Constructing sustainable biofuels: governance of the emerging biofuel economy

"We find ourselves on the same side of the fence with NGOs that have been our critics in the past. This is about ethics, it is about public health and it is about sustainable agriculture."

Alan Jope, vice-president of Unilever (quoted in Mortished, 2006)

''We haven't been able to halt the supply from rainforests of illegally felled timber so how can we have confidence that sustainability certificates would be worth the paper on which they are written?,''

Chris Davies, British Liberal Democrat Euro-MP (quoted in Waterfield, 2007)

"There absolutely must be environmental certification [for biofuels]. The announcement [of the RTFO] says there will be, but the devil lies in the detail."

Oliver Harwood, Country Land and Business Ass'n (UK) (quoted in Davies, 2005)

I. Introduction

Recent shifts in environmental governance have shown the power of non-nation-state actors (NNSAs) to drive policy formulation. Driven by multiple agendas and acting variously in concert with, or in opposition to the state, as well as in its absence, NNSAs have been key participants in the development of what Swyngedouw has termed "governance beyond the state" (Swyngedouw, 2005). These forms of governance are affecting the provision of diverse commodities ranging from minerals and forest products to fresh produce and even non-material goods like carbon offsets. These shifts are driven by an emergent awareness of the detrimental impacts of globalized production/consumption and reflect the jostling for position among various actors to affect policy outcomes in areas where the state has been traditionally weak: the governance of production/consumption itself.

Biofuels have also drawn the attention of NNSAs who are interested in addressing sustainability concerns. Numerous national and sub-national policies have been drafted that will dramatically increase biofuel consumption in both developed and developing economies in order to meet a range of environmental and socio-political objectives, including climate change mitigation and domestic energy security, as well as support for the agricultural sector in the North and the development of rural livelihoods in the South (The Observer, 2005). However, evidence from recent scientific research has raised questions about whether large-scale biofuel production can meet some or all of these objectives (Naylor et al., 2007; Fargione et al., 2008; Searchinger et al., 2008; Searchinger et al., 2009). These studies emerged concurrently with media reports of deforestation (Waterfield, 2007), food price spikes (von Braun, 2007; Chakrabortty, 2008), and even forced labor associated with biofuel production (Welch, 2006; Dos Santos, 2007). In response, many efforts are now underway to define and operationalize socially and environmentally acceptable modes of biofuel production through the application of sustainability standards[1] even as others question if this is indeed possible (Colbran and Eide, 2008; Gordon, 2008; Moore, 2008).

With biofuels, a hybrid form of governance is taking shape (Swyngedouw, 2005). Couched in discourses of sustainability, super-governmental organizations like the EC and various UN agencies, national and sub-national governments, corporations and civil society organizations are all weighing in to define standards, meta-standards, labeling schemes, and codes of conduct. Sustainability standards for biofuels, defined by a combination of super-governmental, nation-state and non-state actors, will attempt to govern *how, where and under what conditions* biofuels may be produced if they are to be considered sustainable and therefore, socially and politically acceptable for consumption. Taken in the historical context of North-South trade and aid relationships (Nel, 2006; Moyo, 2009), several decades of North-South tension in global environmental governance (Roberts and Parks, 2007), and the numerous inequities that are both caused and reinforced by the existing global food system (Little and Watts, 1994; Goodman and Watts, 1997), any system of governance that purports to identify and label sustainable pathways for biofuels faces numerous challenges.

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[1] At the time of writing, van Dam (2009) had identified 35 schemes worldwide that attempt to define some form of sustainability criteria for energy derived from biomass (this includes liquid biofuels and solid biomass used for heat and/or power production). In addition, soy, oil palm and sugarcane, which are three major biofuel crops that also have major markets in non-fuel applications, each have their own sustainability initiatives addressing the production of the commodity. Plus, she has identified roughly 30 additional standards that apply to forestry or agriculture, but could be relevant for biofuel production.

Despite these challenges, there are some reasons to be optimistic. As a relatively new industry, with novel crops being introduced and new global trade linkages developing, biofuels represent a rare opportunity to learn from past experiences and “get it right”. There is evidence that the political space opened by newly emergent forms of environmental governance and growing awareness of “ethical consumption”, is being utilized to construct a resilient set of transnational institutions in support of sustainable biofuels. However, such institutions take time to develop and gain legitimacy. The rapid rate of growth in the biofuel sector appears to be outpacing the building of institutions to assure biofuel sustainability. This paper will explore how efforts to promote biofuel sustainability have evolved as our understanding of the potential threats that biofuels pose has grown. Section II outlines the reemergence of biofuels as a viable energy alternative and describes some of the potential impacts of large scale biofuel production. Section III situates the current attempts to govern biofuels in the context of broad movements toward environmental governance at different scales. In Section IV, I review how a sample of sustainability certification schemes are coming together in practice, I close with some concluding remarks in Section V.

II. The (re)emergence of Biofuels

Between 2000 and 2008, the world’s annual production of liquid biofuels increased by roughly a factor of four. Production is expected to continue increasing as a result of deliberate policies that aim to increase biofuel consumption in a number of countries. Figure 1 shows global biofuel production between 2000 and 2008 as well as projections to 2015 based on forecasts from the UN Food and Agriculture Organization (FAO, 2008).[2] These policies hope to satisfy a range of objectives including increased energy security, greenhouse gas emission reductions and, in a number of countries, support for the agricultural sector. In addition, many proponents of biofuels, including international development organizations, have noted the potential for biofuels to boost the livelihoods of rural producers developing countries (Kojima and Johnson, 2005; Peskett et al., 2008).[3]

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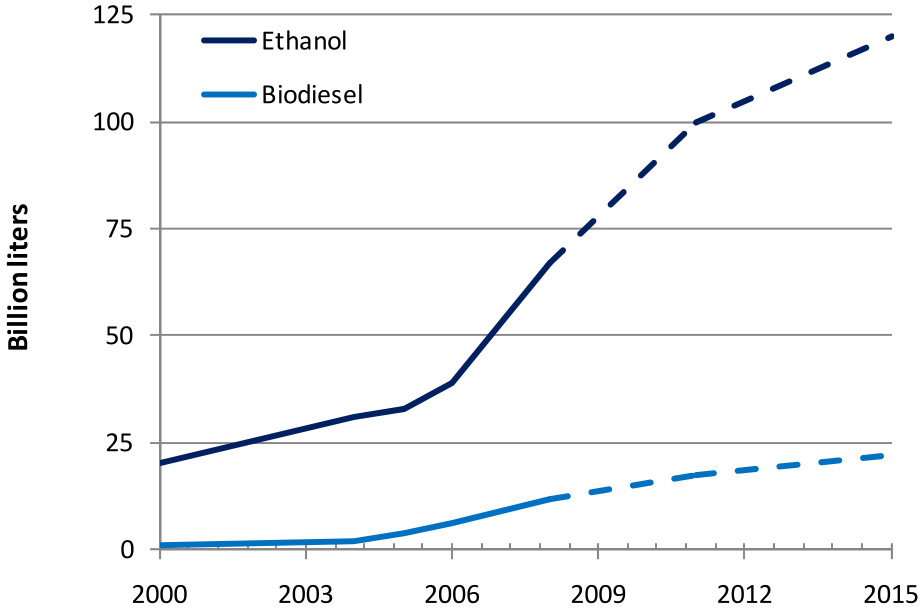
[2] The FAO’s projections are based on current blending targets made in numerous countries. These are shown in Appendix 1.

[3] Much has been written about the potential for biomass energy to boost rural livelihoods. Within this discussion, a distinction must be drawn between biomass feedstocks grown entirely for local use (e.g. household energy applications or small scale off-grid power production) and biofuels grown as cash crop for non-local consumption. Of course, the potential exists for alternatives between these extremes in which a fraction of the crop, or its co-

Figure 1: Global ethanol and biodiesel production 2000-2008 with projections to 2015



While the recent surge in biofuel production is unprecedented, biofuels are not new. Alcohol and edible oils were used in internal combustion engines since the engines themselves were introduced over a century ago.[4] Of course, vegetable-based fuels were rapidly supplanted by fossil fuels and have only been blended with fossil fuels as a matter of policy since the late 1970s. At that time, ethanol was introduced primarily to reduce demand for imported oil during the price shocks of the late 1970s and early eighties. Since that time, there has been some debate about the environmental performance of different starch and sugar-based feedstocks. Some analyses show that certain crops and production systems, particularly corn-based ethanol, which dominates production in the US, require more energy to produce than they save when they are used to displace gasoline.[5] A weakly positive or negative energy

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products, are used locally. For example, many oil crops produce seed husks and press-cake residues that can be processed into fertilizer, fuel, or both, and used locally.

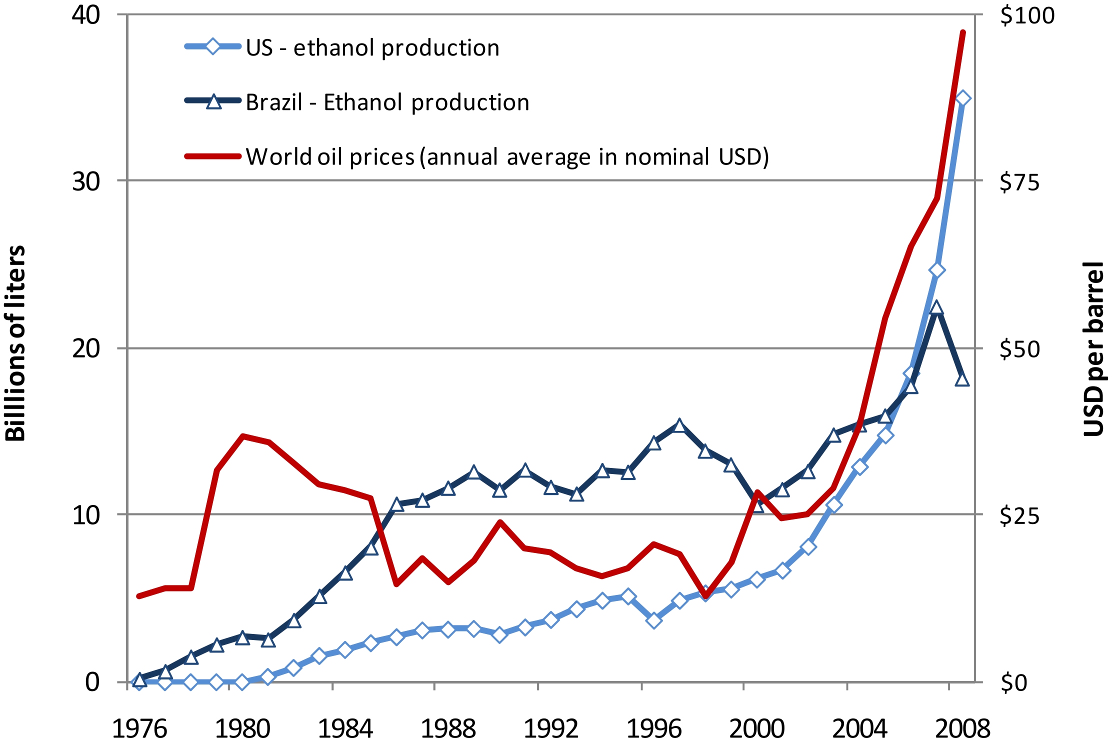
[4] Knothe (2001) notes the use of peanut oil in a diesel engine demonstrated at the Paris World's Fair in 1900. In addition, many accounts cite Henry Ford's affinity for alcohol as a fuel for his early vehicles. The Model-T for example, was a effectively a "flex- fuel vehicle" with an adjustable carburetor that could be tuned to burn alcohol, gasoline, or a "gasohol" mix (Solomon et al., 2007).

[5] See Farrell and colleagues' meta-analysis of energy balances from corn ethanol in the US for a review of this literature (2006b).

balance casts doubt on the extent to which ethanol can contribute to energy security as well as its effectiveness for GHG abatement.

The US and Brazil remain the world's largest biofuel producers. However, the two countries have followed different paths over the intervening years. US production grew very sluggishly through the 1980s and 90s when the oil shock subsided and prices stayed relatively low for nearly 15 years. In contrast, Brazil increased production early and throughout the intervening years and was only recently surpassed by the US (EIA, 2009; UNICA, 2009). Figure 2 shows ethanol production in the US and Brazil together with nominal oil prices from 1975-2008.

Figure 2: Production of fuel ethanol in the US and Brazil from 1975-2008[6]



The resurgence of interest in biofuels in the US and other Northern countries is the result of several coincident factors. In the mid 1990s, ethanol was introduced as a oxygenate in US gasoline to replace

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[6] Brazilian data combines hydrous and anhydrous ethanol production and includes data from three sources which may differ slightly in definitions (Geller, 1985; Rosillo-Calle and Cortez, 1998; UNICA, 2009). US data is shows fuel ethanol production and trade balance (imports minus exports) based on data from (EIA, 2009).

MTBE.[7] At roughly the same time, the international climate regime was taking shape, with most industrialized countries agreeing to reduce GHG emissions by 5-6% by 2012 (UNFCCC, 1997). The transportation sector, which is fueled almost entirely by oil, accounts for roughly 13% of global GHG emissions (IPCC, 2007). Biofuels have long been identified as a mitigation pathway for emissions in the transportation sector (Watson et al., 1996).

While the US and Brazil dominate global biofuel production, other regions are also developing domestic biofuel industries. For example, while the US and Brazil clearly lead in ethanol production, the EU, led by Germany and France, produces more biodiesel than the US and Brazil combined (REN21, 2009).[8] In addition, other countries are rapidly increasing production. For example, Argentina, the world's 3rd largest producer of soy, produced over a billion liters of biodiesel in 2008. Figure 3 shows ethanol and biodiesel production among the world's top producers in 2008.

When biofuel production began to increase up globally, largely in response to blending mandates from the US and EU (described in Appendix 1), there were numerous calls to introduce sustainability standards (Davies, 2005; The Observer, 2005; Mortished, 2006). There were several reasons for this. First, the US biofuel mandate would initially be met by increasing corn-based ethanol production. As was discussed above, corn ethanol is only marginally effective at reducing GHGs (Farrell et al., 2006a; Farrell et al., 2006b).

Second, at the time the mandates were introduced, global biofuel production consisted almost entirely of ethanol, with 90% of production derived from US corn and Brazilian sugarcane. There was relatively little production of biodiesel at the time. The EU is more dependent on diesel than the US, and it was apparent that the EU would rely on imports to meet some of its mandated blending requirements. The feedstock required to meet those requirements would be largely derived from oilseeds and the largest potential for growth in oilseed production was in tropical countries like Brazil (soy) and Indonesia (oil palm). In each of those countries, concerns about deforestation linked in part to expansion of those

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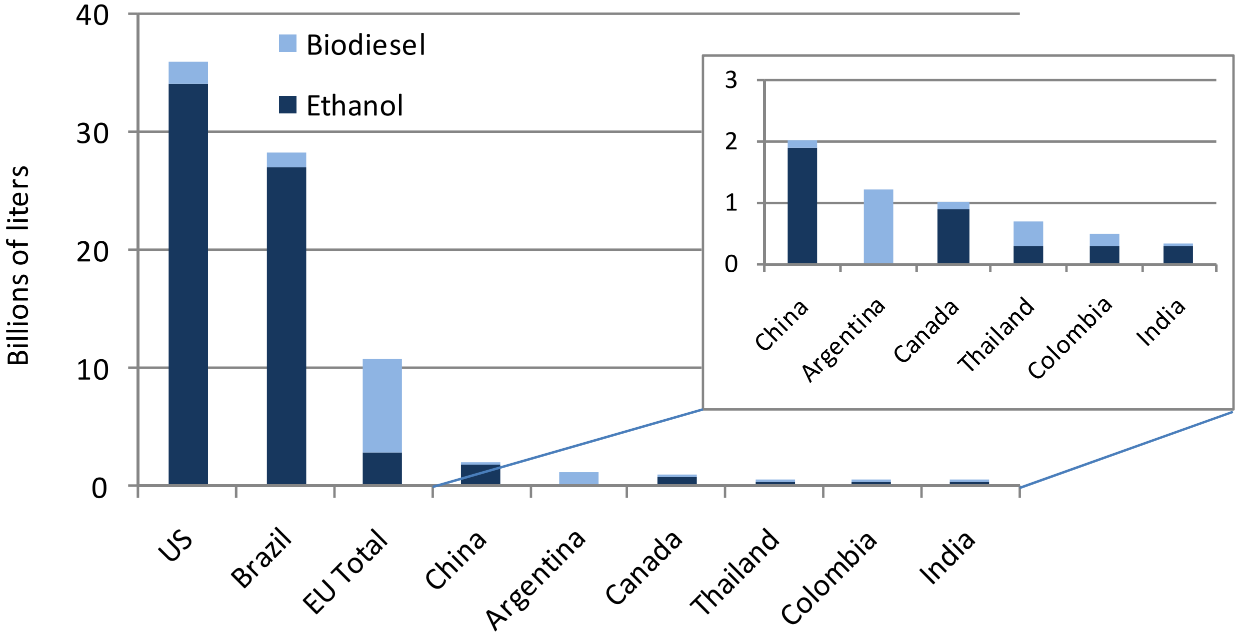
[7] MTBE or methyl tertiary butyl ether was used as a "anti-knocking" additive for gasoline. It was initially introduced in the late 1970s as leaded gasoline was being phased out in the US. Its use was increased in the 1990s to help meet air quality regulations under the 1990 Clean Air Act Amendments, which called for increasing levels of oxygenate to reduce emissions from gasoline. However, by the mid-1990s, MTBE was found to be contaminating ground water. This led to a reductions in its use and a search for alternative oxygenates. Ethanol was a logical choice (US EPA, 2007).

[8] The author estimates that over half of the feedstock necessary to produce 8 billion liters in 2008 was imported.

crops fueled fears that the EU's environmentally motivated biofuel policies would lead to higher rates of forest degradation and loss.

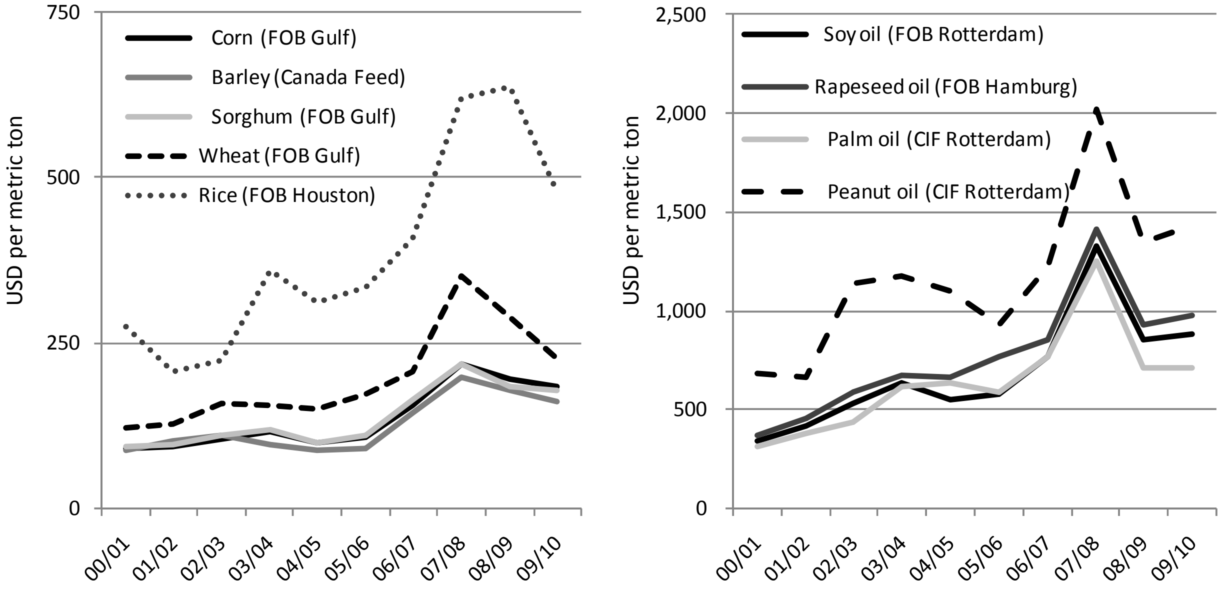
Figure 3: The world's top ethanol and biodiesel producers in 2008 (REN21, 2009).



Third, the dramatic increase in global biofuel production, which began around 2006, was soon followed by unprecedented increases in food prices worldwide, which were felt acutely in the world's less developed region (Figure 4). This fueled preexisting concerns that society's growing dependence on biofuels would lead directly to food insecurity (Pimentel et al., 1984; Ehrlich et al., 1993). Numerous factors affect food prices: weather, existing stockpiles, speculation as well as changing demand profiles. Numerous analyses attempted to quantify the degree to which increasing biofuel production leads to higher food prices. The analyses explored different scenarios and found a range of results (see Appendix 2 for details). Not surprisingly, those analyses that projected large impacts on food prices garnered a lot of media attention and lent support to the calls for biofuel mandates to be modified, weakened, placed on hold, or, in some cases, abandoned entirely (Waterfield, 2007).

As Figure 4 demonstrates, food prices have since declined from their peak in mid-2008.[9] However, at roughly the same time that world food prices reached their peak, several scientific assessments were published that raised (or confirmed) doubts about the ability of biofuels to meet some of their stated environmental objectives. These analyses pointed out that under both existing and proposed production systems, biofuel production could contribute either directly or indirectly to changes in land cover, which lead to loss of biodiversity, deforestation and substantial carbon emissions (Fargione et al., 2008; Searchinger et al., 2008; Searchinger et al., 2009). Thus, biofuels may incur a "carbon debt" either directly as a result of changes in carbon content within the boundaries of the plantation or the land that effectively negates many years worth of emissions reductions that are achieved when biofuels replace fossil fuels.[10] This is discussed in more detail below.

Figure 4: Global grain and edible oil prices from 2001 to 2009 (FAPRI, 2009)



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[9] These declines have led biofuel proponents to conclude that the analyses were faulty. It would be more accurate to say that the forecasts did not predict a massive economic downturn, which dampened many of the drivers of high food prices.

[10] I should note that these analyses particularly implicated "first generation" biofuels, which is a loosely defined category that includes alcohols derived starch and sugar-based annual crops and oil-based fuels derived from annual oil seed crops. The analyses found that "second generation" biofuels, which includes several advanced technologies that are not yet commercialized like cellulosic ethanol, synthetic diesel, and algae-based fuels, have fewer LUC impacts.

In addition to these scientific assessments, which focused on the biophysical implications of large-scale biofuel production, a number of civil society organizations have published critical analyses of the social impacts of biofuel production, particularly in developing countries. In contrast to the risks that biofuels present to food security, which are global in scope, the impacts highlighted in these reports are largely local in nature and relate to the site-specific conditions of production that are established between producers and local communities.

Voicing concern about the localized impacts of biofuels around the world, *Via Campesina*, a global movement of small- and medium-sized agricultural producers and landless peasants notes that:

> Agrofuel production has already started to replace food production. Its ongoing extension will drive even more small scale farmers and indigenous peoples off their lands. Instead of dedicating land and water to food production, these resources are being diverted to produce energy in the form of diesel and ethanol. Today peasants and small farmers, indigenous people, women and men, produce the huge majority of the food consumed worldwide. If not prevented now, agrofuels will occupy our lands and food will become even more scarce and expensive." (in Actionaid, 2008; citing Via Campesina, 2008).

While ActionAid is concerned primarily about biofuels driving out peasants and small farmers, a parallel set of critiques have been raised in response to small famers' direct involvement in biofuel production. As mentioned above, biofuel proponents cite the potential for biofuels to improve rural livelihoods; however, preliminary experiences indicate that biofuel crops do not automatically lead to rapid wealth creation and may put small-scale farmers into debt (Friends of the Earth, 2009; Justiça Ambiental, 2009).

Taken together, associations with food price spikes, concerns about "carbon debt", and NGO reports detailing excessive risks to smallholders, all raise serious doubts about whether biofuels can deliver on any or all of the benefits that proponents claim they will provide to society. Many of these impacts were anticipated and, it is important to note, they are not necessarily unique to biofuels. Shifting patterns of supply or demand for major agricultural commodities unrelated to biofuels have similar impacts on land use change and food security.[11] Similarly, dramatic impacts on rural livelihoods can be observed whenever new agricultural production systems are introduced.[12]

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[11] These similarities are one reason that analysts arrived at contradictory claims concerning the extent to which biofuel demand contributed to the food price shocks observed from 2007 to 2008.

[12] Such impacts may be positive and negative with variable distributional effects depending on both local and non-local political economy. These dynamics have been analyzed in depth by various overlapping fields of study,

III. Sustainable biofuels in theory

Through the 1990s, as biofuels and particularly bioethanol production steadily increased, numerous debates emerged about the environmental effectiveness of biofuels. As was mentioned above, these analyses centered primarily on the energy balance of bioenergy production. Simultaneously, discussions began about the potential tensions between biofuel production and food security. However, while these discussions called into question the logic and morality of turning to biofuels as a source of energy, overall production levels remained fairly low (outside of Brazil) and none of the feared impacts materialized. After the surge in activity resulting from the oil price shocks of the late-70s and early 80s, oil prices declined and stayed relatively low for nearly 15 years. This suppressed any further expansion of biofuel production outside of Brazil. Thus, throughout this period, discussions about the sustainability of biofuels largely limited to academic debates.

However, during the 1990s, several fundamental changes occurred in the way that society views the social and environmental impacts of its collective production and consumption. This changes saw management of many environmental challenges shift away from the "hierarchical state activity" (Biermann and Pattberg, 2008, p. 278) that commonly characterizes state-centered control toward a multifaceted set of institutional arrangements characterized by "new types of agency", "new mechanisms and institutions", and "increasing segmentation and fragmentation " of governance systems (ibid, p. 280).[13] These institutional arrangements "give a much greater role in policy-making, administration and implementation to private economic actors on the one hand and to parts of civil society on the other in self-managing what until recently was provided or organised by the national or local state (Swyngedouw, 2005, p. 1992).

This new mode of rule is playing out in an ongoing process across multiple scales. At the macro-scale, there are now numerous super-governmental agencies with a mandate to seek solutions to problems of

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including *inter alia* Agrarian Change, Peasant Studies, Political Ecology, Rural Sociology, Development Studies and numerous subfields of Geography. Some concrete examples include the disparate social outcomes associated with the introduction of Green Revolution technologies (Bebbington, 1997; Ellis, 1998), market-oriented cooperatives (Little and Watts, 1994), and, more recently, alternative production systems like organic foods and Fair Trade products (Goodman, 2004; Guthman, 2007).

[13] As many scholars have indicated, the emergence of *environmental* governance at a global level is linked to a broader movement toward globalization, free trade, and neo-liberal markets (Swyngedouw, 2005; Lemos and Agrawal, 2006; Biermann and Pattberg, 2008)

global concern like the release of ozone depleting chemicals, the loss of biodiversity and climate change. Though nation-states play a prominent role in developing the treaty-based regimes that have evolved to address the most pressing of these challenges, NNSAs play prominent roles right alongside them. NNSAs are given a direct voice in the proceedings and actively lobby behind the scenes. Moreover, NNSAs play a prominent role in the operationalization of the agreements. This role is perhaps most evident in the climate regime, where a substantial portion of emissions abatement efforts have been turned into market-driven processes through emissions trading and offset schemes.

Both emissions trading and offset schemes exemplify what Lemos and Agarwal have dubbed “market and individual-focused instruments” (MAFIs) (2006, p. 305-8). MAFIs, which also include eco-taxes, voluntary labeling schemes, and other forms of certification, are representative of “new technologies, instruments and tactics” (Swyngedouw, 2005, p. 1992) designed to encourage more sustainable production/consumption practices.

At smaller-scales, environmental governance is evident in phenomena like sustainability standards and product certification. These tools of governance are typically voluntary and take advantage of corporate and individual desires to associate themselves with products that demonstrate (real or perceived) improvements over a range of social and environmental impacts linked to certain products. Some standards primarily address environmental issues (e.g. shade-grown coffee) and others target mainly social conditions (e.g. No Sweat clothing). However, a growing number of efforts consciously incorporate a broad range of environmental and social principles in an attempt to create a comprehensive sustainability standard. Examples of these multi-dimensional efforts include the Forest Stewardship Council’s (FSC) certification schemes as well as some commodity-based standards like the Roundtable for Sustainable Palm Oil (RSPO) and the Roundtable for Responsible Soy (RRS).[14]

The reasons that firms turn to sustainable certification are complex and varied, not unlike the concept of corporate social responsibility (CSR) that is often invoked to explain their motivations.[15] Some firms desire to avoid bad publicity that comes with selling products that are overtly exploitative,

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[14] Though these standards include social and environmental principles, they do not necessarily give them equal weight.

[15] Of course, CSR extends to a broad range of activities beyond the sourcing and selling of “sustainable” raw materials and products (see Auld et al., 2008, for a review).

environmentally destructive, or unnecessarily polluting.[16] Conversely, firms wish to be associated with products that consumers perceive as ethical or environmentally friendly. Firms may also respond to pressure from shareholders. If they are under political pressure to meet certain environmental criteria, for example, emissions reductions, firms may choose to source more sustainable raw materials in order to avoid regulation or act early in a bid to gain an edge over competitors facing similar pressure. In the case of biofuels, which, in many instances, firms have been mandated to use as a result of legislated blending targets, some measure of voluntary action at the corporate level is still possible. This voluntarism applies to the sourcing of fuel and the social and environmental context in which feedstock production occurs.

For individual consumers, motivations are equally complex. Just as some firms wish to project an image through the raw materials they use and the products they sell, some individuals wish to project (to themselves and others) the image of an "ethical consumer". Thus, people may opt to buy sustainably certified products to establish their identify as consumers who are concerned about the environmental impacts and/or labor conditions associated with their consumption practices. We see these dynamics play out for a growing range of consumer goods. However, it is not clear how biofuels will be perceived by consumers as different types of fuels penetrate the market and debates about their sustainability enter the public discourse.

Thus environmental governance incorporates a complex array of actors exercising new forms of agency across multiple scales. Without entirely replacing the state, hybrid forms of governing involving corporate and civil society actors as well as individual consumers have emerged as a critical, possibly dominant mode of addressing the problems caused by current production and consumption practices. In the next section, I explore how these modes of governance are being applied in the case of biofuels.

IV. Sustainable biofuels in practice

There are numerous similarities between the way that governance-beyond-the-state is unfolding for biofuels and the way that it has unfolded in other sectors like timber, organic foods or Fair Trade.

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[16] Admittedly the terms "overtly exploitative" and "unnecessarily polluting" are completely subjective. I use them here for lack of better terminology to describe the way that firms and consumers perceive the complex interface of production/consumption and society/environment. Further, consumers' decisions to buy ethical products are often inconsistent and the retail spaces in which those purchases take place are ridden with contradictions (Goodman and Bryant, 2009).

However, there are also several critical differences between biofuels and other commodities that have been incorporated into sustainability discourses. First, energy is simultaneously a consumer good and a fundamental input into every sector of the economy. Supply shortages can bring economies to a standstill. Thus energy resources have a strategic nature that matched by few other commodities. This strategic nature tends to keep energy resources under the umbrella of state control, although this control is not always visible.[17] These forms of control are manifest many state actions, ranging from price controls and trade policies, to state-funded research and development (R&D), concessions for resource extraction, and environmental regulations.[18] Therefore, it is difficult to imagine a governance regime for biofuels that is entirely separate from state control.

Second, energy resources must fit into a specific technical context. As substitutes for fossil fuels already in use, biofuels are, by definition, "drop-in" technologies. Therefore, they must meet exact specifications in order to be usable in complex technical systems that were originally designed to be used with fossil fuels. This requires that biofuels meet design and performance standards that may be defined and enforced by governmental bodies.

Third, society's use of energy results in unmatched environmental impacts. Annually, energy-related activities contribute to roughly 60% of anthropogenic GHG emissions (IPCC, 2007) and 50% of annual global black carbon (BC) emissions (Bond and Sun, 2005). Fossil fuel combustion also accounts for the majority of global mercury (Pacyna et al.) and sulfur emissions (Koch et al., 2007). These impacts are a major impetus for the promotion of biofuels, particularly in the industrialized North. Several policies promoting biofuel have very explicit environmental objectives, including GHG emissions abatement, which they can deliver together with co-benefits like reduced sulfur and particulate emissions.

However, as was mentioned above, the degree of GHG abatement achieved when biofuels replace fossil fuels depends on the system of biofuel production in place. Under some production systems, biofuels may cause higher GHG emissions than the fossil fuels they substitute due to the "carbon debt" they incur. Thus, their strategic and technical nature, together with the potential that grave environmental problems could be worsened rather than improved if we "get it wrong", raises the stakes with biofuels

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[17] This is also true to some extent with food supply and agriculture more generally.

[18] The latter may include "market mechanisms" like emissions trading, which generally require action and oversight from the state in order to meet their environmental objectives.

in ways that set it apart from commodities that have come under scrutiny by some form of sustainability certification.

These differences become apparent when we examine the proliferation of biofuel sustainability standards and the actors involved in their development. Given that the central motivation of many biofuel mandates is to reduce GHG emissions and that several high-profile analyses have indicated how, under some circumstances, biofuels may have the opposite effect, it is not surprising that GHG accounting often dominates the methodological debates around sustainable biofuels.

However, as the previous discussion made clear, GHGs are not the only motivation behind calls to govern the biofuel industry. Indeed, many of the calls to produce biofuels in a sustainable manner are utilizing holistic approaches that include a wide range of social and (non-GHG) environmental issues. Table 1 presents some of the design features of a selection of bioenergy sustainability schemes. The schemes shown here are not exhaustive, but rather demonstrate the variation in approaches that are emerging. They include initiatives from national governments (UK and Netherlands), a super-governmental organization (the EU), private companies (Essent and Electrabel), and NGO-led multi-stakeholder processes (RSPO and RSB). In the following sections, I explore some of the issues that biofuels governance entails for GHG emissions, non-GHG environmental factors, and socio-economic factors.

GHG emissions

GHG emissions (or energy balance) is common to each of the bioenergy sustainability efforts listed. GHG balances are assessed through life cycle assessment (LCA) of the biofuel. LCA is a complex accounting technique that traces the material flows and processes required to assemble a “functional unit” of fuel. Each material and process is associated with an impact (in this case, a quantity of GHGs), which are aggregated to estimate the fuel’s net impact. This aggregate value is then compared to an estimate of the life cycle impact of the fossil fuel that it is replacing (the baseline fuel). Some, but not all of the schemes listed in Table 1 define a minimum improvement over the fossil baseline in order for a biofuel to be considered *sustainable*.

Table 1: Sustainability principles and design features of a sample of biofuel certification schemes (from van Dam et al., 2008; updated in 2009)

Check list:	Green Gold Label (NL–private sector)	Electrabel Label (BE-private sector)	RTFO (UK-gov't)	NTA 8080 (NL-gov't)	RSPO (Int'l multi-stakeholder process)	RED (EU)	RSB (Int'l multi-stakeholder process)
Type of biomass	All biomass for heat and electricity	All biomass for heat and electricity	Biomass for biofuels	All biomass	Palm oil	Biomass for biofuels	Biomass for biofuels
Status	Certification in implementation, also in development	Certification in implementation, also in development	Implemented	Principles developed, testing phase C&I (pilot studies)	Principles developed, testing phase C&I (pilot studies)	Standards developed; detailed design through 2009	In development
Principles identified [a]							
GHG/energy balance	+ [b]	+	+	+	+	+	+
Biodiversity	+	—	+	+	+	+	+
Other envt'l issues [c]	+	—	+	+	+	—	+
Competition w/ food	—	—	—	+	—	—	+
Leakage	—	—	—	— [d]	—	—	+
Economic well-being	— [e]	—	+	+	+	— [e]	+
Welfare / social	—	—	+	+	+	— [e]	+
Environmental	+	+	+	+	+	— [e]	+
Design features							
Type of system [f]	Track-and-trace Sourcing	Track-and-trace Sourcing	Meta-standard	Track-and-trace, mass balance or book-and-claim, are all under consideration.	Track-and-trace, mass balance or book and claim	Mass balance	Not yet determined
Organization	Established by company Essent, now open for 3rd parties	Label is developed by company Electrabel	Administered by Renewable Fuels Agency, a UK government body	Initiated by government, structure in process	Roundtable with stakeholders in palm oil production	Evolving: probably mix of government and private sector	Roundtable with multi-stakeholder participation
Verifier	Control Union	SGS	Independent 3rd party verification	Requirements not yet determined	Verifier working group (in progress)	Independent 3rd party verification	Not yet determined
Relation to national policies	Stimulated by policy	Required by law	Embedded in national policy	Will be coupled to a subsidy for biomass heat and electricity	On voluntary basis	Will be embedded in national policies	Likely to be voluntary though some governments may promote or require
(Plans to) make use of existing systems	FSC, 'Organic' certification	Yes (e.g. FSC)	Yes – meta-standard approach	Will apply e.g. FSC, and GGL	Makes use of existing systems	Will make use of existing systems	Yes – a meta-standard approach

[a] + indicates that some principles are included ; — indicates that principles are not included.

[b] Included in GGLS8 (http://certification.controlunion.com/publications.aspx?Program_ID=19)

[c] Can include air, soil and water quality, as well as solid waste management, and the use of agro-chemicals, etc.

[d] Currently investigating how to take this into account

[e] The inclusion of socio-economic principles are going to be taken into consideration

[f] Track-and trace implies the physical traceability of the traded biomass. Under book-and-claim, production and redemption of a certificate is separated (and the certificates can be traded separately from the physical biomass). Similar systems exist for example for renewable electricity, where Certificates of Origin are traded. For some of the initiatives described here, this choice has not yet been made, but the requirement of calculating GHG and energy balances makes a track-and-trace requirement likely.

Any LCA for biofuels includes a range of methodological options and requires that numerous assumptions be made in order to account for the contributions of material inputs and processes that are not accurately inventoried (E4Tech, 2008; Fehrenbach et al., 2008).[19] The methodological variation includes choices about how to allocate impacts between the fuel itself and any co-products that are produced, which include fertilizers, animal feed, and industrial chemicals. These co-products can displace other products from the market (e.g. commercial fertilizers made by other processes); any reductions in GHG emissions that result from that displacement should be accounted for. However, questions arise about how to apportion credit, and different choices can lead to wide variation in the fuel's impact (Fehrenbach et al., 2008). There are attempts to harmonize these issues across different sustainability certification schemes, but even within Europe, the EU and the UK differ in their methodological approach, which leads to variations in GHG estimation even when the all of the assumptions about materials and processes are identical (Dehue and Hettinga, 2008).

As was discussed above, LUC is a critical determinant of GHG impacts, which creates challenges for governing biofuel sustainability. It is also a major issue in broader questions of environmental governance, touching on deforestation, habitat destruction and food security. The debate about biofuel sustainability has divided LUC into direct and indirect impacts (dLUC and iLUC respectively). The former define changes that occur within the boundary of the biofuel plantation. The latter define changes that are induced when biofuel production occurs on a scale that affects global commodity prices. When that occurs, higher prices can lead to new land being brought into production. This may occur within the borders of the biofuel producing country or in other world regions. In any case, when new land comes under production there are likely to be losses in terrestrial carbon as native vegetation is cleared and intact soils are plowed. These losses can be quite large in some biomes where crop expansion is likely to occur (Searchinger et al., 2008).

Incorporation of dLUC and iLUC into sustainability certification has followed different pathways. dLUC is well-bounded and depends primarily on the actions of actors associated directly with biofuel production. It can be observed by third parties and, in most reasonable scenarios, it can be attributed to

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[19] The tools for LCA have been developed to address production processes in industrialized countries. Thus many Inaccuracies arise when assessing production in other world regions. Uncertainties also arise because novel technologies (e.g. algae-based fuel production) lack accurate life-cycle inventories of the materials and processes necessary to produce a unit of fuel.

a well-defined set of activities.[20] In contrast, iLUC, by definition, depends on the actions of actors who are spatially and temporally removed from the site, and influence, of the biofuel supply chain. Some of the sustainability standards that are emerging now have introduced “iLUC” factors, which are effectively a penalty applied to biofuels derived from certain crops in certain locations to account for the likely effects of their production elsewhere in the world (e.g. corn from the US, soy from Brazil, or palm oil from Indonesia – see CARB, 2009).[21] This has met with opposition from producers who take exception to accepting penalties for the actions of far-removed actors.

By incorporating dLUC and iLUC into sustainability standards, these efforts attempt steer biofuel production away from particular types of land: land with high carbon stocks in existing biomass or soil to avoid dLUC emissions, and land currently used for food production, which contributes to iLUC emissions. This raises many challenges for biofuel governance because both processes, but particularly iLUC, are driven by land-management decisions of multiple sets of actors (individual, corporate, state) in myriad locations. Further, the impacts of iLUC are likely to be greatest in areas where land management regulation and land-use planning have been historically very weak.

Non-GHG environmental issues

Non-GHG environmental impacts associated with biofuel production typically get less attention from sustainability standards that GHG issues for reasons discussed above. As Table 1 shows, some sustainability schemes do not consider them at all. Nevertheless, the tools are in place to monitor and mitigate other environmental impacts. For example, some issues, such as risks to food security and biodiversity, are closely linked to LUC. If monitoring is in place to minimize negative GHG-related affects of LUC, then biodiversity and food security issues can also be addressed.

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[20] This is not to say that the measurements themselves are easy to carry out; in contrast, measurements can be quite complex. Though some default values exist for certain land-use transitions (e.g. forest or grassland to annual crops – see IPCC, 2003), however, these are not appropriate for biofuel systems that use perennial crops. Moreover, to accurately capture the carbon dynamics of LUC, long-term monitoring of biomass and soil may be needed, which is costly.

[21] These factors are derived from macro-economic models that forecast the global response of shifts in commodity supply and demand based on a number of trade, substitution, and land use elasticities derived from historical data (CARB, 2009).

Other environmental impacts, such as negative effects on air, soil, and water quality, can be informed by a well conducted LCA.[22] However, a close reading of the sustainability standards that are emerging show a distinct difference between the approach to governing GHG emissions and other environmental impacts. While GHG emissions must be quantified, other environmental impacts are only addressed in a qualitative/subjective manner (The Cramer Commission, 2007; RFA, 2009a). These differences are in some ways pragmatic and represent the limitations of environmental governance. Though most stakeholders would claim to value water, soil, and air quality as well as biodiversity, they are complex and costly to monitor. Unlike GHG reductions, there is no common baseline and no published default values to assess changes degradation in air, soil or water quality or the loss of biodiversity. Every location represents a unique starting point. Further, any changes would need to be monitored over time in order to be assessed with any accuracy.[23]

This is also true to some extent for the LUC component of the LCA and associated GHG emissions. However, in that case, the climate regime has mobilized to create and accept generic default values, despite the fact that such values may not be accurate in a particular case. Thus, efforts to define biofuel sustainability have both required that GHGs be quantified, and created pathways to do so, albeit imperfectly. However, they have made no requirement that other environmental impacts be quantified, and provide little guidance to assessing such impacts reflects a broader issue that is relevant for effective environmental governance of biofuels. The playing field is tilted toward carbon. There is a well-established infrastructure for GHG evaluation because countless state and non-state actors have mobilized to create a system in which carbon is monitored, valued, and traded. Other aspects of environmental quality and sustainability, however pressing, are not likely to be treated with the same attention any time soon.

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[22] LCAs do not directly measure air, soil or water quality. Nevertheless, by inventorying most or all of the materials and processes associated with biofuel production, the LCA can raise red flags about potential environmental risks: for example the overuse of agrochemicals or poorly managed waste disposal.

[23] This is also true to some extent for the LUC component of the LCA and associated GHG emissions. However, in that case, the climate regime has mobilized to create and accept generic default values, despite the fact that such values may not be accurate in a particular case.

Socioeconomic Issues

A number of the emerging sustainability standards include social principles, while other standards omit them completely.[24] The inclusion of socioeconomic issues in parallels other agricultural and forest commodities (Fair Trade, FSC, etc). These are grounded in ethical concerns about the social conditions of production: labor rights (freedom of association and collective bargaining), land tenure security, child labor, non-discrimination, and carry special provisions for indigenous peoples or other vulnerable groups. These ethical principles support the ethical notion that biofuel production avoid any coercive measures that leave people worse off than they would be in the absence of biofuel production. Several schemes also carry provisions that go further, suggest biofuel projects should *improve* social conditions among growing communities in order to be considered sustainable. For example, the UK's RTFO requires that Biomass production "not adversely affect workers rights and working relationships" and "existing land rights and community relations" (RFA, 2009a, p. 22). The RSB's principles take a similar approach to working conditions and land rights, but they are more aspirational by requiring that biofuel projects situated in "regions of poverty"[25] also "contribute to the social and economic development of local, rural and indigenous peoples and communities" (RSB, 2009, p. 14). This principle is elaborated by criteria and indicators that require demonstrated improvements in "socioeconomic status of local stakeholders" (p. 14) relative to a predetermined baseline.

By defining sustainability on the basis of improvements in living conditions the RSB and others like it set the bar extremely high. They also present challenges to any assessment of performance as changes in well being are difficult to measure and attribute to specific causes (Deaton, 1997). Further, with any new agricultural investment, it takes several years to recover costs and realize a profit. This is particularly true for perennial crops, which may take several years to produce marketable yields. Thus, in some cases, sustainability assessments will require a long-view in order to determine the welfare effects of biofuel production.

Experiences with other agricultural sectors in which ethical-based standards have been introduced either as stand-alone governance mechanisms or in conjunction with environmental sustainability

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[24] The sample is not necessarily representative of all current biofuel sustainability initiatives, but it is interesting to note that among the standards listed in Table 1, the private sector and regional (EU) initiatives do not include social principles while two national level and two international multi-stakeholder initiatives include them.

[25] The RSB's current version offers no guidance regarding what is considered a "region of poverty" (RSB, 2009)..

standards, reveal mixed results. For example, with forest certification, Taylor finds that “For the most part, forest certification has not delivered on promises of improved direct income for producers or access to new markets,” (Taylor, 2005, p. 137), though he acknowledges that there are numerous non-monetary benefits. For Fair Trade products like coffee and bananas, researchers have noted that some, though not all, small farmers earn better incomes (Shreck, 2005; Taylor, 2005; Sick, 2008). Further, several analysts have noted that many products produced under Fair Trade conditions are marketed and sold as conventional products because at times producers and/or suppliers cannot access Fair Trade market pathways (Taylor, 2005; Sick, 2008). Analysts also note the inherent contradictions in Fair Trade and other ethical market schemes. In attempting to create an alternative path and avoid the exploitative relationships that often result when small producers engage with global trade regimes, ethical consumption schemes seek to both reject and engage with mainstream markets (Shreck, 2005; Taylor, 2005). The degree to which these efforts can actually transform the market for a particular commodity remains an open question and similar questions arise for biofuels.

V. Concluding thoughts

This paper has reviewed the recent development of biofuels and discussed the ways in which emerging forms of biofuel governance are incorporating various principles in order to promote sustainable practices in the emerging industry. Efforts to promote sustainability in the biofuels industry build on previous innovations in environmental governance at multiple scales. These efforts have involved a wide range of NNSAs: super-governmental organizations, private sector stakeholders, and civil society groups.

Biofuel sustainability themselves standards are still evolving. Writing at the end of 2009, nearly three dozen distinct efforts are in some stage of development, with differing emphases. The most prevalent feature among current themes is the focus on GHG reductions relative to a fossil baseline common. Other aspects of sustainability appear with less consistency, although several prominent efforts are taking a holistic approach that also includes non-GHG environmental impacts and social principles (e.g. the UK’s RTFO, the Dutch government’s NTA 8080, and the RSB, a multi-stakeholder process). These developments are promising and deserve support as well as careful critique.

At this time, only one dedicated biofuel certification system is online (the UK's RTFO) and only a fraction of fuel entering that system is certified.[26] It is likely that much of the current biofuels industry would not satisfy the principles articulated by these efforts. This is troubling given that since 2000, global biofuel production has increased nearly three-fold and, driven by over a dozen blending mandates, production will likely continue on an upward trajectory for the near future. It remains to be seen whether the adoption of sustainability standards will accelerate to match the growth of the industry and, whether the principles and criteria that constitute these standards will have a measurable impact on environmental and social conditions.

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[26] The latest data from the RTFO suggest 35% of the biofuels entering the UK meet the RTFO's environmental and social standards (RFA, 2009b).

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VII. Appendix 1

Current National and Sub-National Biofuel Mandates and Targets (REN21, 2009)

COUNTRY	**MANDATE**
Australia	E2 in New South Wales, increasing to E10 by 2011; E5 in Queensland by 2010
Argentina	E5 and B5 by 2010
Bolivia	B2.5 by 2007 and B20 by 2015
Brazil	E22 to E25 existing (slight variation over time); B3 by 2008 and B5 by 2013
Canada	E5 by 2010 and B2 by 2012; E7.5 in Saskatchewan and Manitoba; E5 by 2007 in Ontario
Chile	E5 and B5 by 2008 (voluntary)
China	E10 in 9 provinces
Colombia	E10 and B10 existing
Dominican Republic	E15 and B2 by 2015
Germany	E5.25 and B5.25 in 2009; E6.25 and B6.25 from 2010 through 2014
India	E5 by 2008 and E20 by 2018; E10 in 13 states/territories
Indonesia	E1 and B1 in two major cities of Jakarta and Surabaya. Actual mixture for biodiesel varies with market conditions and reached B5in late 2008, but slipped to B1 again when palm oil prices recovered in early 2009 (USDA FAS, 2009a)
Italy	E1 and B1
Jamaica	E10 by 2009
Korea	B3 by 2012
Malaysia	B5 by 2008 (currently on hold according to USDA FAS, 2009b)
Paraguay	B1 by 2007, B3 by 2008, and B5 by 2009; E18 (or higher) existing
Peru	B2 in 2009; B5 by 2011; E7.8 by 2010
Philippines	B1 and E5 by 2008; B2 and E10 by 2011
South Africa	E8–E10 and B2–B5 (proposed)
Thailand	E10 by 2007 and B10 by 2012; 3 percent biodiesel share by 2011
United Kingdom	E2.5/B2.5 by 2008; E5/B5 by 2010
United States	Nationally, 130 billion liters/year by 2022 split between first and second generation ethanol and biodiesel (see US Congress, 2007, for details) along with numerous sub-national blending targets: - E10 in Iowa, Hawaii, Missouri, and Montana - E20 in Minnesota; - B5 in New Mexico - E2 and B2 in Louisiana and Washington State - Pennsylvania 3.4 billion liters/year biofuels by 2017 - California has introduced a “low-carbon fuel standard” (LCFS) that mandates a 10% reduction in 2005 GHG emissions from the transportation sector by 2020. State analyses estimate that meeting the standard will require 10-17 billion liters of ethanol in 2020 (Crane and Prusnek, 2007).
Uruguay	E5 by 2014; B2 from 2008–11 and B5 by 2012

VIII. Appendix 2

Analyses of forecast food price changes under national/regional biofuels policies[27]

SOURCE	SCENARIO	PROJECTED PRICE INCREASE
The World Bank (Mitchell, 2008)[28]	Analyzed the 140% increase in commodity prices observed between 2002 and 2008 to estimate the influence of different drivers of food price increases like export bans, speculation, weak US currency, and biofuel policies.	Estimated contribution to 140% increase ein food prices between 2002 and 2008: Decline of the dollar 20%. Higher energy prices (and related increases in fertilizer prices, and weak US dollar) 35%. Biofuel policies and related consequences of low grain stocks, large land-use shifts, speculative activity, and export bans 85%
Rosegrant et al. (2006) IFPRI	Four% US gasoline replaced by biofuels, 20% elsewhere, up to 58% in Brazil (biodiesel in EU, ethanol elsewhere); no technology improvement, projected to 2020.	Corn, 41%; wheat, 30%; soy (oilseeds) 76%; sugar (sugarcane), 66%; cassava, 135%
	Same as above, but includes cellulosic technology and crop productivity improvements. Projected to 2020.	Corn, 23%; wheat, 16%; soy (oilseeds) 43%; sugar (sugarcane), 43%; cassava, 54%
Von Lampe (2006) OECD	Constant $60 per barrel price of oil, projected to 2014.	Corn, 19%; wheat, 17%; soy (oilseeds) 19%; sugar, 20%; vegetable oil, 22.3%
	Growth of biofuels follows publicly stated goals: 28 billion liters in the US by 2012, with food prices projected to 2014.	Corn, 2.5%; wheat 4.4%; soy (oilseeds) 1.1%; sugar, 4%; vegetable oil, 12.9%
FAPRI (2005)	US produces and consumes 26.5 billion liters of ethanol and imports an additional 28.4 billion liters biodiesel and ethanol by 2012. Food prices are projected from 2012-2015, relative to baseline.	Corn, 5.4%; wheat, 1.7%; soy, -0.2%; sorghum, 4.2%
Elobeid, and Tokgoz (2006)	Long-run oil price of $60 per barrel with the US using 113 billion liters of ethanol, projected to 2015, relative to baseline.	Corn, 58%; wheat, 20%; soy (meal) -42%; soy (oil) 20%
USDA (2007)	45.4 billion liters of ethanol, 2.65 billion liters of biodiesel in the US, projected to 2016.	Corn, 65%; wheat, 33%; soy, 19%; sugar, -8%; sorghum, 64%
Ferris and Joshi (2006).	21.5 billion gallons of ethanol, 1.14 billion liters of biodiesel in the US by 2015, projected relative to baseline.	Corn, 6%; soy meal, -5%; soy oil, 31%
(FAPRI, 2006)	25 billion liters ethanol in Brazil, 3 billion liters ethanol in EU, 30 billion liters in US; 4.9 million tons of rapeseed oil in EU, projected to 2015–2016	Price increases relative to 2006 prices: corn, 30%; wheat, 11%; soy, 2%; sugar, 21% (FOB Caribbean); palm oil, 17%.

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[27] Adapted from Naylor et al. (2007).

[28] This is a draft document that was not meant for circulation, but was reported in the UK's Guardian (Chakrabortty, 2008). References to this article can now be found on hundreds of websites.