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The Environmental Certification of Biofuels

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1. INTRODUCTION

Bioenergy, including biofuels[1], could become a substantial tool for mitigating greenhouse gas emissions, locally and globally, possibly providing a large fraction of global primary energy supply by 2020. Exactly how large that share will be is not possible to predict with any precision, being dependent on a complex array of physical, social, economic, technical (innovation) and environmental factors. In addition, there will be competition for biomass resources between the different bioenergy sectors (electricity, heat, transport) and alternative uses e.g. for chemical feedstocks and materials. There will be synergies too, particularly arising through advanced polygeneration and biorefinery supply chains that could help to raise primary productivity and raise resource-use-efficiencies.

However, assessing the actual environmental impacts of increased bioenergy and in particular, biofuel usage, will depend sensitively on the scale and mix of technology options employed and on the location. Location is important the fundamental factors that govern biomass productivity vary significantly according to site e.g. soil type, climate, including water availability and temperature. Across a range of indicators, one biofuel may not be the same as another, even where the final fuels are chemically and physically identical e.g. anhydrous ethanol derived from wheat, sugarcane, sugar beet, cassava or from residues.

This heterogeneity in impacts and opportunities arises because the feedstock production, conversion and end-fuel supply chains for biofuels are often longer (geographically and technically) and considerably more complex than existing or alternative transport energy supply chains. There is also uncertainty in a range of potentially important factors that govern the assessment of the net impacts of biofuel production and use which can be divided into three categories:

1. Uncertainty resulting from the complexity of a biofuel supply chain. These can be resolved by more detailed accounting methodologies.
2. Uncertainty resulting from un-resolved methodological and scientific issues. These can only be resolved through additional research.
3. Uncertainty arising from differing current and future societal concerns and changing environmental parameters, for example a better understanding of the nitrogen cycle, and therefore in the indicators and criteria that will need to be developed, measured and monitored.

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[1] Biofuels are assumed to be liquid and gaseous fuels derived from organic materials used for transport, such as bioethanol, biodiesel and biogas.

In practice, very substantial differences are seen in existing biofuel supply chains in terms of environmental impacts. Such impacts include the GHG performance and wider impacts such as on biodiversity, water use, nitrogen use and flows, air and water quality impacts, and on amenity. This variance in impacts provides the justification for national policies in the UK, Netherlands and Germany that support the application of assurance and certification systems for biofuels. In turn, should such assurance and certification systems prove viable and valid, it would then be possible to reward individual biofuel supply options (e.g. by batch), based on their actual performance. Such a system could provide a powerful and flexible mechanism for incorporating externalities and encourage an evolutionary approach towards improved productivities, efficiencies and decreased impacts.

Despite the advantages outlined above, a number of questions remain about the application of assurance and certification to biofuels in this way. The questions centre on the level of detail and therefore regulation needed and the nature and validity of the indicators that might be used to demonstrate compliance with minimum environmental standards. Further doubts exist about the scope and coverage of the institutions around the world that are currently involved in environmental and social certification (mainly of food and timber) and their ability to expand their coverage to include the production and supply of biofuel feedstocks and fuels.

The rapidly expanding global biofuel market is being caused by the high current oil price and the expectation that these high levels will be maintained, is driving a political agenda that is sometimes in advance of the evaluation, monitoring and policy environment. New institutions, methodologies and science will be needed to ensure and assure that biofuels can meet new demands for supply without causing major social and environmental damage. In so doing there is also an opportunity to configure such systems to encourage innovation, and thus, improve efficiencies and lower inputs and impacts. This paper explores these issues and assesses the existing developments in national and regional assurance and certification schemes for biofuels.

2. GLOBAL CONTEXT AND RESOURCES

In many OECD countries a combination of high population densities, high per capita energy demand, particularly for transport, and existing exploitation of much of the potential agricultural land, appears to preclude any significant expansion of land area devoted to biofuel feedstock production. In practice though, land allocation is driven by an appreciation of the opportunity costs of land use which in turn is a function of the market value of the products, regulations for land management and in turn governmental policies, including subsidies for specific products. Even where existing production is assumed to be unchanged there may still be ‘space’ for the production of bioenergy feedstocks as highlighted by a recent European Environment Agency report (EEA, 2006). The EEA report concluded that about 16-17% of projected European 2030 energy demand could be met from biomass resources even when applying ‘strict environmental constraints’.

There is now a growing consensus that the theoretical global potential resource base for bioenergy supply is extremely large, possibly as large as the current total global primary energy consumption (see Figure 1; Rokityanskiy et al, 2006; IEA, 2006; Juergens & Mueller, 2007). This remains to be the case even where allowances are made for future food production and where protected land areas are excluded.

A detailed assessment by the International Institute of Applied Systems Analysis (IIASA, 2006) indicates that the supply of biofuels for transport applications may consume a substantial share of the bioenergy potential as outlined in Figure 1. The main rationale driving this larger share of the biomass supply going to biofuels is the lack of realistic supply-side alternatives to biofuels in the near to medium term for the cost-effective substitution of gasoline and diesel, see Figure 2. Demand-side alternatives, including more efficient vehicles (e.g. hybrids) and behaviour-change, may be difficult to achieve in the short-to-medium term. In addition, the energy security and rural development options provided by biofuels currently enable powerful political motivations for the provision of support mechanisms such as subsidies and import tariffs. Such support mechanisms may distort markets and result in perverse outcomes, for example the poor GHG performance of the US corn-ethanol programme.

In the IIASA analysis (Raihi et al, 2006; Figure 2), energy market development is driven by the IPCC SRES scenarios for global development and in both the ‘a2’ scenario, closer to business-as-usual, and the ‘b2’ scenario (more ecologically / resource use efficiency driven). In both these scenarios the demand for liquid biofuels is projected to increase by between 25 and 50EJ by 2030, representing more than 20% of the projected global transport primary energy demand.

Basic calculations indicate that these levels of demand will require nominally between 0 and 300 Mha of land (depending on if residues are used exclusively or if energy crops yielding the equivalent of 8000 l ethanol per ha are used instead). For comparison, the total area of land dedicated to wheat production globally is about 250Mha.

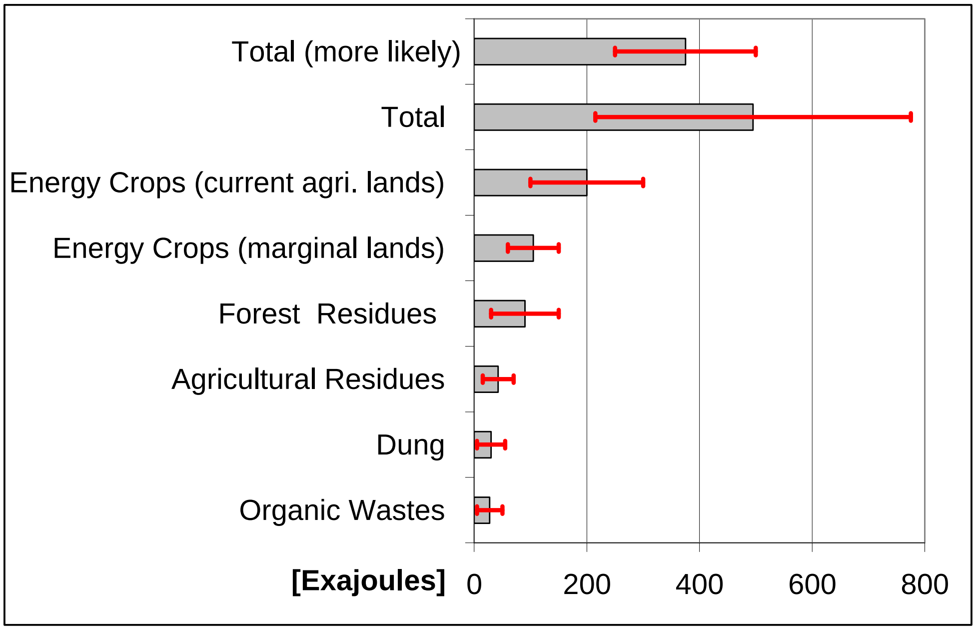

Figure 1: Bioenergy potential categorised by biomass feedstock: different scenarios, year 2050 EJ/yr (Juergens and Mueller, 2007)

2.1. GHG emissions from biofuels

Detailed life-cycle assessments in the US and EU have highlighted that the GHG reduction benefits from biofuels can not be taken for granted. The results from these assessments are based on current and possible future biofuel production chains. The results published vary from at best marginal reductions in GHG emissions when biofuels are used, to reductions of greater than 80% per km driven or unit of transport energy used (Figure 4; Rickeard et al, 2004; Woods & Brown; 2005; JEC, 2006; Farrell et al, 2006).

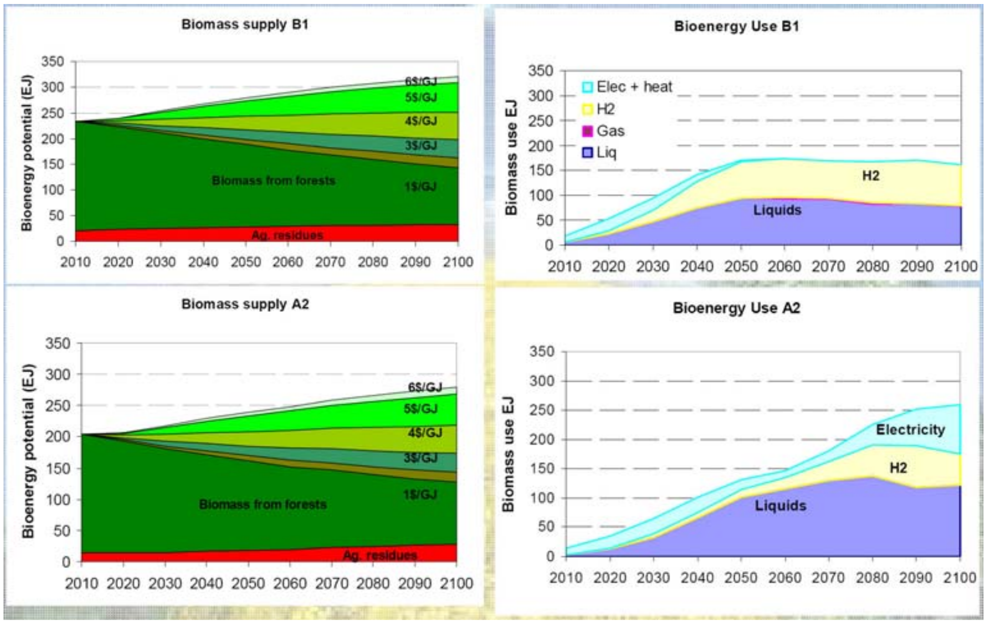

Figure 2: Projections for the supply and use of biomass for energy- 2010 to 2100 (Riahi, 2006, for 'Biomass Supply Graphs on left; IIASA, 2007 for projected biomass use graphs on right)

Despite there now being a number of long running and therefore mature biofuel programmes around the world, e.g. the Brazilian and US fuel-ethanol programmes, emerging developments in feedstock production, conversion and use technologies could lead to substantial reductions in GHG impacts. Indeed employing good/best management agronomic practices and crop selections might result in substantially improved GHG and energy balances and decreased environmental impacts.

Figure 4 highlights the variations in the average GHG emissions associated with the production and use of bioethanol as a vehicle fuel when calculated on a full life-cycle 'well-to-wheel (WTW)' basis. It shows that the average GHG emissions associated with the use of Brazilian sugarcane-derived ethanol would result in about 25 gCO_{2eq} being emitted per km driven by a 1.6 litre vehicle. By comparison, the GHG emissions resulting from the use of standard European gasoline under the same conditions and with the same vehicle would have been c. 170 gCO_{2eq} per km driven. Although not shown, when US corn (maize)-based ethanol is used the emissions would be between 150 and 170 gCO2eq / km i.e. less than 10% reduction compared to gasoline on a full life-cycle basis.

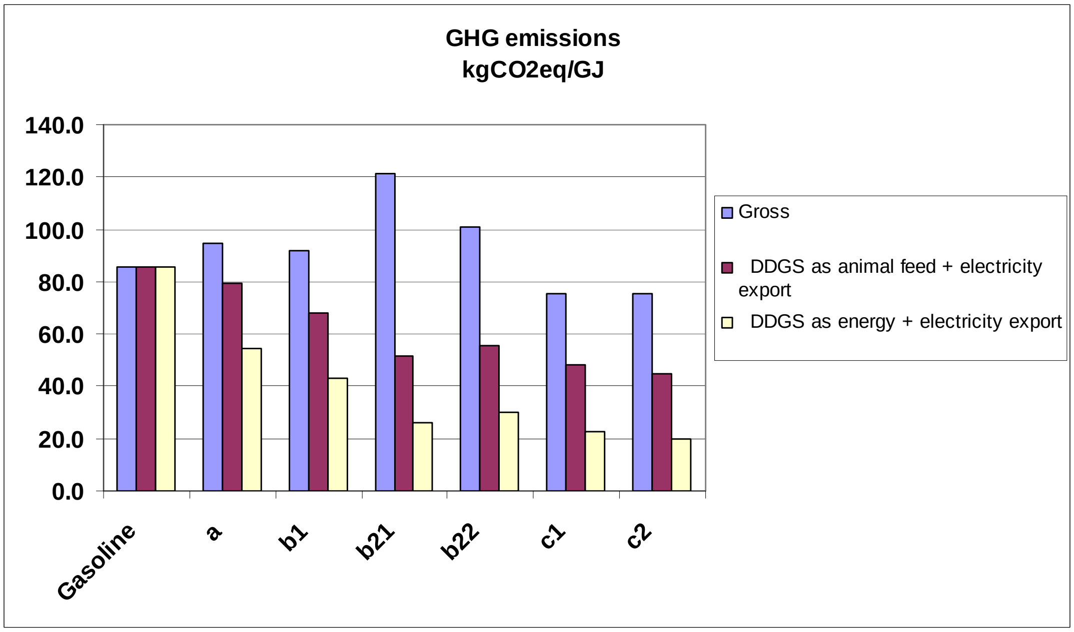

Figure 3: GHG emissions from 6 different models of a wheat-to-ethanol conversion plant (Rickeard et al., 2006). Note: Model ‘a’**: Natural gas-fired boiler and "imported" grid electricity (no CHP).** ‘b’**: Add CHP capability to this basic configuration. ‘b1’ adds a steam turbine, ‘b21’ replaces the boiler with a gas turbine + steam recovery from exhaust, ‘b22’ adds co-firing with natural gas to the steam generator.** ‘c’**: Use straw as an energy source, ‘c1’ straw-fired CHP plant with a steam turbine, ‘c2’ adds a condensing turbine.**

The use of wheat grain and / or straw or sugar beet grown and converted to ethanol in Europe has a wider potential variation in WTW GHG emissions than sugarcane. One study, (Rickeard et al., 2004) which included representatives from CONCAWE (the European Oil Research body), ExxonMobil, EUCAR (The European Council for Automotive Research and Development), JRC (European Joint Research Centre), British Sugar, Imperial College London and North Energy (LCA experts), calculated that the life-cycle GHG emissions from wheat-to-ethanol ranged from a 7% to over 77% reduction compared to gasoline (Figure 3). The actual reduction in GHG emissions depended most strongly on the way energy was generated and used in the conversion plant and the way co-production (particularly distillers dried grains with solubles, DDGS) were used e.g. as animal feed, for internal energy generation in the conversion plant, or as a fuel in a large existing electricity generation plant.

Although the Rickeard et al, study used standard UK-derived wheat agronomic factors, it has emerged that substantial reductions in the emissions arising from the feedstock production could be achieved if different e.g. high starch / feed, varieties of wheat were used for ethanol production (Smith et al, in press). In particular, reductions in the use of nitrogen per unit of ethanol produced can lead to significant reductions in overall GHG emissions both from reduced nitrous oxide (N_2O)

emissions in-field and at the fertiliser manufacture plant, and in improved fermentation efficiency in the ethanol production plant due to the lower protein content of the wheat grain. An important conclusion of this analysis was that the lowest GHG emitting ethanol production chains were also the most capital intensive. Therefore, policies that simply promoted biofuels on a volumetric basis were likely to relatively greater incentives to the worse performing ethanol producers rather than the best.

The wide range in the possible impacts including in those often sited as the main reasons for promoting biofuels, is the prime justification for the requirement to implement measurement and monitoring systems. Over the last two decades, the rise of consumer-led demands to know the origin and environmental impacts of the products they purchase has resulted in the emergence of certification systems aimed at guaranteeing environmentally and socially benign products. The application and/or revision of these certification systems to biofuels is the main focus of this paper. The following sections assess the fundamental applicability of such schemes to biofuels and the practical issues of implantation and monitoring.

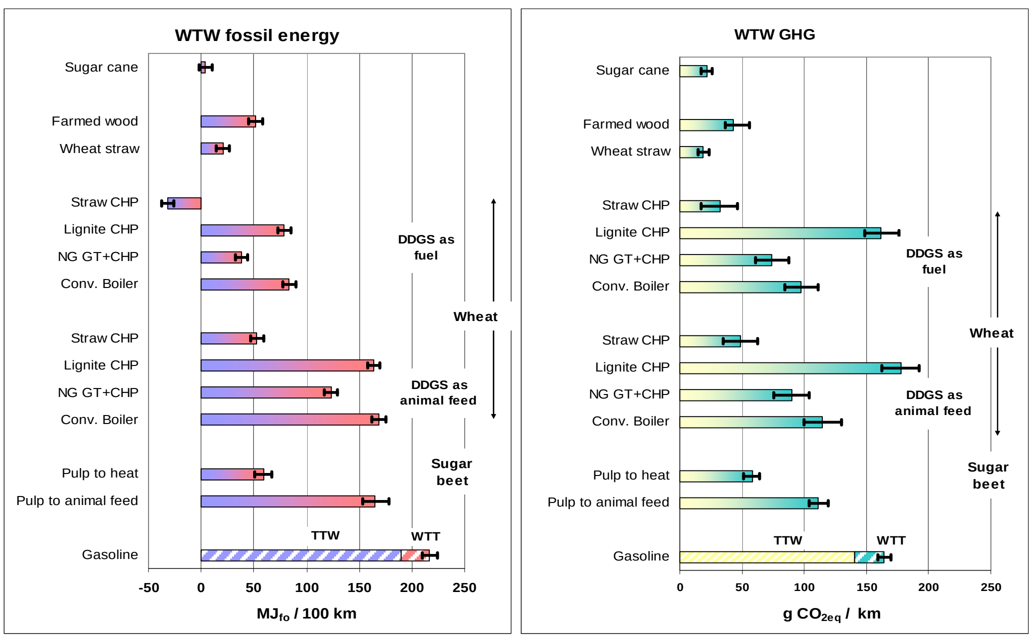

Figure 4: A comparison of energy (MJ/100km) and GHG balances (gCO2eq/km) for different bioethanol supply chains (JEC, 2006)

3. NATIONAL DEVELOPMENTS IN BIOFUEL ASSURANCE AND CERTIFICATION

A range of global to local factors are driving the increasing demand for biofuels as outlined below. Although there is potential conflict between new policies designed to target individual drivers, flexible and carefully developed policies can be developed to provide incentives for biofuel provision systems that meet all or many of the goals simultaneously. However, such policy frameworks are unlikely to happen without careful and detailed planning and implementation.

Figure 5, outlines the diversity of policy drivers from the global to the local that have driven the emergence of bioenergy, and biofuels in particular. At the global level these range from the relatively more recent climate change mitigation and adaptation treaties to long-running subsidies to agricultural production as ‘rural development’ funding. There may also be conflicting policy aims between the global and local / end-user perspectives. For example, ‘rural development’ or ‘energy security’ incentives to biofuels could result in biofuels which are worse than the fossil fuels that are being substituted in terms of GHG emissions or air quality impacts. From the end-user perspective, even environmentally minded purchasers of vehicles will not purchase them if they become liable to breaking down because of the use of biofuels. Or for drivers wishing to reduce their individual (or fleet) GHG emissions tradeoffs may need to be made in terms of increased emissions of acetaldehyde, ozone precursors in general or eve particulates.

In developing policies to address this diverse set of drivers an overarching framework is also implicitly provided for developing the principles and standards needed to underpin any environmental certification scheme to be applied. To avoid duplication and to minimise costs, existing assurance and certification schemes/institutions have been evaluated as possible implementing institutions (Bauen et al, 2004; Tipper et al, 2005; Ecofys, 2006).

These evaluations were carried out for the UK’s Low Carbon Vehicles Partnership on behalf of the UK Government as part of the development of its Renewable Transport Fuels Obligation (RTFO) which comes into force in April 2008. In parallel, the Netherlands Government has been investigating a similar system and now together with the UK and German governments, concerted efforts are being made to develop a single over-arching super-national standard and legislative approach as described below (UK DfT, 2007; Cramer Commission, 2007).

Despite the existence of publicly respected certification schemes, such as the Forest Stewardship Council (FSC), such schemes have been developed to provide assurance for non- biofuel products (mainly forestry-based timber products). Other emerging schemes, such as the Round Table on Sustainable Palm Oil (RSPO), EUREPGAP, UK ACCS, LEAF, FSC, Roundtable on Responsible Soy Oil (RRSO), and others, have also been evaluated (ECOFYS, 2006; RSPO, 2005; FSC, 2005;

ISO, 2006). It was found that no existing certification scheme has sufficient coverage to be adopted, as is, for biofuel certification. As a result, a meta-standard approach was proposed by Tipper et al. (2006) and which has provided the basis for the current developments in the application of 'sustainability' assurance for biofuels under the UK RTFO.

Much of Europe is densely populated with relatively high per capita energy usage, not least for mobility. Indigenously produced agricultural feedstocks are also expensive compared to global commodity prices and so meeting any substantial internal biofuel supply targets will require significant levels of imports of either biofuel feedstocks or the finished biofuels, or a combination of both. In turn, to avoid conflict with international trade rules any incentive system applied must be able to be equally applicable anywhere around the world.

National / Regional / Global	**Local / End User**
1. Climate Change 2. Energy Security 3. Rural Development (Macro-economic costs)	1. Usability 2. Cost 3. Environment e.g. air quality / health / welfare / biodiversity?
← Sustainability health / welfare / environment	→

Figure 5: Global and local drivers for bioenergy and biofuels

Providing answers on the effectiveness of biofuels in meeting each of these drivers has required the careful and parallel development of policy, the meta-standard methodology and the meaningful interaction of the main stakeholders that are likely to be involved in delivering significant volumes of biofuels into the UK and The Netherlands. The balance of representation in the stakeholder group is an important component of the validity, and therefore public acceptability, of the approach. Stakeholders for the UK RTFO's advisory boards include, biofuel suppliers, oil majors, supermarkets (also major fuel distributors in the UK), government departmental representatives (including; Transport, Trade and Industry, Environment, Food and Rural Affairs), Agricultural representatives (National Farmers Union, Home Grown Cereals Authority (HGCA)), academics (primarily LCA experts) and Green NGOs (RSPB). A similar set of stakeholders were convened in The Netherlands under its Cramer Commission (Cramer Commission, 2007).

3.1. International trade implications

Most OECD countries are now engaged in the international trade in biofuels or potential biofuel feedstocks, many of which are predominantly traded as part of the food supply chain. This cross-over between food and fuel commodities poses significant problems to international trade rules, particularly where different categorisations might be applied to the same physical commodity. In particular, by linking national policies that promote and regulate biofuels to assurance and certification systems, new barriers to trade could be erected.

For consumer-led assurance and certification schemes where compliance with the standards of the scheme is voluntary, the WTO has no jurisdiction. However, where government policies direct compliance, WTO and regional trade rules have jurisdiction and understanding the vulnerability to challenge by potential biofuel-exporting countries has played a significant role in guiding the design of new UK and Netherlands policies on biofuels. The focus has been on the treatment of 'like products' and on tariffs and support mechanisms applied to a biofuel or its associated co-product(s).

According to IPC and REIL (2007), a wide range of governmental support mechanisms are relevant to WTO jurisdiction, including:

- Fuel excise tax exemptions and rebates, full or partial;
- Mandates for the production of specified levels of biofuels;
- Mandates for compulsory blending with fossil fuels to a certain percentage by federal and sub-national entities;
- Government-procurement preferences and purchase mandates;
- Local, state/provincial and federal fleet requirements specifying some level of required or subsidized usage of biofuels in the relevant government fleets.
- Environmental legislation mandating certain specific types of fuel additives (typically for fuel oxygenation) related to reducing vehicle exhausts. This has resulted in higher demand for ethanol either as a blending agent or for manufacture into ETBE as a substitute for the more environmentally hazardous MTBE;
- Subsidies not normally associated directly with biofuels, such as agricultural farm supports in the U.S., EU and elsewhere; and

- Government supported R&D for biofuels ranging from basic research to technology demonstration plants.

Mandatory measures applied through national policy such as the linking of support to compliance with environmental or social standards may be construed as a ‘technical barrier to trade’.

4. ASSURANCE AND CERTIFICATION

The European Commission has introduced the concept of minimum environmental (including GHG) standards, and is considering asking member-states to award less support relative to a standard rate for biofuels produced from biomass grown on lands that were converted from high carbon stock areas or from high biodiversity value areas before 2005 as well as to ethanol produced from wheat using lignite-fired CHP (combined heat and power).

To achieve these aims, a workable, globally applicable, system will need to emerge that aims to ensure and verify the origins of the feedstocks for biofuels production. We use the following definitions for such an assurance and certification system (Bauen et al, 2005):

A ‘***standard***’ refers to a set of principles and criteria to be used consistently as rules, guidelines, or definitions of characteristics to ensure that materials, products, processes and services meet their purpose. The ‘standard’ will also define indicators and methods that are used to measure compliance with principles and criteria.

‘***Certification***’ refers to the issuing of written assurance (the certificate) by an independent, external body – a certification body – that has audited an organisation’s management system and verified that it conforms specifically to the standard.

‘***Accreditation***’ refers to the formal recognition by a specialised body – an accreditation body – that a certification body is competent to carry out certification.

Finally, ‘***assurance scheme***’ generally refers to the overall framework relating to the development of a standard, the accreditation of certification bodies, and the certification of products and services.

In practice a certificate is issued when a producer of a product (or process) has answered, or confirms that it is capable of answering a set of standardised questions categorised by the principles that make up the standard as follows:

‘**Principles**’ which are defined as *‘general tenets of sustainable production’.*

‘**Criteria’** *‘Conditions to be met to achieve these tenets’* and which help to define the indicators to be answered.

‘**Indicators’** the individual questions that show h*ow a farm, producer or company could prove that a particular criterion is met.*

Therefore, it is the indicators that need to provide sufficient detail to ensure that the principles underpinning the standard are being adhered to. However, in complex systems a ‘value judgment’ may be necessary to set the detail, total number and complexity of the indicators. With too much detail the certification procedure becomes too unwieldy, expensive and difficult to administer. Too little detail and serious doubts will be raised about the ability of the scheme to assure that its products meet the standard.

This balance between coverage, detail and simplicity can only be met by a transparent decision process that uses a ‘representative’ set of stakeholders encompassing a ‘balance of interests’ to define, the principles, criteria and indicators of the standards. More often than not, for consumer-based environmental and social assurance schemes, the public credibility of a scheme is a function of the degree of participation of high profile NGOs in the decision making process.

A final, but critical issue to the credibility of certification, often as perceived by the major NGOs, is verification. This credibility is a function of the nature of the principles and indicators that make up the standard, but also of the verification procedures. ‘Verification’ requires a detailed set of protocols to be developed and implemented by the certification bodies, which in turn, must be accredited by an accepted accreditation body. Verification protocols must be developed as an agreed part of the ‘standard’ under which the assurance and certification scheme works. However, the nature of the indicators included in the standard will define the complexity of the auditing procedures that lead to the issuance of the certificates, and therefore the complexity and expense of the verification procedure.

4.1. Assurance and reporting methodologies

The proposed UK-Netherlands assurance scheme has 2 core components: i) a GHG reporting (quantified), and ii) a sustainability reporting system (threshold-based). Draft technical guidance for companies wishing to comply with the ‘reporting’ requirements of the UK’s Renewable Transport Fuels Obligation (RTFO) was issued in February 2007. The boundaries of the GHG reporting as proposed for the RTFO scheme (LowCVP/E4Tech) are outlined in Figure 6:

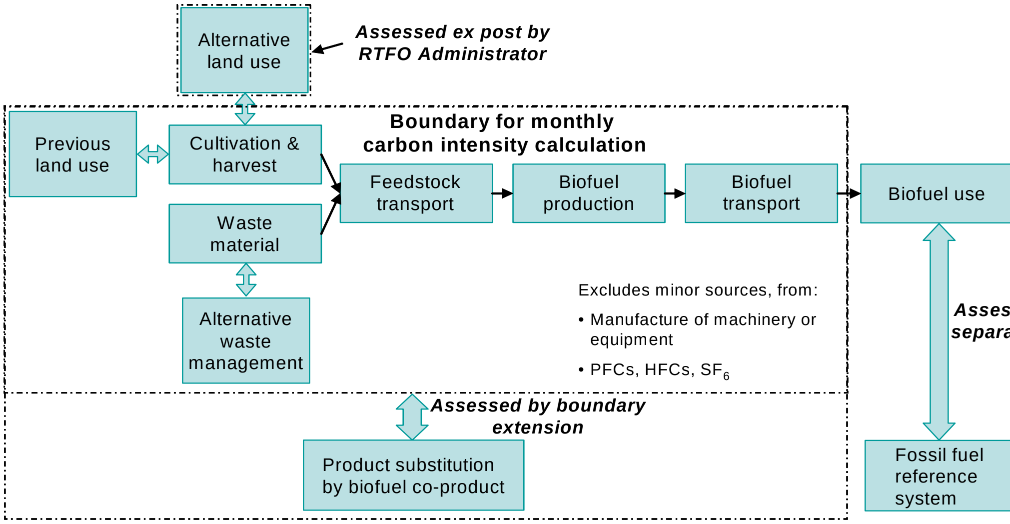

Figure 6: System boundaries for biofuels (E4Tech, 2006)

A Life-cycle Assessment methodology has been adopted for calculating the GHG impacts associated with individual batches of biofuels being passed through the UK fuel-duty points. In order to comply with WTO regulations, a multi-tier, flexible approach has been developed

4.2. Standards and Principles

In 2005, in anticipation of the impending implementation of the RTFO, the UK's Low Carbon Vehicle Partnership commissioned work to develop a draft biofuels standard that would provide environmental assurance for the production of biofuels (Tipper et al, 2006). This work established that it would be possible to apply a 'meta-standard' approach to the implementation of sustainability assurance (including environmental aspects) to biofuels supplied in the UK.

The meta-standard was developed by comparing the standards, principles, criteria and indicators developed by the existing and emerging voluntary standards around the world, including the Forest Stewardship Council (FSC), Roundtable on Sustainable Palm Oil (RSPO), EUREPGAP, etc. A set of seven basic principles were identified as shown in Table 1 with each principle including a number of criteria and indicators designed to assess the extent to which the feedstock produced in accordance with each scheme can be considered sustainable under the RTFO.

Thus, the meta-standard approach enables the use of existing voluntary assurance schemes around the world by the obligated companies, minimising the cost and administrative burden of compliance.

Detailed technical guidance has now been prepared by Ecofys (2006) for the 'sustainability reporting' under the RTFO. These principles and the methodology included in the guidance parallel those proposed by the Netherlands Cramer Commission (2007) thus establishing coherence between the two national schemes. There has also been recent detailed interaction with the German Government, with the intention to harmonise activities between the three countries. In turn, the aim is to help provide the basis for a single EU standard and methodology and collaborate with activities aimed at developing a global standard. Mechanisms to develop a global standard are also emerging under the auspices of the Global Bioenergy Partnership established by the G8 after the Gleneagles summit, the UN-FAO through its Global Bioenergy Platform and through the newly formed Global Roundtable on Sustainable Biofuels.

Table 1: Environmental and social principles

	Environmental principles
1	Biomass production will not destroy or damage large above or below ground carbon stocks
2	Biomass production will not lead to the destruction or damage to high biodiversity areas
3	Biomass production does not lead to soil degradation
4	Biomass production does not lead to the contamination or depletion of water sources
5	Biomass production does not lead to air pollution
	Social principles
6	Biomass production does adversely effect workers rights and working relationships
7	Biomass production does not adversely affect existing land rights and community relations

4.3. Criteria and Indicators

The environmental criteria relate to: carbon storage, biodiversity, soil quality, water quality and quantity and air pollution (see below). They also include a reporting on land-use change (displacement effect and carbon report). These environmental principles are based on the ECCM report (2006), the Dutch criteria defined by the Cramer commission and also existing standards. A reference year of 2005 is adopted for carbon and biodiversity baselines. The criteria relevant to soil, water and air are related to compliance with existing laws and national/GAP (Good Agricultural Practice) guidelines, for example as stipulated under the EU's Cross-Compliance rules.

The social criteria include child labour, freedom of association, discrimination, health and safety, forced labour, wages, working hours (Plus standard only), contracts and subcontractors, and finally land rights. These criteria must provide an equal treatment for all countries, and the extensive agriculture is proposed to be exempted for labour conditions. Such social criteria are not discussed further here.

The land use change carbon intensity measurement proposed by E4Tech is based on the IPCC's 2006 methodology (International Panel on Climate Change) Tier 1 Calculation. Depending on the climate, the ecological zone, the soil and the management practices, land use change carbon intensity can be measured and reported by complying companies, using this methodology. Emissions/stocks from land use change are assumed to be equal to the change in carbon stocks from biomass, in dead organic matter and in mineral or organic soils or wetlands.

There are problems linked to uncertainty in a biofuels certification scheme since emissions of important GHG such as N_2O (nitrous oxide) and CH_4 (methane) from agriculture are very difficult to monitor. Furthermore, changes in biomass stocks (from deforestation) and in soil carbon are very badly measured.

Nevertheless, several on-farm studies reveal that most GHG emissions in agriculture come from the input of nitrogen fertilizer. Furthermore, GHG emissions are higher when the straw is removed than when the straw is simply ploughed back.

The main goal of the UK-RTFO is to deliver incentives for low GHG biofuels and which are not environmentally or socially destructive. At its most comprehensive level, detailed farm-to-garage forecourt assurance and certification tools might be used. For example, in the UK a proposed 'bolt-on' audit to the ACCS (Assured Combinable Crops Scheme) is being developed and tested. A second farm trial (performed by HGCA, Imperial College and CMi) is being carried out in 2007 covering at least 100 farms.

5. CONCLUSIONS

Biofuel supply chains can be very complex. They are often, geographically long and dispersed with almost all countries likely to be self-producers for internal consumption and also for exporting. For example, over the last decade Brazil has both exported and imported bioethanol, Sweden has exported and imported wood chips, Spain (Abengoa) uses a mixture of internally produced wheat grain and imports for bioethanol production some of which it also exports, etc.

The biofuel supply chains are also very diverse and are likely to become increasingly diverse as new technologies for feedstock supply, conversion and use come onto the market. The situation is further complicated by the main biofuel feedstocks also being food feedstocks, introducing difficult issues of product categorisation under international trade rules and their associated tariffs. In addition, international trade rules do not allow direct discrimination against imported products e.g. national policy cannot simply categorise a product e.g. Malaysian palm oil biodiesel, as not acceptable and so ban it (fuel or feedstock) from being imported. However, categorisation of a product using environmental criteria may be possible as long as it is not discriminatory and the systems which verify the categorisation are in turn not discriminatory.

For a number of important potential environmental indicators with regard to the above categorisation, biofuel production and supply chains can range from significantly better than to worse than the fossil fuel being replaced. Such indicators cover a very broad range of potential impacts, with the impacts being both direct and indirect. Narrow policies which target one issue may well cause unintended and negative impacts elsewhere. For example, producing biofuels as a tool for energy security is likely to result in poorly performing biofuel production chains from the perspective of GHG emissions.

Volumetric or production-based policy support can result in a highly competitive market but is also in biofuels with poor GHG performance. Low GHG biofuels require highly integrated and therefore efficient energy supply systems in their production facilities, which entails additional capital investment. From an economic perspective, unless there is value in reducing GHG emissions such investments will not occur.

The combination of rising oil prices and public support mechanisms coupled to improved efficiencies in the feedstock supply and conversion industries has resulted in biofuels becoming cost-competitive. As a result, biofuel markets are growing rapidly from a small base, around the world. If mitigating climate change is a major policy target and existing policies are likely to result in poorly performing biofuels from the perspective of their GHG emission, then urgent action is required to establish new systems that that ensure / assure low GHG biofuels – doing nothing is not an option.

This report outlines how such ‘assurance and certification’ systems could act as the basis for a highly targeted carbon-tax or other performance based reward systems. However, such certification schemes;

- require robust and practical methodologies able to deal with the complexity and heterogeneity of biofuel production, supply and use chains
- the continued and active involvement of the main stakeholders including scientists, NGOs, producers, consumers, and national, supra-national and global institutions. Only then are biofuels likely to be publicly acceptable in the medium to long term.

Fortunately, existing examples of voluntary environmental assurance schemes capture most (if not all) of the indicators necessary, including; PEFC and FSC in the forestry sector. However, environmental assurance and certification does not provide a ‘silver bullet’ solution to the existing unsustainable trends in the transport sector. For environmental assurance specifically, leading academics and also NGO representatives have stated that:

- ENVIRONMENTAL ASSURANCE in forestry has not led to tangible reductions in deforestation or improvements to management outside the certified areas
- ENVIRONMENTAL ASSURANCE is unlikely to solve socio-environmental problems such as conflict over resources
- ENVIRONMENTAL ASSURANCE is not an effective substitute for good governance and regulation of natural resources. The best outcomes are achieved where good governance and ENVIRONMENTAL ASSURANCE go hand-in-hand
- Does not protect smallholders from the deflation of global commodity markets. Assurance schemes tend to advantage larger players,
    - “group assurance schemes” can facilitate small producer entry.
- The credibility of ENVIRONMENTAL ASSURANCE schemes, as perceived by major NGOs, is largely dependent on the degree of participation and consultation in standard development.
- “Good practice” in the development of environmental standards has been set out by ISEAL (http://www.ifoam.org/partners/partners/iseal.html).

Such environmental and broader ‘sustainability’ assurance schemes are beginning to emerge in important sub-sectors e.g. the Round Table on Sustainable Palm (RSPO). However, to be successful most, if not all, these sub-sector schemes must as a minimum be compatible with each other. There is now a growing movement to standardise environmental assurance schemes in general (see ISO, 2006). In addition, biofuel specific activities are occurring led by national governments in the European Union and also through international bodies. It is becoming clear that the development of international environmental assurance and certification systems is becoming tightly linked to the development of ‘sustainable’ biofuels. In order to account for critical but indirect impacts of biofuels such systems are likely to expand to become land-use rather than product specific encompassing integrated food, fuel and materials production and supply chains. Biofuels is likely to be a significant but relatively small component of such future land use.

REFERENCES / FURTHER READING

Bauen, A., J. Howes, A. Chase, R. Tipper, A. Inkinen, J. Lovell, and J. Woods. Feasibility Study on Certification for a Renewable Transport Fuel Obligation. London, UK: LCVP. FWG-P-05-07:1-80, 2005. http://www.lowcvp.org.uk/resources/agendasandminutes/working.cfm?catid=3&catName=Fuels

Cramer Commission. Testing framework for sustainable biomass. Final report from the project group 'Sustainable production of biomass.' IPM, March 2007, The Netherlands. http://www.mvo.nl/biobrandstoffen/download/070427-Cramer-FinalReport_EN.pdf

E4TECH. Methodology for Carbon Reporting under the Renewable Transport Fuel Obligation- draft. Bauen, A, P. Watson, and J. Howes. London, UK:E4TECH / LowCVP. 1-80, 2006.

ECCM (2006) – see Tipper et al (2006) below.

EEA. How Much Bioenergy Can Europe Produce Without Harming the Environment? Kongens Nytorv 6, 1050 Copenhagen, Denmark: European Environment Agency. 7/2006 (ISBN 92-9167-849-X; ISSN 1725-9177):1-72, 2006. www.eea.europa.eu

ECOFYS (2006) Draft Technical Guidance for sustainability reporting under the Renewable Transport Fuel's Obligation. Low Carbon Vehicle Partnership, London, UK.

Farrell, A.E., R.J. Plevin, B.T. Turner, A.D. Jones and M. O'Hare. Ethanol can contribute to energy and environmental goals. *Science* 311:506-508, 2006.

FSC. RAINFOREST ALLIANCE/SMARTWOOD. 2005. Forest Stewardship Council / RainForest Alliance / Smartwood. Generic Standards for Assessing Forest Management. August 2005 (FM-12). p. 22

FSC (2005) FSC principles and criteria for forest stewardship. Available at: <http://www.fsc-uk.info/download/principles.pdf> [Cited January 2006].

IEA (2006). World Energy Outlook. Paris: OECD.

IIASA, International Institute for Applied System Analysis, GGI Scenario Database, 2007, available at: http://www.iiasa.ac.at/Research/GGI/DB/

IPC and REIL. WTO Disciplines and Biofuels: Opportunities and Constraints in the Creation of a Global Marketplace. Ed: J. A. Haverkamp. Renewable Energy and International Law (REIL). late draft:1-23, 2007.

ISO (2006) ISO in brief – International standards for a sustainable world. International Standards Organisation. Available at:

<http://www.iso.org/iso/en/prods-services/otherpubs/pdf/isoinbrief_2005-en.pdf > [Cited January 2006].

JEC (2006). Well-to-Wheels analysis of future automotive fuels and powertrains in the European context. CONCAWE, EUCAR and European Joint Research Council. http://ies.jrc.ec.europa.eu/wtw.html

Juergens & Mueller, 2007 *forthcoming 2007,* based on data from WWI 2006. Presentation given to the 'Foundation for Science' Royal Society, London. 23rd May 2007.

Junginger, M. (2006): *Overview of Biomass – related sustainability certification efforts and policy in IEA Bioenergy. Task 40 member countries*. - Projectgroep duurzame import biomass.

Riahi K, Gruebler A, Nakicenovic N, 2006, Scenarios of long-term socio-economic and environmental development under climate stabilization, Technological Forecasting and Social Change (Special Issue), doi:10.1016/j.techfore.2006.05.026 (in press)

Rickeard,D.J., G. Punter, J-F. Larivé, R. Edwards, N. D. Mortimer, R. Horne, A Bauen, and J. Woods. WTW Evaluation for Production of Ethanol from Wheat. London: LCVP. FWG-P-04-024:1-39, 2004. http://www.lowcvp.org.uk

Rokityanskiy,E.; Benitez,P.C.; Kraxner,F.; McCallum,I.; Obersteiner,M.; Rametsteiner,E.; Yamagata,Y.; Geographically explicit global modeling of land-use change, carbon sequestration, and biomass supply. Technological Forecasting and Social Change, xx:1-25 (in press). 2006.

RSPO. 2005. RSPO Principles and Criteria for Sustainable Palm Oil Production. Round Table on Sustainable Palm Oil. Public Release Version 17 October 2005. p. 6.

Smith,T.C., Kindred,D.R., Brosnan,J.M., Weightman,R.M., Shepherd,M., & Sylvester-Bradley,R. Wheat As A Feedstock For Alcohol Production. Hgca Research Review. In Press. 2007.

Tipper, R., J. Garstang, Vorley.W., and J. Woods. Draft Environmental Standards for Biofuels. London: LowCVP. 2006. http://www.lowcvp.org.uk/resources/reportsstudies/

Woods, J., and G. Brown. BIOETHANOL GREENHOUSE GAS CALCULATOR: user's guide. London, UK:HGCA. 1-38, 2005. http://www.hgca.com/publink.aspx?id=2732

UK DfT (2007). UK Renewable Transport Fuels Obligation: http://www.dft.gov.uk/pgr/roads/environment/rtfo/