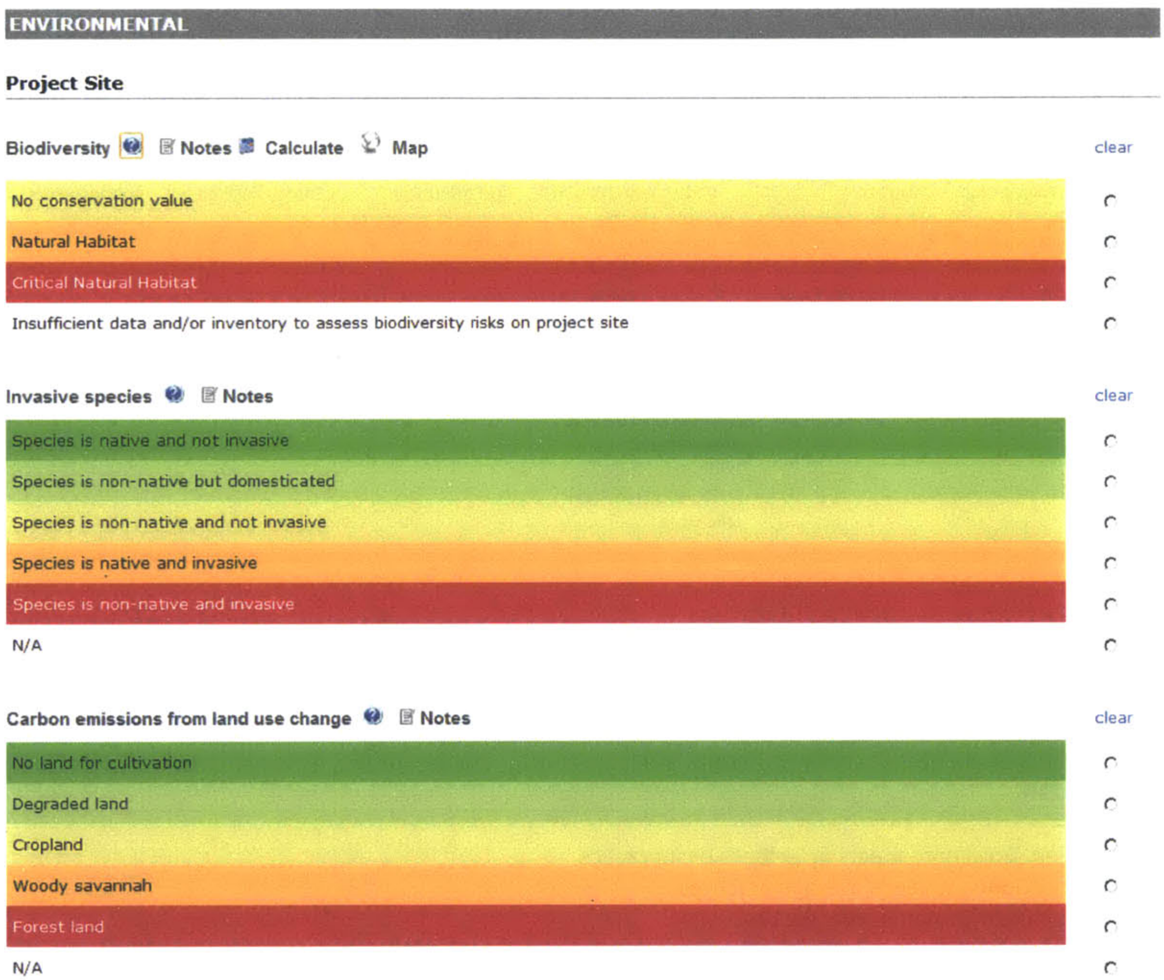

FIGURE 3-4 PART OF THE IDB SUSTAINABILITY SCORECARD ON ITS WEBPAGE

Source: IDB Biofuels Sustainability Scorecard, available at http://www.iadb.org/biofuelsscorecard/, accessed on July 17, 2013

Since the scorecard is filled out in a web-browser, users can have multiple versions of the scorecard and the cards can be edited throughout the course of a project. In addition, Scorecards can be saved and downloaded in the PDF format by users. Furthermore, users can first fill in the Scorecard and see how the specific answers affect the final result. This allows users to fine-tune the bioenergy projects according to their desired final outcomes.

The final result does not contain a final score because not every criterion is quantifiable and there are always uncertainties involved. The final result is a color map that shows different colors across different areas of sustainability topics. With the final color map, a user can figure out which areas of sustainability need further improvement. Figure 3-5 is a screen shot of a final result with a set of arbitrary inputs.

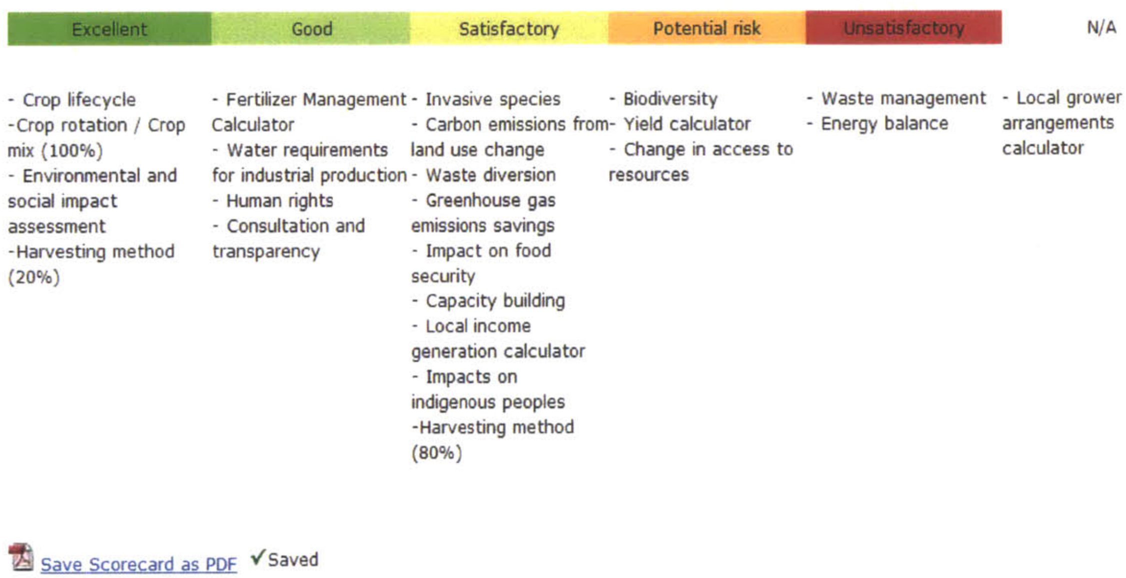

FIGURE 3-5 AN EXAMPLE OF A RESULT BY THE IDB SUSTAINABILITY SCORECARD

*Source: IDB Biofuels Sustainability Scorecard, available at http://www.iadb.org/biofuelsscorecard/, accessed on July 28, 2013

*Note:

-Bright Green: Excellent - meets or exceeds best practice

-Light Green: Good - exceeds average practices

-Yellow: Satisfactory - meets average practices

-Orange: Potential risk - presents potential issues that may lead to significant environmental or social harm

-Red: Unsatisfactory - unsustainable practices that present significant environmental and social (from IDB Biofuels Sustainability Scorecard User Guide)

Another feature of the Scorecard is that it provides several calculators on its webpage. They are Water Management Calculator, Controlled Release Fertilizers Calculator, Biofuel Distribution Energy Efficiency Calculator, Local income generation calculator, Local Grower Arrangements Calculator and Yield Calculator. These calculators help users convert complex real-world conditions into measurable numbers or levels of sustainability. The figure below shows the 'Biofuel Distribution Energy efficiency Calculator' on the web with arbitrary inputs.

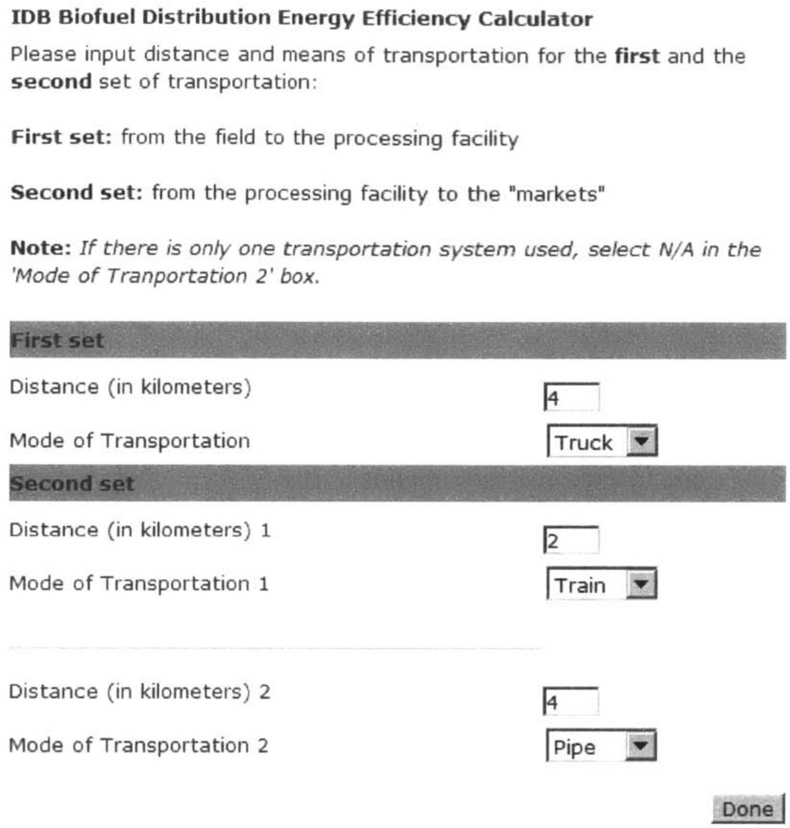

FIGURE 3-6 IDB BIOFUEL DISTRIBUTION ENERGY EFFICIENCY CALCULATOR WITH ARBITRARY INPUT
Source: IDB Biofuels Sustainability Scorecard, available at http://www.iadb.org/biofuelsscorecard/, accessed on March 15, 2013

IDB also provides a userguide document that explains the criteria and what they seek to measure throughtout the card. There are 14 environmental sustainability criteria, 11 social sustainability criteria, and 4 cross-cutting sustainability criteria. Three tables below summarize those criteria as well as the calculators provided.

TABLE 3-6 IDB BIOFUELS SUSTAINABILITY SCORECARD- ENVIRONMENTAL SUSTAINABILITY

	Topic	Description	Calculator	Category
1	Biodiversity	seeks to address the impacts of a project on the biodiversity of the area, including natural habitats and cultural sites, where it will be located.		Project site
2	Invasive species	seeks to address the risks posed by using an invasive species as feedstock		

		for biofuel production.		
3	Carbon emissions from land use change	seeks to address the impact of both direct and indirect land use change on greenhouse gas emissions.		
4	Crop lifecycle	seeks to address issues relating to soil erosion, carbon released from the soil, water run-off, and energy input for harvesting. Choices include: -Permanent/perennial/annual crop -No till/low till/tilling		Feedstock/Crop management
5	Crop rotation, Crop mix	seeks to address issues relating to soil quality, soil input requirements, and crop biodiversity. Choices include: Crop rotation/inter-cropping/no rotation or inter-cropping		
6	Harvesting method	seeks to address issues exclusively related to environmental concerns, such as greenhouse gas emissions, air pollution, and biodiversity loss. Issues associated with the role of labor are addressed in social categories. Choices include: Field burning/ no burning		
7	Water management	seeks to address issues relating to water scarcity and water run-off, in addition to energy input.	IDB Water management calculator	
8	Fertilizer Management	seeks to address issues of soil quality, area biodiversity, nitrogen emissions, run-off and leaching.	IDB Controlled Release Fertilizers Calculator	
9	Pesticide use	seeks to address issues of soil quality, run-off, and area biodiversity.		
10	Energy source for facility	seeks to address greenhouse gas emissions, as well as the ratio of energy return on energy input of the production phase of biofuel projects. Cogeneration from biomass with excess to sell to grid/cogeneration from biomass to power facility only/use of other renewables		Production/Facility Management

11	Water requirements for industrial production	seeks to address the project's level of efficiency in terms of water usage in the production cycle		
12	Waste management	seeks to address issues pertaining to management of waste disposal.		
13	Waste diversion	seeks to address issues pertaining to waste reduction. Waste used for productive purposes, including power generation, fertilizer, food products, and other co-products reduces the amount of waste. Recycling and reuse also reduce the amount of waste.		
14	Relative energy efficiency of transport and distribution	seeks to address issues pertaining to the relative energy efficiency of the transportation and distribution of the biofuel production.	IDB Biofuel Distribution Energy Efficiency Calculator	Distribution

Source: adapted from 'IDB Biofuels Sustainability Scorecard', Inter-American Development Bank, October 2009

TABLE 3-7 IDB BIOFUELS SUSTAINABILITY SCORECARD- SOCIAL SUSTAINABILITY

	Topic	Description	Calculator
1	Human rights	seeks to capture the project's standards and respect for basic human rights at the workplace (beyond the labor relationship itself), within the community as a whole, and compliance with legal and regulatory structures necessary to enforce those rights and ensure non-discriminatory practices.	
2	Labor rights	seeks to capture the project's labor standards, respect for basic human rights at the workplace, and compliance with legal and regulatory structures necessary to enforce those rights.	
3	Land ownership	seeks to address the effect of the project over the land ownership pattern as well as the respect for private property and customary rights and local communities' right to proper compensation.	
4	Change in access to resources	seeks to address the impacts of the project on the access by local people to resources (food, water, natural resources, hunting and fishing stock, land, etc.) that are vital for local food security and/or their subsistence strategies, such as habitat and mobility, cultural practices, and reproduction	

		and customary practices.	
5	Impact on food security	seeks to address the issue of local, national, and global food security resulting from a change in land use with respect to food production.	
6	Consultation and transparency	seeks to address whether stakeholders have had access to information and documentation on environmental, social and legal issues, the local community has been consulted and adequately represented, and adequate strategies for continuous stakeholder engagement exist.	
7	Capacity building	seeks to measure the effect of the project on local employees or general population learning, knowledge transfer, and technology transfer.	
8	Local Income generation	seeks to address the project's potential, given its location, hiring and sourcing practices, to generate income for people that live in poor areas or belong to the poor strata of a country.	IDB Local income generation calculator
9	Local grower arrangements	seeks to address whether the project has acceptable arrangements for sourcing feedstock from local growers, including independent producers and "outgrowers" under exclusive sales agreements.	IDB Local grower arrangements calculator
10	Community development	seeks to address the extent to which the project will maximize benefits for the local community.	
11	Impacts on indigenous peoples	seeks to address whether the project has any potential impacts on indigenous peoples.	

Source: adapted from 'IDB Biofuels Sustainability Scorecard', Inter-American Development Bank, October 2009

TABLE 3-8 IDB BIOFUELS SUSTAINABILITY SCORECARD- CROSS-CUTTING AREA

	Topic	Description	Calculator
1	Environmental and social impact assessment	seeks to address whether the project has conducted an environmental and social impact assessment, including a socio-cultural assessment of how indigenous peoples may be affected, and adequately identifies relevant impacts and mitigation strategies.	
2	Yield of Biofuel and co-products	seeks to measure the overall efficiency of the project, considering the feedstock used and the total volume of biofuel produced, measured by liters of biofuel per hectare of land used in cultivation.	IDB Yield calculator
3	Energy balance	seeks to address the ratio between the energy produced by 1 kg of the biofuel and the total energy necessary to cultivate,	

		produce, and distribute it
4	Greenhouse gas emissions savings	provides a measurement of the direct and indirect greenhouse gas savings resulting from the production of a biofuel project, taking into account the entire lifecycle of biofuel production, from feedstock cultivation to the end-use.

Source: adapted from 'IDB Biofuels Sustainability Scorecard', Inter-American Development Bank, October 2009

3.4. REGIONAL STANDARD: EUROPEAN UNION (EU) - DIRECTIVE 2009/28/EC ON THE PROMOTION OF THE USE OF ENERGY FROM RENEWABLE SOURCES

For a regional standard, the one by the European Commission was chosen for its significance. In fact, the standard by the EC is the first regional sustainability standard for biofuels.

The European Union adopted the 'Renewable Energy Directive (RED) 2009/28/EC on the promotion of the use of energy from renewable sources' in 2009. Articles 17, 18 and 19 of the Directive contain sustainability criteria related to the use of bioenergy. The criteria deal with greenhouse gas emissions savings, protection of land with high carbon stock, protection of land with high biodiversity and reporting duty on environmental and social sustainability issues.

First, the Directive mandates that the greenhouse gas emissions saving from the use of biofuels and bioliquids[27] be at least 35% immediately compared to the reference fossil fuel. From January 1st, 2017, the number becomes 50% and from January 1st, 2018, it becomes 60%.

Second, it mandates that land with high carbon stock should not be used to produce biofuels and bioliquids. Land with high carbon stock is land that meets one of the following conditions in January 2008 and no longer has that status:

i. Wetland that is covered with or saturated by water permanently or for a significant part of the year
ii. Continuously forested area that spans more than one hectare with trees higher than five meters and a canopy cover of more than 30%, or trees able to reach those thresholds in situ

[27] Liquid fuel for energy purposes produced from biomass

iii. Land spanning more than one hectare with trees higher than five meters and a canopy cover of between 10% and 30%, or trees able to reach those thresholds in situ[28]

Third, land with high biodiversity value should not be used to produce biofuels and bioliquids. Land with high biodiversity is land that meets one of the following conditions in or after January 2008, whether or not the land continues to maintain the status:

i. Primary forest and other wooded land of native species, without visible indication of human activity
ii. Areas designated 1) by law or relevant competent authority for nature protection purposes or 2) for the protection of rare and threatened or endangered ecosystems or species
iii. Highly biodiverse grassland that is 1) natural and would remain grassland without human intervention or 2) non-natural and would not remain grassland without human intervention and which is species-rich and not degraded[29]

Fourth, raw material obtained from peatland in January 2008 should not be used to produce biofuels and bioliquids.

Fifth, the Commission will, every two years, report to the European Parliament and the Council report on environmental sustainability (soil, water and air) and social sustainability (land-use rights and food security) in respect of both third countries and Member states.

Sixth, the EU should endeavor to conclude bilateral or multilateral agreements with third countries containing provisions on sustainability criteria.[30]

The main points of the criteria are summarized in Table 3-9 below.

TABLE 3-9 SUMMARY OF EU SUSTAINABILITY CRITERIA

	Topic	Criteria
1	GHG emissions saving	The greenhouse gas emission saving from the use of biofuels and

[28] Adapted from European Commission, Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, 2009
[29] Adapted from European Commission, Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, 2009
[30] Adapted from European Commission, Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, 2009

		bioliquids shall be at least 35 %.
2	High carbon stock protection	Biofuels and bioliquids shall not be made from raw material obtained from land with high carbon stock, namely land that had one of the following statuses in January 2008: -Wetlands -Peatlands -Continuous forest
3	High biodiversity protection	Biofuels and bioliquids shall not be made from raw material obtained from land with high biodiversity value, namely land that had one of the following statuses in or after January 2008: -Undisturbed primary forest -Conservation areas -Biodiverse grassland
4	Peatland protection	Biofuels and bioliquids shall not be made from raw material obtained from land that was peatland in January 2008
5	Reporting duty on soil, water and air sustainability	The Commission shall, every two years, report to the European Parliament and the Council on national measures and for soil, water and air protection.
6	Reporting duty on social sustainability	The Commission shall, every two years, report to the European Parliament and the Council on the impact on social sustainability (availability of foodstuffs, land-use rights, etc.) in the Community and in third countries of increased demand for biofuel.
7	Bilateral or multilateral agreements	The Community shall endeavour to conclude bilateral or multilateral agreements with third countries containing provisions on sustainability criteria that correspond to those of this Directive.

Source: adapted from 'Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC', European Commission, 2009

EU Sustainable Criteria is the first binding sustainability scheme. In addition, there is no discrimination against countries outside the EU since raw materials should meet the criteria irrespective of their origin of cultivation. These principles are set out in the first paragraph of the Article 17:

1. Irrespective of whether the raw materials were cultivated inside or outside the territory of the Community, energy from biofuels and bioliquids shall be taken into account for the purposes referred to in points (a), (b) and (c) only if they fulfill the sustainability criteria set out in paragraphs 2 to 6:

(a) measuring compliance with the requirements of this Directive concerning national targets;

(b) measuring compliance with renewable energy obligations;

(c) eligibility for financial support for the consumption of biofuels and bioliquids.

In addition, the Criteria provides methodologies for calculating life cycle GHG emissions and the amount of carbon stock of a given area. The methodologies are described in Annex V of the Directive. In particular, the default values for greenhouse gas emission saving for the production pathway can be also found. The Criteria mandates that conservative default values are chosen compared to normal production processes in all cases with a few exceptions.[31]

3.5. NATIONAL STANDARDS FROM SELECTED COUNTRIES

For national standards, standards by the USA, Australia, and Sweden were selected due to their unique characteristics, which will be explained in the following sections.

3.5.1. USA – RENEWABLE FUEL STANDARD (RFS)

The Renewable Fuel Standard (RFS) is a federal program administered by the Environmental Protection Agency of the US and it requires transportation fuels sold in the US contain at least certain levels of renewable fuels by volume. The purpose of the RFS is to reduce foreign oil dependence and GHG emissions while providing new economic opportunities for the US.

The origin of the RFS is the Energy Policy Act (EPAct) of 2005. The Act was expanded by the Energy Independence and Security Act (EISA) of 2007 in December 2007. The amount of renewable transportation fuel to be blended with conventional fuel increases each year, reaching 36 billion gallons by 2022(Figure 3-7).

[31] "where the contribution of a factor to overall emissions is small, or where there is limited variation, or where the cost or difficulty of establishing actual values is high, default values must be typical of normal production processes" ('Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources', European Commission, 2009)

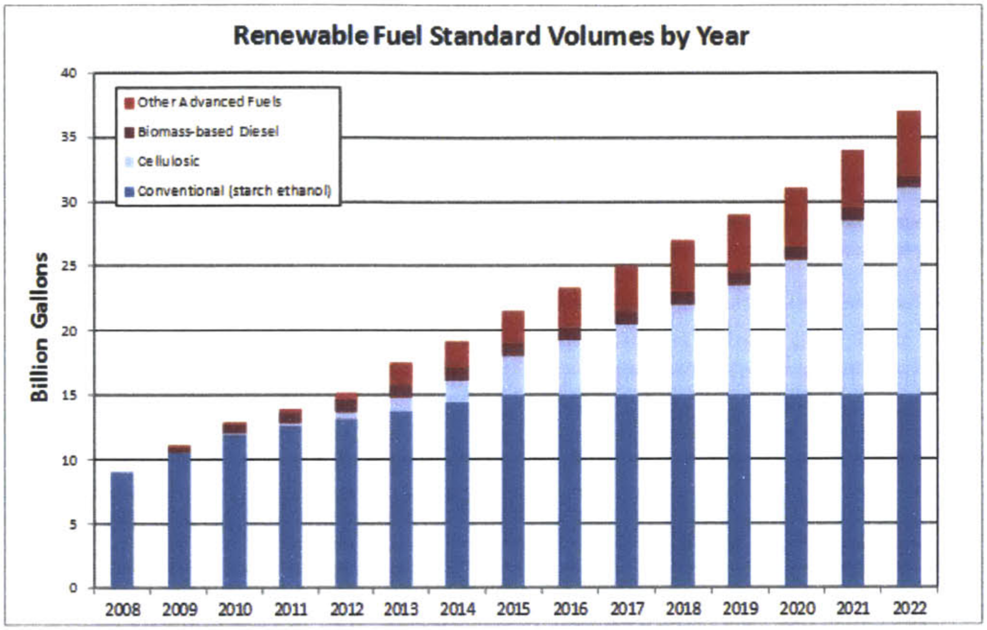

FIGURE 3-7 US VOLUMES OF BIOFUELS REQUIRED TO BE BLENDED WITH TRANSPORTATION FUELS UNTIL 2022 ACCORDING TO THE RENEWABLE FUEL STANDARD

Source: Alternative Fuels Data Center, US DOE, available at http://www.afdc.energy.gov/laws/RFS, accessed on July 7, 2013

The original RFS program by the EPAct of 2005 (so called RFS1) differs from the new RFS program by the EISA of 2007 (so called RFS2) in several ways:

i. The new program includes diesel in addition to gasoline.

ii. The volume of renewable fuel required to be blended with transportation fuel increased from 9 billion gallons in 2008 to 36 billion gallons by 2022.

iii. The new program has new categories of renewable fuel and sets separate volume requirements for each category.[32]

The RFS is administered by the EPA and the compliance to the program is tracked through the Renewable Identification Number (RIN). The entities regulated by the program include oil refiners, blenders, and gasoline and diesel importers and they need to either sell required volumes of renewable fuels or purchase Renewable Identification Numbers from others who met more than the required volumes.

[32] Adapted from Renewable Fuel Standard, US EPA, http://www.epa.gov/otaq/fuels/renewablefuels/index.htm, accessed on February 19, 2013

There are four categories of biofuels defined by the program: conventional biofuel, biomass-based diesel, cellulosic biofuel, and other advanced biofuels. Conventional biofuels are fuels that are derived from starch feedstock (corn, sorghum, wheat). Biomass-based diesel is diesel fuel that is made from renewable feedstock. Cellulosic biofuel is derived from cellulose, hemicellulose or lignin and it is non-food-based biofuel. Other Advanced biofuel is derived from renewable feedstock and it includes sugarcane or sugar beet-based fuel, renewable diesel co-processed with petroleum or other types of biofuels that may exist in the future.[33] For each of these biofuels, thresholds of life cycle GHG emissions are set and it requires a percentage improvement over the gasoline or diesel fuel they replace (Table 3-10). According to EISA, indirect land use change should be taken into account when calculating GHG emissions reduction.

TABLE 3-10 FOUR TYPES OF BIOFUELS DEFINED BY THE RENEWABLE FUEL STANDARD

	Renewable Fuel Type	Standards
1	Conventional biofuels	Conventional biofuels(any fuel derived from starch feedstocks, practically corn ethanol) produced in plants built after 2007 must show a 20% reduction in life cycle GHG emissions compared to the baseline
2	Biomass-based diesel	Biomass-based diesel (a diesel fuel substitute made from renewable feedstocks) must show a 50% reduction in life cycle GHG emissions compared to the baseline
3	Cellulosic biofuel	Cellulosic biofuel (any fuel derived from cellulose, hemicellulose, or lignin) must show a 60% reduction in life cycle GHG emissions compared to the baseline
4	Advanced biofuel	Other Advanced biofuels (any fuel derived from renewable feedstocks) must show a 50% reduction in life cycle GHG emissions compared to the baseline

Source: adapted from 'US Renewable Fuel Standard (RFS)', US Environmental Protection Agency

EISA also requires that renewable fuel be produced from renewable biomass harvest from land that is cleared or cultivated at any time prior to December 19, 2007 (the date of enactment of EISA).[34] In other words, EISA prohibits new conversion of natural areas for renewable biofuel production.

As a standard for the sustainable use of biofuels, the US's approach is unique in several points. First, it is a legally binding standard, not a voluntary one. Second, it focuses on the final goal: the final volumes of different types of biofuels blended by the year 2022. The standard mandates

[33] Alternative Fuels Data Center, US DOE, http://www.afdc.energy.gov/laws/RFS, accessed on May 4, 2013
[34] According to EISA of 2007, renewable biomass means each of the following:
Planted crops and crop residue harvested from agricultural land cleared or cultivated at any time prior to the enactment of this sentence that is either actively managed or fallow, and nonforested. (Energy Independence and Security Act of 2007, PUBLIC LAW 110–140—DEC. 19, 2007)

little about the modes of production or distribution of biofuels nor any social sustainability issues related to biofuels. With the exception of GHG emissions saving, the standard does not deal with any other environmental issues such as non-GHG emissions, water or soil pollution.

3.5.2. AUSTRALIA – THE AUSTRALIAN FORESTRY STANDARD (AFS)

The Australian Forestry Standard (AFS)[35] was developed by the Australian Forestry Standard Technical Reference Committee in 2007. Diverse group of stakeholders were represented in the Committee[36]. The purpose of the standard is to help forest managers and owners produce wood in an economically, socially and environmentally sustainable way. It is a voluntary standard and applies to wood production in either native or planted forests.

Although relevant international frameworks such as the Montreal Process Criteria and Indicators (1995) and those by the International Organization for Standardization (ISO) were taken into account throughout the development of the standard, it also focused on the unique characters of the country's forest ecosystem.

The standard addresses three areas of sustainability: ecological, social and economic. The ecological sustainability criteria correspond to environmental criteria in other sustainability standards. It deals with soil, energy flows, carbon, nutrient and water cycles, biological diversity, among others. The social sustainability criteria, according to the standard, deal with improving social benefit from the use of forests. Finally, the economic sustainability criteria concern economic benefits from employment and goods and services from the use of forests. Table 3-11 summarizes the ten main criteria and FIGURE 3-8 summarizes the requirements for each criterion.

TABLE 3-11 SUMMARY OF AUSTRALIAN FORESTRY STANDARD

	Topic	Criteria
1	General	Forest management shall be undertaken in a systematic manner that addresses the range of forest values
2	Participation	Forest management shall provide for public participation and foster on-going relationships to be a good neighbor

[35] the official title of the standard is "Forest management—Economic, social, environmental and cultural criteria and requirements for wood production"

[36] Aboriginal & Torres Strait Islander Representative, Australian Council of Trade Unions, Australian Forest Contractors Association Limited, Australian Forest Growers, Australian Plantation Products and Paper Industry Council, Forestry and Forest Products Committee (of the Primary Industries Standing Committee), Furnishing Industry Association of Australia (WA) Inc, Independent Environmental Scientist, Independent Forest Scientist

3	Biodiversity	Forest management shall protect and maintain the biological diversity of forests, including their serial stages, across the regional landscape
4	Productive capacity of forests	Forest management shall maintain the productive capacity of forests
5	Forest Ecosystem	Forest management shall maintain forest ecosystem health and vitality
6	Soil and Water	Forest management shall protect soil and water resources
7	Carbon cycle	Forest management shall maintain forests' contribution to carbon cycles
8	Local community	Forest management shall protect and maintain, for Indigenous and non-Indigenous people, their natural, cultural, social, recreational, religious and spiritual heritage values
9	Social and economic benefit	Forest management shall maintain and enhance long-term social and economic benefits

Source: adapted from 'The Australian Forestry Standard: Forest management—Economic, social, environmental and cultural criteria and requirements for wood production', Australian Forestry Standard Limited, 2007

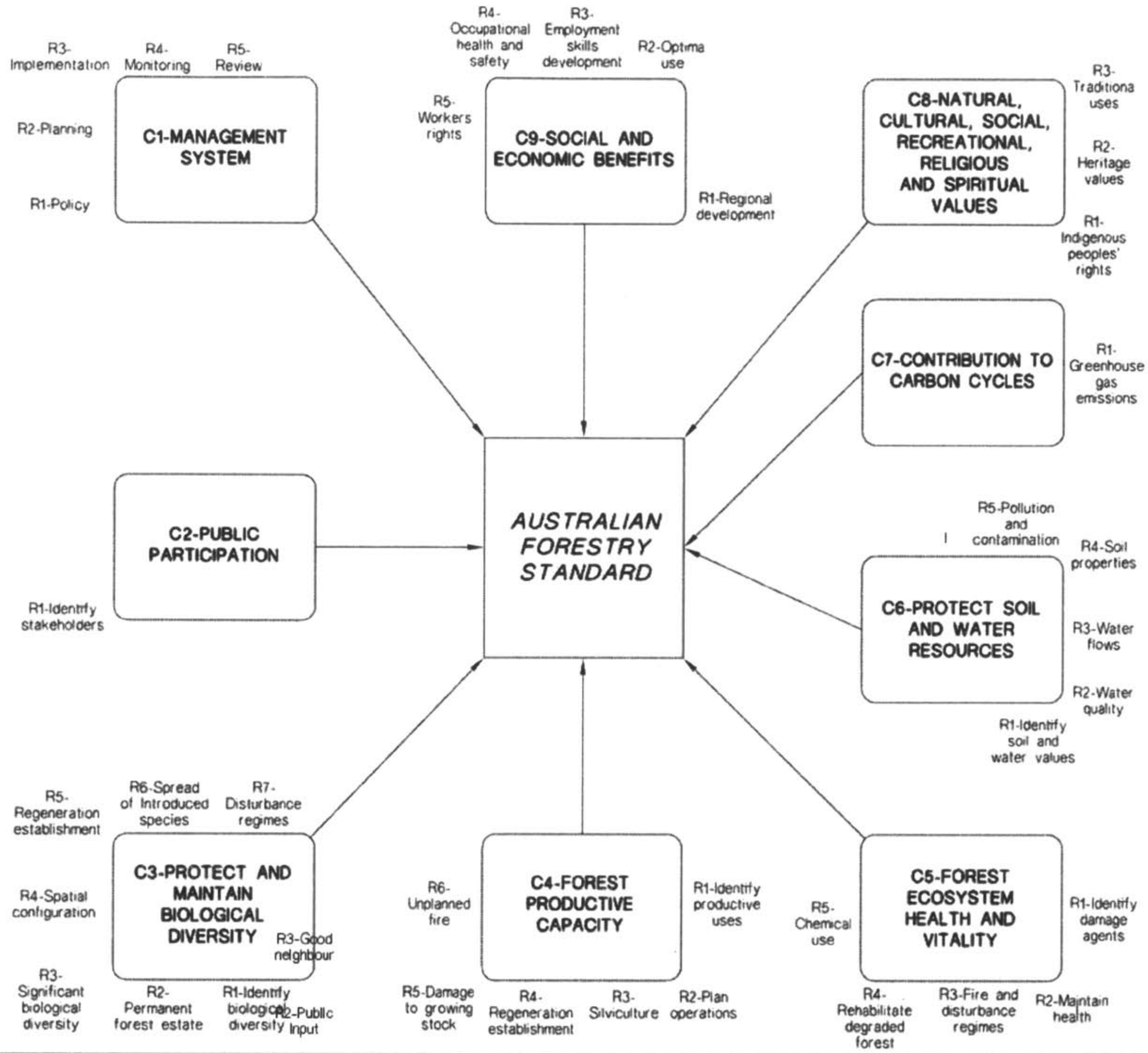

FIGURE 3-8 CRITERIA AND REQUIREMENTS OF THE AUSTRALIAN FORESTRY STANDARD

*Source: 'The Australian Forestry Standard: Forest management—Economic, social, environmental and cultural criteria and requirements for wood production', Australian Forestry Standard Limited, 2007

*Note: C stands for criterion and R stands for requirement.

In general, the criteria mandate the use of precautionary principle and the inter-generational equity principle in order to ensure the benefits of forests from one generation to the next.

To be able to facilitate harmonization with other standards, the Australian Forestry Standard was developed taking into account some important criteria.[37] Some of those criteria are:

- being accessible to all interested stakeholders with a balance of influences

- being voluntary and including the broad participation of forest owners

- being scientifically based and involving the scientific community in its development

- being easily understood and leading to the same results when used by different certifiers

- being regularly assessed and revised in the light of new knowledge as part of a continual improvement process[38]

Another feature of the standard is the protection of the indigenous values. The indigenous people are defined as 'the People of Aboriginal or Torres Strait Islander descent' and the standard emphasizes that indigenous people are one of the most important stakeholders. It argues that the indigenous people's education should be supported and that their economic aspiration in sharing benefits needs to be supported. In addition, indigenous heritage values should be protected.

3.5.3. SWEDEN - VERIFIED SUSTAINABLE ETHANOL INITIATIVE

In Sweden, as the importance of ethanol increased as a transportation fuel, national debates about the sustainability of ethanol arose in the country. Since Brazilian sugarcane-derived ethanol is the major ethanol source for Sweden, the Swedish company SEKAB developed its own sustainability criteria for Brazilian ethanol in collaboration with a number of ethanol producers in the State of Sao Paulo of Brazil in 2008. The resulting criteria, Verified Sustainable Ethanol Initiative, mandates seven principles (Table 3-12) and they address environmental and social sustainability issues around sugarcane ethanol imported from Brazil.

TABLE 3-12 SUMMARY OF SEKAB'S STANDARDS

	Topic	Principles
1	GHG emissions	At least 85 % reduction in fossil carbon dioxide compared with petrol, from a well-to-wheel perspective
2	Mechanization	At least 30 % mechanisation of the harvest now, plus a planned increase in the degree of mechanisation to 100 %

[37] Two principal internationally-recognized initiatives in this area are "the Program for the Endorsement of Forest Certification Scheme" and "the Forest Stewardship Council"('The Australian Forestry Standard: Forest management—Economic, social, environmental and cultural criteria and requirements for wood production', Australian Forestry Standard Limited, 2007)

[38] 'The Australian Forestry Standard: Forest management—Economic, social, environmental and cultural criteria and requirements for wood production', Australian Forestry Standard Limited, 2007, p6

3	Felling of rain forest	Zero tolerance for felling of rain forest
4	Child labor	Zero tolerance for child labour
5	UN Guidelines	Rights and safety measures for all employees in accordance with UN guidelines
6	UNICA[39] environmental initiative	Ecological consideration in accordance with UNICAs environmental initiative
7	Monitoring	Continuous monitoring that the criteria are being met

Source: adapted from 'Verified Sustainable Ethanol Initiative', SEKAB (Swedish Bioenergy Company), published in 2008, available at http://www.sustainableethanolinitiative.com, accessed on March 28, 2013

The first principle mandates that a GHG reduction of at least 85% should be achieved in a well-to-wheel manner. The calculation is based on the principles proposed by the Renewable Transport Fuel Obligation (RTFO) of the United Kingdom.

In Brazil, manual harvesting of sugarcane is still widespread. The Initiative requires that at least 30% of the entire harvest should be mechanized immediately with a planned increase up to 100% mechanization in the future. Although higher mechanization may lead to higher unemployment of workers, it reduces GHG emissions and particulate matter emissions while improving the general working condition.

Furthermore, the initiative does not tolerate deforestation of rainforest. And for non-rainforests, permits are required. In addition, no child labor is tolerated. A child is an individual under 16 years of age according to the Brazilian law. Likewise, an apprentice should be at least 14 years old. Finally, employers should comply with ILO Convention 138 (Minimum Age Convention).

Regarding labor rights, no forced labor is tolerated and employees are given rights to form labor unions. In addition, all employees should be registered while receiving the minimum wage.

Regarding ecological consideration, water sources should be protected and water reuse in industrial processes is encouraged. Plans for soil conservation must be implemented as well.

Among various sustainability standards for biofuels, the Verified Sustainable Ethanol Initiative stands out as a unique example of bilaterally-agreed criteria between an importer and an exporter countries of a specific type of biofuel. The Swedish government explains that there was a lack of expectation that the EU-wide sustainability criteria for biofuels would be released in a timely manner with enough attention on exporter countries, which encouraged the Swedes to take initiative in developing their own. Since both the type of biofuel and the producer country were

[39] Brazilian Sugarcane Industry Association (UNICA) is a lobbying organization for Brazilian products of sugarcane including bioethanol

fixed, the Initiative could have addressed the issues with great detail and specificity.

3.6. PRIVATE GROUPS

For standards by private groups, the ones by the following three groups were selected: Roundtable on Sustainable Biofuels, Council on Sustainable Biomass Production, and Sustainable Biodiesel Alliance. As will be shown, each standard has unique and notable characteristics.

3.6.1. ROUNDTABLE ON SUSTAINABLE BIOFUELS (RSB) - RSB PRINCIPLES & CRITERIA FOR SUSTAINABLE BIOFUEL PRODUCTION[40]

Roundtable on Sustainable Biofuels is an initiative by the Energy Center of École polytechnique fédérale de Lausanne (EPFL) in Switzerland. The group was established in 2006 and its main objective is to provide the global standard for environmental, social and economic sustainability for biomass.

In 2007, RSB published its draft principles for sustainable biofuels production. After thorough discussion with stakeholder groups, 'Version Zero' of the draft was published in 2008. With further revisions and consultation processes, 'Version One' was published in 2009. Finally, after a new round of public consultation, 'Version 2' of the principles & criteria was approved in November 2010.[41] RSB emphasizes that the document is a result of a collaborative work of interested parties with tremendous outreach and stakeholder consultation.

Throughout the stakeholder engagement process, RSB followed the 'ISEAL[42] Code of Good Practice for Setting Social and Environmental Standards'.

RSB's Principles & Criteria addresses the entire processes along the biofuel supply chain. Furthermore, it defines four different types of operators: feedstock producer, feedstock processor, biofuel producer and biofuel blender. The twelve principles proposed by the group are summarized in Table 3-13.

[40] RSB released two versions of sustainability principles & criteria: one for the international market and the other for the EU market. In this paper, the international market vesion is analyzed.
[41] Version 2 is the most recent publication on principles & criteria by RSB.
[42] International Social and Environmental Accredition and Labelling Alliance

TABLE 3-13 SUMMARY OF THE STANDARD BY ROUNDTABLE ON SUSTAINABLE BIOFUELS

	Topic	Principle
1	Legality	Biofuel operations shall follow all applicable laws and regulations.
2	Planning, Monitoring and Continuous Improvement	Sustainable biofuel operations shall be planned, implemented, and continuously improved through an open, transparent, and consultative impact assessment and management process and an economic viability analysis.
3	Greenhouse Gas Emissions	Biofuels shall contribute to climate change mitigation by significantly reducing lifecycle GHG emissions as compared to fossil fuels.
4	Human and Labor Rights	Biofuel operations shall not violate human rights or labor rights, and shall promote decent work and the well-being of workers.
5	Rural and Social Development	In regions of poverty, biofuel operations shall contribute to the social and economic development of local, rural and indigenous people and communities.
6	Local Food Security	Biofuel operations shall ensure the human right to adequate food and improve food security in food insecure regions.
7	Conservation	Biofuel operations shall avoid negative impacts on biodiversity, ecosystems, and conservation values.
8	Soil	Biofuel operations shall implement practices that seek to reverse soil degradation and/or maintain soil health.
9	Water	Biofuel operations shall maintain or enhance the quality and quantity of surface and ground water resources, and respect prior formal or customary water rights.
10	Air	Air pollution from biofuel operations shall be minimized along the supply chain.
11	Use of Technology, Inputs, and Management of Waste	The use of technologies in biofuel operations shall seek to maximize production efficiency and social and environmental performance, and minimize the risk of damages to the environment and people.
12	Land Rights	Biofuel operations shall respect land rights and land use rights.

Source: adapted from 'RSB Principles & Criteria for Sustainable Biofuel Production', Roundtable on Sustainable Biofuels, 2010

The standard mandates that lifecycle GHG emissions from the use of biofuels should be significantly reduced compared to fossil fuels. And in areas where there are legislative policies regarding the reduction requirements of GHG reduction in force, biofuel operators shall comply with those policies. The calculation of lifecycle GHG emissions needs to be done using the RSB Lifecycle GHG Emission Calculation Methodology (RSB-STD-01-003-01), which is available on its webpage. The methodology takes into account the GHG emissions from land use change and the use of biofuels co-products. If an operator is in a situation where the RSB GHG

Calculation Methodology is not applicable, the operator shall use an alternative methodology listed on the RSB GHG Calculation Methodology. In order to compare the GHG emissions to those of fossil fuel baseline, RSB Fossil Fuel Baseline GHG Calculation Methodology was also released in 2011. For example, RSB concludes that the fossil fuel baselines for gasoline, diesel and kerosene-based jet fuel are all 90 gCO_2e/MJ.[44]

Biofuel blends should have 50% lower GHG emissions compared to that of fossil fuel, according to the RSB Lifecycle GHG Emission Calculation Methodology. However, the minimum requirement of 50% will increase over time.

Biofuel operators should guarantee that the workers have freedom of association, the right to organize and collectively bargain. Where the national law does not allow the right to collectively bargain or organize unions, operators need to provide alternative mechanisms for workers while not violating the law.

No slave labor or child labor is tolerated. A child is defined as an individual who is younger than the national schooling age limit or 14, whichever is higher. Furthermore, hazardous child labor, as defined by the ILO Convention 138, is prohibited.

There should be no discrimination of any kind for workers regarding gender, wage, working condition and social benefit. Men and women should receive the same compensation for the work of equal value. These principles are reiterated by the ILO Convention 111. If housing is provided by an operator, the housing should meet sanitary, health and safety conditions. The maximum number of work hours per week is 48. If a worker voluntarily wants to work overtime, the maximum working hours is 80 per week. Finally, even when workers are hired by a third party, the operator should implement mechanisms to ensure the same level of human and labor rights.

Biofuel operators are expected to contribute to the development of rural and indigenous people, especially in regions of poverty. If the result of a socioeconomic baseline survey indicates that an excess number of people are unemployed or under-employed in the region of the operation, the operation should optimize the job creation potential. When it is determined through the RSB Impact Assessment that mechanization should be done in a way that is fair for the workers. Skill training should be provided to workers if it is necessary to ensure the implementation of the criteria under the Principle 5: Rural and Social Development of the RSB Principles & Criteria.

Operators should ensure that local people have secure access to food. When the RSB Impact Assessment indicates that a direct impact on food security exists in the region, the operator should conduct a food security assessment according to the RSB Food Security Assessment

[44] 'RSB Fossil Fuel Baseline Calculation Methodology', Roundtable on Sustainable Biofuels, 2011

Guidelines. If it turns out that the food insecurity in the region was a result of the biofuel operations, the operator should develop and implement a mitigation plan according the Environmental and Social Management Plan (ESMP).

Operators should not negatively impact biodiversity, ecosystem and conservation value in the region of operation. During the RSB impact assessment process (Principle 2), the operator should identify conversation values of the area of (potential) operation. Then, the operator carries out an impact assessment according to the RSB Conservation Impact Assessment Guidelines. If an area is identified as a "no-go area", the area should not be used for any biofuel operation after January 1st, 2009. Areas that contain identified conservation values should not be converted for biofuel operations after January 1st, 2009. The areas can be used for operations if there are sufficient management practices to maintain or enhance the conservation values. Invasive species, either identified officially by country of operation or by any other relevant database (e.g. Global Invasive Species Database) should not be used. If a species is shown to have a highly invasive impact under similar conditions, the species is not allowed even if it is not on the list of prohibited species.

Operators should minimize air pollution from biofuel operations. Operators should develop an emission control plan as part of the Environmental and Social Management Plan (ESMP). In this plan, major air pollutants such as carbon monoxide, nitrogen oxides, particulate matter, sulphur compounds and dioxins should be identified. Operators should eliminate open-air burning of residues or wastes as much as possible. A plan should be made to phase out any existing open-air burning within three years following certification. Limited open-air burning may be permitted if it prevents natural fire, or if it is necessary for periodic crop cultivation, among other reasons.

Along with the standard itself, RSB released several guidelines that apply to related principles in the standard. Table 3-14 summarizes the guidelines with their references numbers and the related Principle numbers.

TABLE 3-14 LIST OF RSB GUIDELINES

REFERENCE	NAME OF THE DOCUMENT	RELATED PRINCIPLE
RSB-GUI-01-002-01	RSB Impact Assessment Guidelines	Principle 2
RSB-GUI-01-002-02	RSB Screening Tool	Principle 2
RSB-GUI-01-002-05	RSB ESMP Guidelines	Principle 2
RSB-GUI-01-005-02	RSB Rural and Social Development Guidelines	Principle 5
RSB-GUI-01-006-01	RSB Food Security Assessment Guidelines	Principle 6
RSB-GUI-01-007-01	RSB Conservation Impact Assessment Guidelines	Principle 7
RSB-GUI-01-008-01	RSB Soil Impact Assessment Guidelines	Principle 8

RSB-GUI-01-009-01	RSB Water Assessment Guidelines	Principle 9
RSB-GUI-01-009-02	RSB Guidelines on Water Rights and Social Impacts	Principle 9
RSB-GUI-01-012-01	RSB Land Rights Guidelines	Principle 12

Source: adapted from RSB Tools & Guidelines, available at http://rsb.org/sustainability/rsb-tools-guidelines, accessed on July 3, 2013

During the course of the development of the standard, RSB made reference to several international standards including 'ISO Guide 59: Code of Good Practice for Standardization', and 'WTO Agreement on Technical Barriers to Trade Agreement, Annex 3: Code of good practice for the preparation, adoption and application of standards'.

So far, the RSB standards have addressed only the direct activities individual operators can undertake. However, RSB recognizes that there are many large-scale conditions that have great impacts on the sustainable biofuel operations. Since it is believed that a voluntary sustainability standard cannot properly address those factors, RSB commissioned a study in 2009 to determine how the indirect impacts have been addressed in other environments.

3.6.2. COUNCIL ON SUSTAINABLE BIOMASS PRODUCTION (CSBP) - STANDARD FOR SUSTAINABLE PRODUCTION OF AGRICULTURAL BIOMASS

The Council on Sustainable Biomass Production is a multi-stakeholder initiative developing sustainability standards for the second generation biofuels. The Council was established in 2007 and it is based in the US. The first consensus version of the CSBP Standard for the second generation biofuel was released in June 2012 and it was the first standard for cellulosic biomass in the US. CSBP is funded by its members and the grants from the US Department of Energy and the US Department of Agriculture's Natural Resource Conservation Service (NRCS).

CSBP proposed 9 principles in environmental, social and economic sustainability areas. Table 3-15 summarizes the principles. Sub-sections in each topic area are listed below each principle.

TABLE 3-15 STANDARDS BY THE COUNCIL ON SUSTAINABLE BIOMASS PRODUCTION

	Topic	Principle
1	Integrated Resource Management Planning	Biomass production is based on an integrated resource management plan that is completed, implemented, monitored, and updated to address the environmental risks associated with current and future production, appropriate to the scale and intensity of the operation. 1.1 Assessment

		1.2 Objectives 1.3 Operations Plan
2	Soil	Biomass production maintains or improves soil quality by minimizing erosion, maintaining or enhancing soil carbon and nutrients at appropriate levels, and promoting healthy biological systems and chemical and physical properties. 2.1 Maintain or Improve soil health Soil productivity and conservation planning/ residue removal/ compaction/ in-field or on-farm travel/ erosion/ soil carbon
3	Biological Diversity	Biomass production contributes to the maintenance or enhancement of biological diversity, in particular native plants and wildlife. 3.1 Biodiversity Vegetation types and wildlife habitat planning/ important wildlife species and their habitats/ rare, threatened, and endangered wildlife, communities and biodiversity/ control of non-crop invasive species 3.2 Species and Cultivars Invasiveness/ crop spread 3.3 Land conversion Documentation of vegetation category/ lands eligible for conversion 3.4 Pest management Control agents
4	Water	Biomass and bioenergy production maintains or improves surface water, groundwater, and aquatic ecosystems. 4.1 Water quality Water quality management planning/ erosion and sediment and runoff control/ use of waste water for irrigation/ trace elements in biosolids/ nitrogen/ phosphorus/ pesticide management / pesticide use/ waste disposal 4.2 Water quality Irrigation plan/ legal compliance/ preventing depletion/ use rights/ irrigation and salinity/ maximum water use per acre 4.3 Aquatic Ecosystems Stream flow/ stream temperature / hypoxia/ wetlands
5	Air Quality And Emissions	Emissions are estimated via a consistent approach to life cycle assessment. 5.1 Air quality and emissions Yield data/ production inputs/ planting and tillage/ soil carbon and organic matter/ harvesting, collection, handling, processing and storage/

		transportation
6	Socio-Economic Well-Being	Biomass and bioenergy production takes place within a framework that sustainably distributes overall socio-economic opportunity for and among all stakeholders (including land owners, farm workers, suppliers, biorefiners, and the local community), ensures compliance or improves upon all applicable federal and state labor and human rights laws, and provides for decent working conditions and terms of employment. 6.1 Compliance with labor laws Fair labor standard act 6.2 Fair Treatment of workers Grievance procedures/ employment contract/ workplace improvements/ freedom of association 6.3 Environment, health, and safety Compliance with laws and regulations/ training/ hazardous materials protection/ accidents and injuries/ sanitation/ insurance against workplace injury
7	Legality	Biomass production complies with applicable federal, state, and local laws, statutes, and regulations. 7.1 Knowledge of laws Ensuring compliance
8	Transparency	The process of certified biomass production is transparent. 8.1 Public Access Public transparency
9	Continuous Improvement	Biomass and bioenergy producers continuously improve practices and outcomes based on the best available science and appropriate grower development benchmarks. 9.1 Compliance Participant compliance 9.2 Review and improvements Standard review/ improve performance/ good agricultural practices (GAP)

Source: adapted from 'Standard for Sustainable Production of Agricultural Biomass', Council on Sustainable Biomass Production, June 2012

Participants should maintain or improve soil health level while monitoring nutrient levels of the soil or plants. The removal of agricultural residues (crop residue and process residue) should not contribute to soil erosion or decrease in soil productivity. Participants should also identify soil vulnerable to compaction and use measures to reduce or prevent soil compaction.

CSBP emphasizes that biomass production contributes to biological diversity, especially for native plants and wildlife. Before operation, participants first assess vegetation cover types, important wildlife species (IWS), and rare, threatened, and endangered species and communities (RTESC) on the production area. During the nesting, calving, fawning and brood-rearing seasons of important wildlife species (IWS), harvesting in the primary biomass production areas should be minimized as much as possible. During the critical reproduction and migratory seasons, disruptive operations such as mowing, disking and harvesting should be minimized.

Introduction or cultivation of energy crops that are invasive to the local ecosystem should be avoided. Before planting, assessments should be conducted by third-party experts such as academic scientists or relevant government agency.

Biomass production should contribute to maintain or improve surface water, groundwater, and aquatic ecosystems in the affected area. Participants need to observe a water management plan that addresses objectives including pollution prevention and control, and disposal treatments of fertilizer, pesticides, biosolids, and waste water. When waste water is used for irrigation, participants should test waste water prior to usage. In particular, waste water from industrial sources must undergo an extensive chemical identification of metals, ions, organics and volatiles.

Both GHG and non-GHG emissions should be measured accurately using a life cycle assessment. For this purpose, participants should provide sufficient data required to conduct a life cycle assessment of emissions from the production of biomass. In addition, participants should provide data on the amount of fertilizer, pesticides, and fuel used during the production. Furthermore, information of the type of equipment should be provided.

Biomass production should contribute to the overall socio-economic opportunity for all types of stakeholders involved. Participants should comply with the Fair Labor Standard Act[45] and other relevant state and federal laws. Participants should demonstrate employee protection measures regarding minimum wage and overtime payment, leave and retirement benefits, youth employment and rights of unionization. Operators with more than 9 full-time employees should provide employees with mechanisms for raising concerns, or safety issues. All employees including seasonal workers should receive information regarding health and safety at workplace with languages they understand.

Finally, the standard emphasizes that biomass producers should continuously improve practices using the best available science and experiences. Participants should demonstrate efforts to improve sustainability performances and adoption of good agricultural practices through "Best

[45] The Fair Labor Standard Act of 1938 is a federal statute of the US. It is also called as the Wages and Hours Bill.

Agricultural Practices". For this purpose, participants are encouraged to participate in periodic reviews.

CSBP also provides a Self-Assessment Checklist to both biomass producers and auditors to evaluate the level of compliance with the standard. The Checklist follows the structure of the standard and it contains questions that ask compliance with major criteria in the standard. Figure 3-9 shows a part of the checklist.

Biological Diversity Principle

Biomass production shall contribute to the conservation or enhancement of biological diversity, in particular native plants and wildlife.

How do you assess wildlife habitat on your operation with regard to vegetation cover, threatened and endangered species, or species identified in state wildlife action plans? How does your assessment affect your planning and management activities? What would you like to

Please provide answer here....

Are there other practices that you implement to help you achieve these objectives that go above and beyond the goals of the standard?

Please provide answer here....

FIGURE 3-9 QUESTIONS IN THE BIOLOGICAL DIVERSITY PRINCIPLE APPEARED ON THE SELF-ASSESSMENT CHECKLIST OF CSBP

Source: 'A comprehensive standard and national certification program for sustainable production of cellulosic biomass and bioenergy', Council on Sustainable Biomass Production, 2013

Although one of the major objectives of CSBP's standard was to provide principles specific to the second generation bioenergy, all of the nine principles and their subsections only deal with issues that are applicable to production of bioenergy in general. In other words, there was no criterion or principle specifically targeted to issues related to the production of cellulosic bioenergy.

3.6.3. SUSTAINABLE BIODIESEL ALLIANCE (SBA) – PRINCIPLES AND BASELINE PRACTICES FOR SUSTAINABILITY

The Sustainable Biodiesel Alliance is a non-profit organization based in the US. It was established in 2006 to address sustainability issues of the biodiesel industry in the US. The first mission of the Alliance is to propose an independent sustainability certification system for US biodiesel. The second objective is to educate the public so that local sustainable biodiesel can contribute to the US' energy and economic security. Finally, the group provides tools for sustainable production and use of biodiesel for consumers and industry. SBA developed principles and baseline practices for biodiesel production and distribution, and they were ratified in September 2008.

SBA is committed to collaborating with other organizations since it stresses the consistency of criteria. However, one thing that differentiates SBA from others is that the group specializes in biodiesel; their standards are designed for all kinds of biodiesel stakeholders – farmers, producers, distributers and end users.[46]

Another feature of the SBA's standards is the emphasis on practicality. The intention was to provide criteria that can be implemented immediately while recognizing limitations that exist in the short run. As new data, policy, research become available regarding biodiesel sustainability, the standards will get continuously updated.

SBA provides sustainability standards in two areas: environmental and social sustainability. Table 3-16 and Table 3-17 summarize the principles.

TABLE 3-16 ENVIRONMENTAL STANDARDS BY THE SUSTAINABLE BIODIESEL ALLIANCE

	Topic	Principle
1	Greenhouse Gas Emissions	Sustainable biodiesel results in net GHG emissions reductions compared to fossil fuels when analyzed via a life-cycle assessment. Fossil energy used in growing, transporting and processing biodiesel must be considered. Converting land from wilderness or grasslands to plant biodiesel feedstock crops also releases GHG and is not sustainable.
2	Energy Conservation	Sustainable biodiesel production improves energy and resource conservation. Wasteful use of fossil fuels should not be replaced with wasteful use of biodiesel. Instead, significant reductions in total consumption, together with increased conservation, shall be a priority.
3	Soil	Sustainable biodiesel does not degrade or damage soils and should contribute to long-term maintenance and improvement of soil quality.
4	Water	Sustainable biodiesel production does not contaminate or imperil water resources, but contributes to improved water quality and efficient utilization.
5	Air	Sustainable biodiesel production and use improves air quality and does not

[46] SBA defines sustainable biodiesel as diesel that is "produced in a manner that, on a life-cycle basis, minimizes the generation of pollution, including greenhouse gases; reduces competition for, and use of, natural resources and energy; reduces waste generation; preserves habitat and ecosystems; maintains or improves soils; avoids use of genetically modified organisms; and provides community economic benefit that results in jobs and fair labor conditions." (Sustainable Biodiesel Alliance, Principles and Baseline Practices for Sustainability, available at http://test.sustainablebiodieselalliance.com/~sustai18/dev/resources.shtml, p1)

		lead to increased air pollution as compared to fossil fuels.
6	Biodiversity Conservation	Sustainable biodiesel production does not lead to the destruction, degradation or declassification of high conservation value areas; areas of high biodiversity; habitats of rare, threatened or endangered species; or rare, threatened or endangered ecosystems. Protected areas, including grasslands, wetlands, forests etc. should not be declassified or appropriated for biodiesel crop production. At the landscape level, sustainable biodiesel production systems contribute to the conservation and maintenance of native biological diversity.
7	Genetically Modified Organisms (GMOs)	Sustainable biodiesel is derived from non-GMO feedstock. However, if GMOs are used for the production of biodiesel, it shall be made transparent, so that producers and consumers can make informed decisions.
8	Agrochemicals	Sustainable biodiesel crop production minimizes, and eliminates whenever possible, the use of dangerous agrochemicals. Agrochemicals that are hazardous to the environment, workers, and local communities will not be used. Chemicals used are non-persistent and chemicals that are endocrine disrupting, carcinogenic or mutagenic in humans should be phased out. Preference should be given to the selection of crops and cropping systems that are productive and sustainable without reliance on agrochemicals.
9	Development of Next Generation Feedstock	Should be developed with the consideration of the aforementioned principles.

Source: adapted from 'Principles and Baseline Practices for Sustainability', Sustainable Biodiesel Alliance, published in September 2008

SBA requires that sustainable use of biodiesel reduce lifecycle GHG emissions compared to fossil fuel baselines. However, it does not specify a reduction goal. They also discourage converting land for biodiesel feedstock plantation since it increases GHG emissions.

SBA stresses on energy conservation during biodiesel production and distribution. They argue wasteful use of fuel should not be tolerated. Rather, significant decrease in energy consumption should become a priority.

Protection of soil, water, air and biodiversity is emphasized. Sustainable biodiesel production should maintain or improve the quality of soil, water and air.

According to SBA, sustainable biodiesel is not from GMO feedstock. In cases when GMOs were used, however, the information should be available to producers and consumers of biodiesel.

SBA requires that the use of dangerous agrochemicals should be minimized. Crops and cropping systems that are not dependent on agrochemicals should be preferred.

Regarding the use of second generation biodiesel feedstock, the standard argues that the same principles proposed for first generation biodiesel apply.

TABLE 3-17 SOCIAL SUSTAINABILITY STANDARDS BY THE SUSTAINABLE BIODIESEL ALLIANCE

	Topic	Principle
1	Food Security	Sustainable production of biodiesel does not jeopardize food security by displacing land or water used for growing critical food crops with biodiesel feedstock crops.
2	Local Communities	Local communities are an integral part of the development of the sustainable biodiesel industry. Local strategies for biodiesel production with citizen input are created. Local consumption of sustainable biodiesel is prioritized and encouraged.
3	Communities and Workers	Family and smallholder farmers are not to be displaced to grow or harvest biodiesel feedstock. Farmers should receive fair compensation for the biodiesel feedstock they produce. The health and safety of workers and communities should be protected. In addition, fair / livable wages for agricultural workers and workers at biodiesel production facilities are ensured.
4	Local consumption	Local consumption is encouraged and prioritized.

Source: adapted from 'Principles and Baseline Practices for Sustainability', Sustainable Biodiesel Alliance, 2008

Compared to the environmental principles, social principles of SBA is shorter and only deals with four issues: food security, local communities, communities and workers, and local consumption. SBA argues that biodiesel production should not displace land used for food crops critical to food security of the communities. SBA emphasizes that local consumption of biodiesel should be encouraged and that local communities are an integral part of the biodiesel industry.

The safety of workers should be emphasized while the workers should receive fair compensation.

In addition to general environmental and social sustainability standards, SBA also provides specified sustainability principles for four different types of biodiesel stakeholders: biodiesel feedstock producer, biodiesel producer, biodiesel distributor and biodiesel end user. A summary of the topics proposed for each stakeholder is presented in Table 3-18.

TABLE 3-18 SUMMARY OF SUSTAINABILITY STANDARDS FOR FOUR TYPES OF STAKEHOLDERS OF SUSTAINABLE BIODIESEL BY THE SUSTAINABLE BIODIESEL ALLIANCE

	Biodiesel Feedstock	Biodiesel Production	Biodiesel Distribution	Biodiesel End User
1	Soil Quality and Conservation	Air Emissions	Quality of biodiesel	Quality of biodiesel

2	Water Resources Quality and Consumption	Water use	Emissions Reduction	Sourcing/Availability
3	Ecosystem Protection - Biodiversity	Waste Handling & Reduction	Sourcing / Procurement of biodiesel	Biodiesel Blends
4	Climate – Emissions & Sequestration Potential	Energy production		
5	Energy Use	Plant/Worker Safety		
6	Fair Wages & Working Conditions – Farmer, Farm Worker	Sustainable Purchasing		
7	Community Benefit Localization	Sustainable sourcing of biodiesel		
8	Waste & Rendered Oils treatment	Social considerations		
9	Next Generation Feedstock	Quality of biodiesel		

Source: adapted from 'Principles and Baseline Practices for Sustainability', Sustainable Biodiesel Alliance, 2008

Topics addressed for feedstock producers and biodiesel producers are similar to the general sustainability principles presented earlier. However, the criteria are more specific to each stakeholder and the stage of biodiesel production. For example, according to the criteria, water management for biodiesel feedstock producer deal with soil sediment containing phosphorus & pesticides and drainage tiles which is a major source of in-stream pollution by nitrate. In comparison, water management for biodiesel producers deal with monitored effluent water criteria such as FOG (fats, oils, grease), BOD (biological oxygen demand), TSS (total suspended solids), and COD (chemical oxygen demand). It is these parts of the SBA standard where specific criteria for biodiesel are provided.

With continue running pilot programs and encouraging participation from SBA members, SBA's sustainability standard is expected to become more and more specific to relevant topics.

In this chapter, sustainability standards for biofuels from nine different groups (2 international organizations, 1 regional group, 3 national governments, and 3 private groups) were introduced and their notable characteristics were presented. The following chapter will compare and contrast these standards in diverse areas.

CHAPTER 4. COMPARISON OF STANDARDS & KEY FINDINGS

The purpose of this chapter is to comprehensively compare the nine sustainability standards chosen in the previous chapter. Since most of the standards follow the three-pillar categorization, which is composed of environmental, social and economic areas of sustainability, this chapter will follow the same classification scheme. However, the first section will present a comparison of the 'general' characteristics of each standard, which do not belong to either of the environmental, social or economic area. In each area of comparison, a comparison table as well as a list of key findings from the comparison will be presented.

4.1. GENERAL CHARACTERISTICS

All of the standards reviewed in this paper were developed during the past decade. The oldest one is the Australian Forestry Standard (published in August 2007) and the latest one is the Standard for Sustainable Production of Agricultural Biomass (published in June 2012) by the Council on Sustainable Biomass Production. And all of the nine standards are currently in implementation.

The judicial basis of the standards was "voluntary" except for those by the European Union and USA. It is notable that unlike the US, the other two national standards by Australia and Sweden are on voluntary bases.

Two internationally-developed standards from Global Bioenergy Partnership and Inter-American Development Bank have the largest groups of members. GBEP has 46 countries and 24 international organizations as its members or observers. IDB has 48 member states, the majority of which are central and South American states. In addition, the European Union has 28 member countries.

The makeup of the three private groups is more diverse. Roundtable on Sustainable Biofuels is the biggest among the three private groups. Its members include farmers and growers of biomass; industrial biofuel/biomaterial producers; retailers, transportation industry, bioproduct industry and banks; right-based NGOs concerning water, land, human and labor rights and trade unions; rural development or food security organizations, smallholder farmer organizations, indigenous peoples' organizations; environment or conservation organizations; intergovernmental organizations and governments.[47] Members of the Council on Sustainable Biomass Production include energy companies, association of agriculture and conservation, university research centers, among others. Several centers on agriculture, forestry and conservation of the US Department of Energy and US Department of Department of Agriculture are technical advisors

[47] See http://rsb.org/about/organization/rsb-members/ for the full member list

of the Council.[48] Meanwhile, Sustainable Biodiesel Alliance has farm organizations, environmental organizations, energy experts, NGOs and interested individuals as its members.

All the standards by the international, regional and private organizations are not geographically limited to specific regions of the world while the three national standards by US, Australia and Sweden are only effective within their respective national territories. Note that most of the principles proposed by SEKAB of Sweden apply to Brazil rather than Sweden, since the standard mostly apply to the ethanol produced in Brazil. However, some of the principles were applicable to the consumption of ethanol in Sweden. For example, GHG emissions are continuously measured in Sweden since the emissions reduction is on a well-to-wheel basis.

It seems that most of the standards follow the three-fold classification of sustainability areas: environmental, social, and economic. All the standards addressed environmental sustainability issues although the Australian Forestry Standard named it 'ecological' sustainability area. Except for the US's standard, all the other standards proposed social sustainability principles or indicators. In fact, US's standard is unique in that it only concerns GHG emissions reduction. As for economic sustainability, only GBEP, Australia, Roundtable on Sustainable Biofuels and Council on Sustainable Biomass production suggested principles related to the economic sustainability of biofuels.

While GBEP's work only provided a set of 24 indicators regarding sustainability issues around biofuels, all the other eight standards presented criteria as well. The other groups that proposed indicators were: GBEP, Inter-American Development Bank, European Union, US, and SEKAB.

In addition to criteria and indicators, many groups provided certain methodologies. The most frequently-provided methodology was the methodology for calculating life cycle GHG emissions (GBEP, Inter-American Development Bank, European Union, US, Roundtable on Sustainable Biofuels, and Council on Sustainable Biomass Production). In particular, GBEP's work has a section named 'methodological approach' for the whole 24 indicators. In addition, IDB's Scorecard contains 6 web-based calculators on water management, release of fertilizers, biofuel distribution energy efficiency, local income generation, local grower arrangements and yield of biofuels, respectively.

For the development of standards, the groups made reference to various relevant works by other international organizations. For example, for social sustainability principles, many conventions of the International Labor Organization were cited (European Union, SEKAB, and Roundtable on Sustainable Biofuels). For environmental sustainability UN Framework Convention on Climate Change, Convention on Biological Diversity, Intergovernmental Panel on Climate Change, Ramsar Convention on Wetlands, Cartagena Protocol on Biosafety were referenced,

[48] See http://www.csbp.org/AboutUs.aspx for the full member list

among others. In addition, works on standardizations themselves were referenced as well, including 'ISO Guide 59: Code of Good practice for Standardization', 'ISEAL Code of Good Practice for Setting Social and Environmental Standards' and 'WTO Agreement on Technical Barriers to Trade Agreement – Annex 3: Code of good practice for the preparation, adoption and application of standards'.

Among various sustainability standards for biofuels, references were made from one another. For example, parts of the Scorecard of the Inter-American Development Bank were based on the criteria proposed by Roundtable on Sustainable Biofuels. And the GHG emissions calculation method of the SEKAB standard was adapted from the one by the Renewable Transport Fuel Obligation of the UK.

Additionally, some of the standards also addressed the issues around the use of second generation biomass (European Union, US, Council on Sustainable Biomass Production, and Sustainable Biodiesel Alliance). Among them, the standard by the Council on Sustainable Biomass was the first standard for cellulosic biomass in the US.

In addition to the above-mentioned characteristics, each standard had its unique features. GBEP, as the biggest international group among the groups analyzed, collaborated extensively with other international organizations for the development of the standard. For example, the development of its environmental indicators was co-led by UNEP, social indicators was by FAO, and economic indicators was by IEA and UN Foundation.

The Scorecard of the Inter-American Development Bank was the only one that had a web-based platform. After creating accounts, users can access the webpage and fill out the scorecard on a web browser.

The Australian Forestry Standard concerned the distribution of benefits from bioenergy use among current and future generations. It also underscored the use of Precautionary Principle when a lot of uncertainties are involved.

SEKAB's standard was unique in that it was the only bilateral standard between two countries. It is also notable that the standard only focused on the sugarcane-derived ethanol produced in Brazil as its subject.

Like the Australian Forestry Standard, Roundtable on Sustainable Biofuels also stressed on the use of Precautionary Principles, especially when negative indirect impacts may exist. The group also provided ten additional guidelining documents as supplements for the standard (e.g. RSB Impact Assessment Guidelines, RSB Screening Tool, and RSB Food Security Assessment Guidelines).

The standard by the Council on Sustainable Biomass Production was the first sustainability standard for second generation biomass in the US. The Council is funded by its members as well as the US Department of Energy and Department of Agriculture.

Finally, the standard by the Sustainable Biodiesel Alliance was specific to the use of biodiesel in the US. Along with general environmental and social principles associated with the use of biodiesel, it provided separate standards in four different areas: biodiesel feedstock, production, distribution, and end use. Table 4-1 is a comparison table of the general characteristics of the nine standards.

TABLE 4-1 COMPARISON OF VARIOUS STANDARDS – GENERAL CHARACTERISTICS

Group Name	Global Bioenergy Partnership (GBEP)	Inter-American Development Bank (IDB)	European Union	USA	Australia	Sweden (SEKAB)	Roundtable on Sustainable Biofuels (RSB)	Council on Sustainable Biomass Production (CSBP)	Sustainable Biodiesel Alliance (SBA)
	International		Regional		National			Private	
Standard Name	The Global Bioenergy Partnership Sustainability Indicators for Bioenergy	IDB Biofuels Sustainability Scorecard	Directive 2009/28/EC on the promotion of the use of energy from renewable sources – Articles 17, 18 and 19	Renewable Fuel Standard	Australian Forestry Standard	Verified Sustainable Ethanol Initiative	RSB Principles & Criteria for Sustainable Biofuel Production (Version 2.0)	Standard for Sustainable Production of Agricultural Biomass	Principles and Baseline Practices for Sustainability
Status of The Standard	In implementation	In implementation	In implementation	In implementation	In implementation	In implementation	In implementation	In implementation	In Implementation
Release Date	December 2011	October 2009	April 2009	December 2007	August 2007		May 2010	June 2012	
Effective Date			December 2010			2008	January 2011		September 2008
Judicial Basis	Voluntary	Voluntary	Legally-binding	Legally-binding	Voluntary	Voluntary	Voluntary	Voluntary	Voluntary
Members	Members: 23 countries and 13 international organizations + Observers: 23 countries and 11 international organizations	IDB member countries	EU member countries	USA	Australia	Sweden, Brazil	1. Farmers and growers of biomass 2. Industrial biofuel/biomaterial producers 3. Retailers/blenders, the transportation industry, the bio-product industry, banks/investors 4. Rights-based NGOs	• ArborGen, Inc. • Association of Fish & Wildlife Agencies • Bio-Resource Management, Inc. • Ceres, Inc. • Chevron • Energy Biosciences Institute, University of Illinois	Farm organizations, environmental organizations, energy experts, NGOs, universities, individuals, etc.[50]

[50] See http://test.sustainablebiodieselalliance.com/~sustai18/dev/about.shtml for more information on the members

Group Name	Global Bioenergy Partnership (GBEP)	Inter-American Development Bank (IDB)	European Union	USA	Australia	Sweden (SEKAB)	Roundtable on Sustainable Biofuels (RSB)	Council on Sustainable Biomass Production (CSBP)	Sustainable Biodiesel Alliance (SBA)
	International		Regional		National			Private	
							(including land, water, human, and labour rights) & Trade Unions 5. Rural development or food security organisations & Smallholder farmer organizations or indigenous peoples' organizations 6. Environment or conservation organisations & Climate change or policy organisations 7. Intergovernmental organizations (IGOs), governments, standard-setters, specialist advisory agencies, certification agencies[49]	• Environmental Defense Fund • DuPont • Duke Energy • Genera Biomass LLC • Great Plains Institute • Institute of Renewable Natural Resources, Texas A&M University • Mendel Biotechnology, Inc. • Monona Farms • National Wildlife Federation • Natural Resources Defense Council • Oak Ridge National Laboratory • Prairie Lands Bio-Products, Inc. • Show Me Energy Cooperative • Theodore Roosevelt Conservation Partnership	
Geographical Scope	International	International	International	National-USA	National - Australia	National : Sweden + Brazil	International	International	National-USA

[49] See http://rsb.org/about/organization/rsb-members/ for the full member list

Group Name	Global Bioenergy Partnership (GBEP)	Inter-American Development Bank (IDB)	European Union	USA	Australia	Sweden (SEKAB)	Roundtable on Sustainable Biofuels (RSB)	Council on Sustainable Biomass Production (CSBP)	Sustainable Biodiesel Alliance (SBA)
	International		Regional	National			Private		
Areas of Sustainability	Environmental, Social, Economic	Environmental, Social, Cross-cutting	Environmental, Social	Environmental	Ecological, Social, Economic	Environmental, Social	Environmental, Social, Economic	Environmental, Social, Economic	Environmental, Social
Criteria included?		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Indicators included?	Yes -24 Indicators in total -8 environmental indicators -8 social indicators -8 economic indicators	Yes	Yes	Yes		Yes			
Methodologies included	Methodologies are provided for the entire 24 indicators	various calculators: -Water management calculator -Controlled Release Fertilizers Calculator -Biofuel Distribution Energy Efficiency Calculator -Local income generation calculator -Local grower arrangements calculator -Yield calculator	-life cycle GHG calculations methodology - guidelines for the calculation of land carbon stocks	methodology for calculating lifecycle GHG emissions			-RSB GHG Calculation Methodology -RSB Fossil Fuel Baseline Calculation Methodology	CSBP GHG modeling tool	

Group Name	Global Bioenergy Partnership (GBEP)	Inter-American Development Bank (IDB)	European Union	USA	Australia	Sweden (SEKAB)	Roundtable on Sustainable Biofuels (RSB)	Council on Sustainable Biomass Production (CSBP)	Sustainable Biodiesel Alliance (SBA)
	International		Regional		National		Private		
		- Calculation method for the greenhouse gas impact of biofuels and bioliquids							
Reference to Other International Organizations	-UN Framework Convention on Climate Change - Convention on Biological Diversity -Intergovernmental Panel on Climate Change	-RAMSAR Convention on Wetlands -Guide for Integrating Human Rights into Business Management (UN-BLIHR) -Guide for Human Rights Impact Assessment and Management (IFC) -UN List of National parks and Protected Areas	-Several Conventions of the International Labour Organisation -Cartagena Protocol on Biosafety -Convention on International Trade in Endangered Species of Wild Fauna and Flora		-Forest Stewardship Council's Principles and Criteria -Programme for the Endorsement of Forest Certification Schemes	-article 1 and 2 in ILO convention 138(Minimum Age Convention)	- ISO Guide 59: Code of Good Practice for Standardization. 1994 - ISEAL Code of Good Practice for Setting Social and Environmental Standards. P005 - Public Version 5.01 – April, 2010 - WTO Agreement on Technical Barriers to Trade (TBT) Agreement. Annex 3: Code of good practice for the preparation, adoption and application of standards - WTO TBT Second Triennial Review Annex 4, Principles for the Development of International Standards, Guides and Recommendations with Relation to Articles 2, 5 and Annex 3 of the		

Group Name	Global Bioenergy Partnership (GBEP)	Inter-American Development Bank (IDB)	European Union	USA	Australia	Sweden (SEKAB)	Roundtable on Sustainable Biofuels (RSB)	Council on Sustainable Biomass Production (CSBP)	Sustainable Biodiesel Alliance (SBA)
	International		Regional		National			Private	
							Agreement -ILO Convention 111(Employees, contracted labor, small outgrowers, and employees of outgrowers shall all be free of discrimination) -ILO Convention 138 (Definition of hazardous child labor)		
Reference to other sustainability standards		The Scorecard is based on sustainability criteria of the Roundtable on Sustainable Biofuels			-the Montreal Process Implementation Group framework - ISO 14001	-GHG calculations are according to RTFO(Renewable Transport Fuel Obligation) principles			
Second generation feedstock included?			Yes	Yes				Yes (the standard specializes in second generation feedstock)	Yes The same principles for the first generation feedstock apply
Genetically Modified Organisms included?								Yes	Yes
Other features	Actively collaborated with international organizations for the development of indicators	-Internet-based platform -provides specific units of measurement for each indicator	-sets incentives for second generation biofuels		- concerns the distribution of benefits from bioenergy among generations -stresses the use of Precautionary	-standard specific to sugarcane-derived ethanol -first bilateral biofuel standard between two countries (Brazil and Sweden)	-specifies the type of operators applicable to each principle -provides 10 additional guideline documents for its standard	- First U.S. standard for second generation biomass feedstock - funded by its members and grants from the U.S. Department	-standard specific to biodiesel -provides assumptions for each principle -provides

Group Name	Global Bioenergy Partnership (GBEP)	Inter-American Development Bank (IDB)	European Union	USA	Australia	Sweden (SEKAB)	Roundtable on Sustainable Biofuels (RSB)	Council on Sustainable Biomass Production (CSBP)	Sustainable Biodiesel Alliance (SBA)
	International		Regional	National			Private		
					Principle		-emphasizes the use of Precautionary Principle when negative indirect impacts may be strong	of Energy and the U.S. Department of Agriculture's Natural Resource Conservation Service(NRCS Conservation Innovation Grant)	standards for four different areas (Feedstock, Production, Distribution, End Use)

Source: Material in this table was reproduced or adapted from the groups' webpages and the following documents:

- 'Update: Initiatives in the Field of Biomass and Bioenergy Certification', J. van Dam, April 2010
- 'The Global Bioenergy Partnership Sustainability Indicators For Bioenergy', First edition, Global Bioenergy Partnership, December 2011
- 'IDB Biofuels Sustainability Scorecard', Inter-American Development Bank, October 2009
- 'Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC', European Commission, 2009
- 'US Renewable Fuel Standard (RFS)', US Environmental Protection Agency
- 'The Australian Forestry Standard: Forest management—Economic, social, environmental and cultural criteria and requirements for wood production', Australian Forestry Standard Limited, 2007
- 'Verified Sustainable Ethanol Initiative', SEKAB (Swedish Bioenergy Company)
- 'RSB Principles & Criteria for Sustainable Biofuel Production', Roundtable on Sustainable Biofuels, 2010
- 'Standard for Sustainable Production of Agricultural Biomass', Council on Sustainable Biomass Production, June 2012
- 'Principles and Baseline Practices for Sustainability', Sustainable Biodiesel Alliance

The following section summarizes some of the key findings obtained from the comparison of the general characteristics of the standards.

KEY FINDINGS FROM THE COMPARISON OF GENERAL CHARACTERISTICS OF THE STANDARDS

1) The majority of the standards were market-based and voluntary standards with a set of proposed criteria. Most standards were open to multi-stakeholder participation for the development and update. All of them were developed relatively recently, with the Australian Forestry Standard being the oldest one (released in August 2007).

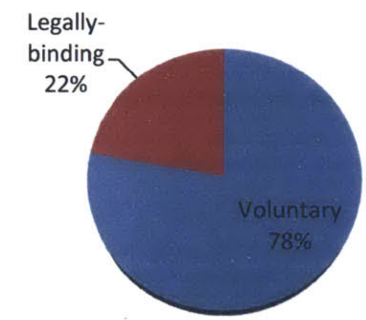

FIGURE 4-1 DISTRIBUTION OF JUDICIAL STATUSES OF STANDARDS

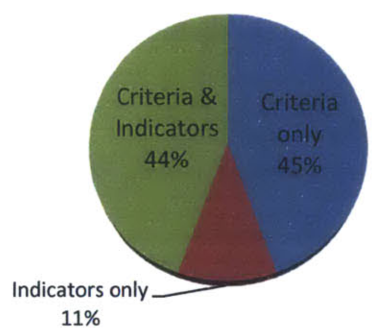

FIGURE 4-2 DISTRITUBION OF STANDARDS ACCORDING TO THEIR RELEASE OF CRITERIA AND/OR INDICATORS

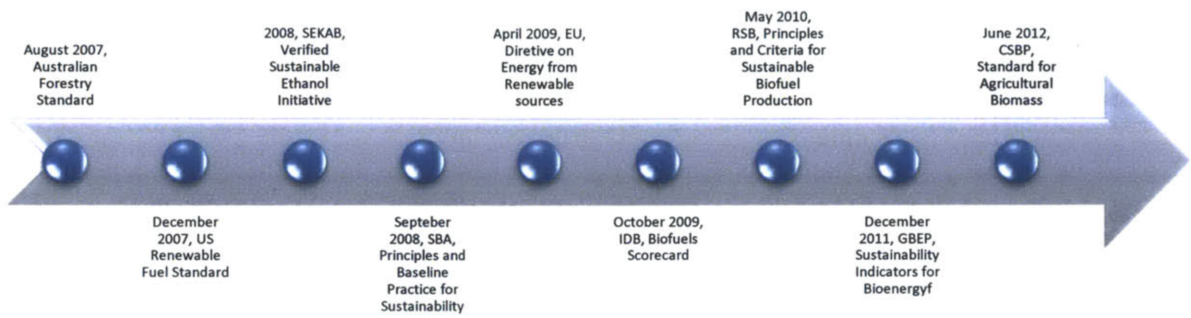

FIGURE 4-3 TIMELINE OF THE RELEASE OF STANDARDS ANALYZED

2) With the exception of IDB's Scorecard, all the standards followed the three-pillared sustainability area scheme: environmental, social and economic sustainability areas. Among them, environmental sustainability area was addressed by all of the standards, followed by social sustainability area with 88.9% of frequency and economic sustainability area with only 44.4% of frequency.

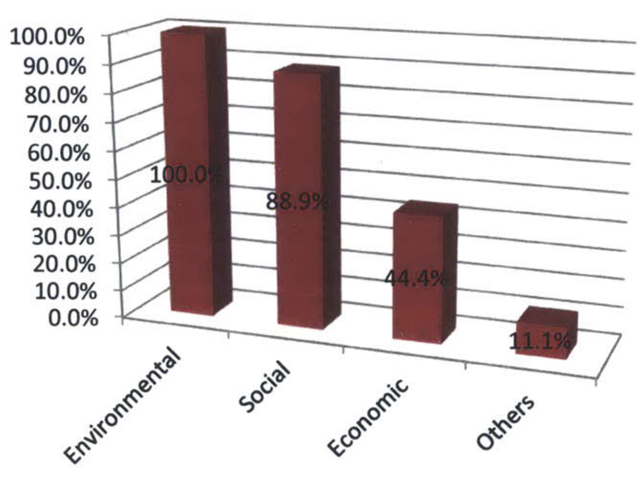

FIGURE 4-4 FREQUENCY OF APPEARANCES OF SUSTAINABILITY AREAS IN THE STANDARDS

The Australian Forestry Standard has criteria in 'ecological' sustainability area, not in 'environmental' sustainability area, possibly in order to pay specific attention to Australian forests' ecosystem. In addition, IDB's Scorecard has a sustainability area called 'cross-cutting' area, where issues that belong to multiple sustainability areas are addressed.

3) In general, there was lack of coverage on the use of the second generation biofuels. The CSBP's standard, which was released in June 2012, was the first standard for cellulosic biomass in the US. However, CSBP's principles did not properly address second generation biofuel-specific issues; it only dealt with general sustainability principles of biofuels that were commonly found in other standards. Although many principles that were designed for the first generation biofuels are applicable to the second generation biofuels, it is urgent to develop standards specializing in second generation biofuels considering the fuel's potential large contribution to sustainability goals.

4) For the standards that proposed criteria, most of the criteria were described in qualitative manners. In fact, every criterion in both social sustainability and economic sustainability area was described qualitatively. Among environmental sustainability issues, GHG emissions were the only topic where the majority of the standards proposed specific target goals. For example, SEKAB mandated at least 85% reduction in CO_2 emissions from the use of Brazilian sugarcane-derived ethanol.

5) Along with principles and criteria, many standards also proposed various methodologies for better implementation of their standards. Among them, the most frequent one was 'life cycle GHG calculation methodology', with different algorithms and default values for calculation across standards, as also observed by Dam et al.[51] IDB's Scorecard provided web-based calculators in many different areas including water management, controlled release of fertilizers, energy efficiency of biofuel distribution, local income generation, etc. In particular, GBEP was the most notable case; GBEP's entire set of 24 indicators were supported by specific methodologies with thorough description on the required data.

6) Previous works such as principles, guidelines, and conventions by other international organizations were referred to during the development of the standards, most frequently in the following areas: standard development, environmental sustainability, and social sustainability. Regarding the standard development, many standards followed ISEAL's Code of Good Practice. Among environmental sustainability issues, previous works on climate change and biological diversity were the most frequently referred to. In the social sustainability area, a number of ILO's conventions on labor rights were referred to, along with human rights guidelines by the

[51] Jinke van Dam, 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, 2010, p2468

UN-BLIHR (Business Leaders Initiative on Human Rights) and the IFC (International Finance Corporation). Figure 4-5, 4-6, and 4-7 show some of the referred works regarding standard development, environmental sustainability area, and social sustainability area, respectively.

On Standard Development

- ISO Guide 59: Code of Good Practice for Standardization 1994
- ISEAL Code of Good Practice for Setting Social and Environmental Standards
- WTO Agreement on Technical Barriers to Trade (TBT) Agreement, Annex 3: Code of good practice for the preparation, adoption and application of standards
- WTO TBT Second Triennial Review Annex 4, Principles for the Development of International Standards, Guides and Recommendations

FIGURE 4-5 REFERECE TO OTHER INTERNATIONAL ORGANIZATIONS' WORK ON STANDARDIZATION

On Climage Change

- UN Framework Convention on Climate Change
- Intergovernmental Panel on Climate Change

On Biological Diversity

- The Convention on Biological Diversity
- UN List of National parks and Protected Areas
- RAMSAR Convention on Wetlands
- Cartagena Protocol on Biosafety
- Convention on International Trade in Endangered Species of Wild Fauna and Flora

On Forests

- Principles and Criteria by the Forest Stewardship Council
- Programme for the Endorsement of Forest Certification Schemes

FIGURE 4-6 REFERENCE TO OTHER INTERNATIONAL ORGANIZATIONS' WORK ON ENVIRONMENTAL SUSTAINABILITY ISSUES

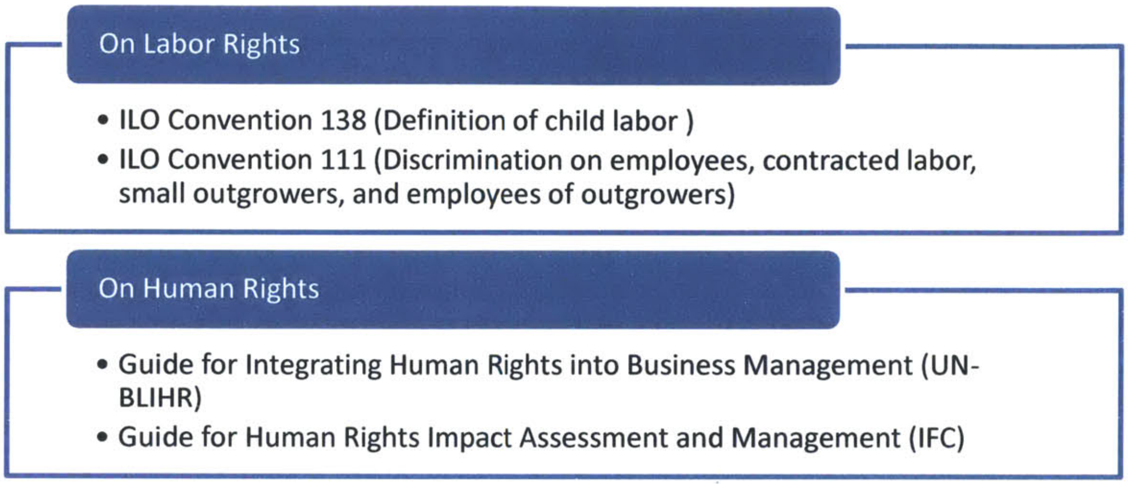

FIGURE 4-7 REFERENCE TO OTHER INTERNATIONAL ORGANIZATIONS' WORK ON SOCIAL SUSTAINABILITY ISSUES

7) GBEP's 24 indicators were intentionally designed in such a way that they can facilitate the harmonization process of numerous biofuels sustainability standards in the world. To achieve this goal, GBEP did not propose another new set of principles or criteria; however, it only released a set of standardized indicators. In addition, it focused on extensive collaboration with other international organizations throughout the indicator development process. In fact, GBEP's indicators are currently the only indicators taken by consensus of numerous major international organizations. Therefore, it is essential to make the best use of GBEP's indicators for further harmonization of standards.

8) IDB's Scorecard standed out as the only web-based platform. A web-based tool has many advantages. For example, users can save and open multiple sessions, users can see the results instantly, users can see how a specific change impacts the final results and by how much, etc. These convenient features and simultaneousness of the tool attract users and help them fine-tune their bioenergy projects. Therefore, IDB's Scorecard provides an insight for a format of future biofuels standards.

9) SEKAB's standards is the world's first bilateral sustainability standard for sugarcane-derived ethanol between two countries. Thanks to this localized approach, SEKAB's principles could have addressed specific sustainability issues present in Brazil such as child labor or lack of mechanization. Likewise, partly thank to this target-specific approach, SEKAB could propose an

85% reduction in GHG emissions, which is the most ambitious GHG reduction goal among the standards. Therefore, SEKAB's approach provides insights for the future development of standards.

4.2. ENVIRONMENTAL SUSTAINABILITY

In general, environmental area of sustainability was thoroughly described by all the groups. In particular, important issues regarding GHG emissions, biodiversity, water, soil, air, land use change received special attention.

Overall, many standards were dedicated to reiterating fundamental principles without touching on specific topics. Therefore, there were not significant disagreements or conflicting details among the contents.

All of the standards stressed on the reduction in GHG emissions. While most standards proposed unspecific reduction goals (e.g. 'significant reduction' by Roundtable on Sustainable Biofuels and 'substantive reduction' by Council on Sustainable Biomass Production), EU proposed 35% reduction goal as a minimum compared to the fossil fuel baseline. The US was more specific regarding the reduction goal for each fuel type: 20% for conventional biofuel, 50% for biomass-based diesel, 60% for cellulosic biofuel, and 50% for other Advanced Biofuels. Finally, SEKAB was the most ambitious; it mandated at least 85% reduction in carbon dioxide compared with petrol baseline. In addition, another common feature among the standards was the adoption of life cycle GHG measurement. Finally, some groups (e.g. Inter-American Development Bank) made it clear that both direct and indirect GHG emissions should be counted.

Several standards emphasized the importance of preserving 'land with high carbon stock'. EU officially prohibited the production of biofuels and bioliquids from raw material produced from land with high carbon stock. According to the regional group, land with high carbon stock was defined as wetland, peatland or continuous forest from January 2008. The Inter-American Development Bank mandated that carbon emission from indirect land change should also be considered.

Except for US and SEKAB, all the groups underscored the protection of biological diversity. EU forbid the use of land with high biodiversity value for the production of raw material for biofuels or bioliquids. The organization defined land with high biodiversity as primary undisturbed forest, conservation area, or biodiverse grassland from January 2008. Sustainable Biodiesel Alliance maintained that high conservation values should be protected in areas including habitats of rare, threatened or endangered species.

Among the standards, only Roundtable on Sustainable Biofuels and Sustainable Biodiesel

Alliance and SBA addressed the issue regarding the use of genetically modified organisms (GMO). RSB argued that technologies of GMOs, microorganisms and algae should minimize the risk of environmental damages. SBA did not support the use of GMOs; it mandated that the information should be made available to the consumers if they were used.

Regarding water protection, standards generally argued that sustainable biofuels production should maintain or improve water quality. Issues regarding water use included water scarcity and water run-off. The types of water sources addressed were surface water, groundwater, and aquatic ecosystems.

Likewise, many standards emphasized soil protection. GBEP was particularly interested in soil organic carbon contained in land of feedstock cultivation or harvest. Council on Sustainable Biomass Production also argued that soil carbon and nutrients should remain at appropriate levels. Roundtable on Sustainable Biofuels and Sustainable Biodiesel Alliance maintained that soil degradation should be prevented or reversed. EU, in particular, mandated that any land that had been maintaining its status as 'peatland' from January 2008 should not be used to produce raw material for biofuels or bioliquids.

The Scorecard of IDB asked users about crop lifecycles and the mode of crop rotation. Users can select whether a specific crop is permanent, perennial or annual and whether it is produced with crop-rotation or inter-cropping. These questions concern multiple issues such as soil erosion, release of carbon stock from land, water run-off, and energy input from harvesting.

Principles for air protection showed several characteristics in common with those of GHG emissions reduction. First, the emissions of non-GHG air pollutants should be monitored throughout the entire supply chain: feedstock production, processing, transport and use. Second, measurements should be based on a life cycle assessment. Finally, the air quality is compared with fossil fuel baselines.

Both Inter-American Development Bank and Sustainable Biodiesel Alliance addressed the use of agrochemicals. SBA argued that chemicals should be non-persistent, non-endocrine disrupting, non-carcinogenic and non-mutagenic. SBA standards also maintained that priority should be given to crops and that are less or non-reliant on the use of agrochemicals. Likewise, IDB stressed that fertilizer should be managed for protecting soil quality, biodiversity, soil run-off and leaching.

Regarding harvesting methods, IDB was specifically interested in field burning practices before harvesting takes place[52] . Field burning seriously damages sustainable biofuels production since it greatly contributes to GHG emissions, air pollution, and loss of biodiversity among others.

[52] For example, before harvesting sugarcane, field burning takes place in some parts of the world.

SEKAB's standard regarding harvest set the minimum level of mechanization for sugarcane harvest for ethanol produced in Brazil. SEKAB immediately required Brazil to have at least 30% of mechanized harvesting with a planned increase up to 100%. Additionally, SEKAB does not allow felling of rain forest for sustainable production of ethanol in Brazil.

SBA and IDB had standards about management of waste during the biofuels production. According to SBA, ideally sustainable biodiesel production does not produce any waste; however, when wastes are created they should be recycled or disposed in an environment-friendly manner. IDB sought to reduce waste production and it also encouraged the use of waste for productive purposes such as for power generation, as fertilizer, and as food products.

Table 4-2 is a comparison table of the environmental sustainability principles and criteria of the nine standards.

TABLE 4-2 COMPARISON OF VARIOUS STANDARDS – ENVIRONMENTAL STANDARDS

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional		National			Private	
GHG Emissions	**Lifecycle GHG emissions** Lifecycle greenhouse gas emissions from bioenergy production and use, as per the methodology chosen nationally or at community level, and reported using the GBEP Common Methodological Framework for GHG Lifecycle Analysis of Bioenergy 'Version One'	**Greenhouse gas emissions savings** Greenhouse gas emissions savings provides a measurement of the direct and indirect greenhouse gas savings resulting from the production of a biofuel project, taking into account the entire lifecycle of biofuel production, from feedstock cultivation to the end-use.	**GHG emissions saving** The greenhouse gas emission saving from the use of biofuels and bioliquids shall be at least 35 %.			At least 85 % reduction in fossil carbon dioxide compared with petrol, from a well to-wheel perspective	**Greenhouse Gas Emissions** Biofuels shall contribute to climate change mitigation by significantly reducing lifecycle GHG emissions as compared to fossil fuels.	full life cycle assessment (LCA) as the primary tool for ensuring substantive reduction in GHG emissions.	**Greenhouse Gas Emissions** Sustainable biodiesel results in net GHG emissions reductions compared to fossil fuels when analyzed via a life-cycle assessment. Fossil energy used in growing, transporting and processing biodiesel must be considered. Converting land from wilderness or grasslands to plant biodiesel feedstock crops also releases GHG and is not sustainable.
				Conventional biofuels(any fuel derived from starch feedstocks) produced in plants built after 2007 must show a 20% reduction in life cycle					

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
				GHG emissions compared to the baseline					
				Biomass-based diesel (a diesel fuel substitute made from renewable feedstock) must show a 50% reduction in life cycle GHG emissions compared to the baseline					
				Cellulosic biofuel (any fuel derived from cellulose, hemicellulose, or lignin) must show a 60% reduction in life cycle GHG emissions compared to the baseline					
				Other Advanced biofuels (any fuel derived from renewable feedstocks) must show a 50% reduction in life cycle GHG emissions compared to the baseline					

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
Carbon Conservation		**Carbon emissions from land use change** seeks to address the impact of both direct and indirect land use change on greenhouse gas emissions.	**High carbon stock protection** Biofuels and bioliquids shall not be made from raw material obtained from land with high carbon stock, namely land that had one of the following statuses in January 2008: •Wetlands •Peatlands •Continuous forest		Forest management shall maintain forests' contribution to carbon cycles				
Energy	**Net energy balance** Energy ratio of the bioenergy value chain with comparison with other energy sources, including energy ratios of feedstock production, processing of feedstock into bioenergy, bioenergy use; and/or lifecycle analysis	**Energy balance** seeks to address the ratio between the energy produced by 1 kg of the biofuel and the total energy necessary to cultivate, produce, and distribute it							
	Change in the consumption of fossil fuels and traditional use of biomass -Substitution of fossil fuels with domestic bioenergy measured by energy content and in annual savings of convertible currency from reduced purchases of fossil fuels -Substitution of traditional								

Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
use of biomass with modern domestic bioenergy measured by energy content								
Energy diversity Change in diversity of total primary energy supply due to bioenergy								
	Relative energy efficiency of transport and distribution seeks to address issues pertaining to the relative energy efficiency of the transportation and distribution of the biofuel production.							
	Energy source for facility seeks to address greenhouse gas emissions, as well as the ratio of energy return on energy input of the production phase of biofuel projects. Cogeneration from biomass with excess to sell to grid/cogeneration from biomass to power facility only/use of other renewables							
								Energy Conservation Sustainable biodiesel production improves energy and

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
									resource conservation. Wasteful use of fossil fuels should not be replaced with wasteful use of biodiesel. Instead, significant reductions in total consumption, together with increased conservation, shall be a priority.
Biodiversity	**Biological diversity in the landscape** -Area and percentage of nationally recognized areas of high biodiversity value or critical ecosystems converted to bioenergy production -Area and percentage of the land used for bioenergy production where nationally recognized invasive species, by risk category, are cultivated	**Biodiversity** seeks to address the impacts of a project on the biodiversity of the area, including natural habitats and cultural sites, where it will be located.	**High biodiversity protection** Biofuels and bioliquids shall not be made from raw material obtained from land with high biodiversity value, namely land that had one of the following statuses in or after January 2008: •Undisturbed primary forest •Conservation areas •Biodiverse grassland		Forest management shall protect and maintain the biological diversity of forests, including their serial stages, across the regional landscape		**Conservation** Biofuel operations shall avoid negative impacts on biodiversity, ecosystems, and conservation values.	**Biological Diversity** Biomass production contributes to the maintenance or enhancement of biological diversity, in particular native plants and wild life.	**Biodiversity Conservation** Sustainable biodiesel production does not lead to the destruction, degradation or declassification of high conservation value areas; areas of high biodiversity; habitats of rare, threatened or endangered species; or rare, threatened or endangered ecosystems.
Invasive Species		**Invasive species**						Participants recognize the	

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
		seeks to address the risks posed by using an invasive species as feedstock for biofuel production.						risks associated with non-crop invasive species and adopt conservation practices related to control of non-crop invasive species (e.g. those not intentionally planted) on biomass production acres.	
Genetically Modified Organisms							Criterion 11.b The technologies used in biofuel operations including genetically modified: plants, micro-organisms, and algae, shall minimize the risk of damages to environment and people, and improve environmental and/or social performance over the long term.		**Genetically Modified Organisms (GMOs)** Sustainable biodiesel is derived from non-GMO feedstock. However, if GMOs are used for the production of biodiesel, it shall be made transparent, so that producers and consumers can make informed decisions.

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
Water	**Water use and efficiency** - Water withdrawn from nationally-determined watershed(s) for the production and processing of bioenergy feedstocks, expressed as the percentage of total actual renewable water resources (TARWR) and as the percentage of total annual water withdrawals (TAWW), disaggregated into renewable and non-renewable water sources	**Water management** seeks to address issues relating to water scarcity and water run-off, in addition to energy input							
	Water quality Pollutant loadings to waterways and bodies of water attributable to fertilizer and pesticide application for bioenergy feedstock cultivation, and expressed as a percentage of pollutant loadings from total agricultural production in the watershed				Forest management shall protect soil and water resources		**Water** Biofuel operations shall maintain or enhance the quality and quantity of surface and ground water resources, and respect prior formal or customary water rights	**Water** Biomass and bioenergy production maintains or improves surface water, groundwater, and aquatic ecosystems	**Water** Sustainable biodiesel production does not contaminate or imperil water resources, but contributes to improved water quality and efficient utilization
		Water requirements for industrial production seeks to address the project's level of efficiency in terms of water usage in the production cycle							
Soil	**Soil quality** Percentage of land for which soil quality, in				Forest management shall protect soil and		**Soil** Biofuel operations	**Soil** Biomass production	**Soil** Sustainable biodiesel does

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	particular in terms of soil organic carbon, is maintained or improved out of total land on which bioenergy feedstock is cultivated or harvested				water resources		shall implement practices that seek to reverse soil degradation and/or maintain soil health	maintains or improves soil quality by minimizing erosion, maintaining or enhancing soil carbon and nutrients at appropriate levels, and promoting healthy biological systems and chemical and physical properties	not degrade or damage soils and should contribute to long-term maintenance and improvement of soil quality
Peatland Protection			**Peatland protection** Biofuels and bioliquids shall not be made from raw material obtained from land that was peatland in January 2008						
Crop		**Crop lifecycle** seeks to address issues relating to soil erosion, carbon released from the soil, water run-off, and energy input for harvesting. Choices include: Permanent/perennial/annual crop No till/low till/tilling							
		Crop rotation / Crop mix seeks to address issues							

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
		relating to soil quality, soil input requirements, and crop biodiversity. Choices include: Crop rotation/inter-cropping/no rotation or inter-cropping							
Air	**pollutants, including air toxics** Emissions of non-GHG air pollutants, including air toxics, from bioenergy feedstock production, processing, transport of feedstocks, intermediate products and end products, and use; and in comparison with other energy sources						**Air** Air pollution from biofuel operations shall be minimized along the supply chain	**Air Quality and Emissions** Emissions are estimated via a consistent approach to life cycle assessment	**Air** Sustainable biodiesel production and use improves air quality and does not lead to increased air pollution as compared to fossil fuels
Ecosystem					Forest management shall maintain forest ecosystem health and vitality Forest management shall maintain the productive capacity of forests	Ecological consideration in accordance with UNICAs environmental initiative	**Conservation** Biofuel operations shall avoid negative impacts on biodiversity, ecosystems, and conservation values.		
Pest Control								Participants use an integrated pest management approach to effectively control	

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
								outbreaks of pests, diseases, fire, and introduction of invasive plants while protecting human health and the environment	
Agrochemicals		**Fertilizer Management** seeks to address issues of soil quality, area biodiversity, nitrogen emissions, run-off and leaching.							**Agrochemicals** Sustainable biodiesel crop production minimizes, and eliminates whenever possible, the use of dangerous agrochemicals. Agrochemicals that are hazardous to the environment, workers, and local communities will not be used. Chemicals used are non-persistent and chemicals that are endocrine disrupting, carcinogenic or mutagenic in humans should

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
									be phased out. Preference should be given to the selection of crops and cropping systems that are productive and sustainable without reliance on agrochemicals.
		Pesticide use seeks to address issues of soil quality, run-off, and area biodiversity.							
Harvest	**Harvest levels of wood resources** Annual harvest of wood resources by volume and as a percentage of net growth or sustained yield, and the percentage of the annual harvest used for bioenergy	**Harvesting method** seeks to address issues exclusively related to environmental concerns, such as greenhouse gas emissions, air pollution, and biodiversity loss. Issues associated with the role of labor are addressed in social categories. Choices include: Field burning/ no burning				At least 30 % mechanisation of the harvest now, plus a planned increase in the degree of mechanisation to 100 %			
						Zero tolerance for felling of rain forest			
Land Use Change	**Land use and land- use change related to bioenergy feedstock production** - Total area of land for								

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	bioenergy feedstock production, and as compared to total national surface and agricultural and managed forest land area - Percentages of bioenergy from yield increases, residues, wastes and degraded or contaminated land								
Waste		**Waste management** seeks to address issues pertaining to management of waste disposal.							**Waste Handling & Reduction** Sustainable biodiesel production ideally does not create waste. Wastes that are created are recycled. If waste cannot be recycled then it is disposed of in an environmentally responsible manner.
		Waste diversion seeks to address issues pertaining to waste reduction. Waste used for productive purposes, including power generation, fertilizer, food products, and other co-products reduces the amount of waste. Recycling and reuse also reduce the amount of waste.							

Source: Material in this table was reproduced or adapted from the following material:

- 'The Global Bioenergy Partnership Sustainability Indicators For Bioenergy', First edition, Global bioenergy Partnership, December 2011
- 'IDB Biofuels Sustainability Scorecard', Inter-American Development Bank, October 2009
- 'Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC', European Commission, 2009
- 'US Renewable Fuel Standard (RFS)', US Environmental Protection Agency
- 'The Australian Forestry Standard: Forest management—Economic, social, environmental and cultural criteria and requirements for wood production', Australian Forestry Standard Limited, 2007
- 'Verified Sustainable Ethanol Initiative', SEKAB (Swedish Bioenergy Company)
- 'RSB Principles & Criteria for Sustainable Biofuel Production', Roundtable on Sustainable Biofuels, 2010
- 'Standard for Sustainable Production of Agricultural Biomass', Council on Sustainable Biomass Production, June 2012
- 'Principles and Baseline Practices for Sustainability', Sustainable Biodiesel Alliance
- Jinke van Dam, Update: Initiatives in the Field of Biomass and Bioenergy Certification, April 2010

Note:

- In this table, some standards were assigned to sustainability areas different from the ones from their original standards (e.g., 'Price and Supply of a national food basket' was proposed to be under the Social Sustainability area by the Global Bioenergy Partnership, but it belongs to the Economic Sustainability area in this paper).

The following section summarizes some of the key findings obtained from the comparison of the standards in the environmental sustainability area.

KEY FINDINGS FROM THE COMPARISON OF STANDARDS IN THE ENVIRONEMTAL SUSTAINABILITY AREA

1) Environmental area of sustainability was thoroughly described by all the standards. In fact, the majority of the standards covered environmental sustainability area as the most important area. However, most principles and criteria were described in qualitative ways with the exception of those concerning GHG emissions.

2) Among various topics in the area, reduction in GHG emissions received the strongest attention followed by the protection of biodiversity. This is in agreement with the general perception that GHG reduction has been one of the most important motivations for the development of sustainability standards of biofuels. Meanwhile, conservation of water, air and soil were addressed with similar frequencies of apperances. Among the least-covered topics were both direct and indirect land use change, pest control and topics related to cropping system.

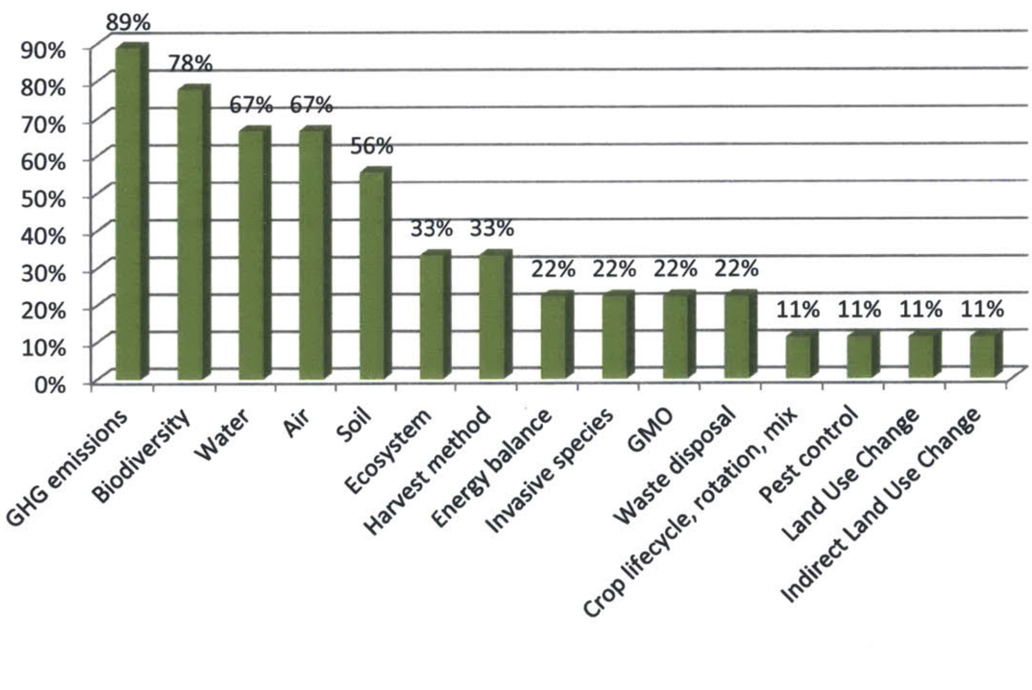

FIGURE 4-8 TOPICS APPEARED IN ENVIRONMENTAL SUSTAINABILITY AREA BY FREQUENCY

3) Many standards requested meaningful reduction in GHG emissions, in some cases

with setting specific targets. The reduction goals were set either as numerical targets or with qualitative expressions. Figure 4-9 shows the numerical targets by standards. Other non-quantifiable reduction targets were described as 'significant reduction', 'substantive reduction' or 'net GHG reduction'. Note that almost all standards suggested using life cycle analysis for GHG emissions calculation. Specifically, IDB made it clear that both direct and indirect GHG emissions should be counted. Finally, all of the standards used the term GHG without separating CO_2 from non-CO_2 emissions.

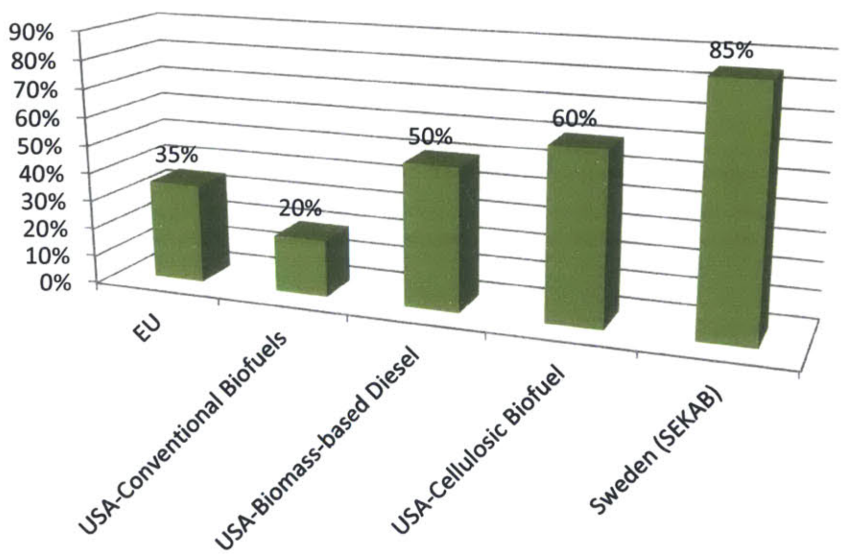

FIGURE 4-9 GHG REDUCTION GOALS OF VARIOUS STANDARDS

4) Followed by GHG emissions reduction, biological diversity was the second most frequent topic in environmental sustainability area. However, no specific target goal was proposed although European Commission was required to report to the European Parliament on environmental sustainability performance every two years. In addition, most of the standards emphasized the general principle that biodiversity should not be threathened. Among them, CSBP proposed the most detailed principle by specifying the Important Wildlife Species (IWS) and the critical seasons for animal protection. Moreover, there were

terms and concepts whose definitions were not clear, as also argued by Dam et al.[53] For example, 'land with high biodiversity value' (EU), 'areas of high biodiversity' (SBA), 'protected areas including grasslands, wetlands, and forests' (SBA) were mentioned without clear-cut definitions, which would impede implementation of the standards on the ground.

5) The use of GMO for biofuel production did not receive much attention by the standards. Only two standards –RSB and SBA – dealt with the topic and they only requested that GMO should not be used or the risk of damages to environment and the human should be minimized. Therefore, it is important to argue that more in-depth principles regarding the use of GMOs in social, economic and technological perspectives should be included in future standards.

[53] Jinke van Dam, 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, 2010, p2456

6) Only IDB and SBA addressed the use of agrochemicals. However, except for reiterating general principles, they lacked detailed target goals or quantifiable criteria for real implementation on the ground.

7) Regarding harvesting methods, IDB was specifically interested in field burning practices before harvesting happens. Field burning seriously threatens sustainable biofuels production since it greatly contributes to GHG emissions, air pollution, and loss of biodiversity among others. That is why SEKAB's standard mandates that Brazil mechanize immediately at least 30% of the entire harvest sugarcane for ethanol.

8) The majority of the standards have not paid sufficient attention to the Indirect Land Use Change (ILUC), as also observed by Dam et al.[54] As one of follow-ups to the Directive 2009/28/EC, which was analyzed throughout this paper, the EC released in October 2012 an 'executive summary of the impact assessment on indirect land-use change related to biofuels and bioliquids'[55]. In this summary, the EC acknowledged that indirect land-use change would greatly reduce the expected savings of GHG emissions. Among the five proposed solutions, the EC concluded that limiting the contribution from conventional biofuels was the best option. Likewise, RSB also released a follow-up document[56] on the ILUC in April 2012, about two years after the group's standard was released. In the document, RSB emphasized the difficulty of taking into account uncertainties around quantifying indirect impacts. Among the five suggested solutions, RSB acknowleged that they were not able to give one definite option as the final solution. Rather, they provided detailed evaluation of the five options.

9) As previously mentioned, only CSBP's standard dealt with possible impact of second generation biofuel production in the environment. CSBP proposed the first standard on sustainable production of second generation biofuel in the US; however it only reiterated general principles that were also present in other standards for the first generation biofuel.

4.3. SOCIAL SUSTAINABILITY

Social area of sustainability was the most commonly addressed by the groups following the environmental sustainability area; only the US' standard lacked social sustainability criteria. In

[54] Jinke van Dam, 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, 2010, p2464

[55] Document available at http://ec.europa.eu/energy/renewables/biofuels/doc/biofuels/swd_2012_0344_ia_resume_en.pdf, accessed on May 5, 2013

[56] Indirect Impacts of biofuel production and the RSB Standard, RSB Secretariat, April 2012, available at http://rsb.org/pdfs/working-and-expertGroups/II-EG/EG-on-Indirect/12-04-13-RSB-Indirect-Impacts.pdf, accessed on May 5, 2013

general, social sustainability criteria addressed various rights (e.g. human, labor and land rights), food security issues, and issues concerning local communities including indigenous people and stakeholder engagement.

Especially for the labor and human rights, many Conventions of the International Labor Organization were referenced. For example, SEKAB referenced article 1 and 2 of the ILO 138(Minimum Age Convention) and RSB referenced ILO Convention 111(Discrimination Convention -Employment and Occupation). In addition to ILO, IDB used UN-BLIHR's "Guide for Integrating Human Rights into Business Management) and the "Guide for Human Rights Impact Assessment and Management" for the development of its Scorecard regarding human rights. SEKAB wrote that rights and safety measures for all employees followed UN guidelines, but it did not specify the list of guidelines.

Regarding land rights, IDB concerned about the effect of any bioenergy project on the land ownership change pattern. It argued that private property and customary rights for local communities should be respected and appropriately compensated. RSB wrote that biofuels operators should respect land and land use rights.

GBEP was the only organization who specifically dealt with the issue of human health. It proposed an indicator to measure the change in mortality rate and disease due to indoor smoke caused by, for example, biomass-based cookstoves. The organization also provided an indicator for occupational injury and fatalities during the bioenergy production.

Local community was an important topic in the social sustainability area. In general, there were two sub-topics: protection of local community and development of local community during the production of biofuels. Regarding protection, Australian Forestry Standard mandated that natural, cultural, social, recreational, religious and spiritual heritage values should be maintained. IDB maintained that impacts on the access to food, natural resources, hunting and fishing stock, land or anything vital for subsistence strategies for local people should be monitored. Further included in the list are mobility, cultural practices and customary practices. Meanwhile, RSB specialized in water protection and argued that quality of water and customary water rights should be maintained.

Standards sought local development through various measures. IDB sought to address whether there were arrangements for sourcing feedstock from local growers under exclusive sales agreements. Likewise, SBA encouraged and prioritized local consumption. IDB was also interested in building capacity of the local employees. Its Scorecard measured the effect of projects on learning, knowledge transfer, and technology transfer. Meanwhile, GBEP was especially interested in the women and children among the employees; it presented an indicator to measure the change in unpaid time for women and children who are hired for the biomass collection process. IDB, on the other hand, measured projects' hiring and sourcing practices to generate income for the people who live in poor areas, in particular.

Three groups (IDB, Australia, and RSB) addressed the issue of indigenous people. They emphasized the general principle that bioenergy projects should protect natural, cultural, social and heritage values of the indigenous people.

Only two standards (IDB's Scorecard and Australian Forestry Standard) explicitly emphasized the importance of stakeholder participation. IDB's Scorecard asked whether stakeholders had access to information and documentation on environmental, social, and legal issues. In addition, the card was also interested in whether the local community had been adequately represented.

Although food security is a hotly debated issue worldwide, only three groups (IDB, RSB, and SBA) proposed principles regarding the topic. IDB's Scorecard measured the impact of land use change on food security. RSB and SBA, on the other hand, put emphasis on the general principle that biofuel operations should not jeopardize food security in food-insecure regions. Furthermore, RSB released a dedicated guideline document on food security: RSB Food Security Assessment Guidelines. The guideline explained its Food security impact assessment process (see Figure 4-10). It also introduced the so-called four pillars of food security[57] first defined by the Food and Agriculture Organization and the United Nations.

Table 4-3 is a comparison table of the social sustainability principles and criteria of the nine standards.

[57] Food availability, food access, food utilization, and food stability

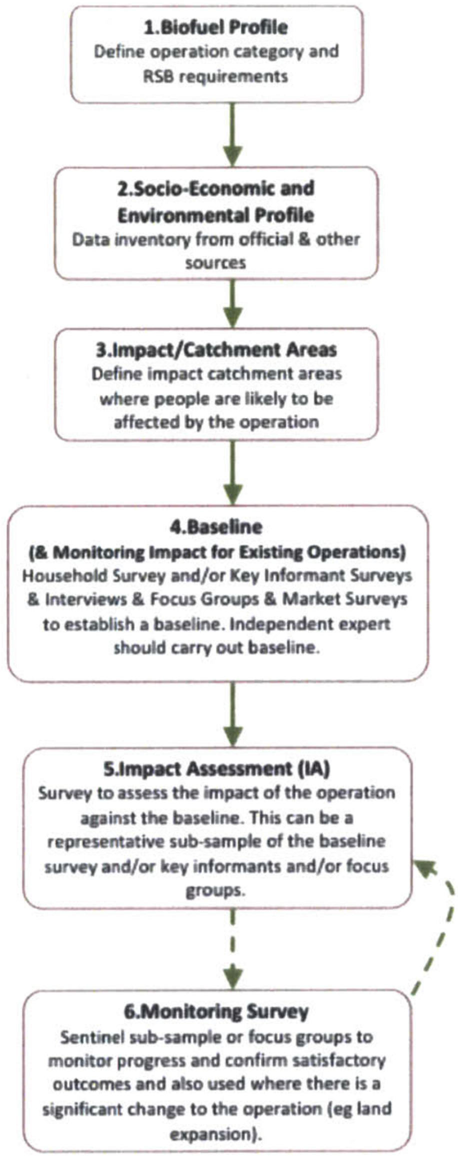

FIGURE 4-10 FOOD SECURITY IMPACT ASSESSMENT PROCESS

Source: RSB Food Security Guidelines, available at http://rsb.org/pdfs/guidelines/12-30-04-RSB-GUI-01-006-01-RSB-Food-SecurityGuidelines.pdf, accessed on May 18, 2013

RSB's guideline on food security explains its Food security impact assessment process from profiling of a biofuel until the monitoring survey.

TABLE 4-3 COMPARISON OF VARIOUS STANDARDS – SOCIAL STANDARDS

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional	National			Private		
Human Rights		**Human rights** seeks to capture the project's standards and respect for basic human rights at the workplace (beyond the labor relationship itself), within the community as a whole, and compliance with legal and regulatory structures necessary to enforce those rights and ensure non-discriminatory practices.					**Human and Labor Rights** Biofuel operations shall not violate human rights or labor rights, and shall promote decent work and the well-being of workers.		
Labor Rights		**Labor rights** seeks to capture the project's labor standards, respect for basic human rights at the workplace, and compliance with legal and regulatory structures necessary to enforce those rights.							
									Fair Wages & Working Conditions – Farmer, Farm Worker Fair wages, non-discriminatory and safe working conditions are provided for workers in sustainable biodiesel feedstock production.
									Plant/Worker Safety The health and safety of

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional	National			Private		
									workers and communities, both present and future, are protected in sustainable biodiesel production.
						Child Labor Zero tolerance for child labour			
						UN Guidelines Rights and safety measures for all employees in accordance with UN guidelines			
Land Rights		**Land ownership** seeks to address the effect of the project over the land ownership pattern as well as the respect for private property and customary rights and local communities' right to proper compensation					**Land Rights** Biofuel operations shall respect land rights and land use rights.		
Allocation of Land	**Allocation and tenure of land for new bioenergy production** Percentage of land – total and by land-use type – used for new bioenergy production where:								

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional		National		Private		
	-a legal instrument or domestic authority establishes title and procedures for change of title; and -the current domestic legal system and/or socially accepted practices provide due process and the established procedures are followed for determining legal title								
Human Health	**Change in mortality and burden of disease attributable to indoor smoke** Change in mortality and burden of disease attributable to indoor smoke from solid fuel use, and changes in these as a result of the increased deployment of modern bioenergy services, including improved biomass-based cookstoves								
	Incidence of occupational injury, illness and fatalities Incidences of occupational injury, illness and fatalities in the production of								

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional		National		Private		
	bioenergy in relation to comparable sectors								
Local Community									**Local Communities** Local communities are an integral part of the development of the sustainable biodiesel industry. Local strategies for biodiesel production with citizen input are created. Local consumption of sustainable biodiesel is prioritized and encouraged.
									Communities and Workers Family and small holder farmers are not to be displaced to grow or harvest biodiesel feedstock. Farmers should receive fair compensation for the biodiesel feedstock they produce. The health and safety of workers and communities should be protected. In addition, fair / livable wages for agricultural workers and workers at biodiesel production facilities are ensured.
					Forest management shall protect and maintain, for Indigenous and non- Indigenous people, their natural, cultural, social, recreational, religious and				**Plant/Worker Safety** The health and safety of workers and communities, both present and future, are protected in sustainable biodiesel production.

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional		National		Private		
					spiritual heritage values				
Access to Resource by the local community	**Bioenergy used to expand access to modern energy services** Total amount and percentage of increased access to modern energy services gained through modern bioenergy (disaggregated by bioenergy type), measured in terms of energy and numbers of households and businesses	**Change in access to resources** seeks to address the impacts of the project on the access by local people to resources (food, water, natural resources, hunting and fishing stock, land, etc.) that are vital for local food security and/or their subsistence strategies, such as habitat and mobility, cultural practices, and reproduction and customary practices.			Forest management shall protect and maintain, for Indigenous and non- Indigenous people, their natural, cultural, social, recreational, religious and spiritual heritage values		**Water** Biofuel operations shall maintain or enhance the quality and quantity of surface and ground water resources, and respect prior formal or customary water rights.		
Local Development		**Community development** seeks to address the extent to which the project will maximize benefits for the local community. **Capacity building** seeks to measure the effect of the project on local employees or general population learning, knowledge transfer, and technology transfer.					**Rural and Social Development** In regions of poverty, biofuel operations shall contribute to the social and economic development of local, rural and indigenous people and communities.		**Community Benefit – Localization** Local communities are an integral part of the development of the sustainable biodiesel industry. Local strategies for biodiesel production with citizen input are created. Local community benefit is prioritized, because the power of local businesses can transform communities for the better by working cooperatively toward a shared vision.

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional		National		Private		
		Local grower arrangements seeks to address whether the project has acceptable arrangements for sourcing feedstock from local growers, including independent producers and "outgrowers" under exclusive sales agreements.							**Local consumption** Local consumption is encouraged and prioritized.
Employment	**Change in unpaid time spent by women and children collecting biomass** Change in average unpaid time spent by women and children collecting biomass as a result of switching from traditional use of biomass to modern bioenergy services	**Local Income generation** seeks to address the project's potential, given its location, hiring and sourcing practices, to generate income for people that live in poor areas or belong to the poor strata of a country.							
Indigenous People		**Impacts on indigenous peoples** seeks to address whether the project has any potential impacts on indigenous peoples.			Forest management shall protect and maintain, for **Indigenous** and non- Indigenous people, their natural, cultural, social, recreational, religious and spiritual heritage values		**Rural and Social Development** In regions of poverty, biofuel operations shall contribute to the social and economic development of local, rural and **indigenous** people and communities.		
Stakeholder Engagement		**Consultation and transparency** seeks to address whether stakeholders have access to			Forest management shall provide for **public participation** and foster on-going relationships to be a				

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional	National			Private		
		information and documentation on environmental, social and legal issues, whether the local community has been consulted and adequately represented, and adequate strategies for continuous stakeholder engagement exist.			good neighbor				
Food Security		**Impact on food security** seeks to address the issue of local, national, and global food security resulting from a change in land use with respect to food production.					**Local Food Security** Biofuel operations shall ensure the human right to adequate food and improve food security in food insecure regions.		**Food Security** Sustainable production of biodiesel does not jeopardize food security by displacing land or water used for growing critical food crops with biodiesel feedstock crops.

Source: Material in this table was reproduced or adapted from the following material:

- 'The Global Bioenergy Partnership Sustainability Indicators For Bioenergy', First edition, Global bioenergy Partnership, December 2011
- 'IDB Biofuels Sustainability Scorecard', Inter-American Development Bank, October 2009
- 'Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC', European Commission, 2009
- 'US Renewable Fuel Standard (RFS)', US Environmental Protection Agency
- 'The Australian Forestry Standard: Forest management—Economic, social, environmental and cultural criteria and requirements for wood production', Australian Forestry Standard Limited, 2007
- 'Verified Sustainable Ethanol Initiative', SEKAB (Swedish Bioenergy Company)
- 'RSB Principles & Criteria for Sustainable Biofuel Production', Roundtable on Sustainable Biofuels, 2010
- 'Standard for Sustainable Production of Agricultural Biomass', Council on Sustainable Biomass Production, June 2012
- 'Principles and Baseline Practices for Sustainability', Sustainable Biodiesel Alliance
- Jinke van Dam, Update: Initiatives in the Field of Biomass and Bioenergy Certification, April 2010

Note:

- In this table, some standards were assigned to sustainability areas different from the ones from their original standards (e.g., 'Price and Supply of a national food basket' was proposed to be under the Social Sustainability area by the Global Bioenergy Partnership, but it belongs to the Economic Sustainability area in this paper).
- Some standards appear more than once if the they deal with multiple sustainability sub-areas(e.g., 'Human and Labor Rights' by the Roundtable on Sustainable Biofuels applies both to 'Human rights' and 'Labor rights' sections).

The following section summarizes some of the key findings obtained from the comparison of the standards in the social sustainability area.

KEY FINDINGS FROM THE COMPARISON OF STANDARDS IN THE SOCIAL SUSTAINABILITY AREA

1) Social area of sustainability was the most commonly addressed by the groups after the environmental sustainability; only the US' standard did not deal with social sustainability area.

2) Among various topics in the area, principles and criteria concerning 'local community' appeared the most frequently, followed by those about 'labor rights', 'land rights', 'indigenous people' and 'food security' with the same frequencies. In general, criteria were described in qualitative ways, rather than quantative. As argued by Elbehri et al., most topics were those with 'obvious negative impacts', such as child labor and rights of indigenous people, and they did not include other critical social factors such as common management of resources or smallhoder engagement[58].

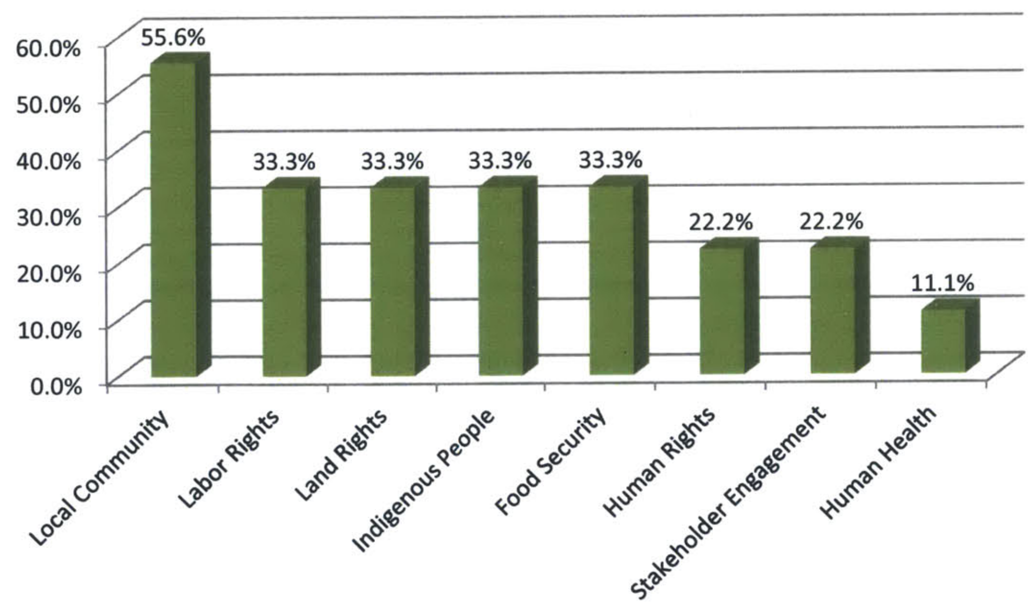

FIGURE 4-11 FREQUENCY OF APPEARANCES OF TOPICS IN SOCIAL SUSTAINABILITY AREA

3) As previously mentioned, 'local community' was the most frequently addressed topic in

[58] Aziz Elbehri et al., Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and relatdate wased feedstocks, FAO, 2013, p9

social sustainability area. There were two sub-topics: protection of the local community and development of the local community during the production of biofuels. Protection of local community concerned about human health, local cultural values and environment & natural resources. On the other hand, local community development concerned about economic development of the community and knowledge and technology transfer to strengthen local capacity. Figure 4-12 shows the sub-topics of 'local community' in social sustainability area. Particularly for the local economic development, IDB proposed exclusive sales agreement with local communities and SBA suggested 'prioritized' local consumption of biodiesel produced. This is to ensure that local bioenergy projects contribute to the local economy, which is also related to the economic sustainability area of biofuels.

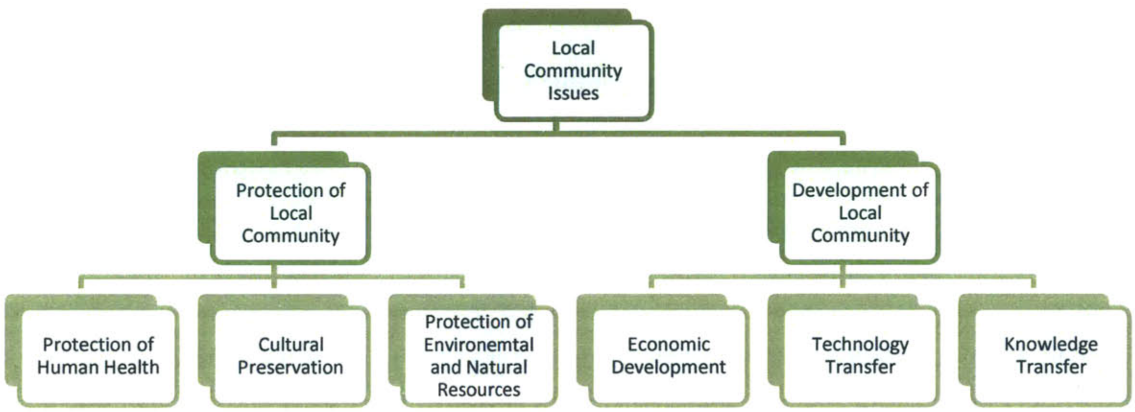

FIGURE 4-12 SUB-TOPICS OF 'LOCAL COMMUNITY' IN SOCIAL SUSTAINABILITY AREA

4) While most active producers of the feedstock of biofuels are developing countries, the indigenous people in the region are often under the poverty line without well-defined property rights of local resources. IDB's Scorecard, AFS and RSB addressed the issue of possible impacts of biofuel production on indigenous people; however, they simply reiterated general principles. Since discussion on the importance of indigenous issues is drawing increasing attention in recent years, it is expected that future standards consider addressing the issue with more depth and specificity.

5) Gender equality did not receive much attention by standards. Only RSB's standard explicitly mentioned that men and women should receive the same compensation for the work of equal value. Although inequal compensation is an important issue for sugarcane growers in Brazil, SEKAB's standard did not seem to have paid much attention. GBEP, on the other hand, tried to measure "the change in unpaid time spent by women collecting biomass" when a traditional biomass business is changed into a modern bioenergy business.

6) The majority of references from work or conventions of other international organizations

were made in the social sustainability area, especially regarding labor rights and human rights. ILO's conventions were the most frequently referenced. For example, RSB referred to ILO conventions 138 (no child labor), 111(no discrimination), 29(no forced labor), and 169(rights of indigeouns people). SEKAB and EU also mentioned several ILO conventions[59]. As argued by Scarlat et al., it is assumed that observing principles by ILO was generally regarded as having fulfilled social requirements in the corresponding areas of social sustainaility[60]. Thus, it is expected that ILO conventions could become the common ground for future standard-harmonization processes, particularly in regard to human rights and labor rights, as argued by Dam et al. [61]

4.4. ECONOMIC SUSTAINABILITY

Compared to environmental or social area, economic area of sustainability did not receive much attention by the standard-setting groups in general. In fact, most of the economic principles or criteria summarized in Table 4-4 came from GBEP's indicators from the economic pillar.

There was some degree of overlap between some social sustainability principles and economic sustainability principles. For example, "price and supply of a national food basket" was categorized as a social sustainability indicator by GBEP. The rationale could have been that the price and supply of a collection of important foodstuffs had a great impact on the food security, which is widely known as a social sustainability issue. Meanwhile, some believed the issue of food security was an economic issue rather than a social issue. According to Elbehri et al.[62], for example, food security is an economic issue since it is one of the key drivers determining long-term economic viability of biofuels production.

GBEP proposed an indicator measuring the amount of net job creation thanks to the bioenergy project. The indicator records the number of skilled/unskilled and temporary/indefinite jobs.

GBEP's 'change in income' indicator measures the wages paid for employees and the net income gained.

GBEP's indicator on the training and re-qualification of employees measures the percentage of

[59] SEKAB also wrote that rights and safety measures for all employees should follow UN guidelines, but it did not specify the list of guidelines.

[60] Nicolae Scarlat and Jean-Francois Dallemand, Recent developments of biofuels/bioenergy sustainability certification: A global overview, Energy Policy, January 2011, p1643

[61] Jinke van Dam, 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, 2010, p2468

[62] Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and related feedstocks, Aziz Elbehri et al., FAO, 2013

the trained workers in the total workforce in a bioenergy project. Likewise, it measures the percentage of re-qualified workforce in the workforce.

IDB and Australia proposed principles on productivity. IDB's Scorecard measured the overall efficiency of a project; it took into account the total feedstock used and the biofuel produced. Finally, Australian Forestry Standard presented a general principle on maintaining productive capacity of forests.

In addition, GBEP presented an indicator of 'capacity and flexibility of use of bioenergy'.

Table 4-4 summarizes the economic sustainability principles and criteria of the standards.

TABLE 4-4 COMPARISON OF VARIOUS STANDARDS – ECONOMIC STANDARDS

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional		National		Private		
Employment	**Change in unpaid time spent by women and children collecting biomass** Change in average unpaid time spent by women and children collecting biomass as a result of switching from traditional use of biomass to modern bioenergy services								
	Jobs in the bioenergy sector -Net job creation as a result of bioenergy production and use, total and disaggregated (if possible) as follows: - skilled/unskilled - temporary/indefinite								
Income Change	**Change in income** Contribution of the following to change in income due to bioenergy production: -wages paid for employment in the bioenergy sector in relation to comparable sectors -net income from the sale, barter and/or own-consumption of bioenergy products, including feedstocks, by self-employed households/individuals	**Local Income generation** seeks to address the project's potential, given its location, hiring and sourcing practices, to generate income for people that live in poor areas or belong to the poor strata of a country.							
Worker Training	**Training and re- qualification of the workforce** Percentage of trained workers in the bioenergy sector out of total	**Capacity building** seeks to measure the effect of the project on local employees or							

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional		National		Private		
	bioenergy workforce, and percentage of re-qualified workers out of the total number of jobs lost in the bioenergy sector	general population learning, knowledge transfer, and technology transfer.							
Local Development		**Community development** seeks to address the extent to which the project will maximize benefits for the local community. **Local grower arrangements** seeks to address whether the project has acceptable arrangements for sourcing feedstock from local growers, including independent producers and "outgrowers" under exclusive sales agreements.					**Rural and Social Development** In regions of poverty, biofuel operations shall contribute to the social and economic development of local, rural and indigenous people and communities.		**Community Benefit – Localization** Local communities are an integral part of the development of the sustainable biodiesel industry. Local strategies for biodiesel production with citizen input are created. Local community benefit is prioritized, because the power of local businesses can transform communities for the better by working cooperatively toward a shared vision. **Local consumption** Local consumption is encouraged and prioritized.
Infrastructure and Distribution	**Infrastructure and logistics for distribution of bioenergy** Number and capacity of routes for critical distribution systems, along with an assessment of the proportion of the bioenergy								

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional	National			Private		
	associated with each								
Productivity	**Productivity** -Productivity of bioenergy feedstocks by feedstock or by farm/plantation -Processing efficiencies by technology and feedstock -Amount of bioenergy end product by mass, volume or energy content per hectare per year	**Yield of Biofuel and Co-products** seeks to measure the overall efficiency of the project, considering the feedstock used and the total volume of biofuel produced, measured by liters of biofuel per hectare of land used in cultivation.			Forest management shall maintain the productive capacity of forests				
Value Added	**Gross value added** Gross value added per unit of bioenergy produced and as a percentage of gross domestic product								
National Food Basket	**Price and supply of a national food basket** Effects of bioenergy use and domestic production on the price and supply of a food basket, which is a nationally-defined collection of representative foodstuffs, including main staple crops, measured at the national, regional, and/or household level								
Flexibility of Use of Bioenergy	**Capacity and flexibility of use of bioenergy** -Ratio of capacity for using bioenergy compared with actual use for each significant utilization route -Ratio of flexible capacity which can use either bioenergy or other								

	Global Bioenergy Partnership	Inter-American Development Bank	EU	USA	Australian Forestry Standard	Sweden (SEKAB)	Roundtable on Sustainable Biofuels	Council on Sustainable Biomass Production	Sustainable Biodiesel Alliance
	International		Regional		National		Private		
fuel sources to total capacity									

Source: Material in this table was reproduced or adapted from the following material:

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- 'IDB Biofuels Sustainability Scorecard', Inter-American Development Bank, October 2009
- 'Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC', European Commission, 2009
- 'US Renewable Fuel Standard (RFS)', US Environmental Protection Agency
- 'The Australian Forestry Standard: Forest management—Economic, social, environmental and cultural criteria and requirements for wood production', Australian Forestry Standard Limited, 2007
- 'Verified Sustainable Ethanol Initiative', SEKAB (Swedish Bioenergy Company)
- 'RSB Principles & Criteria for Sustainable Biofuel Production', Roundtable on Sustainable Biofuels, 2010
- 'Standard for Sustainable Production of Agricultural Biomass', Council on Sustainable Biomass Production, June 2012
- 'Principles and Baseline Practices for Sustainability', Sustainable Biodiesel Alliance
- Jinke van Dam, Update: Initiatives in the Field of Biomass and Bioenergy Certification, April 2010

Note:

- In this table, some standards were assigned to sustainability areas different from the ones from their original standards (e.g., 'Price and Supply of a national food basket' was proposed to be under the Social Sustainability area by the Global Bioenergy Partnership, but it belongs to the Economic Sustainability area in this paper).

The following section summarizes some of the key findings obtained from the comparison of the standards in the economic sustainability area.

KEY FINDINGS FROM THE COMPARISON OF STANDARDS IN THE ECONOMIC SUSTAINABILITY AREA

1) Compared to environmental or social area, economic area of sustainability did not receive much attention in general. In fact, only GBEP's indicators explicitly dealt with an area named 'economic pillar'. However, there was some degree of overlap between some environmental and economic sustainability principles. For example, measuring the income change of employees can address both economic and social perspectives of a biofuel project. Due to this point, some social sustainability principles and criteria were categorized as also belonging to economic sustainability area in the comparison table above. Figure 4-13 shows the list of topics covered by social and economic sustainability pillars by GBEP. Note that some topics can belong to both areas depending on contexts.

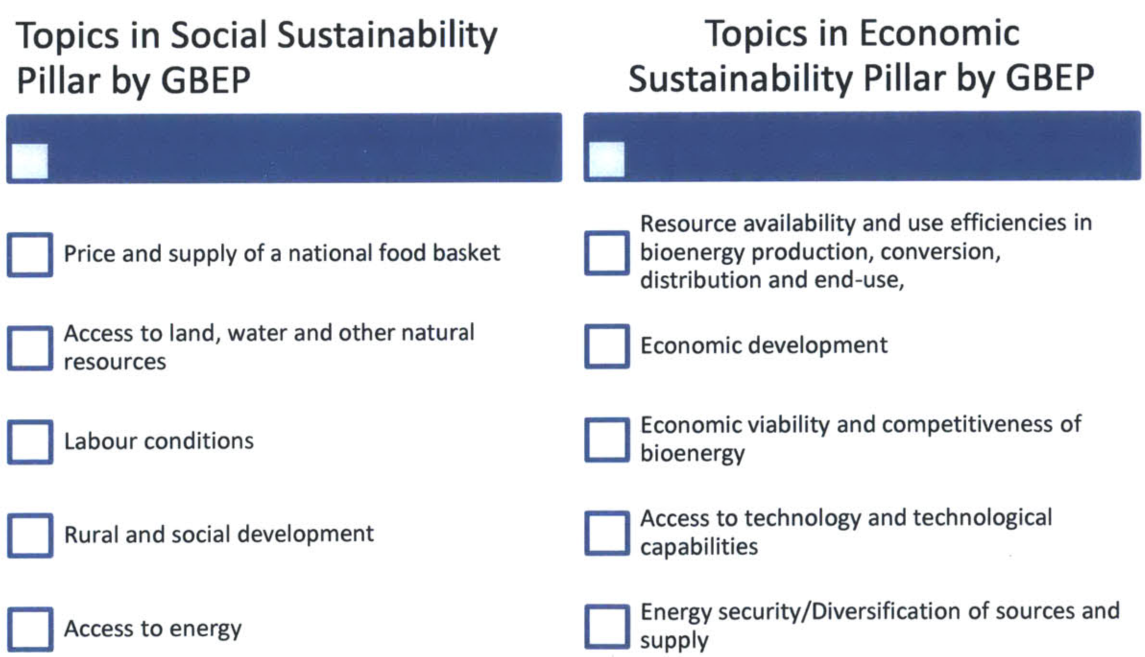

FIGURE 4-13 COVERAGE OF TOPICS IN SOCIAL AND ECONOMIC SUSTAINABILITY AREAS BY GBEP
Source: adapted from 'The Global Bioenergy Partnership Sustainability Indicators for Bioenergy', First edition, Global Bioenergy Partnership, December 2011

2) As previously mentioned, GBEP was the major contributor of criteria in economic sustainability area, followed by the IDB's scorecard. Among various topics in the area, local development was the most frequently addressed, partly due to the fact that it also appeared in the social sustainability area of other standards. 'Local development' topic concerned about ensuring economic development of the local communities where bioenergy projects take place. For example, prioritizing local consumption of biofuels and making exclusive sales agreements with local communities were suggested. The second-most frequent topic was 'productivity', which concerned about the productivity of bioenergy projects in order to make sure the projects make better economical senses especially in comparison to the projects of fossil fuel-based energy sources.

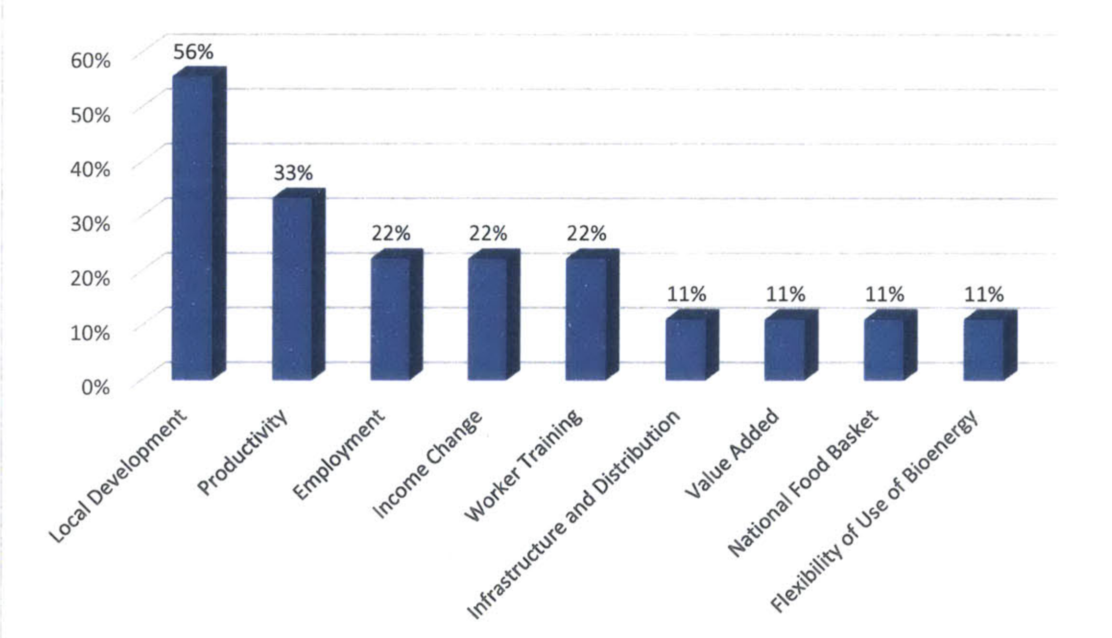

FIGURE 4-14 TOPICS APPEARED IN ECONOMIC SUSTAINABILITY AREA BY FREQUENCY

3) Standards concerned issues both at individual worker level and the local community level. At the individual worker level, change in employment rate, change in income level, and change in unpaid time between jobs were considered. At the local community level, it was proposed that bioenergy projects should contribute to the economic development of the local community. GBEP also proposed an indicator that measured bioenergy projects' contribution to infrastructure development in the community. Furthermore, GBEP's indicators evaluated the productivity of

bioenergy business and price & supply of a national food basket.

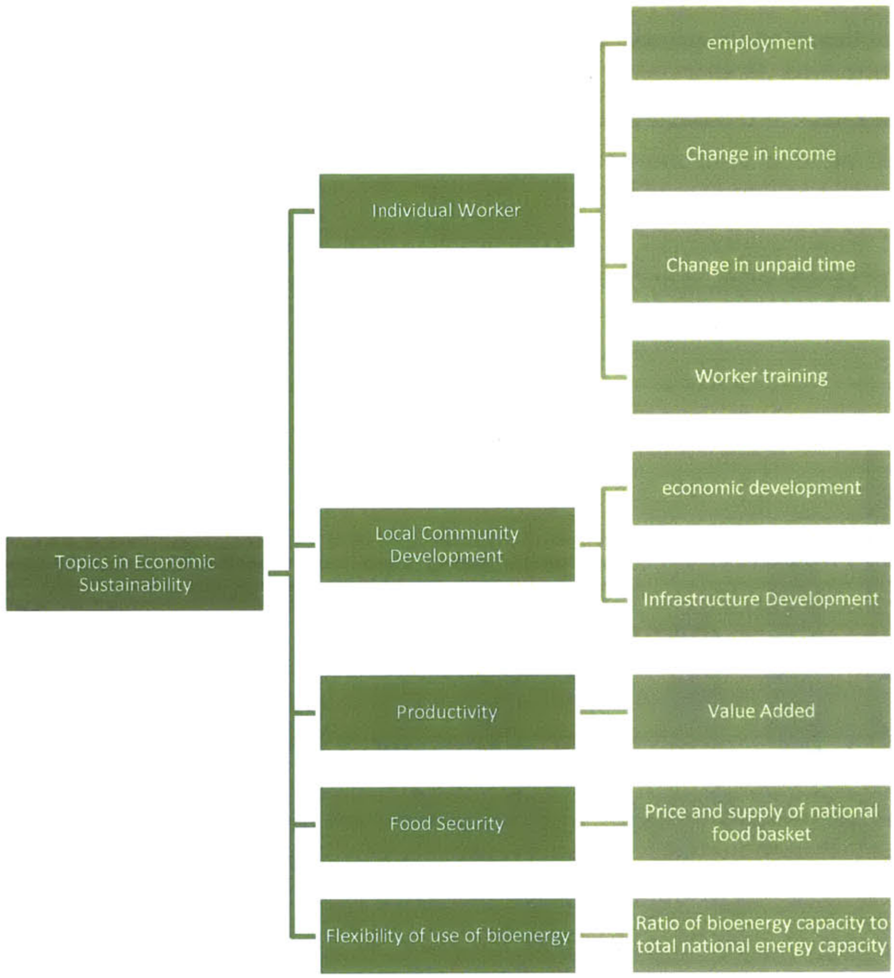

FIGURE 4-15 HIERARCHY OF TOPICS IN ECONOMIC SUSTAINABILITY AREA

4) GBEP was the only group that proposed 'flexibility of use of bioenergy' be included in economic sustainability criteria. According to the group, its indicator measures the ratio of flexible capacity that is capable of using other energy sources as well. For example, flexible-fuel vehicles in Brazil, which can run both on ethanol and gasoline, represent the level of flexibility of use of sugarcane-derived ethanol in the country. Considering that high level of flexibility of use of bioenergy can be an important prerequisite for the competitiveness of biofuels in the market, GBEP's indicator is both relevant to and important for economic feasibility of biofuels.

To wrap up, this chapter compared the nine sustainability standards in the general, environmental sustainability, social sustainability, and economic sustainability areas. In each area, a comparison table and a list of key findings were provided. In the following chapter, we will look at some of the most-common weaknesses of the standards.

CHAPTER 5. WEAKNESSES AND LIMITATIONS OF CURRENT SUSTAINABILITY STANDARDS

In the previous chapter, criteria and indicators of sustainability for biofuels from nine groups were analyzed and compared. Based on the findings, this chapter will present some of the commonly-observed weaknesses and limitations of the standards. Specific examples drawn from the pool of nine standards will be provided where necessary.

5.1. INCOMPATIBILITIES AND LACK OF HARMONIZATION AMONG STANDARDS

While the selected standards share fundamental principles in the environmental, social, and economic areas, there was a lack of harmonization among them, as also observed by Dam et al. in their previous study[64].

In general, there were four major areas where standard showed differences: types of feedstock, types of products, scopes of supply chain, and goals of standards.For example, Australia Forestry Standard is different from the other standards which apply to non-forest based products (e.g. SEKAB's standard only applies to bioethanol). Likewise, the US' Renewable Fuel Standard is different from others in that its main goal is to reduce GHG emissions from the use of transportation fuels.

Other elements that were not well-harmonized across standards were the definitions of terms and various methodologies used, as also argued by Dam et al. in their previous work[65] For example, the EU Directive does not clearly define 'land with high biodiversity value'. Although the standard explains that such land is defined as 'undisturbed primary forest', 'conservation areas', or 'biodiverse grassland', it is not pin-pointing the type of lands.

[63] Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and related feedstocks, Aziz Elbehri et al., FAO, 2013

[64] Jinke van Dam, 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, 2010, p2468

[65] Jinke van Dam, 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, 2010, p2456

Many standards presented methodologies for their criteria. Although there is some degree of overlap, they are not identical. For example, many groups proposed their own GHG calculation methodologies, often with different baseline values (these methodologies include GBEP Common Methodological Framework for GHG Lifecycle Analysis, EU life cycle GHG calculations methodology, US life cycle GHG calculations methodology, RSB GHG Calculation Methodology, and CSBP GHG modeling tool).

Furthermore, while the three-pillar classification system was widely used across the standards, classification of criteria and indicators was sometimes ambiguous, especially between social and economic areas. For example, GBEP presented 'change in income', and 'job creation in the bioenergy sector' as social indicators, supposedly due to their impact on the social well-being of the local community, but those indicators could also be indicative of the degree of economic profitability of a biofuel project. In addition, while food security is widely known as a social sustainability issue, some argue that it can be an economic issue as well.[66]

Figure 5-1 summarizes the topics that often showed differences across different standards.

[66] Aziz Elbehri et al., Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and relatdate wased feedstocks, FAO, 2013, p59

Areas of Focus

- Forestry, Agriculture, Bioenergy

Scope of Implementation

- International, regional, national, bi-national, bioenergy project-specific

Sustainability Areas

- Environmental, Social, and Economic, Ecological, Cross-sectional

Coverage of supply chain

- Feedstock production, feedstock logistics, feedstock conversion, biofuel logistics, biofuel end use

Definitions of Key Concepts

- Different definitions or ambiguous definitions
- e.g. biodiverse area, high conservation value area

Methodologies

- Different assumptions and parameters
- e.g. GHG calculation methodologies

Tools

- Proliferation of tools with different assumptions and data source

Indicators

- Different selection of indicators by standards

Public or Private

- Standards were developed for either private organizations or public organizations

FIGURE 5-1 AREAS OF DIFFERENCES AMONG SUSTAINABILITY STANDARDS OF BIOFUELS

5.2. PRACTICAL DIFFICULTIES FOR IMPLEMENTATION OF STANDARDS

Some criteria and indicators had characteristics that could potentially make implemtation on the ground difficult. This is due to the limitations that exist both internally and externally.

First, there were unclear cocepts and definitions of terms, also observed by Scarlat and Dallemand in their work[67]. For instance, in the EU's Directive, the meaning of 'land with high carbon stock', and 'mass balance' were not clearly described. Other ambiguous expressions included 'critical ecosystem' (GBEP), 'fair wages' (SBA) and 'significant reduction in GHG emissions' (Roundtable on Sustainable Biofuels).

In addition, some indicators had high degree of uncertainties in their methodologies, as also observed by Elbehri et al. in some of the LCA analyses[68]. For example, the section on GBEP's lifecycle GHG emissions indicator acknowledged that uncertainties existed in the estimates from LCA, causing differing results across different methodologies from different groups. This was largely due to the different assumptions of different methodologies. In fact, uncertainty cannot be totally eliminated for any indicator. That is why each of 24 indicators of GBEP has a dedicated section named 'Anticipated limitations'.

Another limitation of many indicators was that they usually focused on local level, as argued by Dam et al.[69] That is, the interaction between the 'inside' and 'outside' of the production unit cannot be addressed with such localized indicators; small changes inside a production unit can add up to have meaningful impacts on the environment outside of the production unit and the reverse scenario can occur as well. Therefore, indicators that can address both micro (local) and macro level as well as the interaction between them should be developed, as argued by Dam et al.

Even when indicators are well-developed with little internal inconsistency, they still require external data input to produce useful results. In many occasions, however, data is either limited or unavailable[70]. However, it is generally more challenging to collect relevant data in developing

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[67] Nicolae Scarlat and Jean-Francois Dallemand, Recent developments of biofuels/bioenergy sustainability certification: A global overview, Energy Policy, January 2011, p1645

[68] Aziz Elbehri et al., Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and relatdate wased feedstocks, FAO, 2013, p68

[69] Jinke van Dam, 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, 2010, p2457

[70] Aziz Elbehri et al., Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and relatdate wased feedstocks, FAO, 2013, p9

countries. This is an important issue since most of the biofuels or biofuel feedstock is produced in the developing world. From 2011 to 2013, a pilot project of the application of GBEP indicators was carried out in Ghana.[71] According to the final report, many indicators suffered from lack of data. For the 'price and supply of a national food basket' indicator, for example, the report concluded "data required for the Causal descriptive assessment have not been found and probably are not available at all."

Finally, implementation of standards on the ground can be especially challenging in some developing countries where enforcement of law is weak, as argued by Pelkmans et al.[72] This is one of the examples of the external factors that standards themselves cannot internalize.

5.3. INSUFFICIENT COVERAGE OF INDIRECT EFFECTS

Effects that occur beyond the control of individual producers or farms are called indirect effects of bioenergy projects. External macro-level factors that have impacts on food security, social well-being, or land use change that individual operators cannot have under control are some examples. An important feature of indirect effects is that it is generally hard to pinpoint one factor as the sole or major contributor of the phenomenon since multiple factors are often in action.

Because of this complicated nature of indirect effects, few standards have addressed them, as also observed by Dam et al. in their previous study[73]. However, in order to ensure real sustainability of biofuels projects, it is critical to properly address them.

To this end, RSB commissioned a study in 2009 to advise the group on how to deal with indirect effects in its standards. The study only concluded that RSB consider developing a standard 'at a lower risk of causing indirect effects', among the five possible options presented, since it was hard to accurately quantify the degree of indirect effects involved for a given operation and

[71] 'GBEP pilot Ghana: very valuable and successful; a follow-up is suggested', Netherlands Programmes Sustainable Biomass, 2013

[72] Pelkmans et al., Task 4: Recommendations for improvement of sustainability certified markets, IEA Bioenergy, February, 2013, p8

[73] Jinke van Dam, 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, 2010, p2464

environment.[74]

In this study, however, RSB pointed out some common drivers for two kinds of indirect effects: indirect land use change and indirect impacts on food security. For indirect land use change, poor land governance, economic and policy incentives to deforest land in order to claim ownership, increased demand for agricultural products, and urban development were pointed out as the major causes. In addition, the factors that contribute to the instability of food security were found out to be increased oil prices, occasional poor harvests, population growth, higher demand for food caused by rise in incomes, export and trade restriction, and fluctuations in currency markets.

Ultimately, addressing indirect effects will require a comprehensive approach, as argued by Scarlat and Dallemand.[75] It is an approach that incorporates criteria of various areas at different levels at the same time while taking into account the types of uncertainties involved. For example, when newly converted land is only allowed for food production, land owners can still increase bioenergy production by using the newly converted land for food and using the previous area for bioenergy production, as pointed out by Dam et al.[76] Therefore, if one does not fully capture the big picture on the ground, indirect effects cannot be fully avoided.

The EU Renewable Energy Directive (Directive 2009/28/EC) requires that members report on some indirect effects including food security and local energy supply issues every two years. However, not everyone is convinced that this reporting obligation can be an effective tool to address the effects.[77]

To wrap up, this chapter pointed out three commonly-found weaknesses of the standards. The following chapter will provide conclusion of this study as well as recommendations for future standards.

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[74] 'Indirect Impacts of biofuel production and the RSB Standard', RSB Secretariat, Roundtable on Sustainable Biofuels, April, 2012

[75] Nicolae Scarlat and Jean-Francois Dallemand, Recent developments of biofuels/bioenergy sustainability certification: A global overview, Energy Policy, January 2011, p1644

[76] Jinke van Dam, 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, 2010, p2468

[77] Nicolae Scarlat and Jean-Francois Dallemand, Recent developments of biofuels/bioenergy sustainability certification: A global overview, Energy Policy, January 2011, p1643

CHAPTER 6. CONCLUSION AND RECOMMENDATIONS FOR FUTURE STANDARDS

The purpose of this chapter is to provide conclusion of this study and to suggest recommendations that can address some of the previously-mentioned limitations of the standards. Although there is no 'silver bullet' to most of the critical issues considering the complex nature of the topic, some possible next steps were suggested based on the analyses of the standards.

6.1. CONCLUSION

As explained in Chapter 3, there exist a number of sustainability standards for biofuels. Among them, this study selected a set of nine sustainability standards for biofuels (standards from 2 international organizations, 1 regional group, 3 national governments, and 3 private groups) to present their notable characteristics and then to comparatively analyze them (the selection criteria is explained in 3.2).

This section summarizes all of the key findings from the analyses in previous chapters. As explained in '1.2 Thesis Overview,' most of these findings correspond to one of the four goals of this thesis: 1) to provide the latest updates on the standards of great importance, 2) to review and analyze standards with notable characteristics that had not been thoroughly covered by previous studies, 3) to provide analyses from direct comparison of standards, and 4) to figure out the depth of discussion on technological sustainability in some of the current standards.

1) With the exception of IDB's Scorecard, all the standards followed the three-pillared sustainability area scheme: environmental, social and economic sustainability areas. Among them, environmental sustainability area was addressed by all of the standards, followed by social sustainability area with 88.9% of frequency and economic sustainability area with only 44.4% of frequency.

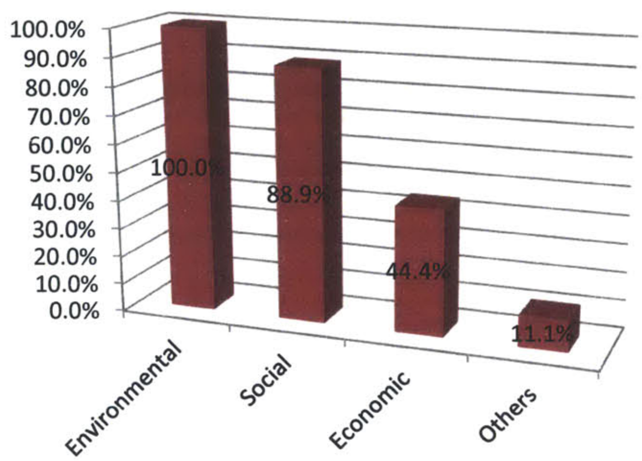

FIGURE 6-1 FREQUENCY OF APPEARANCES OF SUSTAINABILITY AREAS IN THE STANDARDS

The Australian Forestry Standard has criteria in 'ecological' sustainability area, not in 'environmental' sustainability area, possibly in order to pay specific attention to Australian forests' ecosystem. In addition, IDB's Scorecard has a sustainability area called 'cross-cutting' area, where issues that belong to multiple sustainability areas are addressed.

2) In general, there was lack of coverage on the use of the second generation biofuels. The CSBP's standard, which was released in June 2012, was the first standard for cellulosic biomass in the US. However, CSBP's principles did not properly address second generation biofuel-specific issues; it only dealt with general sustainability principles of biofuels that were commonly found in other standards. Although many principles that were designed for the first generation biofuels are applicable to the second generation biofuels, it is urgent to develop standards specializing in second generation biofuels considering the fuel's potential large contribution to sustainability goals.

3) For the standards that proposed criteria, most of the criteria were described in qualitative manners. In fact, every criterion in both social sustainability and economic sustainability area was described qualitatively. Among environmental sustainability issues, GHG emissions were the only topic where the majority of the standards proposed specific target goals. For example, SEKAB mandated at least 85% reduction in CO_2 emissions from the use of Brazilian sugarcane-derived ethanol.

4) Along with principles and criteria, many standards also proposed various methodologies for better implementation of their standards. Among them, the most frequent one was 'life cycle GHG calculation methodology', with different algorithms and default values for calculation across standards, as also observed by Dam et al.[78] IDB's Scorecard provided web-based calculators in many different areas including water management, controlled release of fertilizers, energy efficiency of biofuel distribution, local income generation, etc. In particular, GBEP was the most notable case; GBEP's entire set of 24 indicators were supported by specific methodologies with thorough description on the required data.

5) IDB's Scorecard standed out as the only web-based platform. A web-based tool has many advantages. For example, users can save and open multiple sessions, users can see the results instantly, users can see how a specific change impacts the final results and by how much, etc. These convenient features and simultaneousness of the tool attract users and help them fine-tune their bioenergy projects. Therefore, IDB's Scorecard provides an insight for a format of future biofuels standards.

6) SEKAB's standards is the world's first bilateral sustainability standard for sugarcane-derived ethanol between two countries. Thanks to this localized approach, SEKAB's principles could have addressed specific sustainability issues present in Brazil such as child labor or lack of mechanization. Likewise, partly thank to this target-specific approach, SEKAB could propose an 85% reduction in GHG emissions, which is the most ambitious GHG reduction goal among the standards. Therefore, SEKAB's approach provides insights for the future development of standards.

7) Among various topics in the area, reduction in GHG emissions received the strongest attention followed by the protection of biodiversity. This is in agreement with the general perception that GHG reduction has been one of the most important motivations for the development of sustainability standards of biofuels. Meanwhile, conservation of water, air and soil were addressed with similar frequencies of apperances. Among the least-covered topics were both direct and indirect land use change, pest control and topics related to cropping system.

[78] Jinke van Dam, 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, 2010, p2468

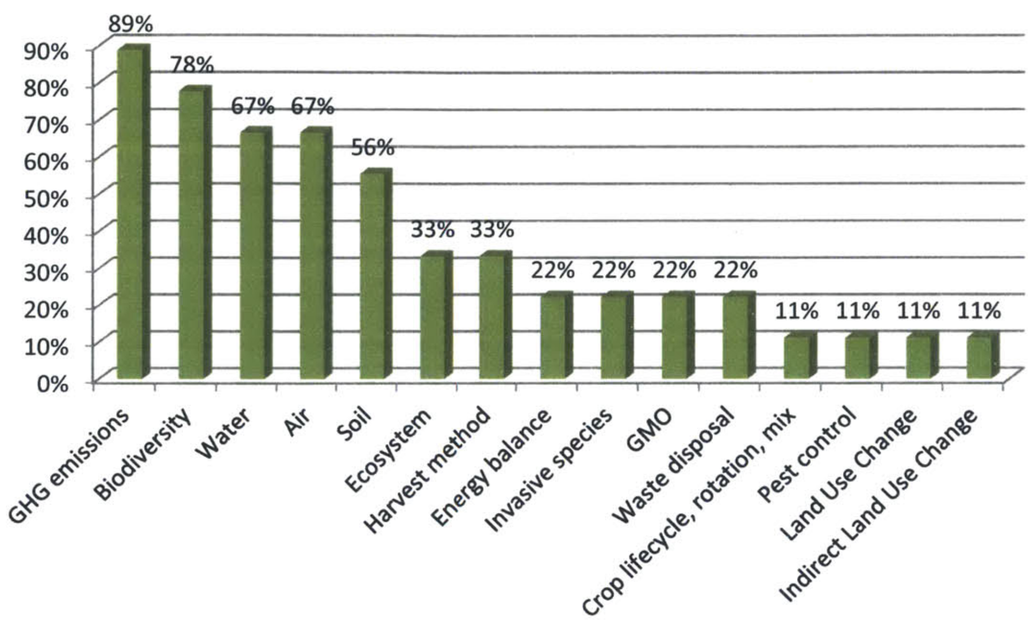

FIGURE 6-2 TOPICS APPEARED IN ENVIRONMENTAL SUSTAINABILITY AREA BY FREQUENCY

8) Many standards requested meaningful reduction in GHG emissions, in some cases with setting specific targets. The reduction goals were set either as numerical targets or with qualitative expressions. Figure 4-9 shows the numerical targets by standards. Other non-quantifiable reduction targets were described as 'significant reduction', 'substantive reduction' or 'net GHG reduction'. Note that almost all standards suggested using life cycle analysis for GHG emissions calculation. Specifically, IDB made it clear that both direct and indirect GHG emissions should be counted. Finally, all of the standards used the term GHG without separating CO_2 from non-CO_2 emissions.

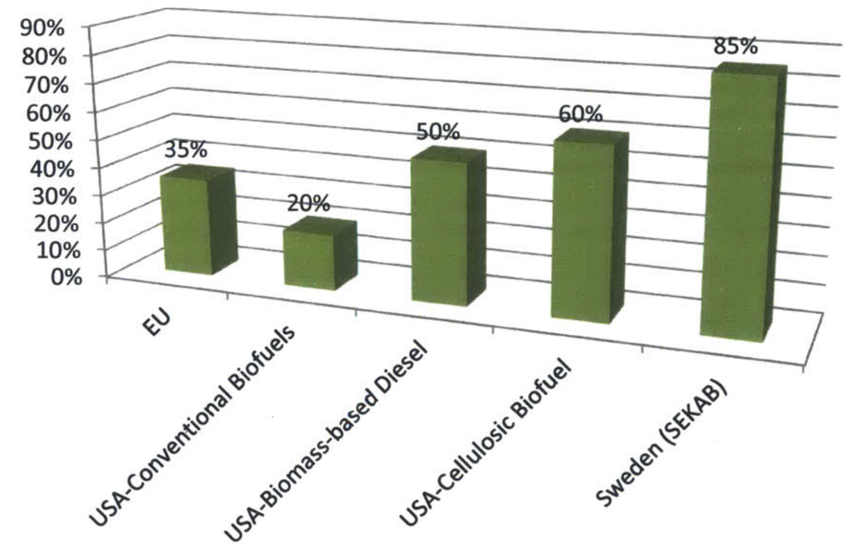

FIGURE 6-3 GHG REDUCTION GOALS OF VARIOUS STANDARDS

9) Followed by GHG emissions reduction, biological diversity was the second most frequent topic in environmental sustainability area. However, no specific target goal was proposed although European Commission was required to report to the European Parliament on environmental sustainability performance every two years. In addition, most of the standards emphasized the general principle that biodiversity should not be threathened. Among them, CSBP proposed the most detailed principle by specifying the Important Wildlife Species (IWS) and the critical seasons for animal protection. Moreover, there were terms and concepts whose definitions were not clear, as also argued by Dam et al.[79] For example, 'land with high biodiversity value' (EU), 'areas of high biodiversity' (SBA), 'protected areas including grasslands, wetlands, and forests' (SBA) were mentioned without clear-cut definitions, which would impede implementation of the standards on the ground.

10) The use of GMO for biofuel production did not receive much attention by the standards. Only two standards –RSB and SBA – dealt with the topic and they only requested that GMO

[79] Jinke van Dam, 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, 2010, p2456

should not be used or the risk of damages to environment and the human should be minimized. Therefore, it is important to argue that more in-depth principles regarding the use of GMOs in social, economic and technological perspectives should be included in future standards.

11) Regarding harvesting methods, IDB was specifically interested in field burning practices before harvesting happens. Field burning seriously threatens sustainable biofuels production since it greatly contributes to GHG emissions, air pollution, and loss of biodiversity among others. That is why SEKAB's standard mandates that Brazil mechanize immediately at least 30% of the entire harvest sugarcane for ethanol.

12) Among various topics in the area, principles and criteria concerning 'local community' appeared the most frequently, followed by those about 'labor rights', 'land rights', 'indigenous people' and 'food security' with the same frequencies. In general, criteria were described in qualitative ways, rather than quantative. As argued by Elbehri et al., most topics were those with 'obvious negative impacts', such as child labor and rights of indigenous people, and they did not include other critical social factors such as common management of resources or smallhoder engagement[80].

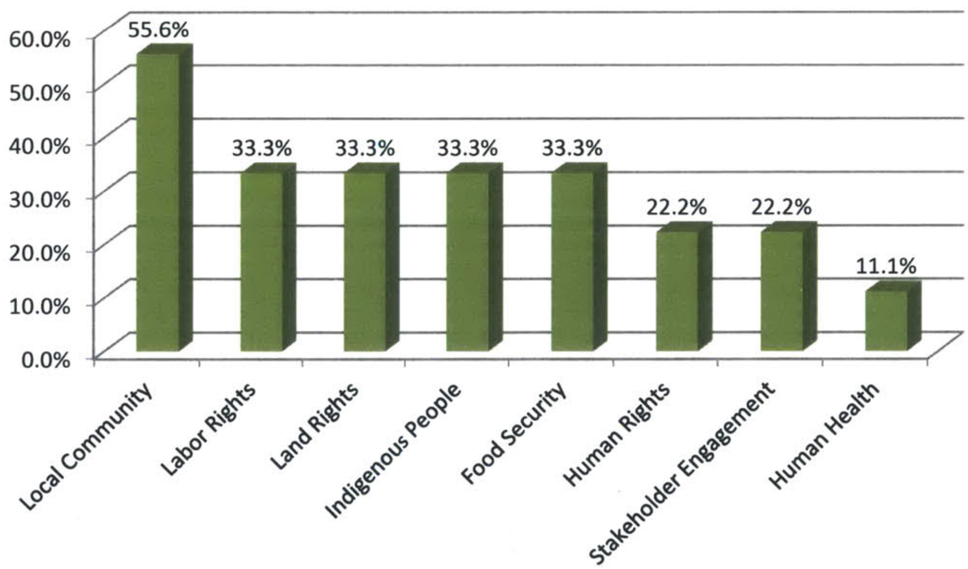

FIGURE 6-4 FREQUENCY OF APPEARANCES OF TOPICS IN SOCIAL SUSTAINABILITY AREA

13) As previously mentioned, 'local community' was the most frequently addressed topic in social sustainability area. There were two sub-topics: protection of the local community and development of the local community during the production of biofuels. Protection of local community concerned about human health, local cultural values and environment & natural resources. On the other hand, local community development concerned about

[80] Aziz Elbehri et al., Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and relatdate wased feedstocks, FAO, 2013, p9

economic development of the community and knowledge and technology transfer to strengthen local capacity. Figure 4-12 shows the sub-topics of 'local community' in social sustainability area. Particularly for the local economic development, IDB proposed exclusive sales agreement with local communities and SBA suggested 'prioritized' local consumption of biodiesel produced. This is to ensure that local bioenergy projects contribute to the local economy, which is also related to the economic sustainability area of biofuels.

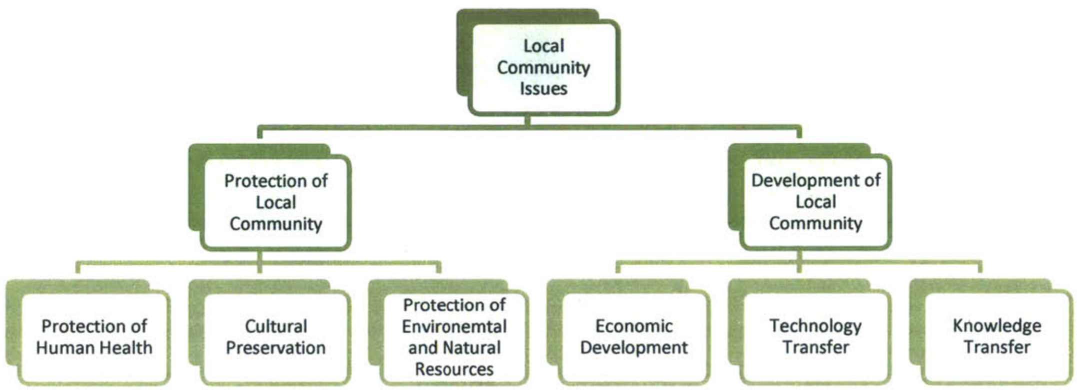

FIGURE 6-5 SUB-TOPICS OF 'LOCAL COMMUNITY' IN SOCIAL SUSTAINABILITY AREA

14) Gender equality did not receive much attention by standards. Only RSB's standard explicitly mentioned that men and women should receive the same compensation for the work of equal value. Although inequal compensation is an important issue for sugarcane growers in Brazil, SEKAB's standard did not seem to have paid much attention. GBEP, on the other hand, tried to measure "the change in unpaid time spent by women collecting biomass" when a traditional biomass business is changed into a modern bioenergy business.

15) As previously mentioned, GBEP was the major contributor of criteria in economic sustainability area, followed by the IDB's scorecard. Among various topics in the area, local development was the most frequently addressed, partly due to the fact that it also appeared in the social sustainability area of other standards. 'Local development' topic concerned about ensuring economic development of the local communities where bioenergy projects take place. For example, prioritizing local consumption of biofuels and making exclusive sales agreements with local communities were suggested. The second-most frequent topic was 'productivity', which concerned about the productivity of bioenergy projects in order to make sure the projects make better economical senses especially in comparison to the projects of fossil fuel-based energy sources.

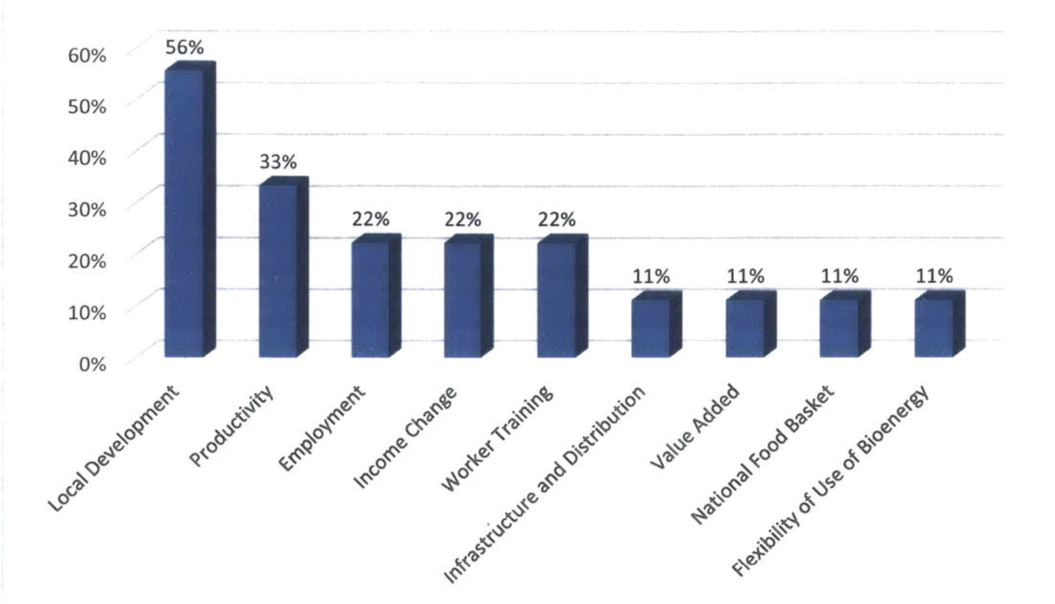

FIGURE 6-6 TOPICS APPEARED IN ECONOMIC SUSTAINABILITY AREA BY FREQUENCY

16) Standards concerned issues both at individual worker level and the local community level. At the individual worker level, change in employment rate, change in income level, and change in unpaid time between jobs were considered. At the local community level, it was proposed that bioenergy projects should contribute to the economic development of the local community. GBEP also proposed an indicator that measured bioenergy projects' contribution to infrastructure development in the community. Furthermore, GBEP's indicators evaluated the productivity of bioenergy business and price & supply of a national food basket.

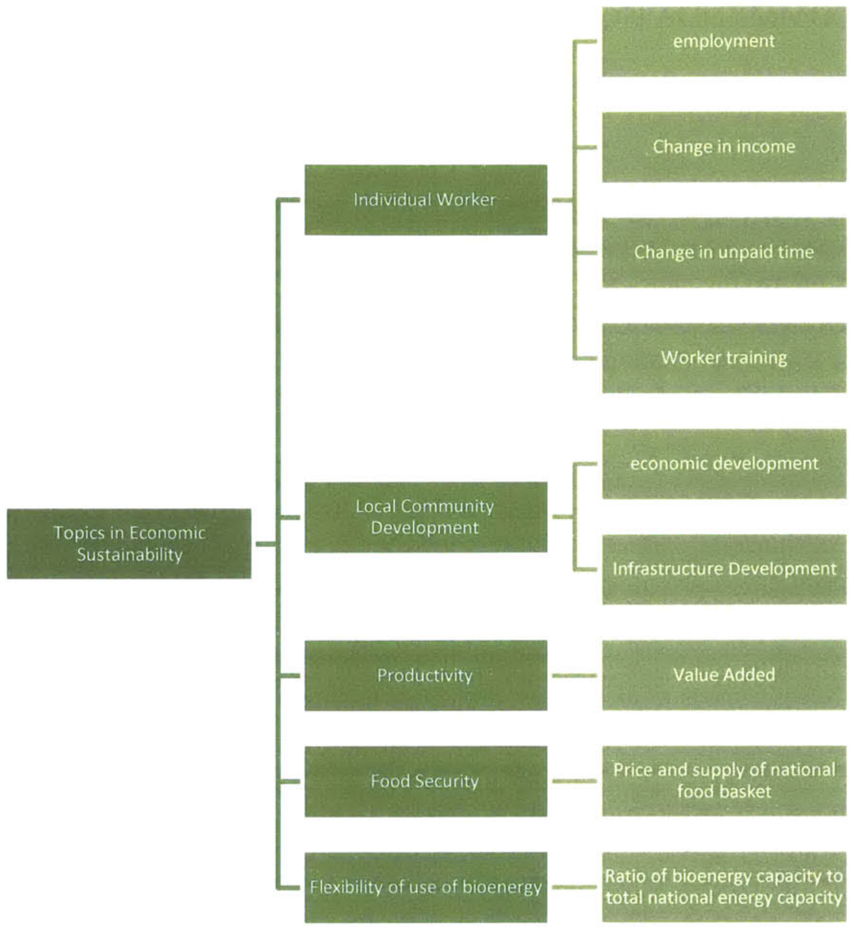

FIGURE 6-7 HIERARCHY OF TOPICS IN ECONOMIC SUSTAINABILITY AREA

17) GBEP was the only group that proposed 'flexibility of use of bioenergy' be included in economic sustainability criteria. According to the group, its indicator measures the ratio of flexible capacity that is capable of using other energy sources as well. For example, flexible-fuel vehicles in Brazil, which can run both on ethanol and gasoline, represent the level of flexibility of use of sugarcane-derived ethanol in the country. Considering that high level of flexibility of use of bioenergy can be an important prerequisite for the competitiveness of biofuels in the market, GBEP's indicator is both relevant to and important for economic feasibility of biofuels.

6.2. RECOMMENDATIONS FOR FUTURE STANDARDS

In this section, four different recommendations are suggested for the direction of future standards.

6.2.1. IMPROVE HARMONIZATION OF STANDARDS

In order to minimize the undesirable consequences from the existence of numerous standards, harmonization among standard is highly necessary; in particular, fundamental principles, definitions of terms, methodologies including assumptions, calculation algorithms should be consistent or at least inter-changeableas, as argued by Dam et al.[81] [82]

In order to minimize confusion due to the creation of additional standards, local standards should be based on 'meta standards', as argued by Dam et al.[83] Meta standards address most of the major sustainability issues of biofuels and they can serve as benchmarks for other standards. Specifically, several existing standards can be integrated to develop a meta standard. During the integration process, particular scopes of individual standards are merged into one, while other inconsistencies among them are identified and fixed. Figure 6-8 summarizes how the areas of differences among different standards can be integrated throughtout the process.

[81] Jinke van Dam, 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, 2010, p2468

[82] Figure 5-1 summarizes the areas where different standards commonly show differences.

[83] Jinke van Dam, 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, 2010, p2452

Areas of Focus

- Standards specially developed for either forestry, agriculture, or bioenergy are integrated

Scope of Implementation

- The scope of implementation of a meta standard is not limited to a specific region of the world

Sustainability Areas

- Most current standards follow the environmental-social-economic categorization scheme. Therefore integration of the standards by this categorization of sustainability areas is not a challenging task.

Coverage of supply chain

- stages of a supply chain is almost universal among current standards.

Definitions of Key Concepts

- A meta standard should provide clear and standard definitions of key concepts

Methodologies

- A meta standard should provide standard methodologies relevant to bioenergy projects.
- The "Compilation of Tools and Methodologies to Assess the Sustainability of Modern Bioenergy" by FAO can take the lead

Tools

- International cooperation is recommended for integration of data, for the development of tools that can be used by all interested parties
- e.g. IBAT tool is a result of compliation of different data sources related to biodiversity.(Jinke van Dam, 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, 2010)

Indicators

- 24 Indicators developed by GBEP can take the lead

FIGURE 6-8 DIFFERENT CHARACTERISTICS OF INDIVIDUAL SUSTAINABILITY STANDARDS BECOME INTEGRATED THROUGHOUT THE DEVELOPMENT OF A META STANDARD

In general, meta standards are developed by international organizations with global recognition. Among the nine standards analyzed in this paper, those by GBEP, EU, and RSB are commonly known as meta standards.

Recently, two more internationally recognized organizations joined the effort. They are ISO (International Organization of Standardization) and CEN (European Standardization Institute).

ISO is an international standard-setting organization with more than six decades of history. In June 2009, a preliminary meeting was held for the development of 'sustainability criteria for bioenergy' and the expected final publication date is April 30, 2015. The final document plans to address environmental aspect, social aspect, economic aspect, terminologies, GHG emissions, and indirect effects, among others.

In addition, CEN, the European Committee for Standardization, is also developing a European standard for sustainable biomass, which is in accordance with the EU's Directive of 2009. The 'CEN Technical Committee 383' was formed in 2008 and the final standard plans to address GHG emissions and fossil fuel balances, biodiversity, environmental, economic and social areas of sustainability as well as various types of indirect effects[84].

Based on the analyses of current standards as well as on the projection of the development of future standards, a comprehensive diagram for the harmonization of standards is suggested in Figure 6-9. While the world's three major meta stanrdards by RSB, ISO and CEN propose the future direction of further harmonization of standards, relevant methodologies and indicators are continuously provided by the FAO and GBEP, respectively[85], since they have already developed comprehensive and widely-recognized methodologies and indicators.

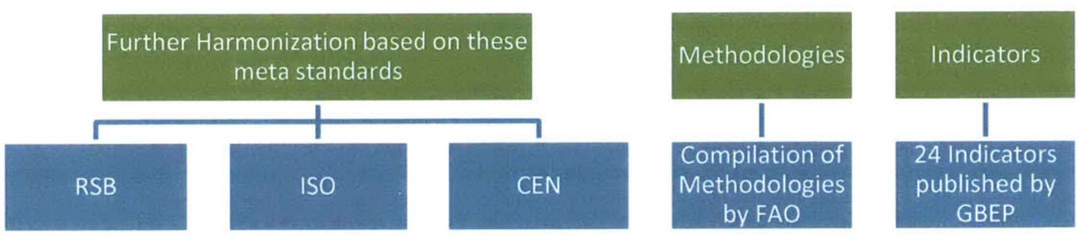

FIGURE 6-9 SUGGESTED FUTURE DIRECTION FOR FURTHER HARMONIZATION OF SUSTAIANBILITY OF STANDARDS

In addition to the harmonization efforts by the use of meta standards, the idea of mutual-

[84] European Committee for Standardization, http://www.cen.eu/cen/Sectors/Sectors/UtilitiesAndEnergy/Fuels/Pages/Sustainability.aspx, accessed on April 21, 2013

[85] A similar idea was previously proposed by by Pelkmans et al. in 'Task 4: Recommendations for improvement of sustainability certified markets, IEA Bioenergy, February, 2013'. They proposed that ISO and CEN make efforts on harmonization of standards and GBEP on methodologies. Likewise, Dam et al. proposed that meta-standards such as by IFOAM, PEFC, and RSB could take the lead in the process.

recognition among standards has been proposed by several authors, including Goovaerts et al.[86], especially for the short-term for the existing standards. For example, when standard A has enough contents in common with standard B, standard A can be recognized as a 'compatible' standard to B by the publisher of standard B or any other appropriate authorities. In this case, previous users of standard A do not need to get another certification to prove compliance with standard B, which will reduce the costs of the users. Or, in some situations, stakeholders who previously needed certification of both A and B standards, can now choose whichever standard makes more sense to them. As this type of mutual recognition among standards becomes common, a 'recognition relationship' chart can be made in order to guide the users to figure out the standards that fit their needs the best.

There are already some examples of mutual recognition. The agricultural scheme SAN by the Rainforest Alliance was recognized by RSB and the International Sustainability and Carbon Certification recognized some forestry schemes.[87]

Finally, many different international organizations should collaborate for better harmonization, as suggested by Scarlat and Dallemand. They proposed linking biofuels sustainability standards with international policies on climate change so as to achieve wider international acceptance. They proposed an 'International Bioenergy Sustainability Pact' and 'International Agreement for the Protection of 'No-Go Areas'.[88]

In sum, Figure 6-10 summarizes these three suggestions for further harmonization of standards.

[86] Goovaerts et al.,Task 1: Examining Sustainability Certification of Bioenergy, IEA Bioenergy, February, 2013, p33

[87] Pelkmans et al., Task 4: Recommendations for improvement of sustainability certified markets, IEA Bioenergy, February, 2013, p10

[88] Nicolae Scarlat and Jean-Francois Dallemand, Recent developments of biofuels/bioenergy sustainability certification: A global overview, Energy Policy, January 2011, p1644

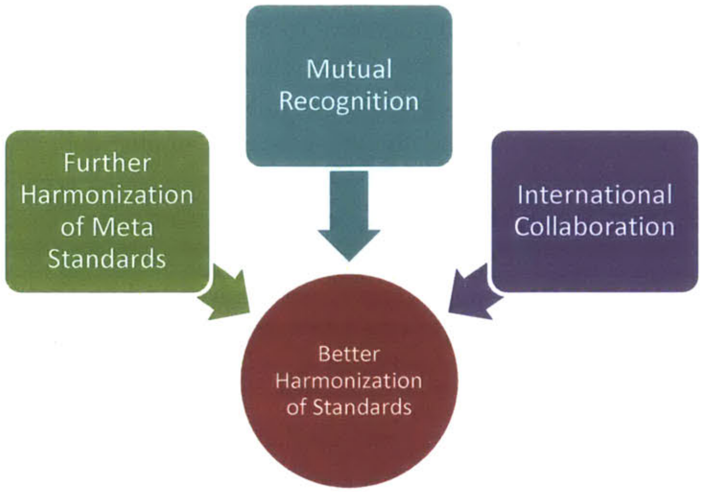

FIGURE 6-10 SUGGESTIONS FOR FURTHER HARMONIZATION OF STANDARDS

Although a better-harmonized system will benefit a lot of stakeholders, there are challenges to overcome. Aligning the distinct interests of different types of stakeholders is one of the most challenging tasks. In addition, different political goals might conflict among nations or regional groups. Therefore, overcoming these types of barriers should be taken into consideration, when regional or international organizations plan to develop mutually-compatible standards.

6.2.2. IMPROVE LOCALIZATION OF STANDARDS

Although harmonized sustainability standards are expected to be comprehensive in terms of their coverage of sustainability issues, there is still a need for local standards in order to address local-specific issues. In that case, local standards should still follow the principles of universally-agreed standards, but they focus more on the geographical, historical, cultural and ethical characteristics of the target areas.

In order to minimize the confusion due to the creation of additional standards, local standards should be based on 'meta standards', as argued by Dam et al.[89] For example, many biofuels certificate schemes were developed based on the EU Directive as their meta standard. And the agricultural scheme SAN was developed with RSB's standard as the meta standard.[90]

[89] Jinke van Dam, 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, 2010, p2452

[90] Pelkmans et al., Task 4: Recommendations for improvement of sustainability certified markets, IEA Bioenergy, February, 2013, p10

In fact, one of the motivations of the development of GBEP's indicators was to facilitate the localization processes of standards. For example, developers of a local standard can decide which set of indicators to include based on their own evaluation of relevance to specific local conditions. Likewise, governments can develop their own sets of criteria and indicators taking into account the domestic legal, political and economic contexts. The European Commission also encouraged the differentiation of national schemes based on the EU Directive for high energy conversion efficiencies for electricity, heating and cooling installations.[91]

6.2.3. IMPROVE IMPLEMENTATION ON THE GROUND

In many cases, limited or unavailable data is the reason for unsuccessful application of sustainability standards on the ground.[92] Therefore, the selection of standards and the selection of specific criteria to use should take into account the availability of data in a given environment. If some necessary data is not available, the level of difficulty for collecting or producing the data, in terms of time and cost, should be considered in advance.

In fact, many international organizations and initiatives already possess databases relevant to sustainability of biofuels in their respective areas of expertise. Therefore, if their databases can be integrated and accessed through a single channel, the availability of data for stakeholders will be enhanced while possible inconsistencies and confusion among different databases will be minimized[93]. This approach can also help avoid indirect effects since indirect effects can be minimized when issues are analyzed in a comprehensive manner.

Sustainability indicators are, in a sense, a set of conceptual tools that we use to measure sustainability in reality. Therefore, it is safe to argue that the set of indicators we have on the list already somehow frames the way we define and evaluate sustainability. This is why the selection criteria for indicators should be chosen with careful consideration.

Farrell et al.[94] proposed three determinants of effectiveness of an assessment that can be applicable to the selection of sustainability indicators: credibility, salience, and legitimacy. According to them, credibility is the degree at which the scientific community agrees with the process, methodology, data, and results of an indicator. And salience is the degree of relevance of an indicator to the issue of interest. Finally, legitimacy is the political acceptance

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[91] Nicolae Scarlat and Jean-Francois Dallemand, Recent developments of biofuels/bioenergy sustainability certification: A global overview, Energy Policy, January 2011, p1632

[92] Aziz Elbehri et al., Biofuels and the sustainability challenge: A global assessment of sustainability issues, trends and policies for biofuels and relatdate wased feedstocks, FAO, 2013, p9

[93] Dam et al. previously stressed the need for database harmonization in the area of biodiversity in "From the global efforts on certification of bioenergy towards an integrated approach based on sustainable land use planning, Renewable and Sustainable Energy Reviews, 2010, p2456"

[94] 'Assessment of Regional and Global Environmental Risks', Alexander Farrell, Jill Jager, and Stacy VanDeveer, 2006

or fairness for a subset of stakeholders.

For the selection of indicators, GBEP also used three essential selection criteria: relevance, practicality and scientific base. Furthermore, there were two additional selection criteria: geographical scale and the 'comprehensiveness and balance of the full set of final indicators'. Compared to the set of determinants of effectiveness proposed by Farrell et al., GBEP used 'practicality' criterion instead of 'legitimacy'. In fact, GBEP put special emphasis on practicality of indicators; descriptions on indicators have sections dedicated to explaining practicality of a given indicator and giving suggestion for situations where practicality may be limited. However, considering that addressing the interests of stakeholders is an important goal of a standard, 'legitimacy' needs to be added to the list of selection criteria.

Finally, the implementability of indicators also depends on the capacity of the user, since using an indicator requires a reasonable amount of time and costs. In this regard, some developing countries lack capacity to make sufficient use of the indicators. This is an important issue since many developing countries are the most active biofuels or biofuels feedstock producers in the world. Therefore various forms of aid such as direct assistance or technical cooperation from the international community can be one of the solutions, as argued by Pelkmans et al.[95]

6.2.4. INCORPORATE TECHNOLOGICAL SUSTAINABILITY AREA

So far, the global discussion on sustainabile development has followed the so-called three pillar approach, with environmental, social and economic areas being the three pillars. This was partly due to the result of the United Nations 2005 World Summit, where the Summit Outcome document referred to the three areas as "independent and mutally reinforcing pillars of sustainable development[96].

However, many have expressed that the three pillar approach was not suitable enough to capture the complex nature of sustainable development and thus there have been suggestions for adding more sustainability pillars. Among the discussed includes technological sustainability area.

Although there has not been a clear definition of technological sustainability up to date, GBEP defined sustainable development as a process of 'technological progress' and social organization:

[95] Pelkmans et al., Task 4: Recommendations for improvement of sustainability certified markets, IEA Bioenergy, February, 2013, p13
[96] "2005 World Summit Outcome", The General Assembly, United Nations, September 2005

"Sustainable development is a process of technological progress and social organization that meets the needs of society in a manner that does not damage the environment to the extent that future generations cannot meet their own needs."[97]

Furthermore, BioenergyWiki has introduced several topics in technological sustainability of biofuels without providing the concept of technological sustainability itself.

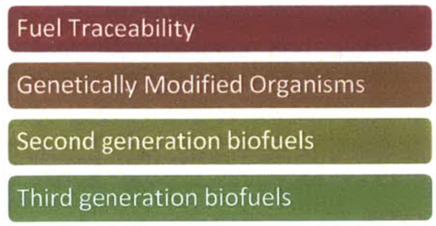
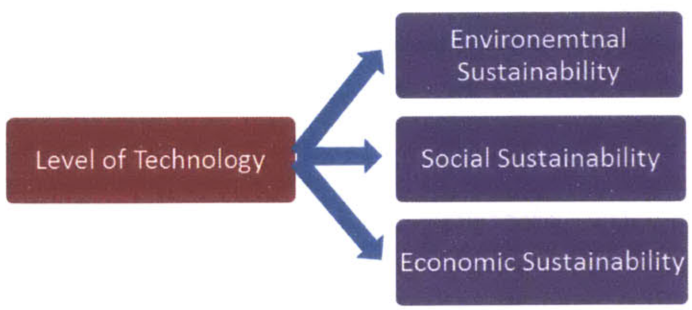


FIGURE 6-12 EXAMPLES OF TOPICS IN TECHNOLOGICAL SUSTAINABILITY OF BIOFUELS BY BIOENERGYWIKI[98]

Source: adapted from BioenergyWiki, available at http://www.bioenergywiki.net/Sustainability, Accesed on May 5, 2013

One of the most important characteristics of technological sustainability is that its goals are not the end-goals as themselves, unlike environmental, social and economic sustainability. Rather, they will ensure that sustainability goals in other areas are achievevalble within the boundaries of the current level of technology. Therefore, the specific levels set by environmental, social and economic goals are 'adjusted' by advancement of technology each time. This is why Vancock wrote that sustainability is a 'continually evolving process'.[99]



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[97] 'The Global Bioenergy Partnership Sustainability Indicators for Bioenergy', First edition, Global Bioenergy Partnership, December 2011

[98] At the moment, third generation biofuel is defined as fuels that are produced from algae.

[99] Hasna, A. M. (2007). "Dimensions of sustainability". *Journal of Engineering for Sustainable Development: Energy, Environment, and Health.*

FIGURE 6-13 THE LEVEL OF CURRENT TECHNOLOGY DEFINES THE BOUNDARYS OF SUSTAINABILITY GOALS IN OTHER SUSTAINABILITY AREAS

Despite its strong impact on sustainability goals, the standards analyzed in this paper paid little attention to the technological sustainability or related topics. Only RSB and GBEP dealt with the use of technologies in order to ensure high production or processing efficiencies, which, in turn, would affect the economic feasibility of bioenergy projects. In addition, they stressed technology's contribution to both environmental and social performance. Figure 6-14 summarizes topics related to technological sustainability appeared in the standards.

RSB's Standard on Use of Technology

- The use of technologies in biofuel operations shall seek to maximize production efficiency and social and environmental performance, and minimize the risk of damages to the environment and people.

GBEP's Indicators in the Economic pillar

- Technology's impacts on processing efficiencies
- Access to technology and technological capabilities

FIGURE 6-14 TOPICS RELATED TO TECHNOLOGICAL SUSTAINABILITY AMONG THE STANDARDS COMPARED

Source:

- 'The Global Bioenergy Partnership Sustainability Indicators for Bioenergy', First edition, Global Bioenergy Partnership, December 2011,
- 'RSB Principles & Criteria for Sustainable Biofuel Production', Roundtable on Sustainable Biofuels, 2010

Currently, most standards do not deal with 1) the technology-related topics themselves and 2) the kinds of uncertainties associated with the technologies used. For example, GMOs, second generation biofuels, algae-based third generation biofuels belong to the former. And limitations of LCA analyses, current GPS technology for the quantification of indirect land use change, estimation of non-CO_2 GHG emissions belong to the latter.

Naturally, technologies always evolve while creating different types and levels of uncertainties around them. Since our sustainability goals are bound by the technologies we possess, it is important that we have correct understanding about the characteristics and nature of the technologies. Therefore, it is recommended that future standards address technological issues that were not previously dealth with (e.g. GMO, second generation biofuels) and give thorough descriptions on the controversial technologies (eg. LCA analyses) while addressing their implications to others sustainability areas.

The majority of sustaianability standards for biofuels were developed within the past decade and there have not been many studies in this field yet. In fact, we still do not have sufficient real world evidence regarding how effectively sustainability standards can ensure sustainable use of biofuels. Therefore, while continuing to improve current standards, another important future direction of research is to collect real-world data and determine the effectiveness of current standards in terms of achieving sustainability on the groud. This will, at the same time, help diagnose more accurately the weaknesses and limitations of current standards.

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