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Executive Summary

California's Low Carbon Fuel Standard (LCFS) adopted by the California Air Resources Board (CARB) on April 23, 2009 requires a 10% reduction in the average greenhouse gas (GHG) emission intensity of the state's transportation fuels by 2020. This regulation is expected to reduce lifecycle GHG emissions per year by 20–25 million metric tons by 2020. Given available technology options, biofuels are expected to play a major role toward achieving the target. However, the rapid expansion of biofuel production may have environmental and social impacts at local, regional, and international levels. In response, many governments and national consortia have adopted sustainability requirements for their biofuel programs. The CARB is to propose a strategic plan for addressing overall sustainability provisions for the LCFS, for consideration by the Board for adoption by the end of 2011.

This report examines a range of sustainability requirements for biofuels and considers a possible framework for the LCFS sustainability provision. Our goal is to identify the proper mechanisms to further incentivize sustainable production of biofuels and other relevant transportation fuels while minimizing environmental impacts and unintended consequences.

This study reviews sustainability requirements and criteria being implemented or proposed by governments promoting biofuel programs, particularly the United Kingdom's (UK's) Renewable Transport Fuel Obligation (RTFO) carbon and sustainability reporting and the European Union's (EU's) sustainability criteria under the EU Renewable Energy Directive (EU-RED). We also review the sustainability principles and criteria (Version 0.5) proposed by the Roundtable on Sustainable Biofuels (RSB), an international initiative involving stakeholders across the entire biofuel supply chain, non-governmental organizations, experts, governments, and inter-governmental agencies.

Based on our review, an LCFS sustainability requirement may be most effective if it adopts the following principles:

- Stakeholders should collaborate to establish a **performance-based sustainability framework** that sets reasonable expectations, clear measures of compliance, and methods of enforcement; encourages innovation; and rewards practices exceeding a minimum standard.
- The sustainability framework should adopt a lifecycle approach and apply to all fuels, feedstocks, and production and conversion technologies. In the short term, however, the standards may apply only to **non-baseline LCFS-participating fuels**, to address acute concerns for new fuels, reduce administrative burden, and recognize existing regulations on baseline fuels.

- Careful coordination and integration among diverse international initiatives is required to improve coherence and efficiency of sustainability standards between countries. To build on **international consensuses**, avoid duplication of efforts, and take into account the special background, constraints, and interests of California's LCFS, RSB principles and criteria (Version 0.5 or Version 1.0 when it becomes available) could be considered as a starting point and tailored to California's context.

There has been limited experience in implementing sustainability standards over large geographical and political regions; many technical, policy, and implementation issues remain to be tested. There are remaining policy design challenges to identify appropriate incentives for performance-based requirements for meeting sustainability goals. Equally challenging are the sustainability issues associated with market-mediated effects at the system level, such as food prices, indirect land use change (ILUC), and cumulative environmental impacts. Despite continued improvement in understanding science and reducing modeling uncertainties, stakeholders should be engaged to discuss ways to create a robust policy framework that will reflect evolving scientific understanding and provide a stable compliance environment.

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Acronyms

BD: Biofuel Directive
BMP: Best management practices
BSI: Better Sugarcane Initiative
CARB: California Air Resources Board
CEC: California Energy Commission
CoC: Chain of custody
CSBP: Council on Sustainable Biomass Production
ECP: Environmental Choice™ Program
EISA: Energy Independence and Security Act
EQIP: Environmental Quality Incentives Program
ESIA: Environmental and Social Impact Assessment
EurepGAP: Integrated Farm Assurance for Combinable Crops
FQD: Fuel Quality Directive
FSC: Forest Stewardship Council
GBEP: Global Bioenergy Partnership
IFOAM: International Federation of Organic Agriculture Movements
IFWG: Interagency Forest Work Group
ILUC: Indirect land use change
IPCC: Intergovernmental Panel on Climate Change
ISOR: Initial Statement of Reasons—Proposed Regulation to Implement the Low Carbon Fuel Standard by the California Air Resources Board (2009)
LCFS: Low Carbon Fuel Standard
LEAF: Linking Environment and Farming
LSE: Load Serving Entity
NRCS: National Resources Conservation Service
PTD: Product Transfer Document
RED: Renewable Energy Directive
RFS: Renewable Fuel Standard
RFS2: Renewable Fuel Standard Program
RIN: Renewable Identification Number
RPS: Renewable Portfolio Standard
RSB: Roundtable on Sustainable Biofuels
RSPO: Roundtable on Sustainable Palm Oil
RTFO: Renewable Transport Fuel Obligation
RTRS: Round Table on Responsible Soy
SA 8000: Social Accountability International
SAN/RA: Sustainable Agriculture Network / Rainforest Alliance

1. Introduction

On April 23, 2009, the California Air Resources Board (CARB) adopted the Low Carbon Fuel Standard (LCFS), which mandates a 10% reduction in the average lifecycle greenhouse gas (GHG) emission intensity of transportation fuels by 2020. Lifecycle GHG intensity is defined as grams of carbon dioxide equivalent per megajoule of fuel energy (gCO_2e/MJ). This measure captures lifecycle emissions associated with fuels, from extraction, cultivation, land use conversion, processing, transport and distribution, and use. The LCFS uses market-based emission-trading mechanisms for compliance, where the regulated parties, i.e., oil refiners, fuel importers, producers, or providers, can develop their own compliance strategies or buy credits from or sell credits to other regulated parties. Except for aviation and maritime fuels, over which California has limited legislative authority, low-GHG transportation fuels, such as compressed natural gas, oil sands with carbon capture and sequestration, biofuels, electricity, and hydrogen, can contribute to the program. Given available technology options, biofuels will play an important role in meeting the program target (CARB 2009; Yeh, Lutsey, and Parker 2009).

In the past few years, more than a dozen governments and national consortia, including The Netherlands, Germany, the UK, the US, and the EU, have adopted biofuel policies that set specific volumetric mandates/targets or blending requirements by certain target years. These biofuel programs often are justified based on the benefits of reducing reliance on foreign oil and improving energy security, reducing GHG emissions, and supporting agricultural and rural developments within the countries where policies are developed and in developing countries. These policies have resulted in a large increase in global demands for biofuels and a small increase in trade in biofuels, mostly ethanol from Brazilian sugarcane and biodiesel from US soybeans and Malaysian and Indonesian palm oil. However, new studies began to link this increased biofuel production to increased risk of adverse environmental impacts (Donner and Kucharik 2008; Miller, Landis, and Theis 2007; Robertson et al. 2008) and of social and economic impacts (FAO 2008; Rajagopal et al. 2007; Tenenbaum 2008), casting doubt on the real GHG benefits of some biofuels (Fargione et al. 2008; Gibbs et al. 2008; Searchinger et al. 2008). Even though there are vastly different views on the nature and magnitude of causal relationships between biofuel policies and diverse environmental impacts, land use changes, and global food prices, there have been increasing efforts to adopt sustainability requirements to minimize potential social and environmental damage and unintended consequences. These efforts are intended to provide environmental and social safeguards for biofuels that are encouraged directly or indirectly by biofuel subsidies, tax credits, demand mandates, or other mechanisms.

In the past few years, sustainability requirements for biofuel production have been adopted/implemented by The Netherlands (Cramer et al. 2007; Cramer et al. 2006; NEN 2009), the UK (RFA 2009a), Germany (BioNachV 2007; WWF 2006), the EU (EC 2008), and California (CEC 2008b). International organizations, including the United Nations' Food and Agriculture Organization (FAO), the UN Environment Programme (UNEP), and the G8's Global Bioenergy Partnership (GBEP), have encouraged and supported the research, modeling, and negotiation efforts among stakeholders at the country level. There are also more private and public efforts in promoting certifications, facilitating information sharing, and developing guidelines for sustainability best management practices (BMP). Many new, especially commodity-based, biofuel-targeted certifications have recently been or are being established, such as the Roundtable on Sustainable Palm Oil (RSPO), the Roundtable on Responsible Soy (RTRS), the Better Sugarcane Initiative (BSI), the Council on Sustainable Biomass Production (CSBP, focusing on second-generation feedstock), and the Roundtable on Sustainable Biofuels (RSB, focusing on creating internationally consistent sustainability criteria and certification schemes). A more detailed review of these recent activities can be found elsewhere (Endres 2009; Lewandowski and Faaij 2006; van Dam et al. 2008; Winrock International 2009).

This study compares major sustainability requirements and proposes a framework of sustainability requirements that may be suitable for California. Section 2 reviews major biofuel policies and efforts in formulating sustainability requirements internationally and in the US and compares their key characteristics in program design, scope, and implementation. Section 3 outlines the essential elements for an expanded California LCFS sustainability requirement. Section 4 discusses remaining design issues and policy challenges.

2. Overview of Major Efforts in Sustainability Requirements for Biofuels

The purpose of a sustainability requirement for biofuels is to ensure that the cultivation, production, processing, transport, and delivery of biofuels do not impose unmitigated harm to the environment. This section briefly reviews recent sustainability requirements, highlighting similarities and differences in framework and implementation.

2.1 Major Efforts at the Country Level and in the US

Recent key biofuel sustainability standards and criteria all address the environmental principles of carbon storage, biodiversity, soil conservation, water use, water quality, and air pollution, and the socio-economic principles of welfare of local communities, land-rights issues, and labor welfare. Many also require government to monitor and periodically report sustainability impacts associated with market-mediated effects, including indirect land use change (ILUC), food price, and food availability.

2.1.1 Overview of sustainability requirements in The Netherlands, the UK, and the EU

The first major biofuel sustainability effort started with the Cramer Commission of The Netherlands (Cramer et al. 2007; Cramer et al. 2006). The Commission defined the sustainability of biomass using six themes: (a) greenhouse gas emissions, (b) competition with food and local applications of biomass, (c) biodiversity, (d) environment, (e) prosperity, and (f) social well-being. For each theme, a series of principles, criteria, and indicators were developed. The Cramer Commission consulted stakeholders and worked closely with the UK in order to maximize consistency between the two countries (UNCTAD 2008) and to harmonize criteria across regulatory and certification systems (van Dam et al. 2008). It adopted a "meta-standard" approach, in which a country defines its own principles and criteria and sets a mandatory reporting requirement against the meta-standard. The Commission benchmarked certifications against the meta-standards to maximize the use of existing standards, and gap reporting was required for principles and criteria failing to meet the benchmarks (Dehue et al. 2008). Most of the sustainability standards and certification systems (including Sustainable Agriculture Network / Rainforest Alliance (SAN/RA), RSPO, RTRS, Basel, Integrated Farm Assurance for Combinable Crops (GLOBALGAP), FSC, Social Accountability International (SA 8000), and International Federation of Organic Agriculture Movements (IFOAM)) meet the Cramer framework's goals for biodiversity preservation, environmental protection, and concern for social-welfare distribution. However, there exists little or no agreement on quantitative benchmarks for GHG emissions, displacement of food production, local power supply, medicines, building materials, or prosperity (Cramer et al. 2007). The Dutch government assumes responsibility for collecting data on indirect changes including land (prices, ownership, deforestation and loss of nature reserves, changes in the type of vegetation and share of vegetation and crops) and food

(price, availability, relocation of food production and cattle breeding), and the deforestation and loss of nature reserves in relation to the supply of food, construction material, fertilizers, and medicines.

The UK's Renewable Transport Fuel Obligation (RTFO) carbon and sustainability reporting implemented in April 2008 is the only operational system so far. It contains "minimum requirements" for meeting the meta-standard of five environmental principles, two social principles, and "recommended" criteria and indicators. The reporting requirement under the RTFO requires individual fuel suppliers to provide confidential monthly reports to the Renewable Fuels Agency (RFA) on the carbon and sustainability performance of renewable fuels supplied under the RTFO. Fuel suppliers must also provide annual certifications by independent auditors and submit aggregated annual reports to the RFA. Targets are set for each company regarding percentage of feedstock meeting the "qualifying" Environmental Standard, GHG saving, and data provision, but with no penalties associated with missing the target. The answer "Don't know" is allowed but will be phased out (RFA 2009a). Qualifying standards are existing standards that meet most of the RTFO sustainability criteria and are accepted as proof of acceptable sustainability.

The EU in December 2008 adopted its biofuel sustainability criteria within its Renewable Energy Directive (EU-RED) and Fuel Quality Directive (FQD). Voluntary certification schemes, international agreements, and schemes to measure GHG emissions can be accredited by the Commission as giving reliable proof of compliance. The EU intends to "…encourage the development of multilateral and bilateral agreements and voluntary international or national schemes that cover key environmental and social considerations, in order to promote the production of biofuels and bioliquids worldwide in a sustainable manner. In the absence of such agreements or schemes, Member States should require economic operators to report on those issues." (EC 2008) Member States will need to require economic operators to show that the sustainability criteria have been fulfilled and to ensure an "adequate standard of independent auditing." Biofuels and bioliquids produced from waste and residues, other than agricultural, aquaculture, fishery, and forestry residues, need not fulfill the sustainability criteria except GHG emission reductions. The Commission reports to the European Parliament every two years on the issues with respect to the Member States and third countries (i.e. biofuel producing countries) on soil, water, and air, and on social issues such as food prices, food availability, land-use rights, and those covered under the Conventions of the International Labour Organization.

In the UK, as of December 2008, 97% of the renewable fuels supplied are imports. Major sources of imports are American soy, rapeseed from Germany, and palm oil from Malaysia and Indonesia for

biodiesel and Brazilian sugarcane for ethanol (RFA 2009b). In the EU, most of biofuel trades involve Brazilian sugarcane and palm oil from Malaysia and Indonesia (OECD 2008).

2.1.2 US Renewable Fuel Standard (RFS2) and California's Low Carbon Fuel Standard (LCFS)

The US biofuel (RFS2) and bioenergy programs in the Energy Independence and Security Act (EISA) (US EPA 2009a), and to some extent the California LCFS (CARB 2009), are designed to incentivize domestic biomass production and use: the federal RFS2 specifies volumetric requirements for corn ethanol, cellulosic biofuel, and biomass-biodiesel and provides tax credits and subsidies; the LCFS favors low-carbon second-generation biofuel technologies, which are more mature in the US. Therefore, the majority of sustainability concerns in the US focus on domestic environmental impacts including water use, water pollution, local air pollution, environmental justice, biodiversity, and resource use, especially agricultural residues and forestry biomass. EISA sets limits on the qualification of "renewable biomass" by limiting the type of land conversion and feedstock sources and requires the Environmental Protection Agency (EPA) to report to Congress every three years on the impacts to date or future impacts of meeting the EISA requirement on issues regarding the environment, conservation, and invasive species in the environment and agriculture.

At present, California's LCFS is a GHG policy that does not emphasize sustainability requirements aside from lifecycle GHG emissions (CARB 2009). In contrast to other biofuel programs reviewed here, California's LCFS and the EU's FQD are performance-based GHG policies that are fuel neutral. The performance-based standard incentivizes ultra low-GHG second-generation biofuels from organic waste or other biomass and cellulosic ethanol from energy crops, crop residues, and forest wastes. These fuels are attractive because they tend to use much less land than crops (FAO 2008; Gibbs et al. 2008; OECD 2008; Searchinger 2009), compete less with food production, have higher yields and lower intensity of agricultural inputs (less land, fertilizer, irrigation. and pesticides), and cause less soil erosion and loss of biodiversity (Robertson et al. 2008; Tilman, Hill, and Lehman 2006; Tilman et al. 2009).

Table 1 summarizes the framework of the key biofuel programs and their sustainability efforts in California, the US, the UK, and the EU. The table outlines the major similarities and differences in the program goals, how GHG emissions are treated, and the framework of sustainability standard.

Table 1. Comparison of major biofuel programs and sustainability requirements.

Characteristic	Policy			
	California Low Carbon Fuel Standard (**LCFS**)	US Renewable Fuel Standard Program (**RFS2**)	EU Renewable Energy Directive (**RED**) and Fuel Quality Directive (**FQD**)	UK Renewable Transport Fuel Obligation (**RTFO**)
Date of last update and reference(s)	April 2009 (CARB 2009)	May 2009 (US EPA 2009a)	December 2008 (EC 2008)	April 2009 (RFA 2009a)
Program goal(s)	**Intensity target**. Reduction of transportation fuel average lifecycle GHG intensity by 10% by 2020. Includes biofuels and other alternative fuels such as electricity and hydrogen.	**Volumetric target**. A mandate of 36 billion gallons of biofuels by 2022, of which 21 billion gallons must be advanced biofuels, which include biodiesel and renewable biofuels.	**Blend target**. EU-RED sets a target of 10% renewable energy in transport by 2020. FQD requires a reduction of 6% transportation lifecycle GHG intensity by 2020.	**Blend target**. Requires 3.25% of all UK fuel sold in UK to come from a renewable source by 2009/2010, and 5% by 2013/2014.
Chain of Custody (CoC)	Demonstrate the Evidence of Physical Pathway for each of the fuels and blendstocks that are delivered, introduced, or removed (e.g., sales contract) to meet the LCFS. The Physical Pathway can be the applicable combination of actual fuel delivery methods, such as truck routes, rail lines, gas/liquid pipelines, or electricity transmission lines.	RIN and Product Transfer Document (PTD). Annual attest engagement for third-party auditing. The RIN is sold with the renewable fuel as it enters the supply chain. Product Transfer Documents (PTD) are required when ownership of a renewable fuel is transferred to another party.	Prefers a mass balance approach for sustainability reporting.	All chains of custody are possible. Where no chain of custody exists, mass balance should be used. All information submitted in the annual report must be verified independently.
Sustainability requirement	GHG-only policy. Regulation resolution includes sustainability provisions.	Defines "renewable biomass" to exclude biofuels not meeting the sustainability requirement. The government shall report impacts on the environment, resources, and social problems.	Biodiversity no-go areas and conversion of high carbon stock areas prohibited. Reporting obligations for economic operators on measures taken for protection of soil, water, air emissions, restoration of degraded land, and social issues. Reporting from the Commission on social issues, including ILO conventions.	Reporting requirement for fuel providers on five environmental and two social principles. Government monitors and reports any potential direct and indirect effects.

2.1.3 Chain of custody (CoC) requirement

To validate the delivery of biofuels meeting the sustainability requirements, one of the most critical components is the identification of chain of custody (CoC) that tracks participating fuels from feedstock production to delivery of biofuels. There are four major types of CoC: identity preserved, segregation, mass balance, and book and claim (Cramer et al. 2007; Dehue et al. 2008; Fehrenbach et al. 2008; Winrock International 2009). The **identity preserved** and **segregation** systems are the strictest, requiring certified feedstock to be completely separated from non-certified product, and the identity preserved system also requires full traceability to individual farms (NEN 2009). The segregation system does not require complete segregation of certified material from different sources, but all companies in the supply chain must be fully certified. Both usually appeal to small, niche-market businesses such as Fair Trade Coffee (Bender 2001), organic products, and non-GMO products. In the **mass-balance** system, in which feedstock/biofuel may be mixed with non-certified products, feedstock/biofuel is only partly traceable. Certifications can not be separated from the feedstock/biofuel and must stay with the finished products along the supply chain. The finished product is often labeled with its average percentage content of certified product over a specific reporting period. With a **book-and-claim** system, feedstock/biofuel is not traceable to the source. The end users (in this case, the fuel suppliers/importers) submit certificates that guarantee the production of a certain quantity of sustainable biomass, but only the primary producer such as a farmer or forester is certified, whereas the companies in the supply and production chain are not. Electricity markets and the cap-and-trade program adopt this model, in that the renewable sources, for example, are certified and earn GHG credits. The credits are traded in the market, but the source can not be identified. The mass-balance and book-and-claim systems are easier to implement for large volumes and a wide range of feedstock types and sources, because they do not require certified products to be kept physically separate from non-certified products throughout the entire production chain.

The UK's RTFO accepts all chains of custody, but where no chain of custody exists, mass-balance is preferred (Dehue et al. 2008). The EU's RED prefers mass-balance, in which Member countries are responsible for requiring economic operators to ensure an "adequate standard of independent auditing." Voluntary certification schemes, international agreements, and schemes to measure GHG emissions can be accredited by the Commission as giving reliable proof of compliance (EC 2008).

The US RFS2 uses the renewable identification number (RIN) to track biofuels. The RIN is a 38-digit code that is generated by the producer or importer of renewable fuel. It encodes the number of gallons of renewable fuel produced/imported and assigned to batches of renewable fuel that are transferred to others through change of ownership. The RIN tracks biofuel only at the facility level and has no information

regarding feedstock origin, production, or processing characteristics. The system is under consideration to be expanded to include specific facility information such as process information and feedstock origin (US EPA 2009b). EPA is considering to institute a mass-balance system for domestic feedstock,[1] whereas foreign imports of biofuel, however, need to remain segregated from non-RFS fuel until it is imported into the United States (US EPA 2009a).

California's LCFS requires regulated parties to demonstrate the Evidence of Physical Pathway for each of the fuels and blendstocks that are delivered, introduced, or removed (e.g., evidence of sales contract) to meet the LCFS. The Physical Pathway can be the applicable combination of actual fuel delivery methods, such as truck routes, rail lines, gas/liquid pipelines, or electricity transmission lines.

2.1.4 Indirect land use change (ILUC)

Both the federal RFS2 and California's LCFS include GHG emissions from indirect land use change (ILUC) in the fuel pathway lifecycle GHG emission calculations. ILUC represents the overall land use conversion of new or existing agriculture lands in response to increased demand for biofuels. The conversion of land induced by market-mediated effects can be direct or indirect. Indirect land use changes (ILUC) represent the effect of diverting crop land to bioenergy production, leading to extensification and intensification. Extensification is the expansion of cultivated land area. Intensification is the increased input of nitrogen, another greenhouse gas, to increase yields of agriculture. Extensification modifies the quantity of land devoted globally to farms, forests, and marginal lands, and thus to total carbon stocks associated with those lands. The ILUC effects cannot be directly observed or easily measured.

When lands with rich soil and biomass carbon deposits are initially converted to agricultural production, a large amount of carbon is emitted. This initial "carbon debt" can take years or even decades of cultivation to pay back (Delucchi 2004; Fargione et al. 2008; Gibbs et al. 2008). Recent studies have shown that massive consumption of biofuels could lead to expansion of farm lands throughout the world at the expense of other crop lands and non-crop lands, such as forest and grass lands (FAO 2008; Hertel, Tyner, and Birur 2008; Koh and Wilcove 2008; Laurance 2007; Melillo et al. 2009; Searchinger et al. 2008; Searchinger et al. 2009).

[1] EPA requires that "renewable fuel producers obtain documentation about their feedstocks from their feedstock supplier(s) and take the measures necessary to ensure that they know the source of their feedstocks and can demonstrate to EPA that they have complied with the EISA definition of renewable biomass." Further, the RFS2 states, "In the event that some portion of a load of feedstock does meet the definition of renewable biomass and some portion does not, the renewable fuel producer would need to maintain documentation from their supplier that states the percentage of each portion." This would make the RFS2 in theory a mass-balance system.

The LCFS, by including ILUC into the GHG lifecycle calculations, encourages the use of low-GHG biofuels from organic waste or other biomass and cellulosic ethanol from energy crops, crop residues, and forest wastes. These biofuels are attractive because they tend to use much less land than do crops (FAO 2008; Gibbs et al. 2008; OECD 2008; Searchinger 2009; Tilman et al. 2009), compete less with food production, have higher yields and lower intensity of agricultural inputs (less land, fertilizer, irrigation, and pesticides), and cause less soil erosion and loss of biodiversity (Robertson et al. 2008; Tilman, Hill, and Lehman 2006).

2.2 Multi-stakeholder and Intergovernmental Initiatives

With increasing recognition of the need for stakeholder involvement and achieving maximum consistency among sustainability standards, the G8 + 5 (Brazil, China, India, Mexico, and South Africa) countries launched a Global Bioenergy Partnership (GBEP) in July 2005 to "support wider, cost effective, biomass and biofuels deployment" and established a working group to help bring about a "voluntary international sustainability framework of principles for bioenergy" (Fehrenbach 2008). Other international efforts, including the UNCTAD Biofuels Initiatives, the IEA Bioenergy Tasks, the FAO International Bioenergy Platform, the Inter-American Development Bank, and especially the Greenhouse Gas Balances of Biomass and Bioenergy Systems (Task 38) and the Sustainable International Bioenergy Trade (Task 40), contributed substantially to the development of biofuel research and collaboration (van Dam et al. 2008).

The Roundtable on Sustainable Biofuels (RSB), established in November 2006, is an international initiative that engages in a multi-stakeholder process aiming to achieve an international consensus on sustainability standards and criteria for biofuel production (RSB 2007). The RSB adopts the meta-standard approach, which benchmarks certifications based on the RSB's principles and criteria and adds information on GHG emissions and indirect effects that are currently lacking for most certifications (especially non-biofuel-specific). The RSB recently delivered its Version 0.5 (RSB 2009b) and is currently working on Version 1.0, implementing pilot testing and benchmarking certifications.

2.3 Existing Biofuel Sustainability Work in California

In response to increased interest in utilizing biomass for bioenergy and biofuels in California, the California Biomass Collaborative (CBC) established targets for bioenergy production in California (CBC 2006) and recommended sustainable management of resource feedstock supply, land use, environmental impacts (for agriculture, forestry, and urban biomass), resource monitoring, collection and transport of feedstock, infrastructure, and financial environment. Recognizing the need for sustainability considerations, the California Energy Commission (CEC) developed a Draft Sustainability Framework to

guide the Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program (AB118) in California. This framework identifies four sustainability goals: substantial reductions of GHG emission; natural resource protection and promotion of superior environmental performance; certification of sustainable production practices; and minimization and/or mitigation of impacts from unanticipated environmental, social, or economic consequences. It includes a list of characteristics for measuring sustainability goals (CEC 2008a) and a set of minimum reporting and voluntary certification requirements for alternative and renewable fuel projects that it intends to fund. It also proposes a checklist for measuring how well each proposed investment project can meet its sustainability goals and a weighting scheme that gives a combined sustainability score for each project. The weighted sustainability scores will be used to rank projects that seek funding from the CEC for biofuel, hydrogen, electricity, and natural gas technologies, infrastructure, and fuels.

2.4 Comparisons of Existing Sustainability Requirements for Fuel Providers

In this section, we discusses several selected principles and sustainability requirements of the UK-RTFO, EU-RED, and US-RFS2. The comparisons of RSB principles and criteria against the requirements of the UK-RTFO, EU-RED, and US-RFS2 are detailed in Appendix A.

2.4.1 Legality

Cross-compliance with existing laws and regulations in the relevant jurisdiction is the foundation of any sustainability criteria and standards. Agricultural activities in the US are guided by the US Department of Agriculture (US DA) and US EPA's regulatory and voluntary programs covering water use and water quality, pesticide use, biodiversity, pollution and spills, conservation and recovery, air quality, etc. (US EPA 2007). The information should be familiar to agricultural producers, federal and state regulators, and third-party information providers who serve agricultural producers.

2.4.2 Planning, monitoring, and continuous improvement

The RSB requires biofuel operators (including feedstock producer, feedstock processor, biofuel producer, and biofuel blender) to perform environmental and social impact assessment (ESIA) that "include a summary analysis of potential impacts on all of the sustainability criteria in the RSB, both positive and negative." The ESIA shall be carried out using independent and qualified professionals and is intended to be a planning, implementation, and continuous improvement principle. ESIA will provide important information regarding the baseline environmental performance prior to the project and will provide more accurate assessment of potential sustainability *impacts* and *risks* than using many of the primary or intermediate indicators (such as reporting on the amount of water usage, fertilizer use, or waste storage

and handling). It also allows for more adaptation and interpretation of sustainability criteria according to feedstock and local conditions.

Existing voluntary programs and best management practices (BMP) that have been developed to minimize environmental impacts and encourage mitigation or remediation of impacts and technological innovation may complement ESIA. Voluntary programs such as the conservation partnerships with the USDA National Resources Conservation Service (NRCS) and the federal Environmental Quality Incentives Program (EQIP) provide technical assistance, cost-share payments, and incentive payments to crop, livestock, forestry, and other agricultural producers adopting practices that reduce environmental and resource problems. In the absence of any guideline or technical assistance, a wide range of tools and information can be utilized to develop BMP. We outline four potential approaches to develop BMP to support the development of EISA:

1. Coordinate local and state regulatory agencies to update/harmonize BMP plans for feedstock/fuel production/fuel conversion pathways.

   For example, public timberland management is generally guided by land management plans prepared under the National Forest Management Act of 1976 (NFMA) and site-specific environmental analyses prepared under the National Environmental Policy Act of 1970 (NEPA). The California Department of Forestry & Fire Protection regularly updates the California Forest Practice Rules through a multi-stakeholder process, and further update/guidance can be more carefully crafted to specifically address forest biomass for biofuel production. The US EPA and USDA have a long history on providing BMP for agricultural production (US EPA 2007), and more work is needed in second-generation biofuels.
2. Participating certifications such as the Roundtable on Sustainable Palm Oil (RSPO), Council on Sustainable Biomass Production (CSBP), Better Sugarcane Initiative (BSI), FSC, and Sustainable Biodiesel Alliance (SBA) can assist in defining BMP for their respective industries.
3. Industry groups such as the Renewable Fuel Association could define BMP, especially for fuel manufacturing.
4. In the absence of the above, regulated parties may define BMP if they can provide evidence, such as industry or third-party data, that their performance is within the best 10-25%[2] of industry practices.

It is important to note that even though BMP can serve a critical function in providing useful tools to support the development of EISA, BMP should not be considered as a "state or indicator of

[2] An alternative is 50%. This threshold should be decided by the regulatory body in consultation with stakeholders.

sustainability," due to the limitations in the lack of baseline, lack of understanding of site-specific drivers, and the lack of monitoring and evaluation (Winrock International 2009).

2.4.3 Greenhouse gas emissions

The UK-RTFO set targets for biofuels of at least 40% GHG savings over fossil fuels in 2008/2009, 45% in 2009/2010, and 50% in 2010/2011. Starting in April 2010, the government will reward biofuels under the RTFO, based on the amount of carbon the fuel saves. The government sets default values by fuel production pathways and allows companies to provide opt-in values for emissions lower than the default. Companies are required to report land use in the monthly report. GHG emission from ILUC will be separately monitored by the government. As of April 2009, one year after the implementation of sustainability reporting, industry-defined defaults or "real" data on input to the fuel chain, for example, information on fertilizer inputs and crop yield of the source feedstock, were provided for 27% of biofuel (RFA 2009b).

In the US-RFS2, the EPA determines whether a certain feedstock meets the minimum GHG emission reduction requirement as shown in Table 1. Once the EPA determines that the feedstock/pathway meets the requirements, there is no additional requirement to demonstrate the compliance of GHG targets for each batch of fuel. The assessment of lifecycle GHG emissions is required to include "emissions related to direct and indirect land use changes, attributable to all potential biofuel feedstocks and production processes."

California uses the CA-GREET model to calculate lifecycle GHG emissions for particular feedstock and production pathways. There is no minimum standard for individual fuel, but the fuel mix of each regulated party must meet a schedule of GHG emission reduction that will achieve 10% reduction from the baseline fuels, gasoline and diesel, by 2020. Being a multi-fuel program, it adjusts GHG emissions of other transportation fuels based on efficiencies of the engines, such as electricity fuels for plug-in hybrid vehicles and hydrogen for fuel cell vehicles. Similar to the RTFO, it provides default and opt-in mechanisms that allow industries to provide their own actual GHG values to incentivize innovations and continuous improvement. There are two opt-in options: Method 2A allows regulated parties to modify the input values of the *existing* pathways within the CA-GREET model, the LCFS GHG calculation tool, to reflect their specific processes. Method 2B allows regulated parties to generate a *new* pathway absent from the CA-GREET model (CARB 2009). California's LCFS considers GHG emissions from ILUC as part of the lifecycle GHG emissions and adopted the GTAP (Global Trade Analysis Project) model to analyze the ILUC GHG emissions and assigns a default ILUC value to each pathway (CARB 2009).

2.4.4 Conservation

The RFS2 defines "renewable biomass" by specifying the source of feedstock and conditions/activities where the land/feedstock may be used for biofuel production. For example, it restricts crops and crop residues to lands that were cultivated or cleared prior to the December 19, 2007 and are actively managed, fallow, or non-forested (see Table 5 for further discussion). The EPA proposes to utilize a wide range of existing resources to implement the definition of renewable biomass, including using land categorizations defined by the USDA's Natural Resources Inventory (NRI) (Natural Resource Conservation Service 2007) to define various types of "agricultural lands" and their management status that may be qualified for feedstock production; adopting the definition of forest status of critically imperiled, imperiled, or rare, based on the State Natural Heritage Program, part of the non-profit NatureServe network; and identifying "areas at risk of wildfire" based on wildland urban interface (WUI) land as defined in the Healthy Forests Restoration Act (PL 108-148). Despite the attempt to utilize existing resources/databases for definition and identification, these existing resources might not be sufficient and/or reliable for implementation (US EPA 2009b).

2.5 Comparisons of Sustainability Reporting Requirement for Governments

The UK-RTFO and EU-RED both require governments to monitor, assess, and report social and environmental impacts in their own or other countries where a large amount of feedstock is produced, and any potential indirect effects beyond directly impacted areas. The US EPA is required by Congress to consult with the USDA and the Department of Energy to assess and report to Congress on the environmental (including air, water, soil, biodiversity, and ecosystem health) and social impacts (including job creation, food prices, and rural development) of the biofuel program. These impact assessments, with the exception of the mandate to include GHG emissions from ILUC, are limited to domestic impacts.

As part of the LCFS regulation, CARB evaluated the impacts of the regulation on air quality (including biofuel facilities, transport, and vehicle use), water use, soil, ecology, cultural resources, hazards and hazardous materials, and waste within State boundaries. The requirements of these programs for reporting social and environmental impacts are summarized in Appendix B.

2.6 Future Scenarios for California LCFS

Currently, biofuels used in the US for meeting the oxygenated requirement and for biofuel programs are primarily domestically produced. Imported sugarcane ethanol accounted for 3–13% annually between 2005 and 2008, with the highest monthly average of 23% in August 2006 (EIA 2009). Even though the US is a significant biodiesel importer, most of it was re-exported to other countries to take advantage of

the US subsidy program for biodiesel (the "splash-and-dash") (OECD 2008). Future ethanol imports will depend on import tariffs and the demand from other countries with biofuel requirements (Lee and Sumner 2009; US EPA 2009a). But in general, the additional ethanol use to meet the EISA requirement is expected to be largely domestically produced—from maize and cellulosic material such as crop residues and dedicated biomass—due to the design of the RFS2 program.

Meeting the California LCFS is predicted to require 1.5–3 billion gallons of ethanol, 0.65–0.83 million gallons of biodiesel, 1.2–11 GWh of electricity, and 0–33,000 tonnes of hydrogen annually by 2020, eliminating 20–25 million tonnes CO_2e/yr (CARB 2009; Yeh, Lutsey, and Parker 2009). A new study estimates that there will be sufficient feedstock and expansion capacities within the western US to meet the LCFS goals, and these fuels will rely on a diverse resource base with significant contributions from municipal solid waste, agricultural residue, herbaceous energy crop, forest thinning, corn, and tallow resources (Yeh, Lutsey, and Parker 2009). A recent analysis suggests that large quantities of biofuels with inherently low ILUC effects—from perennials grown on degraded lands (previously used for agriculture), municipal and industrial solid waste, crop and forestry residues, and double or mixed crops—can be produced annually in the US (NAS 2009).

Biofuel programs, if not done right, can cause global consequences in land use conversion and food price increases (FAO 2008; Tilman et al. 2009)(CARB 2009; Hertel, Tyner, and Birur 2008; OECD 2008; Searchinger 2009; Searchinger et al. 2008; US EPA 2009a). Even though the impacts of cellulosic ethanol on land conversion and commodity prices are generally expected to be more moderate than those of corn ethanol (OECD 2008; Searchinger et al. 2008), the actual impacts of second-generation biofuels will depend largely on the allocation of feedstock between agricultural residues and dedicated energy crops, the types of land used for energy crops (e.g., agricultural land vs. lands currently not for food production), and the yield of energy crops. For example, using largely non-agricultural land to expand dedicated energy crops would have less price impact than using first-generation biofuels such as corn ethanol, but at the cost of potential "negative environmental impacts on sensitive areas and high-carbon soils, including GHG emissions, water use and biodiversity losses" (OECD 2008). Therefore, policies to prevent worse-than-baseline GHG emissions and environmental degradation will be necessary.

The projected scenarios to meet the RFS2 and the LCFS targets suggest that more of the sustainability concern for biofuels and other alternative fuels will be on domestic environmental impacts and market-mediated effects of ILUC, food vs. fuel issues, and biodiversity loss than on social issues such as land rights and workers' rights. But this may change if more biofuel imports start to enter California's market.

3. A Proposed Expanded Sustainability Scheme for California

Through its GHG policy, California intends its LCFS to incentivize ultra-low GHG biofuels that pose minimal local and regional environmental impacts, minimal competition for food, and minimal stress on indirect land use conversion of agricultural and new forest lands. With the exception of GHG emissions and the discussion on direct and indirect land use change, the current sustainability requirements in the US RFS2 and the California LCFS primarily concern environmental and social impacts in the US and within California. But CARB acknowledged broader sustainability issues and is scheduled to propose a strategic plan by December 2010 for public comments and December 2011 for adoption by the Board.[3]

This chapter discusses the potential requirements for implementing expanded sustainability criteria for California's LCFS program.

3.1 Essential Elements for the Overall Framework

Developing a functional sustainability scheme requires the development of standards, standard accreditation requirements, and verification procedures (Figure 1). The "standard setting component" includes developing a set of principles and criteria that define sustainability goals, and specifying how fuels meeting these sustainability goals will be tracked and reported (i.e., through CoC rules). If the scheme accepts outside "standards" and "certification schemes"[4] as a proof of compliance, then a benchmarking system must be in place to systematically qualify certifications against its own principles and criteria (Figure 1, left box).

[3] The Sustainability Directives from the LCFS Board Resolution states, "BE IT FURTHER RESOLVED that the Board directs the Executive Officer to work with the Interagency Forest Work Group (IFWG), the California Natural Resources Agency, the California Energy Commission, the California Department of Forestry and Fire Protection, the United States Forest Service, the U.S. EPA, environmental advocates, regulated parties, and other stakeholders to further develop definitions and safeguards for the use of 'biomass' and 'renewable biomass,' and propose amendments to the LCFS regulation, if appropriate, by December 2009. As part of this effort, the Board further directs the Executive Officer to consider the specific effects of incentivizing the use of forest biomass from public and private lands; the greenhouse gas emissions from different fuel pathways on public and private lands; and the additional protections, if any, necessary to ensure the sustainable and environmentally beneficial use of such forest biomass, with the goal of certifying pathways for the use of forest biomass.

"BE IT FURTHER RESOLVED that the Board directs the Executive Officer to work with IFWG, appropriate state agencies, environmental advocates, regulated parties, and other interested stakeholders to present a workplan to the Board by December 2009 for developing sustainability provisions to be used in implementing the LCFS regulation. The workplan should include, but not be limited to, a science-based definition of sustainability; how the sustainability provisions can incentivize sustainable fuels; what provisions will be reviewed for inclusion in the LCFS regulation; the framework for how sustainability provisions could be incorporated and enforced in the LCFS program; and a schedule for finalizing sustainability provisions by no later than December 2011, unless the Executive Officer determines that such actions are not feasible and not appropriate."

[4] A "sustainability standard" includes a set of principles and criteria, whereas a "certification scheme" includes a set of standards, a mechanism for certification, and an accreditation system.

The scheme also needs to establish rules for the requirement for an approved certification organization based on systems, records, or processes and on accredited auditors (Figure 1, middle box).

The verification system sets rules for compliance, the control of claims (credits), and a database that provides all the necessary information regarding fuels, certification, and compliance. Rules must also be established for a grievance mechanism.

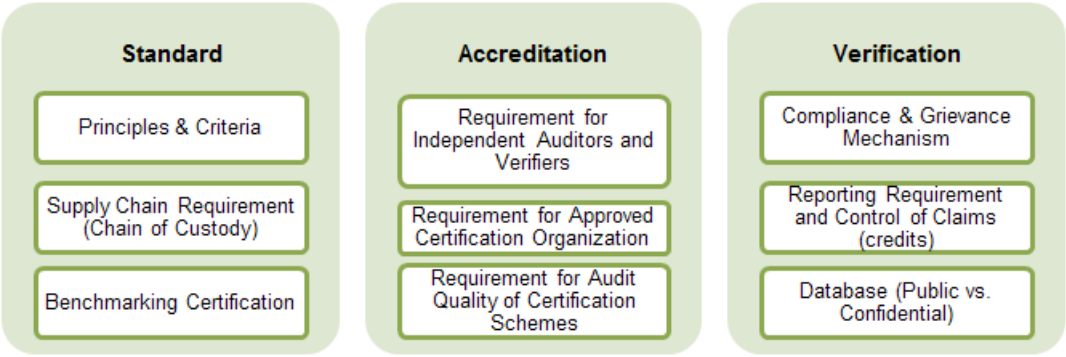

Figure 1. Three main categories of requirements in developing a functional sustainability scheme. Source: Adapted from RSB (2009a).

3.2 Key Design Elements for the Sustainability Criteria

This section discusses key design elements accompanying the expanded sustainability requirement.

3.2.1 Principles, criteria, and fuel types covered

The RSB has emerged as a global consensus on a sustainability standard for biofuels. Among such standards, it has the most transparent process and the most complete multi-stakeholder participation from the supply chain, the experts, governments, and inter-governmental agencies. It has held at least 10 regional consultation workshops, which were attended by more than a thousand stakeholders providing feedback on its principles and criteria. It recently joined the ISEAL Alliance Code of Good Practice for Standard Setting to fulfill the accreditation requirement and become an accreditation body. Governments participating in the RSB process included the UK, the EU, and California. There is a shared recognition that internationally consistent standards will reduce unnecessary confusion and market segregation, minimize leakage and shuffling of fuels, and improve system efficiencies. These advantages are essential for the successful implementation of the sustainability requirement

The discussion on principles, criteria, and applicability to California LCFS is summarized in Table 2 below. The requirements can potentially be applicable to *all* transportation fuels participating in the LCFS program *or* only to fuels earning LCFS credits (thus excluding baseline fuels). In the short term, however,

in order to address acute concerns for new fuels, reduce administrative burden, and recognize existing regulations on baseline fuels, it may be more appropriate to apply the requirements to non-baseline LCFS-participating fuels. The final decision of whether to adopt, modify, or reject these principles and criteria should be based on the consensus of the CARB and stakeholders.

Table 2. Summary of recommended sustainability principles and criteria (based on RSB Version 0.5) and proposed reporting requirements and frequencies.

Principle	Adoption for the Quarterly Reporting Requirement	Adoption for the Annual Reporting Requirement	Adoption for Periodic Government Monitoring and Reporting Requirement
Principle 1: Legality		X	
Principle 2: Planning, Monitoring, and Continuous Improvement		X	
Principle 3: Greenhouse Gas Emissions		*California LCFS regulations*	
Principle 4: Human and Labor Rights		X (for large fuel suppliers)	
Principle 5: Rural and Social Development		X (for large fuel suppliers)	
Principle 6: Local Food Security		X (for large fuel suppliers)	X
Principle 7: Conservation	X minimum requirement (with potential amendments on forestry biomass residues)	X minimum and progress requirement (with potential amendments on forestry biomass residues)	X
Principle 8: Soil	X minimum requirement	X minimum and progress requirement	X
Principle 9: Water	X minimum requirement	X minimum and progress requirement	X
Principle 10: Air	X minimum requirement	X minimum and progress requirement	X
Principle 11: Use of Technology, Inputs, and Management of Waste	X minimum requirement	X minimum and progress requirement	X
Principle 12: Land Rights		X	

3.2.2 Reporting frequency

The LCFS requires all regulated parties (fuel providers) to report quarterly progress and to submit an Annual Compliance Report. The quarterly report includes company ID, fuel type, blendstock, feedstock type, fuel quantity (MJ), federal RIN number (if applicable), feedstock origin, process information, and fuel carbon intensity.

Meeting the proposed minimum sustainability standard can be demonstrated through quarterly reporting (Table 2, Column 2) verified by an independent entity or by submitting certification schemes benchmarked by CARB. (See Section 3.2.4 below: Benchmarking standards.)

The LCFS Annual Compliance Report is designed to accept reports of aggregated data from quarterly reports and overall yearly credits (the credit balance and credit trade's being tracked separately in the Credit Tracking System, CTS) (CARB 2009). An expanded sustainability annual progress report can include aggregation of quarterly sustainability performance and qualitative information that aims to reflect the past year's progress and planned activities to monitor, implement, and improve sustainability performance (Table 2, Column 3).

CARB has committed to periodic reviews (2–5 years) of LCFS GHG compliance progress, to evaluating the need to adjust program design and default values, and to addressing other concerns. Evaluations of sustainability progress, review of key areas of concern, plans for continuous improvements in sustainability plans, and future recommendations on a wide range of environmental and social sustainability concerns that may be directly or indirectly related to LCFS policy are recommended (Table 2, Column 4). Special reports can be commissioned to examine particular concerns identified in the periodic review or by stakeholders.

3.2.3 Supply chain and chain of custody (CoC)

The supply chain for biofuel feedstock, especially for food and feed crops such as corn, soybean, and sugarcane, can be complex. A complete segregation CoC will be difficult to implement for feedstocks such as sugarcane and oil palm. Once harvested, these feedstocks are collected from nearby plantations, sent to local mills, and processed within 24 hours. In the case of sugarcane, sugarcane ethanol is sent via pipeline, shipped to Caribbean countries for dehydration, and shipped again to US ports, at which point denaturant (typically gasoline) is added and an RIN number is generated.

Products such as soybean are often being combined from many farms, stored, delivered to crushers, and then sold on the markets. Generating profit relies on capturing economies of scale in production, storage, and processing. A parallel, small-scale, identity-preserved supply chain exists for the organic markets and non-GMO products, where firms contract variety-specific products with farmers, specifying particular production and management requirements in contracts (Bender 2001). This system can be profitable when the added value (e.g. higher profit margins of organic products) is greater than the additional costs of production, handling, and segregation compared to the conventional commodity supply chain (Bender 2001; Lentz and Akridge 1997).

The supply chains for dedicated energy feedstocks (e.g., switchgrass) may be simpler in that they seem to have few important uses outside the biofuels complex. Some of the cellulosic feedstocks can be easily stored for days and processed in a large batch. Thus, implementing a strict CoC (i.e., identity-preserved or segregation) may entail minimal additional cost over the other CoC methods.

In the GreenPalm program, which is a book-and-claim system, a producer declares the number of GreenPalm certificates it wants to sell. When the trades are confirmed, the end user makes a sustainable palm oil claim and the certificates are retired from the producer's record. Therefore, a physical pathway does not exist. Similarly for electricity fuel, a load serving entity (LSE) will demonstrate the renewable content of the electricity it provides, through the Western Renewable Energy Generation Information System (WREGIS), an electronic book-and-claim system. A WREGIS certificate is issued for each MWh of renewable energy generated by a participating generator. The WREGIS certificate will be transferred between accounts of the buyer and seller, and the certificates will be retired from the system. Under such systems, sustainable *production* of fuels is certified and delivered to the grid. Certification through WREGIS could in theory allow an LSE to use Method 2A to get an opt-in carbon intensity value lower than the default value.

If California adopts a sustainability reporting requirement beyond the RFS2 requirement, such as those proposed in Table 2, it can build on the existing supply chain requirement for RFS2 and a mass-balance system would be possible.

The EU suggests that mass-balance will "provide an appropriate balance between supply and demand and ensuring a price premium that is greater than in systems where there is no such link" (EC 2008). The Dutch framework, however, is based on the belief that book-and-claim is more likely to create incentives for primary producers and that the market is likely to respond favorably to certified producers, whereas mass-balance is more likely to favor suppliers/companies that are vertically integrated (Cramer et al. 2007). Many certifications develop rules for multiple CoCs (Table 3).

The difference between mass-balance and book-and-claim begs the questions of whether a physical link is necessary and the objectives of chain-of-custody. The two systems serve different purposes: book-and-claim guarantees the *production,* whereas mass-balance guarantees the *consumption* of sustainable feedstock (Dehue et al. 2008). Stricter CoC systems (such as mass-balance and segregation) are regarded as less prone to error and favored by regulators because they provide direct incentives for fuel providers to ensure that the fuels they purchased and delivered meet sustainability requirements.

3.2.4 Benchmarking standards

If an LCFS sustainability provision has been developed and existing standards and certifications are allowed to be used as a proof of compliance, applicable standards and certifications will need to be "benchmarked" against the LCFS sustainability provision. Benchmarking sustainability standards and certification schemes assesses two aspects (RFA 2009a):

- The criteria and indicators of the sustainability standard;
- The audit quality of the sustainability standard.

The UK-RTFO went through extensive benchmarking. At present, only two standards meet the full RTFO environmental meta-standard (Assured Combinable Crops Scheme (ACCS) and Genesis Quality Assurance (Genesis QA)), but no standards meet the full RTFO meta-standard. Four other standards meet both the environmental and social qualifying standards[5] (Basel Criteria for Soy (Basel), Roundtable on Sustainable Palm Oil (RSPO), Round Table on Responsible Soy (RTRS), and Sustainable Agriculture Network/Rainforest Alliance (SAN/RA)), and two meet only the environmental qualifying standard (Forest Stewardship Council (FSC) and Linking Environment and Farming (LEAF)). These qualifying standards cover a wide range of categories, including standards and certification schemes that cover bioenergy, biomass, biofuels, and non-biofuel-specific products/process. A list of certifications potentially applicable to California is summarized in Table 3.

Table 3. Certifications potentially applicable to California (where blank means not yet developed or information unknown to us).

Applicable Feedstock/Process	Organization/Initiative	Certification	Chain of Custody (CoC)
	Feedstock Specific		
Forest product	Forest Stewardship Council (FSC)	FSC certification	FSC Pure (segregation), FSC Mixed (mass balance), FSC Recycled, or FSC Controlled.
	Programme for the Endorsement of Forest Certification (PEFC) schemes		
	American Tree Farm Systems (ATFS)		
	Sustainable Forestry Initiative (SFI)		
	Canadian Standards Association (CSA)		
Soybean	Roundtable on Responsible Soy (RTRS)		All CoC methods are under development
	Basel Criteria for Responsible Soy		
Palm Oil	Roundtable on Sustainable Palm Oil (RSPO)	GreenPalm	Book-and-claim and mass-balance (under development)

[5] As explained previously, qualifying standards are existing standards that meet most, but not all, of the RTFO meta-standard.

Energy Crops	Council on Sustainable Biomass Production (CSBP)		
Sugarcane	Better Sugarcane Initiative (BSI)		
Electricity	Western Renewable Energy Generation Information System (WREGIS)	Renewable energy certificates (RECs)	Book-and-claim
Non-feedstock Specific			
	Sustainable Biodiesel Alliance (SBA)		
	Sustainable Agriculture Network (SAN)		Segregation
	Roundtable on Sustainable Biofuels (RSB)	RSB certification (in progress)	All CoC methods are under development
Meta-standard			
	RSB	RSB-approved certification (in progress)	

The quality of certification also needs to be benchmarked. The UK RTFO developed "a norm for audit quality" based on seven criteria for adherence to ISO standards, including the requirements for certifying body, audit competency, and quality and accreditation process (RFA 2009a). The recent GBEP working group identified the continual assurance of conformable certification results as the central challenge in adopting the meta-standard (Fehrenbach 2008). There is a potential for proliferation of certification protocols as well as misuse of such systems due to variations in quality control. Some certifications have a long history of success and enjoy the trust of the majority of the public, although at times these also receive severe criticism from NGOs. Other protocols are perceived to have non-uniform standards and uneven quality, e.g., forest certifications other than FSC. It will be much harder to judge the quality of certification protocols that are new or that certify products that may be perceived as fundamentally problematic, such as agricultural products based on food crops or near tropical forests (Fehrenbach 2008).

Developing an LCFS sustainability requirement based on the RSB framework or accepting RSB as a qualifying standard would mean that biofuels with an RSB certificate would be automatically certified as meeting the LCFS sustainability requirement, thus reducing the need to benchmark RSB-certified sustainability standards.

3.2.5 Verification

The current LCFS requires that "all data and calculations submitted by a regulated party for demonstrating compliance or claiming credit are subject to verification by the Executive Officer or a third party approved by the Executive Officer" (CARB 2009). Sustainability reporting as depicted in Table 2 would require CARB to review an increasing amount and complexity of information that also needs to be verified. Both the UK-RTFO and EU-RED require fuel providers / economic operators to arrange for an adequate standard of independent auditing of the information submitted and to provide evidence for this

(EC 2008; RFA 2009a, 2009c). The auditor will verify the accuracy and truthfulness based on the quarterly and annual reports as well as on information provided by the supply chains (which should provide traceability of proofs of compliance/certification). The qualification of verifiers will also need to be defined based on criteria such as independence and credentials. (See Section 3.1.)

A transition phase may be needed to build the system capacity for implementation, including building the CoC system, conducting benchmarking of certification, and developing requirements for verifiers. The experience of the UK has proved that a transitional model that starts with piloting followed by voluntary reporting and mandatory certification helps ease the transition and provides useful lessons. The RTFO experience proves that the capacity-building efforts for a complete mass-balance system will be substantial, and such a system has not yet been fully established despite two years of planning and a year and a half of implementation. To date in the UK, biofuels reported by fuel providers as meeting the environmental and social qualifying standards are 24% and 21% of the total, respectively. These reported data are in the process of been verified and audited (RFA 2009b).

4. Remaining Issues and Policy Challenges

This section addresses many of the improvements needed and policy challenges associated with the implementation of sustainability requirements. The modeling of GHG emissions associated with ILUC and appropriate policy design are not discussed here, because in California they are considered part of GHG regulation and independent of the sustainability provision in California (CARB 2009). We address key remaining design issues including the definition of wastes, residues, and marginal lands as well as policy design challenges in accommodating our evolving understanding of the science of lifecycle analysis, costs of implementation, incentive mechanisms, and potential violation of WTO rules.

4.1 Remaining Design Issues

4.1.1 Definition of wastes and residues

With the intense discussion on the impacts of biofuel policy on ILUC, several recently revised biofuel programs have adopted sustainability measures or carbon accounting schemes designed to encourage the use of biofuels made from feedstocks cultivated on abandoned or marginal lands or from wastes (including biodegradable fraction of industrial and municipal wastes) and residues, including plant and animal substances (CARB 2009; Dehue et al. 2008; EC 2008; RSB 2008; US EPA 2009a). The implicit assumption is that biofuels produced from wastes and residues and marginal lands will have significant environmental advantages, higher GHG savings, and little competition with agricultural land and food sources (Tilman et al. 2009). The definitions of wastes, residues, and byproducts from different sources are summarized in Table 4 below.

Table 4. Definition of wastes, residues and by-products.

Program	Definition
UK-RTFO	By-product: a feedstock that represents less than 10% of the farm or factory gate value (RFA 2009a). The biofuel producer purchasing these by-products will have little influence on the sustainability of the production process for the original product. For example, a biofuel producer buying tallow will have little or no influence on the standards applied to rearing the cattle. For the purpose of the Guidance, the following products are considered by-products: tallow, used cooking oil, municipal solid waste, animal manure, molasses, cheese by-products, corn oil.
EU-RED	Wastes and agricultural crop residues include straw, bagasse, husks, cobs, and nut shells. Residues from processing include crude glycerine (i.e., glycerine that is not refined). "Biomass" means the biodegradable fraction of products, waste, and residues from biological origin from agriculture (including vegetal and animal substances), forestry, and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste.
Intergovernmental	Residues and wastes: any liquid, solid or gaseous material produced during feedstock

Panel on Climate Change (IPCC)	processing or biofuel production, with little to no economic value. By-products: any liquid, solid, or gaseous material produced during feedstock processing or biofuel production, with a lower economic value than the main product.
RSB	Agricultural residues, wastes, or byproducts: those generated through feedstock production. Processing residues, wastes or by-products: those generated through feedstock processing, biofuel production, and biofuel blending.

The use of waste streams as feedstock implies net environmental benefit, but lifecycle impacts and cross-media impacts must be accounted for. Shifting from disposal to use may inevitably introduce changes in the type of environmental impact, such as increasing certain air emissions and pollutant exposures while reducing land- or water-quality impacts. Increasing the use of by-products may also increase the economic value of the "waste" products for other uses and result in net GHG emission increase if substitutes are derived from more carbon-intensive products or production pathways. The RFA concluded in a study on tallow that "the Renewable Transport Fuel Obligation could create an incentive to divert tallow away from its existing uses to biodiesel production...this diversion could result in a net increase in GHG emissions due to more carbon-intensive feedstocks replacing tallow in its existing uses – as a result biodiesel produced from tallow would achieve no GHG saving" (Dale, Howes, and Watson 2008).

Similarly, agricultural residues, such as wheat straw, corn stover, and slash and pre-commercial thinning from forestland, prevent soil erosion, maintain soil organic carbon and nitrogen content, and provide animal habitats (CBC 2006). The removal of these waste products may become unsustainable if careful management and sustainability practices are not implemented, resulting in soil, water, and air pollution (CBC 2006; Marshall and Sugg 2008b, 2008a); soil carbon and nutrient loss; and habitat loss for endangered species. More careful definition of wastes and sustainability reporting requirement is needed to incentivize the use of wastes (by reducing reporting requirements) while providing adequate safeguards for avoiding unintended consequences.

4.1.2 Definition of marginal and degraded lands

The distinction among marginal, abandoned, and degraded land also needs to be carefully defined in the LCFS sustainability criteria. In the LCFS, fuels produced from feedstocks grown on "marginal lands" were assumed to have 75% less carbon than a typical grass land and to have a small ILUC compared to corn ethanol, soybean, or Brazilian sugarcane (CARB 2009). However, the LCFS regulation neither defines nor proposes a procedure for defining marginal land. The EU-RED sustainability criteria award a bonus of 29 gCO_2e/MJ if biomass is obtained from abandoned agricultural land, restored degraded land,

or heavily contaminated land (EC 2008). Definitions for marginal, degraded, and abandoned land are summarized in Table 5.

Table 5. Definition of marginal/degraded/abandoned land.

Program / Proposed Party	Definition
UK-RTFO	For the purpose of the RTFO, idle land is that which meets all of the following criteria: • Compliance with all criteria of the RTFO Biofuel Sustainability Meta-Standard on Carbon Storage (criterion 1.1), i.e., no destruction of large carbon stocks may have taken place. • Compliance with all criteria of the RTFO Biofuel Sustainability Meta-Standard on Biodiversity (criteria 2.1/2.3), i.e., no conversion in or near areas with one or more High Conservation Values. • Compliance with all criteria of the RTFO Biofuel Sustainability Meta-Standard on Land Rights and Community Relations (criteria 7.1/7.2), i.e., no violation of local people's rights. • As of Nov 30, 2005, the land was not used for any other significant productive function, unless a viable alternative for this function existed and has been applied that does not cause land use change in violation of any of the criteria for "idle land."
EU-RED	Idle land: land not in use for agriculture or any other activity in January 2008. Severely degraded land: land that, for a significant period of time, has either been significantly salinated or presented significantly low organic matter content and been severely eroded. Heavily contaminated land: land that is unfit for the cultivation of food and feed due to soil contamination.
IPCC	Severely degraded land: land that will not revert to its former state through good agricultural, rangeland management, or forestry practice alone. Practices include restoration of severely eroded land and land polluted with heavy metals or mine spoils, as well as reclamation of deserts, saline soils, and alkaline soils.
US-RFS2	RFS2 does not define marginal/degraded/abandoned land. However, to meet the definition of "renewable biomass," planted crops and crop residue must come from "agricultural land" cleared or cultivated at any time prior to December 19, 2007, that is either actively managed or fallow, and nonforested. The definition of "agricultural land" is proposed to include cropland, pastureland, Conservation Reserve Program (CRP) land, and possibly rangeland.[6] Pastureland: land managed primarily for the production of indigenous or introduced forage plants for livestock grazing or hay production, and to prevent succession to other plant types. Under this proposed definition, land would qualify as pastureland if it is maintained for grazing or hay production and not allowed to develop greater ecological diversity. Range land: land on which the indigenous or introduced vegetation is predominantly grasses, grass-like plants, forbs, or shrubs and which – unlike cropland or pastureland – is predominantly managed as a natural ecosystem, to allow, for example, existing switchgrass or native grasses on rangeland to be used for renewable fuel production that qualifies for RIN generation under this program. Fallow: agricultural land that is intentionally left idle to regenerate for future agricultural purposes, with no seeding or planting, harvesting, mowing, or treatment during the fallow period.

[6] Based on mutually exclusive categories of land defined by the USDA's Natural Resources Conservation Service (NRCS) in its annual Natural Resources Inventory (NRI), a statistical survey designed to estimate natural resource conditions and trends on non-federal U.S. lands.

Abandoned and marginal lands are hard to define, as their status may change due to economic conditions, technology, environmental factors, or other factors. Though information is scarce, databases concerning these lands and the appropriate steps to utilize them sustainably have been explored (Wiegmann, Hennenberg, and Fritsche 2008). As shown in Table 5, the US-RFS2 had detailed discussion on the proposed definition of "agricultural land," which includes crop land, pastureland, Conservation Reserve Program (CRP) land, and possibly rangeland. The US EPA noted that the challenge often lies in implementation and enforcement, as complex definition and verification criteria may prove to be "unworkable and unenforceable" (US EPA 2009b).

It is also unclear whether and how to calculate the GHG emissions from converting degraded land to produce biofuel feedstock. Methodologies would be needed to define what type of soil carbon data for degraded land is adequate, based on IPCC Tier 2 (country-specific parameter values) or Tier 3 (detailed modeling and/or inventory measurement systems) criteria. Methodologies would also be needed to quantify the impacts of intended energy cultivation of degraded land, which could function as a sink for many years—perhaps more than half a century (IPCC 2001), on soil carbon and ecosystem function.

4.2 Remaining Policy Challenges

4.2.1 Continuous improvement in lifecycle assessment research and the interaction with policy design

Lifecycle analysis methodology will continue to extend our scientific understanding of the impacts of future transportation fuels. Little is known about the lifecycle environmental effects of new alternative fuels, such as on air pollution, water use, water pollution (Costello et al. 2009; Dodds et al. 2009; Donner and Kucharik 2008; Fingerman et al. 2008), biodiversity, and invasive species. The methodologies of conducting these types of analyses are in its infancy stage. Much is yet to be defined regarding the selection of physical, temporal and spatial system boundaries, methods of co-product allocation, and the integration of different impacts. The sustainability framework should adopt a lifecycle approach and apply to all fuels, feedstocks, and production and conversion technologies, a supply-chain approach reflected in the RSB framework and elsewhere (NRC 2009). Despite continued improvement in understanding science and reducing modeling uncertainties, stakeholders should be engaged to discuss ways to create a robust policy framework that will reflect evolving scientific understanding and provide a stable compliance environment. Far more work will be needed to test the scientific robustness of new studies, the general applicability of study results across time and space, and the legal framework of taking lifecycle environmental impacts into account.

4.2.2 Cost of implementing a sustainability standard

The cost of meeting a sustainability standard includes compliance and verification. The cost of establishing a sustainability claim depends on the type of biomass or feedstock, the strictness of sustainability criteria, the country of study, the reference situation, the price of the final product, and many other factors (van Dam et al. 2008). The cost of certification and traceability also depends on the scale of production, the strictness of sustainability criteria, the complexity of the supply chain and the risk factors involved (e.g., the integrity of the managements such as internal control and quality control within the system, histories of complaints, and risk of corruption) (RSB 2009c). A company with a complex supply chain or lax internal control will require more rigor of audit and thus incur higher cost. As mentioned earlier, the supply chains for dedicated energy feedstocks (e.g., switchgrass) may be simpler in that they seem to have few important uses outside the biofuels complex. Thus the additional cost of implementing strictest CoC to ensure traceability may be less than for other types of feedstocks.

In its Regulatory Impact Assessment, the UK estimated that the annual cost of gathering carbon and sustainability information along the biofuel supply chain and the preparation and auditing of annual carbon and sustainability reports is £43.3K ($71.0K US dollars) for each supplier, consisting of monthly collection and submission of carbon and sustainability (C&S) data (24%), work with suppliers to improve the quality and collection of data (31%), and validation of the annual C&S report by external consultants (45%) (RFA 2009d).

4.2.3 Incentives for performance-based approach

California's LCFS provides strong incentives for GHG performance. The lower the average GHG intensity of the fuels, the smaller quantity of alternative fuels would be needed to meet the GHG reduction target. Thus, use of lower-carbon fuels will generate more LCFS credits than the same volume of fuel with higher carbon intensity. Similarly, low-GHG fuels incurring higher relative costs of production may still remain more competitive in the LCFS credit system.

For the other sustainability criteria, the "basic" and "progress" requirements proposed by the RSB also embrace the concept of a performance standard. However, the crucial element for ensuring the success of the concept is to provide adequate incentives to encourage innovation and reward certifiably superior performance beyond minimum requirements. Voluntary incentives could come from public pressure and regulated parties' desire to improve public image (e.g., corporate social responsibility). However, biofuels deemed more sustainable may or may not command a premium in the market place. Studies suggest that even though consumers favor "green" products and labeling, they are unwilling to pay more or they find

the information on green products confusing, lacking transparency, and difficult to verify (HGCA 2008; LowCVP 2008).

More structured regulatory incentives can be achieved by providing credits or tax breaks (e.g., reductions in state gasoline tax) for improvements in environmental quality or conservation. For example, the federal Environmental Quality Incentives Program (EQIP) provides technical assistance, cost-share payments, and incentive payments to crop, livestock, forestry, and other agricultural producers adopting practices that reduce environmental and resource problems with regard to soil quality, soil erosion, water quality, water shortage, and air quality and that protect wildlife and animal and plant species of concern. Applicants must develop conservation plans, which are evaluated by how well they meet national, state, and local environmental objectives as well as by their cost-efficiency. Total EQIP payments to producers reached $735 million in 2008.

4.2.4 World Trade Organization (WTO)

Some, if not many, of the proposed sustainability standards are believed to possibly violate WTO rules (van Dam et al. 2008). The WTO requires that regulations and standards should neither create unnecessary barriers nor discriminate against products with the same physical appearance (properties) but with different production *process* and *production methods* (PPM). The GATT[7] "Dolphin-Tuna" case[8] in 1991 set the precedent that labeling on the basis of unrelated PPM[9] is allowed as long as the labeling is voluntary and any advantage in trade would depend on the free choice of consumers rather than granted by the government (FAO 2003). The Forest Stewardship Council (FSC) certification was accepted under the rules of the WTO under three conditions (van Dam et al. 2008): (1) there should be an open market for all certification schemes; (2) there should be no political action to diminish the trade of uncertified products; and (3) to avoid discriminatory action against specific regions, the origin of the timber should not be included on the label.

Standards, certifications, and labeling developed by NGOs such as the RSB are required to "accept and comply with the Code of Good Practices for the Preparation, Adoption and Application of Standards" (GATT, the Technical Barrier To Trade (TBT) agreement), which stipulates the following: the standards should not discriminate like products of national origin and not restrict trade; efforts should be made to ensure international harmonization and public consultation; standards should not create unnecessary

[7] GATT (General Agreement on Tariffs and Trade) is the predecessor of WTO, which was established in 1995.
[8] The settlement panel report, though never adopted, is one of the few Panel reports on PPM-labeling to guide further interpretation.
[9] Unrelated PPM refers to PPM not related to product characteristics. Examples of unrelated PPM are the quality or safety of a product (FAO 2003).

obstacles to the expansion and diversification of exports from developing countries; and efforts should be made to allow developing countries to comment on the standards (FAO 2003). The RSB process has mostly followed and complied with the WTO guidelines.

However, requiring all participating fuels to meet the sustainability criteria can be considered trade-restrictive, as it would grant advantage to labeled products and restrict the trade of non-labeled products. Voluntary standards can become de facto mandatory if a standard has the effect of market segregation or can affect consumers' perception (FAO 2003) or the competitiveness of a product. Exceptions to the "no discrimination against like product" rule are, however, allowed for Members to adopt or enforce standards, certification, or labeling if any of the conditions in the General Exceptions of the GATT Article XX is met (FAO 2003):

> *(a) necessary to protect public morals;*
> *(b) necessary to protect human, animal or plant life or health;*
> *...*
> *(g) relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption.*

Studies examining the WTO issue (Cramer et al. 2007; van Dam et al. 2008) generally concluded the following:

- Some of the sustainability principles and criteria may violate this WTO PPM rule.
- A reporting obligation for companies to deliver information on the sustainability of their biomass is considered feasible under WTO/EU law. Therefore, the proposed sustainability framework that requires reporting is unlikely to violate WTO rules.
- Minimum demands for biodiversity and environment may have a medium-high risk of violating WTO rules.
- Minimum demands on economic prosperity and well-being will be in violation of the WTO, except for extreme human rights violations (e.g., slavery).

As the UK-RTFO and EU-RED have adopted more stringent certification requirements for meeting social and environmental sustainability criteria for biofuels, they have received strong support for these schemes from major feedstock producers via the developments of certifications such as the RSPO for palm oil and the RTRS for soybeans. The RSB process has mostly complied with WTO's guidance for Code of Good Practices for the Preparation, Adoption and Application of Standards under the TBT agreement. It remains to be seen whether this new regime of international collaboration will reduce the risk of violating WTO rules.

4.3 Concluding Remarks

This paper compares major efforts in social and environmental sustainability requirements for biofuels and attempts to outline a feasible pathway for California's LCFS sustainability provision. With the increasing recognition of the need to adopt sustainability safeguards for new transportation fuels that have potentially large environmental consequences, stakeholders should collaborate to establish a performance-based sustainability scheme that sets reasonable expectations and clear measures of compliance. The scheme should encourage innovation and reward practices exceeding a minimum standard, but proper incentive mechanisms will be needed. A sustainability scheme can only be effective if the proposed framework is robust but not excessively complicated, and the criteria are measureable and verifiable. It also needs to acknowledge the limitations of resources, politics, and California's legal jurisdiction and be consistent with international efforts in sustainability criteria. Government assistance in facilitating information sharing, certification, and capacity will be crucial for the development of the sustainability criteria.

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Appendix A. Comparison of Sustainability Standards/Requirements by Governments Based on the Framework of RSB Principles and Criteria (Version 0.5).

RSB	**Principle 1: Legality** Biofuel production shall follow all applicable laws and regulations **Criterion 1.** Biofuel operations shall comply with all applicable laws and regulations of the country in which the production activity occurs and with relevant international law.
RTFO	The first criterion of all five environmental principles and the fist social principle.
RED	**Article 17. 6.** Agricultural raw materials cultivated in the Community and used for the production of biofuels and bioliquids … shall be obtained in accordance with the requirements and standards under the provisions referred to under the heading 'Environment' in part A and in point 9 of Annex II to Council Regulation (EC) No 73/2009 of 19 January 2009 ... and in accordance with the minimum requirements for good agricultural and environmental condition defined pursuant to Article 6(1) of that Regulation.

RSB	**Principle 2: Planning, Monitoring and Continuous Improvement** Sustainable biofuel operations shall be planned, implemented, and continuously improved through an open, transparent, and consultative Environmental and Social Impact Assessment (ESIA) and an economic viability analysis. **Criterion 2.a** Biofuel operations shall undertake an Environmental and Social Impact Assessment (ESIA) to assess impacts and risks and ensure sustainability through the development of effective and efficient implementation, mitigation, monitoring and evaluation plans. **Criterion 2.b** Free, Prior & Informed Consent (FPIC) shall form the basis for the process to be followed during all stakeholder consultation, which shall be gender sensitive and result in consensus-driven negotiated agreements. **Criterion 2.c** Biofuel operations shall implement a business plan that reflects a commitment to long-term economic viability.
RTFO	In all environmental principles, regulated parties are required to report compliance in the monthly report by demonstrating the evidence of compliance with national and local laws and regulations with respect to Environmental Impact Assessment (EIA). In the annual report, fuel suppliers are expected to report details of: • Actions that have been taken to increase the sourcing of sustainable biofuels and biofuels with a lower carbon intensity, including actions to promote production on idle land. • Environmental management system certificates. • Successful prosecutions for breaches of compliance with any environmental and/or social regulations related to biofuels activities; • Existing verified environmental / corporate responsibility reporting Information on other parties within the supply chain: • Environmental management system certificates held, e.g. ISO14001.
RED	**Article 18. 3.** Member States shall require economic operators to arrange for an adequate standard of independent auditing of the information submitted, and to provide evidence that this has been done. The auditing shall verify that the systems used by economic operators are accurate, reliable and protected against fraud. It shall evaluate the frequency and methodology of sampling and the robustness of the data. The information referred to in the first subparagraph shall include in particular information on compliance with the sustainability criteria set out in Article 17(2) to (5), appropriate and relevant information on measures taken for **soil**, **water** and **air** protection, the restoration of **degraded land**, the avoidance of excessive **water consumption** in areas where water is scarce and appropriate and relevant information concerning measures taken in order to take into account the issues referred to in the second subparagraph of **Article 17(7)**.[10]

RSB	**Principle 3: Greenhouse Gas Emissions** Biofuels shall contribute to climate change mitigation by significantly reducing lifecycle GHG emissions as compared to fossil fuels. **Criterion 3.a** GHG emissions shall be calculated via an RSB-approved approach to lifecycle assessment, with system boundaries from land to tank.

[10] This refers to social and economic impacts both for third countries and Member States that are a significant source of raw material for biofuel consumed within the Community.

	Criterion 3.b For the assessment of lifecycle GHG emissions, either default values determined by the RSB or calculated values shall be used for the major steps in the biofuel production chain. **Criterion 3.c** Biofuels' contribution to climate change mitigation shall be improved over time.
RTFO	**Principle 1: Carbon Conservation.** Biomass production will not destroy or damage large above or below ground carbon stocks. **Criterion 1.1** Preservation of above and below ground carbon stocks (reference date 30-11-2005). Evidence that biomass production has not caused direct land use change with a carbon payback time exceeding 10 years. Evidence that the biomass production unit has not been established on soils with a large risk of significant soil stored carbon losses such as peat lands, mangroves, wetlands and certain grasslands.
RED	**Article 17. 2.** The greenhouse gas emission saving from the use of biofuels and bioliquids … shall be at least 35 %. With effect from 1 January 2017, the greenhouse gas emission saving … shall be at least 50 %. From 1 January 2018 that greenhouse gas emission saving shall be at least 60 % for biofuels and bioliquids produced in installations in which production started on or after 1 January 2017. **Article 17.4.** 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 and no longer has that status: (a) wetlands, namely land that is covered with or saturated by water permanently or for a significant part of the year; (b) continuously forested areas, namely land spanning more than one hectare with trees higher than five metres and a canopy cover of more than 30 %, or trees able to reach those thresholds in situ; (c) land spanning more than one hectare with trees higher than five metres and a canopy cover of between 10 % and 30 %, or trees able to reach those thresholds in situ, unless evidence is provided that the carbon stock of the area before and after conversion is such that, when the methodology laid down in part C of Annex V is applied, the conditions laid down in paragraph 2 of this Article would be fulfilled.
RFS2	'advanced biofuel' (renewable fuel, other than ethanol derived from corn starch) … has lifecycle greenhouse gas emissions... at least 50 percent less than baseline lifecycle greenhouse gas emissions. 'biomass-based diesel' … at least 50 percent less… 'cellulosic biofuel'… at least 60 percent less than the baseline lifecycle GHG emissions.

RSB	**Principle 4: Human and Labor Rights** Biofuel production shall not violate human rights or labor rights, and shall promote decent work and the well-being of workers. **Criterion 4.a** Workers shall enjoy freedom of association, the right to organise, and the right to collectively bargain. **Criterion 4.b.** No slave labour or forced labour shall occur. **Criterion 4.c** No child labour shall occur, except on family farms and then only when work does not interfere with the child's schooling and does not put his or her health at risk. **Criterion 4.d** Workers shall be free of discrimination of any kind, whether in employment or opportunity, with respect to wages, working conditions, and social benefits. **Criterion 4.e** Workers' wages and working conditions shall respect all applicable laws and international conventions, as well as all relevant collective agreements. Wages shall aim to be above poverty levels and equal to or better than the average conditions established for work of the same character or offered by comparable employers in the local market. Men and women shall receive equal remuneration for work of equal value. **Criterion 4.f** Conditions of occupational safety and health for workers shall follow internationally-recognised standards. **Criterion 4.g** Operators shall implement a mechanism to ensure the human rights and labor rights outlined in this principle apply equally when labor is contracted through third parties.
RTFO	**Principle 6: Workers rights.** Biomass production does adversely affect workers rights and working relationships C 6.1 Compliance with national law on working conditions and workers rights. C 6.2 Contracts. C 6.3 Provision of information. C 6.4 Subcontracting. C 6.5 Freedom of association and right to collective bargaining. C 6.6 Child labour. C 6.7 Young workers. C 6.8 Health and safety. C 6.9 Wages/ compensation. C 6.10 Discrimination. C 6.11 Forced Labour.
RED	See also under Principle 2.

RSB	**Principle 5: Rural and Social Development** **Principle 5.** In regions of poverty, biofuel production shall contribute to the social and economic development of local,

	rural and indigenous people and communities. **Criterion 5.a** In regions of poverty, the socioeconomic status of local stakeholders impacted by biofuel production shall be improved (criterion for operations located in regions of poverty). **Criterion 5.b** In regions of poverty, special measures that benefit and encourage the participation of women, youth, indigenous communities and the vulnerable in biofuel production shall be designed and implemented (criterion for operations located in regions of poverty).
RTFO	See RTFO Principle 7 recommended only social criteria

RSB	**Principle 6: Local Food Security** Biofuel production shall ensure the right to adequate food and improve food security in food insecure regions. **Criterion 6.a** Biofuel production shall assess risks to food security in the region and locality and shall mitigate any negative impacts that result from biofuel production. **Criterion 6.b** In food insecure regions, biofuel production shall enhance local food security.

RSB	**Principle 7: Conservation** Biofuel production shall avoid negative impacts on biodiversity, ecosystems, and High Conservation Value areas. **Criterion 7.a** High Conservation Value areas, native ecosystems, buffer zones, ecological corridors and other public and private biological conservation areas shall be identified and protected. **Criterion 7.b** Ecosystem functions and services shall be maintained. **Criterion 7.c** Buffer zones shall be protected, restored or created. **Criterion 7.d** Ecological corridors shall be protected, restored or created to minimize fragmentation of habitats. **Criterion 7.e** Biofuel production shall not use crop species considered invasive under local conditions.
RTFO	**Principle 2: Biodiversity conservation.** Biomass production will not lead to the destruction or damage of high biodiversity areas **2.1** Compliance with national laws and regulations relevant to biomass production in the area and surroundings where biomass production takes place. **2.2** No conversion of high biodiversity areas after November 30, 2005. **2.3** The status of rare, threatened or endangered species and high conservation value habitats, if any, that exist in the production site or that could be affected by it, shall be identified and their conservation taken into account in management plans and operations.
RED	**Article 17.3.** Biofuels and bioliquids … shall not be made from raw material obtained from land with high biodiversity value, namely land that had one of the following statuses in or after January 2008, whether or not the land continues to have that status: (a) primary forest and other wooded land, namely forest and other wooded land of native species, where there is no clearly visible indication of human activity and the ecological processes are not significantly disturbed; (b) areas designated: (i) by law or by the relevant competent authority for nature protection purposes; or (ii) for the protection of rare, threatened or endangered ecosystems or species recognised by international agreements or included in lists drawn up by intergovernmental organisations or the International Union for the Conservation of Nature, subject to their recognition in accordance with the second subparagraph of Article 18(4); unless evidence is provided that the production of that raw material did not interfere with those nature protection purposes; (c) highly biodiverse grassland that is: (i) natural, namely grassland that would remain grassland in the absence of human intervention and which maintains the natural species composition and ecological characteristics and processes; or (ii) non-natural, namely grassland that would cease to be grassland in the absence of human intervention and which is species-rich and not degraded, unless evidence is provided that the harvesting of the raw material is necessary to preserve its grassland status. The Commission shall establish the criteria and geographic ranges to determine which grassland shall be covered by point (c) of the first subparagraph. **Article 17.4.** 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 and no longer has that status: (a) wetlands, namely land that is covered with or saturated by water permanently or for a significant part of the year; (b) continuously forested areas, namely land spanning more than one hectare with trees higher than five metres and a canopy cover of more than 30 %, or trees able to reach those thresholds in situ; (c) land spanning more than one hectare with trees higher than five metres and a canopy cover of between 10 % and 30 %, or trees able to reach those thresholds in situ, unless evidence is provided that the carbon stock of

	the area before and after conversion is such that, when the methodology laid down in part C of Annex V is applied, the conditions laid down in paragraph 2 of this Article would be fulfilled. **Article 17.5.** Biofuels and bioliquids … shall not be made from raw material obtained from land that was peatland in January 2008, unless evidence is provided that the cultivation and harvesting of that raw material does not involve drainage of previously undrained soil. See also under Principle 2.
RFS2	(I) RENEWABLE BIOMASS.—The term 'renewable biomass' means each of the following: (i) Planted crops and crop residue harvested from agricultural land cleared or cultivated at any time prior to December 19, 2007, that is either actively managed or fallow, and nonforested. (ii) Planted trees and tree residue from actively managed tree plantations on non-federal land cleared at any time prior to enactment of this sentence, including land belonging to an Indian tribe or an Indian individual, that is held in trust by the United States or subject to a restriction against alienation imposed by the United States. (iiii) Animal waste material and byproducts (iv) Slash and pre-commercial thinnings that are from non-federal forestlands, including forestlands belonging to an Indian tribe or an Indian individual, that are held in trust by the United States or subject to a restriction against alienation imposed by the United States, but not forests or forestlands that are ecological communities with a global or State ranking of critically imperiled, imperiled, or rare pursuant to a State Natural Heritage Program, old growth forest, or late successional forest. (v) Biomass obtained from the vicinity of buildings at risk from wildfire. (vi) Algae, and (vii) Separated yard waste or food waste.

RSB	**Principle 8: Soil** Biofuel production shall implement practices that seek to maintain soil health and reverse degradation. **Criterion 8.a** Feedstock producers shall implement a soil management plan designed to maintain or improve soil physical, chemical, and biological conditions.
RTFO	**Principle 3: Soil conservation.** Biomass production does not lead to soil degradation **3.1** Compliance with national laws and regulations relevant to soil degradation and soil management. **3.2** Application of good agricultural practices with respect to: – Prevention and control of erosion – Maintaining and improving soil nutrient balance – Maintaining and improving soil organic matter – Maintaining and improving soil pH – Maintaining and improving soil structure – Maintaining and improving soil biodiversity
RED	**Article 7.6.** Agricultural raw materials cultivated in the Community and used for the production of biofuels and bioliquids … shall be obtained in accordance with the requirements and standards under the provisions referred to under the heading 'Environment' in part A and in point 9 of Annex II to Council Regulation (EC) No 73/2009 of 19 January 2009 establishing common rules for direct support schemes for farmers under the common agricultural policy and establishing certain support schemes for farmers and in accordance with the minimum requirements for good agricultural and environmental condition defined pursuant to Article 6(1) of that Regulation. See also under Principle 2.

RSB	**Principle 9: Water** Biofuel production shall maintain or enhance the quality and quantity of surface and ground water resources, and respect prior formal or customary water rights. **Criterion 9.a** Biofuel production shall respect the existing water rights of local and indigenous communities and water needs for the long-term sustainability of ecosystems. **Criterion 9.b** Biofuel production shall include a water management plan which aims to use water efficiently and to maintain or enhance the quality of the water resources that are used for biofuel production. **Criterion 9.c** Biofuel production shall not withdraw surface or groundwater resources beyond replenishment capacities. **Criterion 9.d** The quality of the surface and groundwater resources that are used for biofuel production shall be maintained or enhanced.
RTFO	**Principle 4: Sustainable water use.** Biomass production does not lead to the contamination or depletion of water sources **Criterion 4.1** Compliance with national laws and regulations relevant to contamination and depletion of water sources.

	Criterion 4.2 Application of good agricultural practices to reduce water usage and to maintain and improve water quality.
RED	See also under Principles 2 and 8.

RSB	**Principle 10: Air** Air pollution from biofuel production shall be minimized along the supply chain. **Criterion 10.a** Air pollution emission sources from biofuel production shall be identified, and air pollution minimized. **Criterion 10.b** Biofuel production shall avoid and, where possible, eliminate open-air burning of residues, wastes or by-products. Good practices for contained burning of residues, wastes or byproducts shall be used to maintain emissions of air pollutants below national and international norms.
RTFO	**Principle 5: Air quality.** Biomass production does not lead to air pollution **Criterion 5.1** Compliance with national laws and regulations relevant to air emissions and burning practices. **Criterion 5.2** No burning as part of land clearing or waste disposal.
RED	See also under Principles 2 and 8.

RSB	**Principle 11: Use of Technology, Inputs, and Management of Waste** **Principle 11.** The use of technologies in biofuel production shall seek to maximize production efficiency and social and environmental performance, and minimize the risk of damages to the environment and people. **Criterion 11.a** Information on the use of technologies in biofuel production shall be fully available, unless limited by national law or international agreements on intellectual property. **Criterion 11.b** The technologies used in biofuel production 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. **Criterion 11.c** Micro-organisms used in biofuel processing which may represent a risk to the environment or people shall be adequately contained to prevent release into the environment. **Criterion 11.d** Good practices shall be implemented for the storage, handling, use, and disposal of chemicals. **Criterion 11.e** Residues, wastes and byproducts from feedstock processing and biofuel production units shall be managed such that soil, water and air physical, chemical, and biological conditions are not damaged.
RTFO	See RTFO Criterion 5.2

RSB	**Principle 12: Land Rights** Biofuel production shall respect land rights and land use rights. **Criterion 12.a** Existing land rights and land use rights shall be assessed, documented, and established. The right to use land for biofuel production or processing of feedstock for biofuel shall be established. **Criterion 12.b** Free, Prior, and Informed Consent shall form the basis for all negotiated agreements for any compensation, acquisition, or voluntary relinquishment of rights by land users or owners for biofuel production. **Criterion 12.c** Biomass production shall ensure no issues relating to use rights, land rights or traditional rights including issues of equitable compensation are pending
RTFO	**Principle 7: Land rights.** Biomass production does not adversely affect existing land rights and community relations **Criterion C 7.1** Land right issues **Criterion C 7.2** Consultation and communication with local stakeholders
RED	See also under Principles 2 and 8.

Appendix B. Comparison of Sustainability Reporting Requirement for Governments

Environmental and Resource Impact Reporting

RTFO	The RFA will separately monitor the potential indirect impacts of biofuel production such as indirect land-use change or changes to food and other commodity prices that are beyond the control of individual suppliers. It will report in these as part of its annual report to Parliament. (e.g. *The Gallagher Review of the indirect effects of biofuels production* (Gallagher 2008)).
RED	**Article 17. 7.** The Commission shall, every two years, report to the European Parliament and the Council, in respect of both third countries and Member States that are a significant source of biofuels or of raw material for biofuels consumed within the Community, on national measures taken to respect the sustainability criteria set out in paragraphs 2 to 5 and for soil, water and air protection. The first report shall be submitted in 2012. **Article 19.4.** The Commission shall, by 31 December 2010, submit a report to the European Parliament and to the Council reviewing the impact of indirect land-use change on greenhouse gas emissions and addressing ways to minimise that impact. The report shall, if appropriate, be accompanied, by a proposal, based on the best available scientific evidence, containing a concrete methodology for emissions from carbon stock changes caused by indirect land-use changes, ensuring compliance with this Directive, in particular Article 17(2).
RFS2	**Sec. 202.** the applicable volumes of each fuel specified in the tables in clause (i) for calendar years after the calendar years specified in the tables shall be determined based on … ''(I) the impact of the production and use of renewable fuels on the environment, including on air quality, climate change, conversion of wetlands, ecosystems, wildlife habitat, water quality, and water supply. **Sec. 204.** … the Administrator of the Environmental Protection Agency, in consultation with the Secretary of Agriculture and the Secretary of Energy, shall assess and report to Congress on the impacts to date and likely future impacts of the requirements of section 211(o) of the Clean Air Act on the following: (1) Environmental issues, including air quality, effects on hypoxia, pesticides, sediment, nutrient and pathogen levels in waters, acreage and function of waters, and soil environmental quality. (2) Resource conservation issues, including soil conservation, water availability, and ecosystem health and biodiversity, including impacts on forests, grasslands, and wetlands. (3) The growth and use of cultivated invasive or noxious plants and their impacts on the environment and agriculture.

Socio-economic Impact Reporting

RTFO	The RFA will separately monitor the potential indirect impacts of biofuel production such as indirect land-use change or changes to food and other commodity prices that are beyond the control of individual suppliers. It will report in these as part of its annual report to Parliament. (e.g. *The Gallagher Review of the indirect effects of biofuels production* (Gallagher 2008)).
RED	**Article 17. 7.** The Commission shall, every two years, report to the European Parliament and the Council … they shall state, both for third countries and Member States that are a significant source of raw material for biofuel consumed within the Community, whether the country has ratified and implemented each of the following Conventions of the International Labour Organisation: — Convention concerning Forced or Compulsory Labour (No 29), — Convention concerning Freedom of Association and Protection of the Right to Organise (No 87), — Convention concerning the Application of the Principles of the Right to Organise and to Bargain Collectively (No 98), — Convention concerning Equal Remuneration of Men and Women Workers for Work of Equal Value (No 100), — Convention concerning the Abolition of Forced Labour (No 105), — Convention concerning Discrimination in Respect of Employment and Occupation (No 111), — Convention concerning Minimum Age for Admission to Employment (No 138), — Convention concerning the Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labour (No 182). Those reports shall state, both for third countries and Member States that are a significant source of raw material for biofuel consumed within the Community, whether the country has ratified and implemented: — the Cartagena Protocol on Biosafety, the Convention on International Trade in Endangered Species of Wild Fauna and Flora.
RFS2	**Sec. 202.** the applicable volumes of each fuel specified in the tables in clause (i) for calendar years after the calendar years specified in the tables shall be determined based on … "(VI) the impact of the use of renewable fuels on other factors, including job creation, the price and supply of agricultural commodities, rural economic development, and food prices.