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SUSTAINABILITY CRITERIA FOR BIOFUELS IN THE EUROPEAN UNION – A SWEDISH PERSPECTIVE

Report from an f3 synthesis project

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PREFACE

This report is written with financial support from the Swedish Knowledge Centre for Renewable Transportation Fuels (f3 – fossil free fuels).

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CONTENT

1 INTRODUCTION

Biofuel mandates are implemented in many countries worldwide, mainly to reduce climate impact from the transport sector, to move away from fossil fuel dependency and to promote regional development. However, production and use of biofuels are not *per se* sustainable. Therefore, sustainability standards, certification schemes or criteria have been implemented in countries like the US and in the EU.

In 2009, EU adopted the Renewable Energy Directive (RED). The Directive mandates all Member States to have 10% biofuels on energy basis in the transport sector by 2020. In order for a biofuel to be eligible for financial support and to be accounted within the national reporting, it must meet a number of sustainability criteria as described in the Directive.

Also in 2009, the Fuel Quality Directive (FQD) was adopted. In the FQD, requirement on fuel suppliers to reduce the greenhouse gas intensity of energy supplied for road transport was introduced. In order for biofuels to count towards the greenhouse gas intensity reduction, they must meet the specified sustainability criteria. The sustainability criteria are the same as in the RED.

The sustainability criteria in the RED and FQD apply to biofuels and bioliquids (i.e. liquids produced from biomass that are used for purposes other than for fuel e.g. electricity generation or heating). This means that biogas used for electricity and/or heating is not included. Solid biofuels are not included.

The sustainability criteria in the RED and FQD includes aspects such as protection of land with recognized high biodiversity value or high carbon stock. In addition to that, the GHG emission savings from the use of the biofuel compared to fossil fuels is regulated.

The sustainability criteria for biofuels have become adopted in record breaking time. The biofuel sector has had very little time to adjust and to enforce the new demands of verification, certification and reporting systems.

1.1 AIM

The aim of this report is to give an overview of the EU biofuel sustainability criteria within the Renewable Energy Directive and the Fuel Quality Directive. The aim is also to describe how the sustainability criteria have been implemented in Swedish law. Further, the aim is to briefly discuss how the implementation has affected biofuel stakeholders and to discuss future changes to the sustainability criteria.

2 BRIEF INTRODUCTION TO THE DIRECTIVES

2.1 THE RENEWABLE ENERGY DIRECTIVE (RED)

The Directive 2009/28/EC sets targets for the use of renewable energy in the Member States. The motive behind the Directive is to establish “a common framework for the use of energy from renewable sources in order to limit greenhouse gas emissions and to promote cleaner transport” (EU, 2012c).

The overall target for EU27 is that 20% of the gross final energy consumption shall come from renewable sources by 2020. Also, the share of energy from renewable sources in the transport sector must be at least 10 % of the final energy consumption by 2020. While the 10% target in transports applies equally to all countries in the EU, the overall energy consumption target is different for all Member States (Figure 1).

	Share of energy from renewable sources in gross final consumption of energy, 2005 (S_{2005})	Target for share of energy from renewable sources in gross final consumption of energy, 2020 (S_{2020})
Belgium	2,2 %	13 %
Bulgaria	9,4 %	16 %
Czech Republic	6,1 %	13 %
Denmark	17,0 %	30 %
Germany	5,8 %	18 %
Estonia	18,0 %	25 %
Ireland	3,1 %	16 %
Greece	6,9 %	18 %
Spain	8,7 %	20 %
France	10,3 %	23 %
Italy	5,2 %	17 %
Cyprus	2,9 %	13 %
Latvia	32,6 %	40 %
Lithuania	15,0 %	23 %
Luxembourg	0,9 %	11 %
Hungary	4,3 %	13 %
Malta	0,0 %	10 %
Netherlands	2,4 %	14 %
Austria	23,3 %	34 %
Poland	7,2 %	15 %
Portugal	20,5 %	31 %
Romania	17,8 %	24 %
Slovenia	16,0 %	25 %
Slovak Republic	6,7 %	14 %
Finland	28,5 %	38 %
Sweden	39,8 %	49 %
United Kingdom	1,3 %	15 %

Figure 1. National overall targets for the share of energy from renewable sources in gross final consumption of energy in 2020 (EC, 2009a).

To make sure the national targets are reached, the Member States where required to establish so-called national action plans in 2010. These action plans describe roadmaps of how each Member State expects to reach its legally binding 2020 target. The action plans can be downloaded from the EU Transparency Platform (EU, 2012b).

To reach the 20% target Member States can "exchange" energy from renewable sources using a statistical transfer, and set up joint projects concerning the production of electricity and heating from renewable sources. It is also possible to establish cooperation with third countries under certain conditions. It is however mandatory that everything is properly documented, as it is required that the origin of the energy source can be proven (EU, 2012c).

To stimulate the production of low GHG impact biofuels, production based on wastes, residues, non-food cellulosic material and ligno-cellulosic material count double towards the 10% renewables in transport target. Further, renewable electricity for electric vehicles count two and a half times towards the target.

In order for biofuels to get financial support and to count towards the 10% target, they must meet the specified sustainability criteria; this is further described in Chapter 3.

2.2 THE FUEL QUALITY DIRECTIVE (FQD)

The Directive 2009/30/EC was adopted by the Council and Parliament on 22 April 2009 and modifies Directive 98/70 on the quality of petrol and diesel. The overall objective of the Directive is to ensure a single market for transport fuel and to ensure respect for minimum levels of environmental protection from use of the fuel. For health and environmental reasons, the Directive establishes minimum specifications for petrol and diesel fuels for use in road and non-road mobile applications (EU Issue tracker, 2012; EC 2009b).

The Directive sets technical specifications for the content of sulphur, lead and many other parameters in fuels used in road vehicles and non-road mobile machinery. Specifications are given for the vapour pressure, although the Directive gives exceptions regarding vapour pressure for bioethanol blends and for artic countries like Sweden. Further, the Directive specifies limits for oxygenate content, thereby regulating the blend-in of biofuels in petrol. For example, maximum 10% ethanol is allowed in petrol. There is however a special clause which says that until 2013 (or as long as the individual Member States decide) petrol with up to 5% ethanol and maximum 2.7 weight % oxygen must be supplied (to allow for older car models that cannot use higher ethanol content). For diesel, maximum 7% FAME is allowed.

The Directive also sets requirement on fuel suppliers to reduce the greenhouse gas intensity of energy supplied for road transport. The reduction of the GHG intensity is specified in the Article 7a. The three main goals of Article 7a are to provide an incentive to (EU, 2012a):

- optimise GHG performance of biofuels
- encourage the use of lower GHG intensity fuels
- reduce GHG emissions from fossil fuel pathways

According to the Directive, suppliers of fuels should by 31 December 2020 for every sold unit of energy, reduce life cycle greenhouse gas emissions by at least 6 %, compared to the EU-average fossil fuel in 2010. The Directive gives the fuel suppliers a number of options to obtain this 6% reduction, for example via reductions in flaring and venting at production sites, the use of biofuels and alternative fuels (such as LPG).

A further 2 % GHG reduction should be obtained through the purchase of credits under the Clean Development Mechanism of the Kyoto Protocol. An additional further 2 % GHG reduction should be obtained through the use of carbon capture and storage technologies and electric vehicles. These last two targets are however non-binding at the moment, but will be reviewed.

In order for biofuels to count towards the greenhouse gas intensity reduction, they must meet the specified sustainability criteria. The sustainability criteria are the same as in the RED.

2.3 HOW THE DIRECTIVES WORK TOGETHER

The Directives are aimed differently (Figure 2). The RED is targeted towards the Member States to reach the energy based 10% mandate. It will act to increase the quantity of biofuels. The FQD on the other hand is targeted towards the fuel suppliers to reduce their emissions. For biofuel suppliers it will be much more cost efficient if the biofuel that is blended in fossil fuels give a large GHG reduction. The FQD will act to increase the quality of biofuels. This way, less biofuel needs to be used to reach the emission reduction mandate. Together the RED and the FQD will put pressure on the entire biofuel production chain to produce more biofuels, with lower GHG profile.

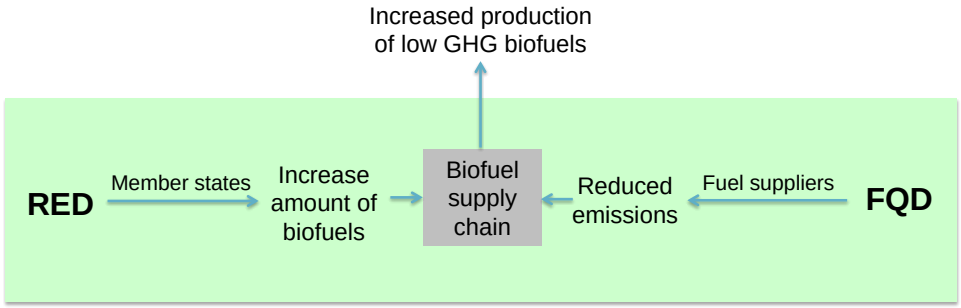

Figure 2. The Renewable Energy Directive (RED) is targeted towards the Member States to increase the use of biofuels, while the Fuel Quality Directive (FQD) is targeted towards the biofuel suppliers to lower their emissions. This could lead to a pressure on the biofuel production chain, so that there will be an increase in the production of low GHG biofuels.

The sustainability criteria that the biofuels needs to comply with in the RED (Article 17) and the FQD (Article 7b) are the same. A comparison of the Directives is presented in Figure 3.

Renewable Energy Directive	Fuel Quality Directive
Article 2: Definitions	not included
Article 5: Calculation of the share of energy from renewable sources	not included
Article 17: Sustainability criteria for biofuels and bioliquids	Article 7b
Article 18: Verification of compliance with the sustainability criteria for biofuels and bioliquids	Article 7c
Article 19: Calculation of the greenhouse gas impact of biofuels and bioliquids	Article 7d
Article 21: Specific provisions related to energy from renewable sources in transport	not included
Article 24: Transparency platform	not included
Annex III: Energy content of transport fuels	not included
Annex V: Rules for calculating the greenhouse gas impact of biofuels, bioliquids and their fossil fuel comparators	Annex IV: Rules for calculating life cycle greenhouse emissions from biofuels

Figure 3. Comparison of the Renewable Energy Directive and the Fuel Quality Directive. Source: BioGrace (2012).

One major difference between the Directives is that in the RED, biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material counts double for the 10% mandate (Article 21.2), while this is not possible in the FQD. One implication of this may be that the FQD 6% GHG reduction target will be difficult to reach (Lonza et al., 2011), this is further treated in the discussion section of this report.

3 THE SUSTAINABILITY CRITERIA

3.1 THE BASIC REQUIREMENTS FOR SUSTAINABLE FUELS

Raw material for biofuel production cannot be obtained from primary forest and other (primary) wooded land; designated nature protection areas; and highly biodiverse grassland.

The Directive also identifies categories of land with high carbon stocks: wetland; continuously forested areas; areas with 10-30 % canopy cover; and peatland. If land fell into one of these categories in January 2008 and no longer does, raw material for biofuels should not be taken from the land.

In practice this means that the status of the land, from which the raw material is collected, must be proven, as well as the status of the land in January 2008. It also means that if raw material for example is taken from land that was wetland in January 2008 and is still wetland when the raw material is taken, using such material would not breach the criterion.

The GHG emission savings from the use of the biofuel must be at least 35% compared with the use of a reference fossil fuel. If the biofuel production plant was in operation before the 23rd of January 2008, the GHG reduction does not have to be obtained before 1st of April 2013 (the so-called grandfathering clause).

The GHG savings constraint increase with time, by the year 2017 the saving must be 50% and from the year 2018 they must be at least 60% for biofuels and bioliquids produced in plants taken into operation after 1st January 2017. The fossil reference is the fossil fuel comparator shall be the latest available actual average emissions. If no such data are available, 83.8 gCO_2eq/MJ can be used.

For social and economic sustainability, the RED does not set any must-criteria. However, every two years the European Commission has to report on the impact of increased demand for biofuel on social sustainability in third countries. This report will analyse how biofuel production has affected the availability of foodstuffs at affordable prices, the respect of land-use rights and whether main producer countries have ratified international labour conventions. The European Commission can thereafter propose corrective action, in particular if evidence shows that biofuel production has a significant impact on food prices (Article 17.7).

3.2 THE ECONOMIC OPERATORS

According to the RED, the economic operators are those responsible for showing that the sustainability criteria have been fulfilled. However, in the Directive it is not defined who is an economic operator. In a communication from the European Commission on the practical implementation of the RED, Member States are however recommended to place the responsibility for submitting information on biofuels on the economic operator who pays duty on the fuel (EC, 2010b).

3.3 DEFAULT AND ACTUAL GHG VALUES

RED Annex V gives default GHG values of 22 biofuel production pathways. These are summarised for a number of biofuels in Figure 4.

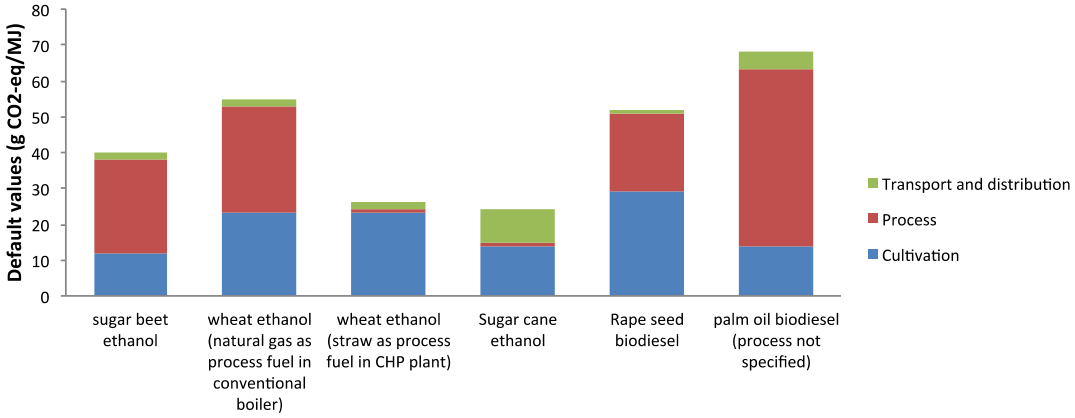

Figure 4. Summary of the default values in the Directive 2009/28/EC for a number of biofuel production pathways. As a comparison, the emission from fossil fuel is at the moment 83.8 g CO_2-eg/MJ.

Default values can only be used:

- if no land use change has taken place for cultivation of the raw materials
- when raw materials are cultivated outside the EU, or in the EU in areas included in one of the lists that are provided by Member States in the so-called 19.2 reports (see description in next chapter).

For production pathways that do not have default values, economic operators have to do their own calculations (so called actual values) according to the methodology in the Annex V:

$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$

where

E = Total emissions from the use of the fuel

e_{ec} = Emissions from the extraction or cultivation of raw materials

e_l = Annualized emissions from carbon stock changes caused by land use change

e_p = Emissions from processing

e_{td} = Emissions from transport and distribution

e_u = Emissions from the fuel in use

e_{sca} = Emission savings from soil carbon accumulation via improved agricultural management

e_{ccs} = Emission savings from carbon capture and geological storage

e_{ccr} = Emission savings from carbon capture and replacement

e_{ee} = Emission savings from excess electricity from co-generation.

For the calculation of GHG emissions of a biofuel, a mix of actual and disaggregated default values listed in the Directive (e.g. emissions from the cultivation, production or transportation) can be used. However, there is a limited amount of default values, so in practice many economic operators have to do their own calculations.

The emissions are calculated as CO_2 equivalents, gases valued as follows:

CO_2: 1

N_2O: 296

CH_4: 23

This means that emitting for example 1 kg of nitrous oxide (N_2O) is considered 296 times more that emitting 1 kg CO_2. The emission factor for CO_2 from combustion of biofuels is zero. This is based on the argument that the same amount of carbon released during combustion is considered to have been taken up by plants while growing.

According to the formula above, the total GHG emissions are the sum of emissions from cultivation, land use change, processing, transportation and use of biofuels. Further, there are a number of emissions that can be subtracted.

For the e_{sca} (emission saving from soil carbon accumulation via improved agricultural management) the European Commission has in a communication explained that 'Improved agricultural management' could include practices such as (EC, 2010b):

- shifting to reduced or zero-tillage
- improved crop rotations and/or cover crops, including crop residue management
- improved fertiliser or manure management
- use of soil improver (e.g. compost)

The emission savings from such improvements can be taken into account if evidence is provided that the soil carbon has increased, or solid and verifiable evidence is provided that it can reasonably be expected to have increased, over the period in which the raw materials concerned were cultivated (EC, 2010b).

Emission savings from carbon capture and geological storage (e_{ccs}) is limited to emissions avoided through the technology CCS (carbon capture and storage) in which CO_2 is captured directly related to the extraction, transport, processing and distribution of fuel. The CCS technology is not on commercial scale and this emissions saving paragraph has at the moment no significance.

Emission savings from carbon capture and replacement (e_{ccr}) is limited to the capture of CO_2 originating from biomass and which is used to replace fossil-derived CO_2 used in commercial products, for example as carbonator in drinking soda.

Emission savings from excess electricity from co-generation (e_{ee}) can be accounted for but under certain conditions. The electricity has to be produced in a system that uses cogeneration. The size of the cogeneration unit shall be assumed to be the minimum necessary for the cogeneration unit to supply the heat that is needed to produce the fuel. The greenhouse gas emission saving associated with that excess electricity shall be taken to be equal to the amount of greenhouse gas that would be emitted when an equal amount of electricity was generated in a power plant using the same fuel as the cogeneration unit.

3.4 ALLOCATION RULES

When producing biofuels it is common with co-products from the process. The environmental impact of the emissions should then be divided (allocated) over the main product and the co-product. The Directives are clear on the choice of allocation method; co-products shall be allocated a share of the greenhouse gas emissions proportional to the lower heating value of the products.

However, not all material that arises from a process can be defined as co-products, some are wastes or residues. Agricultural crop residues are for example not assumed to have any value and are not burdened with any of the emissions from the cultivation. The RED says: 'Wastes, agricultural crop residues, including straw, bagasse, husks, cobs and nut shells, and residues from processing chains, including raw glycerine (glycerine which has not been refined) shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of these materials' (Annex V, Chapter C). The definition of what is a co-product, waste, or residue is very important, this is further treated in the discussion.

3.5 LAND USE CHANGE

In the GHG calculations, the annualized emissions from carbon stock changes (e_l) must be included, if there is a land use change.

Land-use change should be understood as changes in terms of land cover between the six land categories used by the IPCC plus a seventh category of perennial crops (EC, 2010b):

- Forest land
- Grassland
- Cropland
- Wetlands
- Settlements
- Other land
- Multi-annual crops (whose stem is usually not annually harvested such as short rotation coppice and oil palm)

This e.g. means that a change from grassland to cropland is a land-use change, while a change from one crop (such as maize) to another (such as rapeseed) is not. Cropland includes fallow land (i.e. land set at rest for one or several years before being cultivated again). A change of management activities, tillage practice, or manure input practice is not considered land-use change (EC, 2010b).

Regarding multi-annual crops, the rules imply that cultivation of short rotation coppice such as Salix would be considered as land use change. However, Sweden has chosen to not include this land category in the land use change rules.

For the calculation of the emissions related to land use change, the European Commission has issued a special communication with rules (EC, 2010a), which is mainly based on the IPCC Tier 1 guidelines.

The GHG calculations also contain a bonus for use of degraded land of 29 g CO_2eq/MJ biofuel. You can get the bonus if evidence is provided that the land was not in use for agriculture or any other activity in January 2008 and

falls into one of the categories severely degraded land (including such land that was formerly in agricultural use) or heavily contaminated land.

Severely degraded land includes land that for a significant period of time has been salinated, severely eroded or the organic matter content has been significantly lowered. Heavily contaminated land includes land that is unfit for the cultivation of food and feed due to soil contamination. The bonus can be used for a period of up to ten years from the date of conversion of the land to agricultural use, provided there is a steady increase in carbon stocks.

3.6 EMISSIONS FROM CULTIVATION (19.2 REPORTS)

As previously mentioned, economic operators can only use the default values for a biofuel if the raw material has been collected from an area where the GHG emissions from crop cultivation can be expected to be the same as, or below, the average emissions.

For this purpose Member States had to submit a report by March 31st, 2010, including a list of areas on their territory and the associated GHG emissions (Article 19.2 of the Renewable Energy Directive). The report is required to describe the method and data used. The areas in these lists should follow the regions classified as level 2 or a more disaggregated level in the nomenclature of territorial units for statistics (NUTS), se example of winter wheat in Sweden in Figure 5.

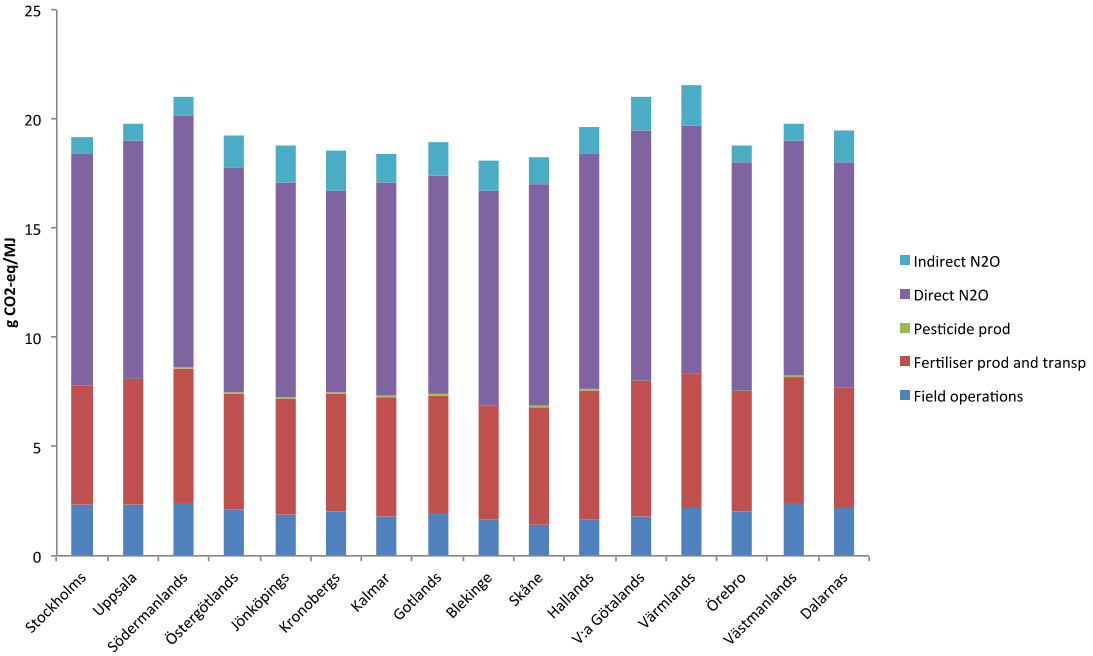

Figure 5. The Swedish 19.2 report calculations for winter wheat in different counties (NUTS 3 level) showed that all winter wheat is under the default value (23 g CO_2-eq/MJ ethanol). Therefore economic operators who utilise winter wheat grown in Sweden can use the default values in Annex V (Ahlgren et al., 2011).

3.7 MASS BALANCE

Biofuels, bioliquids, and the raw material they are produced from must be traceable. Different batches of raw material and biofuel will have differing sustainability characteristics. To provide the necessary sustainability information throughout the value chain a mass balance shall be used, which enables mixing of unsustainable and sustainable

material with different characteristics. The sum of all batches withdrawn from a mixture has to match the sum of all batches added to a mixture (Article 18.1).

In the RED it is said that the European Commission shall report to the European Parliament and the Council on the operation of the mass balance verification method and on the potential for allowing for other verification methods, taking into account the need for integrity and effectiveness of the system while avoiding unreasonable burden on industry. The first report came in early 2011 (since the RED was only about to be implemented, the report contained very little information), a new report is expected in 2012 (EC, 2011).

3.8 CONTROL SYSTEMS AND CERTIFICATION

The sustainability of biofuels needs to be proven by the economic operators (sellers of the biofuels). In practice, the biofuel producer and the raw material producers are the ones who will be responsible for the certification of sustainability; the economic operators will demand of the producers to provide a certificate. The sustainability certification can be done by complying with the national system (as all Member States shall implement the Directive in national law), or by joining a voluntary scheme that has been approved by the European Commission. The first voluntary sustainability schemes have now been approved by the European Commission (EC, 2012b):

- ISCC (International Sustainability and Carbon Certification)
- Bonsucro EU
- RTRS EU RED (Round Table on Responsible Soy EU RED)
- RSB EU RED (Roundtable of Sustainable Biofuels EU RED)
- 2BSvs (Biomass Biofuels voluntary scheme)
- RBSA (Abengoa RED Bioenergy Sustainability Assurance)
- Greenergy (Greenergy Brazilian Bioethanol verification programme)
- Ensus voluntary scheme under RED for Ensus bioethanol production

Some of the certification systems cover only part of the production chain; a batch of biofuel can therefore come with several sustainability certificates.

Economic operators have to have independent auditors that inspect the control system of their biofuels production chain, from the farmer to the trader and the fuel supplier. The auditing is done to verify that the control systems used by economic operators are accurate, reliable and protected against fraud. The auditor also evaluates the frequency and methodology of sampling and the robustness of the data. If the biofuel has a certificate from any of the voluntary schemes it can be used as proof of sustainability and no further proof of sustainability or auditing of the biofuel producer or production chain is required.

Regarding imports of raw material or biofuels, the EU shall seek to make bilateral or multilateral agreements with third countries that guarantee compliance with the sustainability criteria; the European Commission may then decide that those agreements demonstrate that biofuels produced from raw materials cultivated in those countries comply with the sustainability criteria (BioGrace, 2012).

4 IMPLEMENTATION IN SWEDISH LAW

The Renewable Energy Directive has now been implemented in Swedish law (Swedish Energy Agency, 2012a):

- Act (2010:598) and amendments in Act (2011:1065)
- Ordinance (2011:1088)
- Regulations (2011:2)
- Guidance (ER 2011:23)

The FQD is implemented in:

- Act (2010:319)
- Ordinance (2011:346)

No regulations or guidance have for FQD have been implemented, since the European Commission has not yet put forward clarifying rules regarding the GHG calculations (see discussion).

The economic operators have to report to the Swedish Energy Agency annually. The economic operators has in Sweden been identified as those who are taxable for fuel (according to definition in Energy Tax Act 1994:1776) or in their business operations use biofuel or bioliquid (Swedish Energy Agency, 2012b).

The Swedish system for implementation of the RED sustainability criteria consists of a number of elements, as listed below.

Reporting: The economic operators have to report:

- Quantity of sustainable biofuel or bioliquids
- Fuel category
- Type of production chain
- Uses
- Lower heating value
- Raw material
- Cellulose content of the raw material
- Country of origin
- Residuals/waste
- Emission savings
- Method for the determination of emission savings
- Claimed considerations
- Certification that goes beyond requirements in the directive

Verification: The economic operators must have a control system in place. The control system shall (Swedish Energy Agency, 2012a):

- Cover production chains handled by the system
- Be based on a risk assessment of the operation
- Take into account how the greenhouse gas emission saving is calculated

- Include written guidelines and procedures, particularly for sampling and mass balance
- Be auditable regarding the basic data pertaining to the assurance of sustainability that is saved for at least 10 years
- Be managed with a clear distribution of responsibility and functions within the organisation
- Include a specific deviation management system with a designated responsible person.

Auditing: An independent auditor shall verify that the control system is ensuring that the sustainability criteria have been fulfilled.

Sustainability Decision: The economic operators also have to apply for a sustainability decision for their control system. This decision works as the evidence that the biofuels and bioliquids, delivered or used by the economic operator with a reporting obligation, are to be considered sustainable, and therefore exempt from tax or fulfilling future biofuel obligation or mandatory targets. Application for a sustainability decision shall include a description of the verification system, a statement from the independent auditor, and a description of the independent auditor's competence and assurance of independence.

5 DEBATE AND FUTURE EVOLVEMENTS OF THE SUSTAINABILITY CRITERIA

5.1 LARGE UNCERTAINTIES CONCERNING IMPLEMENTATION

"As we speak most Member States have yet to fully implement the RED. Some have done nothing at all. Some elements were not done in a harmonised way. With double counting we see Member States struggling even to find an agreed definition of wastes and residues, which is crucial otherwise you risk severe market distortions," said Gloria Gaupmann, director of energy policy and environmental affairs at European bioethanol producers' association ePure at a conference in Barcelona in January 2012 (Argus Media, 2012).

Indeed, the definition of what is a co-product, a waste, and a residue is important for the double counting of advanced fuels, as well as for determining allocation rules for the GHG accounting. The RED itself does not contain definitions of waste and residue. In a communication from the European Commission it is stated that (EC, 2010b):

"…no emissions are allocated to co-products which production did not aim for, such as straw in the case of wheat production. In this context waste can be understood as any substance or object which the holder discards or intends or is required to discard. Raw materials that have been intentionally modified to count as waste (e.g. by adding waste material to a material that was not waste) should not be considered as qualifying."

In the communication it is further said that residues can include agricultural, aquaculture, fisheries and forestry residues. Also processing residues is included in the definition. A processing residue is a substance that a production process not directly seeks to produce. It is not a primary aim of the production process and the process has not been deliberately modified to produce it. Examples of process residues include crude glycerine, tall oil pitch and manure.

However, even after this clarification by the European Commission there are issues to be resolved regarding the definition of waste and residues. In the Swedish guidelines there is a list of materials and their classifications. But there is no harmonized implementation in the various Member States. There is further no clear interrelation between the RED and the EU Waste Framework Directive (2008/98/EC) (CA-RES, 2012).

Another important definition is classification of land. Raw materials for biofuels must not come from land that had one of the following statuses in 2008 and no longer has that status: primary forest, protected area, highly biodiverse grassland, areas with high stocks of carbon, or peatlands. However, these types of land are not clearly defined, and especially the definition of highly biodiverse grassland needs more specification. For this reason the European Commission held a public consultation in February 2010 (EC, 2012a), however, no new definition has yet been suggested.

Choice of data for the GHG calculations are also an issue, e.g. what mix of electricity shall be assumed. Different sustainability schemes apply different values, making the comparison problematic. An initiative to harmonize the GHG calculations and choice of data has been launched; the BioGrace project publishes lists of data that can be used. To what extent this data is used is however unclear.

The RED is due to revision in 2014.

Also for the FQD, uncertainties remain in practical implementation, e.g. for which baseline the 6% reduction is to be measured, how electric vehicles should be counted, and how flaring and venting reduction emissions should be calculated The European Commission issued a public consultation in September 2009 to resolve some of these issues, but there is still no new guidance.

5.2 THE STAKEHOLDERS´ PERSPECTIVES

In a study by van Dam and Junginger (2011), six different groups of stakeholders in the European bioenergy sector have been identified: NGOs, policy sector, R&D, bioenergy producers (including pre-processing of biomass), end-users and traders.

In a questionnaire these different stakeholders in EU Member States where asked to rank the importance of different sustainability criteria that can be included in a biomass and bioenergy certification system. The study (which included 285 replies from 25 EU Member States) revealed that GHG emissions and energy balance was considered important among all stakeholders. All stakeholder groups, apart from the traders, ranked socio-economic criteria very low. It can also be noted that all stakeholder groups, except for end-users, ranked minimisation of indirect land use change as not relevant to include in a biomass and bioenergy certification system. Further, the study shows that among the stakeholder groups, answers are quite dispersed and that the country of origin plays a larger role on the opinion of which sustainability criteria are most relevant (van Dam and Junginger, 2011).

Similar results on sustainability criteria ranking was found in a study by Buchholz et al. (2009). Bioenergy experts (mostly working for government agencies or in academia) were asked to rank 35 different sustainability criteria. Energy balance and greenhouse gas balance were perceived as especially critical while social criteria generally ranked low.

Concerning the implementation, it is perceived as a huge problem by investors that methodological issues like the inclusion of indirect land use change (see description in chapter 5.5) remain unclear. Uncertainties in policies and regulations cause markets to stagnate. Another critical issue might be the administrative burden of legislative requirements and certification, especially for small players (Pelkmans et al., 2012).

Another complicated question is: Does the sustainability criteria discriminate between national and foreign products? If that is the case, the EU could be violating World Trade Organisation trade rules (Lendle and Schaus, 2010). So far,

the issue has not become a matter of trade dispute, but stakeholders monitor the development (see e.g. Kutas and Phillips, 2011).

A survey study conducted by The Swedish Bioenergy Association investigated the pros and cons of the sustainability criteria as perceived by bioenergy producers. The replies showed opinions that the RED had been implemented too fast, that the costs for the implementation were high and a fear that end-users were not willing to pay for this extra cost. On the other hand it is believed that implementation of the sustainability criteria could increase the credibility of their trademark and increase the market competitiveness (Dahlman, 2012).

5.3 CAN THE TARGETS BE REACHED?

The GHG emission savings from the use of the biofuel must be at least 35%, compared with the GHG emission from the use of a reference fossil fuel (83.8 gCO_2eq/MJ). By the year 2017 the saving must be 50% and from the year 2018 they must be at least 60% for plants taken into production after January 2017. In Figure 6, the default values are shown for some biofuel pathways together with the reduction targets.

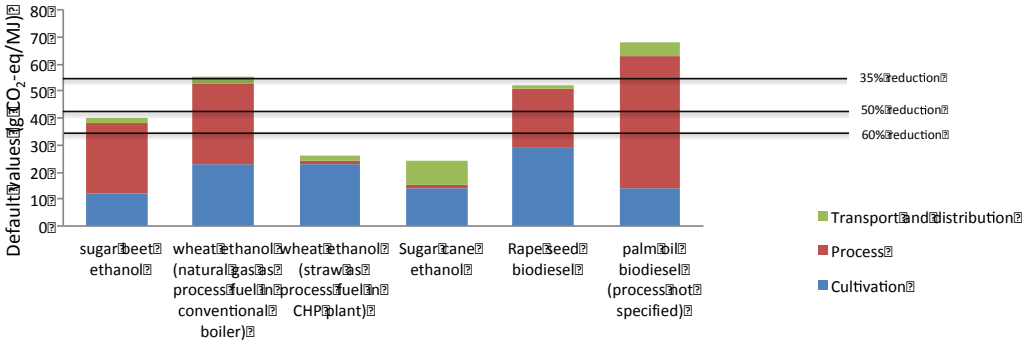

Figure 6. Summary of the default values in the Directive 2009/28/EC for a number of biofuel production pathways, with the reduction targets marked (reduction compared to fossil fuel 83.8 g CO_2-eg/MJ).

It is clear that some biofuels will have difficulties complying with the GHG reduction restrictions. Especially biodiesel, which is one of the most used biofuels in the EU, will have problems with the increasing GHG reduction thresholds. Even biodiesel produced from residues can have trouble reaching the reduction targets; in a study by Thamsiriroj and Murphy (2011) it was calculated that biodiesel based on tallow has a 54% GHG reduction when applying the RED methodology. Used cooking oil scored better with a 69% GHG reduction.

In a study by Lonza et al. (2011) the potential for biofuels and other alternative energy sources to achieve the 10% renewable energy target for the EU transport sector by 2020 as mandated was investigated, using a future projection model. Assumptions regarding the future development of the European vehicle fleet, including different vehicle technology options and the resulting demand for conventional and renewable fuels were made. One reference scenario and eight additional market fuel demand scenarios were developed. The results indicated that although the RED target can be reached, none of the considered scenarios achieved the minimum 6% GHG reduction target mandated in FQD.

Sweden is already close to reaching the 10% target (Swedish Energy Agency, 2012c). Preliminary numbers indicate that Sweden used 9.8% renewables in transport sector during 2011. In Sweden, 5.5 TWh of sustainability certified

biofuels was reported to be used during 2011. Circa 8% of the used biofuel were based on waste or residues, and was counted double towards the 10% target. Half of the biofuels had a GHG emission reduction of more than 50%, which qualifies them as sustainable even after 2017 (Swedish Energy Agency, 2012d).

5.4 DOES FULFILLING THE SUSTAINABILITY CRITERIA REALLY MEAN THAT THE BIOFUELS ARE SUSTAINABLE?

The use of biomass does not automatically imply that its production, conversion and use are sustainable. Sustainability can include a number of different aspects such as economic production of food, fodder and fuels, environmental impacts, biodiversity, social and cultural values, etc. In a paper by Buchholz et al. (2009) 35 different sustainability criteria were found in emerging sustainability assessment frameworks (Table 1).

Table 1. Sustainability criteria identified by Buchholz et al. (2009)

Category	**Criteria**
Social	Compliance with laws
	Food security
	Land availability for other human activities than food production
	Participation
	Cultural acceptability
	Social cohesion
	Respect for human rights
	Working conditions of workers
	Respecting minorities
	Standard of living
	Property rights and rights of use
	Planning
	Monitoring of criteria performance
	Visual impacts
	Noise impact
Economic	Employment generation
	Microeconomic sustainability
	Macroeconomic sustainability
	Economic stability
Environmental	Adaptation capacity to environmental hazards and climate change
	Energy balance
	Natural resource efficiency
	Species protection
	Ecosystems protection
	Ecosystems connectivity
	Crop diversity
	Exotic species applications
	Use of genetically modified organisms
	Use of chemicals, pest control, and fertilizer
	Soil protection

	Land use change
	Water management
	Waste management
	Greenhouse gas balance
	Potentially hazardous atmospheric emissions other than greenhouse gases

The RED covers only a few of the environmental sustainability criteria identified by Buchholz et al. (2009). Some of the social criteria are mentioned in the RED, but are not obligatory to fulfil. The economic criteria are not explicitly addressed in the RED, but could be considered as the underlying reason for implementation of a biofuel policy.

Further, even if the sustainability criteria regarding GHG emissions is well covered in EU biofuel policy, it has to be kept in mind that these kind of calculations are very uncertain. In a study by Soimakallio and Koponen (2011) timing issues, allocation problems, and uncertainty of individual parameters where identified as the main sources of uncertainty, as well as the exclusion of indirect effects (which further treated in the next chapter).

Concerning the parameter uncertainty, nitrous oxide emissions (N_2O) from soil have proven to be a large source of uncertainty. Studies show that N_2O contributes to about 15-60% of the GHG emissions from making biofuels on set-aside land in EU (Edwards et al., 2009). N_2O is formed by microorganisms in the soil when there is an excess of nitrogen. Standard practice in LCA is to use a model to quantify these emissions, in the EU GHG calculations it is advised to use the IPCC model (EC, 2010b). The IPCC model assumes that 1% of the nitrogen fertilisers added to a field is emitted as N_2O, however this factor comes with an uncertainty interval of 0.3-3%. The result of applying this interval for cultivation of winter wheat in Sweden is illustrated in Figure 7. As can be seen, the emission from the cultivation alone could be almost high enough to cancel out the 35% GHG savings; but it could also be much lower.

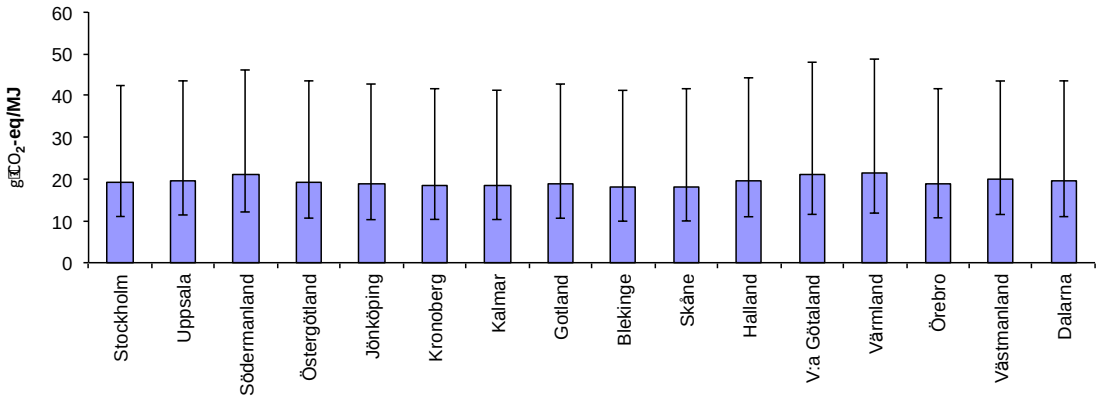

Figure 7. Greenhouse gas emissions (g CO_2-eq/MJ ethanol) from cultivation of winter wheat in different counties in Sweden, including the uncertainty range for calculation of nitrous oxide emissions. The bars indicate the result of applying the highest and lowest emission factor for nitrous oxide, respectively, in the uncertainty range given by IPCC. As a comparison, the emission from fossil fuel is at the moment 83.8 g CO_2-eg/MJ

5.5 INDIRECT EFFECTS

Another complication is that the sustainability criteria do not include indirect effects. For example, the sustainability criteria only cover raw materials used for biofuels and bioliquids. This means that raw material that does not qualify as sustainable for biofuel production will be used elsewhere as feed, food etc. The total environmental impact from

agriculture will therefore not be lowered by the introduction of biofuel sustainability criteria. On the other hand, market demands on low GHG emissions might raise awareness and induce farmers and other stakeholders in the production chain to try to lower their emissions, leading to a positive spill-over effect in other sectors.

Another indirect issue that has received a lot of attention in media and among policy makers the last couple of years is the indirect land use changes connected to biofuel production. As is illustrated in Figure 8, an increase in demand of biofuel raw materials can have many consequences. When speaking of an increase of demand, two different types of land use change can be distinguished; direct land use change (dLUC) and indirect land use change (iLUC). The direct changes are attributed to the raw material production itself, while indirect land use changes refer to the effects of having to produce missing products elsewhere. As most agricultural and forest products are internationally traded, iLUC can occur anywhere on the globe (Ahlgren and Börjesson, 2011).

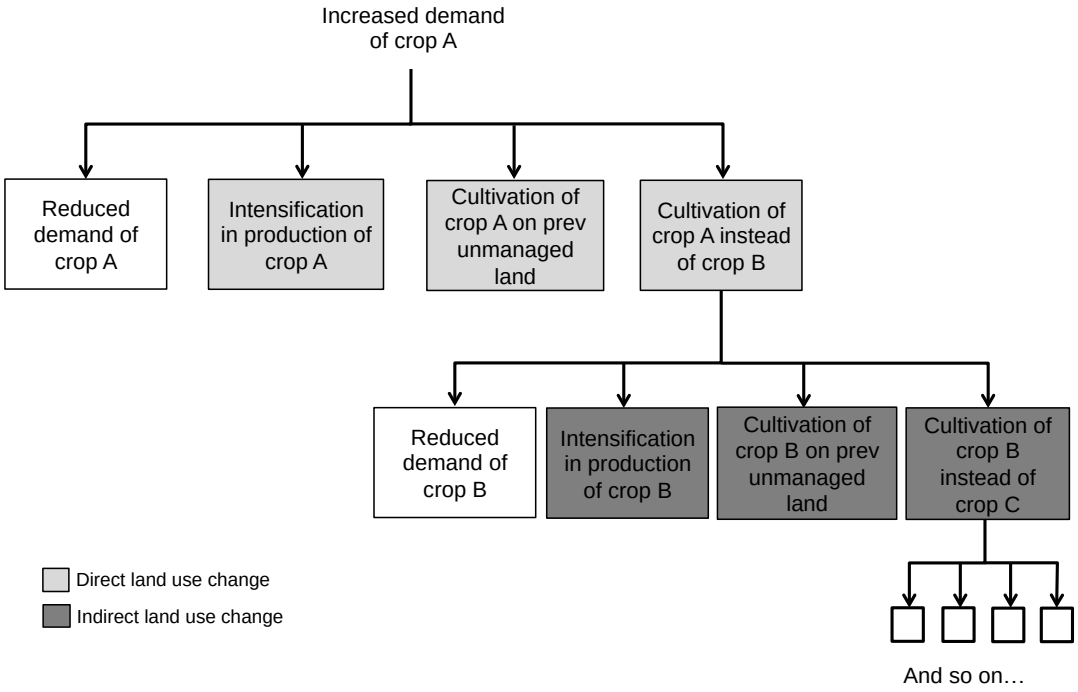

Figure 8. Increased demand of biofuel raw materials can have many consequences. White boxes indicate that no land use change takes place, light grey boxes show direct land use change, dark grey indirect land use change.

In the GHG calculation methodology in the Directives, land use changes must be accounted for. However it is only the direct land used change that is included. Further land use change is only included if it is a change between the listed land categories. For example the GHG calculations include a direct land use change between forest and agriculture, but not intensification of production (read more in chapter 3.5). However, the European Commission is at present considering to include indirect land use changes in the sustainability criteria.

The quantification of iLUC is based on global economic modelling and the results from studies show extremely large variations, the iLUC emissions from wheat based ethanol is estimated to anywhere between 176 and minus 53 g CO_2-ekv/MJ (compare to emissions from petrol 83.8 g CO_2-ekv/MJ). Much of the variance in estimates of iLUC stems from uncertainty that in the future can be reduced with better models and better data. However, due to the complexity of the global economy, so-called epistemological uncertainty (connected to lack of knowledge of system behaviour)

is a major contributor to the uncertainty, and it is not likely that these uncertainties will be reduced soon (Plevin et al., 2010).

The debate on how to address iLUC in EU policy has engaged strong interest groups with high political as well as economical stakes. Major international environmental NGOs (e.g., Greenpeace, Friends of the Earth, and Transport and Environment) have for the past few years expressed sharp criticism against the promotion of biofuels, and some argue for a moratorium on biofuels.

The European Commission is required by the RED to report to the EU institutions on the impact of iLUC on GHG emissions of biofuels and to submit, if appropriate, proposals on ways to minimise it. No action has yet been taken, but a number of reports have been issued. One report from the European Commission list a number of plausible ways to deal with iLUC (EC, 2010c):

1. take no action for the time being, while continuing to monitor;
2. increase the minimum GHG saving threshold for biofuels;
3. introduce additional sustainability requirements on certain categories of biofuels;
4. attribute a quantity of greenhouse gas emissions to biofuels reflecting the estimated indirect land-use impact

A number of stakeholder meetings have also been arranged, but so far no further policy action has been taken.

5.6 SUMMARY OF THE DISCUSSION

Sustainability assessment is an extremely complicated task as there are many aspects to include, and the quantification is in many respects subject to high uncertainty. The EU biofuel sustainability criteria covers only a fraction of the aspects related to sustainability, and do not at present include indirect effects. Concerning the practical implementation of sustainability criteria, there are still major issues to be resolved. For stakeholders, the slow progress of the indirect land use issue and the practical implementation hurdles are perceived as problems.

Regulating sustainability of biofuel is a new way of policy making and it is not surprising that it is connected with difficulties. It will most likely settle into a better working system with time. However, the question whether the sustainability of biofuels can be guaranteed with the implementation of this kind of policy remains unanswered. The EU biofuel policy has however triggered the debate on sustainability of biofuels, which is a positive thing in itself.

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