THE LAND-USE IMPLICATIONS OF EU BIOENERGY POLICY

GOING BEYOND ILUC

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SUMMARY

The EU Renewable Energy Directive promotes the use of biofuels in transport by providing for a 10 per cent target for renewable energy in transport by the year 2020 to be met by each Member State. There is concern that the increased use of biofuels will lead to considerable land use change. This briefing discusses some of the modelling work that is undertaken in support of quantifying the land use change impact and its associated emissions. It is argued that the current debate on the indirect *land use impacts on biofuels should be seen as an opportunity for an extended and general debate on various agricultural activities impacting on land use.*

1 INTRODUCTION

This paper is meant to give an introduction to the debate on indirect land use change that is currently taking place in a biofuel policy context. The first part of the paper provides an elaborated background section needed to understand the policy context and (potential) consequences of the politically driven promotion of bioenergy. The subsequent part presents the outcomes of a study (Bowyer, 2010) that quantifies the potential indirect land use change as a result of biofuel use envisaged by Member States in their National Renewable Energy Action Plans (NREAPs). As Bowyer (2010) relies on parameters derived from economic modelling studies, a non-technical introduction to the models used in this context follows. It is then argued that the land use change debate while very relevant should not remain restricted to the biofuel/bioenergy context but should rather be seen as a starting point for bringing land use change issues and their consequences to the forefront. Also, while not extensively discussed in this study, the last section introduces ways forward to using biofuels more beneficially in environmental terms.

2 BACKGROUND

EU policy in the field of bioenergy is currently most prominently driven by the provisions of the Renewable Energy Directive 2009/28/EC (henceforth: RED), replacing the former directive 2003/30/EC[1] on the promotion of the use of biofuels or other renewable fuels for transport as well as directive 2001/77/EC[2] on the promotion of electricity produced from renewable energy sources in the internal electricity market. Specifically, the RED stipulates that every Member State shall use 10 per cent of renewable energy in transport by 2020 as part of the overall EU renewable energy target of 20 per cent of final energy use in 2020. This is split into individual binding national targets for each Member State.

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[1] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF.

[2] Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:283:0033:0033:EN:PDF.

It has been suspected from the outset that the vast majority of renewable energy in transport up to 2020 would be covered by first-generation biofuels, i.e. produced from food crops and/or crops competing with food crop production for the same pool of available agricultural land. Having assessed the National Renewable Energy Action Plans (NREAPs) recently submitted to the Commission by Member States, these expectations have been met with near certainty. Were Member States to realise the projections set out in the NREAPs, first-generation biofuels would account for 8.8 per cent of transport energy by the year 2020 (Atanasiu, 2010)[3]. Assuming stable or – more realistically – increasing food and feed demand in the future, increased energetic biomass demand induces increased demand for cropland. This pressure can either be relieved to a certain extent by intensification of current land use or lead to more land being taken into production. The latter would imply land use change of various forms: be it through the reactivation of agriculturally idle land (that might currently serve other purposes such as providing space for nature conservation or recreational purposes) or the expansion onto land that has historically not been cropped, such as managed or natural grasslands or forests.

Assuming intensification processes cannot keep pace with increasing demand, which is anticipated to be the case at least in Europe (see also Allen and Lee, 2010) there are three ways the land demands for biofuels can be met:

- conversion of existing *crop land* from current production to meet the biofuel need either through the growth of a new crop or through an existing crop being diverted to a different use i.e. wheat no longer used for food but as a biofuel feedstock;
- conversion of land that is currently under *livestock* farming; and
- conversion of land currently not used for agricultural purposes.

These three possibilities lead to potential environmental threats through the conversion of previously uncultivated (i.e. uncropped) lands in the form of enhanced GHG emissions and biodiversity impacts. In the case of the former two options i.e. conversion of land that is currently used in some way for agriculture there is the potential for indirect land use change consequences as current production activities are displaced to other areas to make way for biofuel feedstocks.

The RED sets out criteria requiring that biofuel feedstocks used to meet the EU targets should not lead to the conversion of particular sensitive land uses - protected on the basis of biodiversity or carbon stocks. In principle this limits the availability of land for biofuels in the third category and to some extent conversion of extensive pasture lands. However, at present there is no mechanism for taking account of the indirect impacts known as ILUC (indirect land use change).

The question of ILUC is at the forefront of the current debate on biofuel policy in Europe with a particular focus on the greenhouse gas (GHG) emissions associated with ploughing up non-arable land for agricultural crop use. The European Commission is currently

[3] Note that the analysis by Atanasiu (2010) is based on 23 NREAPs, those available at the time of drafting. The European Commission recently reported that "National Renewable Energy Action Plans estimate that biofuels will represent around 9 per cent of the total energy consumption in transport in 2020" (European Commission, 2010).

investigating policy options to deal with indirect land use change caused by the increased demand for biofuels and bioliquids triggered by the RED. In this context, it has recently conducted a public consultation (closed 31 October 2010). Following this, at the end of 2010 the Commission published a report on the impact of indirect land use change on the GHG emission performance of biofuels as it was required to according to RED Article 19(6). In this report, the Commission concludes that the available evidence still suffers from deficiencies and uncertainties and continued investigation is required in order to complete an Impact Assessment by July 2011. The Commission acknowledges the risks associated with indirect land use change, and, if deemed necessary will put forward a legislative proposal for addressing these.

3 THE INDIRECT LAND USE CHANGE IMPACTS ASSOCIATED WITH THE NREAPS

A recently released study conducted by IEEP (Bowyer, 2010) combined results taken from agro-economic modelling studies with the biofuel volumes EU Member States anticipate actually using by the year 2020. These volumes are derived from the 23 NREAPs published by end of October 2010.[4] A few observations concerning anticipated biofuel usage are reproduced here, for details please consult Atanasiu (2010) and Bowyer (2010). According to Member State plans, the 10 per cent renewable energy in transport target would result in an 8.8 per cent share of total transport energy comprising first-generation biofuels. Out of this, 72 per cent will be biodiesel and the remaining 28 per cent bioethanol. The target, as defined in the Directive, relates to the *use* of renewable energy, meaning that countries may source biofuels from other Member States or third countries. As a consequence the NREAPs predict that 50 per cent of ethanol and 41 per cent of biodiesel used in 2020 will be imported. Taken together, these figures suggest additional first-generation biofuel use in 2020 of 15,047 Ktoe (kilo ton oil equivalent); additional in the sense that it is triggered by the provisions of the RED and adds to the volumes already being used by Member States in the year 2008. Admittedly, the 2008 usage levels were stimulated at least partly by historic policies; however, the aim of Bowyer and other recent studies is particularly to assess the impact that the RED has.

Using the NREAP figures and combining these with modelling outcomes (discussed in more detail below), Bowyer (2010) finds that RED induced biofuel demand will lead to an area of 4.1 to 6.9 million ha of land being converted into cropland as a consequence of ILUC. By way of illustration, this “ILUC area” ranges roughly from the size of Belgium to the size of Ireland. The carbon that is released during land conversion would amount to emissions ranging from 876 to 1459 $MtCO_2eq$ (mega ton CO_2 equivalents) in total.

Under the RED, biofuels must deliver a minimum level of GHG emission savings. When these levels of savings are subtracted the study finds that the savings associated with biofuel use do not outweigh the land use change emissions.[5] Additional emissions of between 27.3 and

[4] Four NREAPs had not been submitted by the time the report was finalised: Belgium, Hungary, Poland and Estonia.

[5] Bowyer (2010) evaluates the GHG performance of biofuels compared to fossil fuels taking into account the calculated land use change emissions. In doing so, account was taken of the fact that biofuels are bound by

56.5 $MtCO_2eq$ per year would result. This means that emissions from using biofuels up to the year 2020 are 80.5 – 166.5 per cent higher than if fossil fuels had delivered the same amount of transport energy.

4 MODELLING INDIRECT LAND USE CHANGE

There are many different approaches to and outcomes from modelling efforts to address the question of how significant ILUC impacts will be. The analysis within the study by Bowyer (2010) is the first to combine these with the full details as set out in the NREAPs. However, to understand the wider controversy and challenges associated with addressing ILUC it is crucial to grasp the underlying mechanisms at work in modelling studies. Models have been at the forefront of ILUC discussions in both academic and policy settings.

With agricultural markets becoming increasingly integrated globally, it is not straightforward to capture the land use implications of increased biomass use for energy purposes. Increased bioenergy crop production in the EU, for instance, might not necessarily trigger an increase in cropland in the EU but be compensated by reduced EU food production and thus increased food imports (demand being assumed to be constant) and thus intensification or land use change elsewhere outside of the EU. The European Commission has commissioned several studies that aim to quantify the indirect land use change impacts of the EU's renewable energy policy by modelling the interactions across global agricultural and energy markets and the remaining economic sectors. These have been published as a basis for the public consultation on indirect land use change. Among them are a study conducted by IFPRI that uses the general equilibrium model MIRAGE to assess the "Global Trade and Environmental Impact Study of the EU Biofuels Mandate" (Al-Riffai et al., 2010); a further study commissioned from the JRC-IPTS[6] that uses the partial equilibrium model AGLINK-COSIMO to asses the agricultural-market and land-use implications of the EU biofuels target (Blanco Fonseca et al., 2010); and a study that has been compiled by JRC-IE and compares results from various models on marginal biofuels scenarios[7] (Edwards et al., 2010). Apart from this work, several other modelling and analytical exercises have been conducted. When looking at this compendium of work, there is striking variance in results in terms of additional hectares of agricultural land taken into crop production or in terms of the additional land-use emissions caused as a consequence of this land expansion.

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the RED to attain a minimum GHG saving compared to fossil fuels. This minimum savings requirement amounts to 35 per cent from the entry into force of the directive (December 2010) till 2017. From 2017 onwards, the requirement increases to 50 per cent and up to 60 per cent in 2018 for new installations (in operation in or after 2017). The study assumes that all biofuels used do meet the requirement as they would otherwise not count towards the renewable energy target and could not benefit from relevant support measures. Thus, the savings derived in this way are subtracted from the ILUC emissions.

[6] The JRC is the Joint Research Centre of the European Commission made up of seven institutes. JRC-IPTS is the Institute for Prospective Technological Studies based in Seville. JRC-IE is the Institute for Energy based in Ispra.

[7] The models analysed the effects of producing or consuming one additional (or marginal) unit (typically 1 mtoe) of biofuels on top of a reference scenario.

5 WHY DO WE RELY ON MODELS AND HOW DO THEY WORK?

As a consequence of the feedback effects felt from increased use of bioenergy across countries and economic sectors, a comprehensive modelling framework is essential in order to try to quantify effects; comprehensive in the sense that interactions across countries and regions can be depicted and also those occurring across different sectors of the economy, most notably different agricultural and energy sectors in this context. Furthermore, models need to be global in scope in order to account for globally integrated markets. Most of the models used for analysing bioenergy policies have been developed primarily for other purposes, in most cases as agricultural trade models, i.e. they are not outright "bioenergy-models"; others have been developed with an energy sector focus meaning that the modelling of bioenergy activities is still in a development stage.

It is worth spending a moment to set out the nature of the types of models frequently used in analysing bioenergy policies. Essentially, the studies mentioned and other similar studies undertaken employ partial or general equilibrium models. The strength of general equilibrium models (*GE* or *CGE*, the *C* denoting *computable*) is the inclusion of all sectors of the economy and world regions[8], which allows account to be taken of interdependencies across sectors and regions that are established via trade, intermediate use of products and/or substitutability between goods. Partial models, on the other hand, are usually designed for analysing a certain sector, which is then represented in a highly detailed way with the rest of the economy being largely left out. The focussing on a particular sector has the advantage that partial models tend to be much more detailed for the sector under scrutiny. In the case of agriculture this might entail a detailed representation of agricultural policy often missing in CGE models and a wide range of agricultural sectors and activities that are 'hidden' in more aggregate sectors in a CGE model.

Economic models are calibrated to an existing dataset that contains input-output tables for a certain base year. Most, if not all, CGE models make use of the well-known GTAP database, which in its current version (7) consists of data for the year 2004.[9] Given the base data, models then represent the economic structure including different industrial sectors producing goods, for end and intermediate use, households that supply labour and demand final goods, imported and of domestic origin and a public sector that collects tax revenues and might – in the context at hand – finance subsidies for biofuels. Typically, models make standard assumptions about the behaviour of different actors in the economy, such as producers (minimising their costs) and consumers (maximising their utility). Supply equals demand, or – stating it in other words – 'all markets clear'. The interplay of demand and supply determines equilibrium prices and quantities for the different commodities modelled.

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[8] Note that this does not imply all economic activities or all countries singled in detail. Rather, the underlying sectoral and regional/country-data are aggregated as needed for the question at hand.

[9] GTAP is a publicly available database managed at Purdue University. The current database GTAP 7 consists of input-output tables for 113 countries/regions covering 57 economic sectors. Apart from information per country/region, it includes comprehensive data on bilateral trade, transport and protection linkages among the regions (www.gtap.org).

If a model goes beyond the base year for which data exists, i.e. if it is dynamic, exogenous drivers stimulate development over time. These can be external projections of GDP growth rates or productivity growth rates. In order to test the effect of, say an increase in value added tax, the value added tax parameter in the model is manipulated in the desired way. A model outcome of interest, for instance the household consumption level, is then compared between the modified model run and the original model specification. Likewise, in a dynamic setting, the tax increase would be introduced in a certain year and the modeller can then compare consumption levels at the end of the projection period in model runs with and without the tax increase. This is called a comparative-static analysis. Approaching the context at hand, a biofuel mandate and its effects can be modelled in a similar way by manipulating parameters to impose a certain level of biofuel consumption. The features mentioned thus far hold for models covering a wide range of issues.

As models, especially general equilibrium models are very much stylised, they necessarily rely on a range on assumptions to make them 'workable'. It is these assumptions that anyone wishing to understand model results and why they diverge should investigate closely. They determine the so-called market responses of modelling biofuel policy, meaning the changes in market equilibrium prices and quantities in response to a so-called 'policy shock'. Starting again with the fundamentals, examples of such assumptions are the ease of substitutability between different inputs in production processes, the degree to which imports substitute for domestically produced goods (i.e. are they considered identical products or do households or firms have preferences for domestic products) or preferences of households. Models typically do not vary dramatically in relation to these rather standard assumptions. In the context at hand, it is the assumptions surrounding the markets for agricultural goods, land and biofuels that are of particular interest. A few crucial mechanisms are mentioned below, for extensive discussions see Cornelissen and Dehue (2009) and Edwards et al. (2010).

In direct relation to biofuel production processes, it is important to account for the treatment of co-products, i.e. oil meals in the case of biodiesel production and DDGS (Dried Distillers Grains with Solubles) from ethanol pathways. The fact that these co-products can be used as animal feed in the livestock sector frees up resources, as less dedicated crops will be needed for this purpose. Thus, ignoring by-products would overestimate the additional cropland needs resulting from biofuel promotion. This example also shows the interconnections between different sectors, which the models discussed have the potential to account for. Another way of freeing up resources for energy crop production is through reduced food consumption with consumers responding to increased prices, which are likely to arise from increased feedstock demand.

Different models differ in their detail of land modelling. For one thing, this relates to the disaggregation of different land cover types and the carbon stocks associated with these land types leading to varying magnitudes of CO_2 emissions once land is converted to cropland. Also, a crucial element that has been alluded to previously is the degree of substitutability between land and other inputs in agricultural production. The elasticity determining the degree to which, for instance, more fertiliser input can increase crop output is a crucial determinant of the potential for economically viable yield increases and consequently of land use change. Depending on the assumptions, a (biofuel induced) increase in crop demand that raises crop prices will more or less readily lead to new land being taken into this form of crop production. This new land may either be shifted from other agricultural sectors or be new cropland all together. When discussing the case of new land, there is the question of anticipated yield, which tends to be heavily discussed in the modelling and policy-making communities: particularly what the aggregate crop yields on land that is newly brought into agricultural production compared to existing cropland? Edwards et al. (2010) advocate addressing this question in a differentiated way, as so-called frontier or marginal yield assumptions can have a large impact on new cropland requirements. While the ratio of marginal versus average (i.e. average of existing cropland) crop yield is roughly one in the case of soybean production in Brazil, it is around 2/3 for maize cultivation in the US and potentially lower in the EU (see Edwards et al., 2010, pp.102-103 for an extended discussion). The figures reflect the fact that the most suitable land for agriculture is already exploited in the EU while Brazil has spare land of high agricultural value available. In general, there is a lack of understanding of some of the yield response mechanisms because extended time series data, as well as the necessary statistical methods that allow estimating yield-price relationships are only starting to be available.

This is far from an exhaustive discussion about the mechanisms at work in modelling and the drivers and parameters that are being discussed. These issues are addressed in more depth elsewhere in the literature, as referred to above. Instead this paper aims to give examples of mechanisms at work and stress that these are the crucial drivers when it comes to estimating areas of new land being converted into cropland per additional unit of biofuels produced. The sensitivity of model outcomes to different assumptions explains the perhaps wide range of results that must currently be interpreted. Moreover, underlying the calculations are complicated modelling mechanisms that take into account a range of feedback effects and market responses within and across economic sectors and world regions.

6 TAKING THE RESULTS FROM MODELS FURTHER

Hiederer et al. (2010) have recently conducted an analysis based on the results from existing models and including further dimensions that are critical, such as additional N_2O emissions from intensification and a more sophisticated, spatially differentiated method of accounting for emissions from land use change. The study uses results from the MIRAGE model runs (Al-Riffai et al., 2010) and the AGLINK-COSIMO study (Blanco Fonseca et al., 2010) for predicted additional cropland demand and uses a harmonized spatial data set in order to allocate this extra demand and calculate corresponding GHG emissions from above- and below-ground biomass and from soil. The spatial data set is composed of several layers of geographical data including among others land cover types, soil types, suitability maps and climatic conditions.

Hiederer et al. (2010) calculate savings by comparing the RED default values with the fossil fuel comparator (FFC) as included in the RED (83.3 gCO_2eq/MJ) and, alternatively, by comparing default values and FFC as calculated in the well-to-wheels analysis of the JEC consortium[10] (87.0 gCO_2eq/MJ).[11] Since the JRC study does not contain pathway-specific ILUC estimations, Hiederer et al. (2010) calculate emissions from cultivation, processing, transport and distribution as a weighted average of the respective default values per crop/pathway. The weights correspond to the EU demand for each feedstock/pathway as derived from the economic models. ILUC emissions being added, total emissions are then compared to the respective FFCs so as to yield savings. With ILUC emissions spread over twenty years as envisaged in the RED, the following results emerge depending on the choice of the FFC. Applying the RED fossil fuel comparator, the MIRAGE model results (IFPRI-BAU) yield 22 per cent emission savings while the AGLINK-COSIMO results yield 34 per cent of *extra* emissions. Based on the fossil fuel comparator derived in the JEC well-to-wheels analysis, the corresponding figures are savings of 36 per cent (MIRAGE) and *extra* emissions of 21 per cent (AGLING-COSIMO). These results imply that a specific set of assumptions (fossil fuel comparator according to JEC and the IFPRI-BAU run of the MIRAGE model) has to be in place for the 35 per cent GHG savings requirement incorporated in the RED to be met in these modelling frameworks.[12]

A spatially explicit approach is a sophisticated way of accounting for land use change and intensification emissions. This is due to the fact that emissions from land use change and intensification can differ tremendously depending on land cover and soil type characteristics. Using different layers of spatial data as done by Hiederer et al. (2010) accounts for such characteristics in a more detailed way than other studies have done. It should be noted that unlike Bowyer (2010), Hiederer et al. (2010) also rely on assumptions they have made on biofuel use by the year 2020 and not on plans actually formulated by Member States. To illustrate what this implies for the results: while Bowyer (2010) calculates the ILUC area to be between 4.1 and 6.9 million ha and the AGLINK-COSIMO results are well within that range with 5.2 million ha (the share of first-generation biofuels is 7.0 per cent), the IFPRI study modelling a 5.6 per cent share of first generation biofuels only yields an additional cropland area of 0.8 million ha. It follows firstly that in order to narrow the range of results somewhat, it is important to get the underlying assumptions about anticipated biofuel usage right in future modelling, which is possible now with the submission of NREAPs; and secondly that, even doing so, a considerable uncertainty range is likely to remain due to different underlying assumptions. This can be seen in the large divergence between AGLINK-COSIMO and MIRAGE results in terms of ILUC areas that is proportionately larger than the difference in their assumptions on biofuel use in 2020.

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[10] JEC is the acronym for a consortium between the JRC, EUCAR and CONCAWE that conducts well-to-wheels analyses for different transport options (http://ies.jrc.ec.europa.eu/jec-research-collaboration/about-jec.html).

[11] The fossil fuel comparator represents the average lifecycle emissions of a fuel derived from fossil sources.

[12] Note, however, that the minimum GHG savings requirement will increase to 50 per cent in 2017 and to 60 per cent in 2018 for new (i.e. post-1 Jan 2017) installations.

7 GOING BEYOND ILUC

An interesting element in the debate is the continued emphasis on the ILUC impacts of biofuels in isolation, as if they were driven purely by political developments in the biofuels arena while the rest of the world stands still. ILUC does not occur only when additional biofuel feedstocks are grown but also is a consequence of other changes in demand that require additional land use in one location without any reduction in the overall requirement for agricultural commodities previously grown on that land. So the land use needs are shifted elsewhere. Biofuel crops are not unique in this respect. However, it must be appreciated that there are two reasons why the ILUC question is potentially of particular importance in the case of biofuels. One is the unusually large scale of demand for new land in a relatively short period driven largely by policy interventions in support of bioenergy. The other is that biofuels are being promoted as a *low-carbon* alternative for the transport sector, and their value in this role needs to be established and verified.

At the same time bioenergy production is only one part of a spectrum of agricultural and other land-use activities all exerting pressure on the limited resource of land. At present the ILUC acronym is used almost exclusively in the bioenergy community and has played a much more limited part in the wider discussion amongst the group of stakeholders engaged in other land use/land management issues. The increasing demand for biomass, either used for electricity or heat generation or transformed into biofuels for use in transport, is highly significant but it is only one of several drivers determining land use dynamics in Europe. Increased demand for land for the purpose of food production resulting both from a growing world population and changing eating habits is crucial as well; so are pressures resulting from the potentially higher demand for non-energetic industrial biomass use, urbanisation etc. It is important to consider the different drivers as a whole in order to understand future land use patterns and developments.[13]

The current focus of debate on *indirect* land use change as a result of biofuels should create a momentum to bring wider land use issues to the forefront so that the total land use impacts of major policy decisions are taken into account. This applies whether policies are driven by climate considerations or other objectives.

8 CONCLUSIONS AND WAYS FORWARD

The results from various models suggest that biofuel-induced land use change emissions might be as large as or larger than projected GHG emissions savings from using biofuels as a substitute for fossil fuels. Consequently there is a clear case for proposing ILUC-related legislation in the context of the RED. The RED provides for a policy mechanism to address land use change related emissions on an international level. Therefore, introducing legislation as part of the RED could be a first step in extending such standards and appropriate legislation to a wider sphere. Eventually it would be desirable to account for GHG emissions from all additional land demands globally, and to feed this information into

[13] See also Allen and Lee (2010) for future land use dynamics.

land use decisions, although this is rather a long-term solution and not practical within the next decade.[14]

The discussion of the modelling efforts and the inherent uncertainties associated with them raises some questions about how far quantitative estimates of impacts derived from current modelling work can be used to set standards in future legislation. If specific ILUC factors or adders, i.e. attributing a certain amount of ILUC emissions to different biofuel pathways, were to form part of mandatory standards they would necessarily be based on model outcomes. This means that the application of specific ILUC factor would:

- be associated with a considerable degree of uncertainty, with consequences for its treatment in legislation; and
- potentially be contestable for instance with reference to WTO provisions.

The discussion on indirect land use change highlights the fact that land is a finite resource for which different uses are likely to compete for increasingly fiercely. Policy makers therefore would do well if they provided incentives to use land more efficiently. This would reduce pressure for land conversion and would therefore also provide benefits in terms of maintaining habitats for biodiversity conservation. It is one dimension of the need for resource efficiency in Europe and needs to be addressed in the forthcoming EU "Roadmap" on this topic.

However, where the objective is to reduce GHG emissions, it is necessary to take specific steps to ensure that efficient land uses are established. Several options to achieve this are currently being discussed and are investigated by the European Commission as part of its Impact Assessment on ILUC that is under preparation (European Commission, 2010). Adding an ILUC factor to the appraisal of those biofuels intended to contribute to the RED target will in effect increase the need to make the whole biofuel pathway more efficient in order to meet the GHG savings targets stipulated in the RED. The application of feedstock- or pathway-specific ILUC factors would ensure that those biofuels with reduced ILUC risk would be promoted. Another option would be to increase the GHG savings target, for instance by bringing forward the increase in the savings target to 50 per cent in 2017 or by introducing an additional step between the 35 and 50 per cent in the run up to 2017. The advantage of the more demanding GHG target is that it would prevent the need to rely on uncertain and contestable factors derived from modelling. The disadvantage is that it would not necessarily steer production and consumption towards those biofuels with the lowest ILUC risk. It would only do so in those circumstances in which low ILUC risk and carbon efficient conversion from feedstock to fuel coincide. This may be the case in some supply chains, however, such as the case of Brazilian ethanol based on current evidence from lifecycle assessments and ILUC modelling exercises.

[14] Note in this context that the European Commission recently has finished conducting a public consultation on the role of EU agriculture and forestry in achieving the EU's climate change commitments referring to LULUCF (land use, land use change and forestry) activities: http://ec.europa.eu/clima/consultations/0003/index_en.htm.

Another approach is being followed by a consortium lead by Ecofys (Dehue et al., 2010). This targets the project or production level. As a short-term solution to the ILUC debate, they suggest biofuel production to take place on 'unused land' (or Responsible Cultivation Areas as they dub it), to integrate original and bioenergy land uses thus enhancing land productivity while at the same time producing bioenergy from waste and aquatic biomass. The term 'unused land' is to be treated with caution, though. From a conservation point of view, there is very little evidence of much truly unused land. Even though land may not have direct commercial purposes, it may have value in terms of hosting biodiversity and providing ecosystem services that are not well understood, recognised or monetised. Also, the introduction of bioenergy production may be problematic on land currently not commercially used but characterised by complicated ownership structures with many smallholders that may use their land in a very extensive way. However, there is no doubt that the increased use of waste-based advanced biofuels is an environmentally sustainable solution, which is also one of the conclusions from Bowyer (2010). While advanced biofuels from specifically grown woody crops such as short-rotation coppice can be very beneficial in terms of energy yield per hectare, they come with different potential environmental profiles and hazards such as threats to biodiversity due to e.g. the monoculture character of plantations. The use of waste that is currently not used in other sectors to replace fossil inputs, does not entail similar negative consequences for biodiversity and reduces the need for land.

Finally, it would clearly be very beneficial if we needed much less liquid fuel and hence less biofuel than anticipated under the NREAPs. This would be possible in the presence of larger than anticipated energy efficiency improvements in transport for which altogether different policy incentives would be needed.

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