EUROPEAN PARLIAMENT

Briefing

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EU biofuels policy

Dealing with indirect land use change

SUMMARY

In 2003, the European Union established a biofuels support policy, primarily with the aim of lowering CO_2 emissions in the transport sector. Critics have accused this policy of inducing indirect land use change (ILUC), which triggers an increase in global food prices and in food insecurity for the poor, promotes the creation of large land holdings and the use of available ('marginal') land in developing countries, and not least, boosts carbon emissions. Most research carried out recently suggests that while concerns regarding food production may have been overstated, those related to ILUC are not, as ILUC can indeed increase the release of CO_2 emissions during biofuel production. The biofuels industry argues that it sustains many jobs in European rural areas.

In 2012, the European Commission presented a legislative proposal to address some of these concerns while preserving existing investments. It proposed capping conventional biofuels and promoting advanced biofuels. The proposal is expected to go through a second reading in Parliament and the Council in early 2015.

Parliament has called for a conventional biofuels cap, a sub-target for advanced biofuels and the consideration of ILUC factors, while stressing the need for a post-2020 policy.

Advanced biofuels are not yet produced on a large scale in the EU. Although in principle they have advantages over conventional biofuels, the technologies are not fully mature, investment is lacking and the sustainability of feedstocks needs to be assessed.

The biofuels and farming sectors advocate the continued production of conventional biofuels as a source of jobs and economic activity in rural areas and oppose radical changes in policy. Some NGOs are generally opposed to conventional biofuels and would prefer cautious support measures for advanced biofuels.

This briefing updates an earlier one of January 2015.

A field of rapeseed, a crop used for producing biodiesel.

In this briefing:

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Glossary

Biofuels: liquid fuels derived from biomass, used mainly in transport; the most common biofuels are bioethanol (a substitute for petrol) and biodiesel (a substitute for diesel).

Conventional biofuels: also referred to as 'first-generation', conventional biofuels can be sugar- and starch-based ethanol, oil-crop based biodiesel or straight vegetable oil; typically derived from crops which can also be used as food or feed; currently produced on a commercial scale. Bioethanol is produced from biomass (sugarcane, sugar beet, maize, wheat) through fermentation and distillation, whereas biodiesel is produced from vegetable oils (rape, soybean, palm oil) through transesterification.

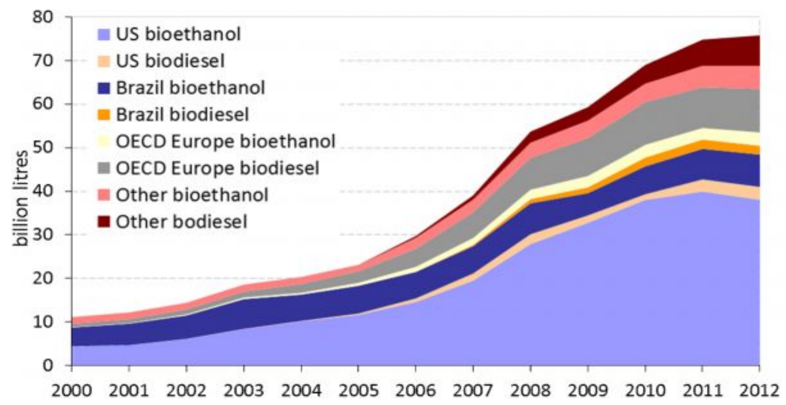
Advanced biofuels: also referred to as second- or third-generation, advanced biofuels are typically derived from plant material which does not have an alternative use as food; they can be based on waste biomass, cereal stalks, other dry plant matter, or crops grown especially for fermentation into biofuels (algae, Miscanthus); at present, mainly produced on R&D, pilot or demonstration scales.

Indirect land use change (ILUC): displacement of agricultural production (food, feed) or forest production (fibre, timber) to previously uncultivated areas such as peatland, grasslands or forested lands, induced by the cultivation of biomass feedstocks (the plant materials used to derive biofuels).

Background

Biofuels have been used as a transport fuel since the late 19th century. Interest in the commercial production of biofuels for transport rose in the mid-1970s, when ethanol started being produced from sugarcane in Brazil and then from maize in the United States. In the 2000s, global biofuel production boomed, as shown in figure 1, mainly as a result of support policies.

Figure 1 – Global biofuels production, 2000-12



Data source: International Energy Agency, 2000-12.

Support policies for biofuels can be driven by various objectives: reducing oil price volatility, strengthening energy security, sustaining the agricultural sector and the rural economy, and, in recent years, decarbonising the transport sector with minimal changes to vehicle stocks and fuel distribution infrastructure. Over 50 countries worldwide have introduced a blending target, defining the proportion of biofuel that must be used in road transport fuel, sometimes combined with other measures such as tax incentives.

In 2003, the European Union introduced a blending target in its Biofuels Directive involving reaching a 5.75% share of biofuels in the EU's transport sector by 2010. In 2009, as part of the 2020 climate and energy strategy, the Renewable Energy Directive introduced a 10% renewable energy target (essentially biofuels) in the transport sector, to be reached by 2020. At the same time, an amendment to the Fuel Quality Directive introduced a mandatory target of a 6% reduction, by 2020, in the greenhouse gas (GHG) intensity of fuels used in road transport and non-road mobile machinery.

In order to reach these targets, EU biofuel production has been subsidised through market price support mechanisms (where Member States set a biofuels target that provides a guaranteed market for producers and pushes prices upwards); and through excise duty exemptions for transport fuels. A study published in 2013 by the International Institute for Sustainable Development placed EU biofuel subsidies at 5.5 to 6.9 billion euros per year, whereas according to the International Energy Agency's estimate published in its World Energy Outlook 2012, they stand at €8.4 billion annually.

The EU is a net importer of biofuels. According to Eurostat data, EU net imports in 2012 represented 22.6% and 29.2% respectively of its biodiesel and bioethanol consumption.[1]

Current and forecast biofuel consumption in the EU and globally

According to data from the International Energy Agency, global biofuel consumption has more than tripled between 2005 and 2012, reaching 224 million tonnes of oil equivalent, or 3% of the fuels used in road transport. In the European Union and the United States, this proportion was 5% in 2012.

EurObserv'ER, a consortium monitoring renewable energies in the EU, states that biofuel consumption has fallen by 6.8% between 2012 and 2013, and attributes this fall – the first since the introduction of support policies in 2003 – to regulatory uncertainty.

A study published in April 2014 by the European Commission's Joint Research Centre indicates that, based on current standard marketed biofuel blends, the share of biofuels in the EU is likely to reach 8.7% by 2020, below the 10% target for renewable energy in the transport sector.

In its World Energy Outlook 2014, the International Energy Agency forecasts that in 2040 the share of biofuels in road transport fuels would range – depending on policies– from 5% to 18% globally, from 11% to 31% in the European Union and from 11% to 29% in the United States.

The EU's biofuels policy, which sets the reduction of CO_2 emissions as its primary goal, has been the subject of much debate. Furthermore, it has drawn criticism mainly from environmental and development NGOs for inducing indirect land use change (ILUC),[2] with secondary impacts on food production, greenhouse gas emissions and the environment (see below for details). Many of these NGOs are generally opposed to conventional biofuels and would prefer cautious support measures for advanced biofuels. The biofuels and farming sectors, on the other hand, advocate the continued production of conventional biofuels as a source of jobs and economic activity in rural areas, and oppose radical changes in policy.

Impacts of EU biofuels policy

The production of biofuel feedstocks on arable and pasture land can induce ILUC by displacing previous production to other land, both inside and outside the EU. Although biofuel production is only one of numerous contributors to land-use change, a study commissioned by the Parliament estimates that by 2020 the overwhelming majority of land-use change – both direct and indirect – could be caused by feedstock production for biofuels.

Because of its indirect nature, ILUC is a not a local phenomenon that can be observed in a given place and time. It cannot be monitored for individual feedstocks (e.g. biofuel crops), because production can be displaced anywhere in the world and because displacement can be distributed through global trading or occur with significant time lags.

Food production

Environmental and development NGOs have blamed EU biofuels policy for having an adverse impact on global food production, through ILUC effects outside the EU and particularly in developing countries. This issue is sometimes referred to as 'food versus fuel.' In his final report published in 2014, UN special rapporteur on the right to food Olivier De Schutter warns that 'the rapid expansion of the demand for liquid agrofuels for transport in rich countries results in higher food prices and speculation on farmland, and encourages land grabs on a large scale', and calls for the abandonment of biofuel consumption and production targets.

The possible impact of developed countries' biofuels policies on global food prices became a significant concern in 2007, when global grain prices reached historic heights. Though some experts associated the unprecedented price spikes in food grain and oilseed with these countries' biofuels policies,[3] most of them now agree that these policies are unlikely to have been the main culprit, although they may have been a factor.[4] A study reviewing previous research published in 2013 by consultancy Ecofys estimates that the impact of EU biofuels demand from 2000 until 2010 has increased world grain prices by about 1-2% and oilseed prices by around 4%. It also estimates that without any cap on crop-based biofuels, EU policy could raise grain prices by 1%, and oilseed prices by 10% by 2020.

A related concern has been the question of food security for the poor as a result of high food prices. Global food-price spikes affect the urban poor in developing countries. However, higher food prices can also benefit many poor people in rural areas who make a living from agriculture.[5]

Another concern has been the effect on land use, and specifically the emergence of large land holdings in developing countries (a phenomenon some development NGOs refer to as 'land grabbing').[6] A 2011 World Bank report estimated on the basis of press reports that in less than a year foreign investors had expressed interest in around 56 million hectares of land globally.[7] Because of diverging methodologies and a lack of robust data, studies on the topic yield a wide variety of outcomes which cannot be easily compared.[8] Though the number of large land holdings in developing countries appears to be rising, the extent and the drivers of this growth are disputed. Some experts point out that water scarcity, resulting from the typically higher water needs of large land holdings compared to traditional agriculture, can be considered a bigger problem than land scarcity.

Use of biofuel co-products as animal feed

Biofuel production from wheat, maize and rapeseed yields valuable protein-rich co-products such as rape meal and dried distillers' grains and solubles, which can be used as animal feed. Because protein-rich crops generally require a relatively large amount of land for a given output compared with cereal crops, the use of co-products can reduce net land use. A report published in 2008 by consulting agency CE Delft estimates that the use of co-products generated from rapeseed, soy, wheat and maize can reduce net land use by 11 to 25%. Biofuels produced from some feedstocks such as sugarcane, where nearly the entire product is used for producing biofuel, do not generate such co-products.

Another source of debate has been how to use 'available land' (sometimes also referred to as 'marginal land') for growing biofuel crops without displacing existing crops. In the EU, arable land has been falling out of agricultural use and is expected to continue to do so. According to the European Commission, the main effects of biofuel consumption on

EU land use have been the reuse of recently abandoned agricultural land and a reduced rate of land abandonment.[9] A study carried out by the Institute for European Environmental Policy (IEEP) on the request of environmental NGOs suggests that, although 7.4 million hectares of agricultural land were recorded as fallow in 2012, only 1-1.5 million hectares of available land in the EU could be used for energy crop cultivation. At global level, the picture is different. Available land often provides key resources for local communities such as pastureland, fuel-wood, foodstuffs and raw materials for the crafts. Moreover, there are likely to be major obstacles to commercial biofuel production on these lands, such as insufficient water availability, fragmented rather than consolidated land holdings, and difficult or no access to markets.

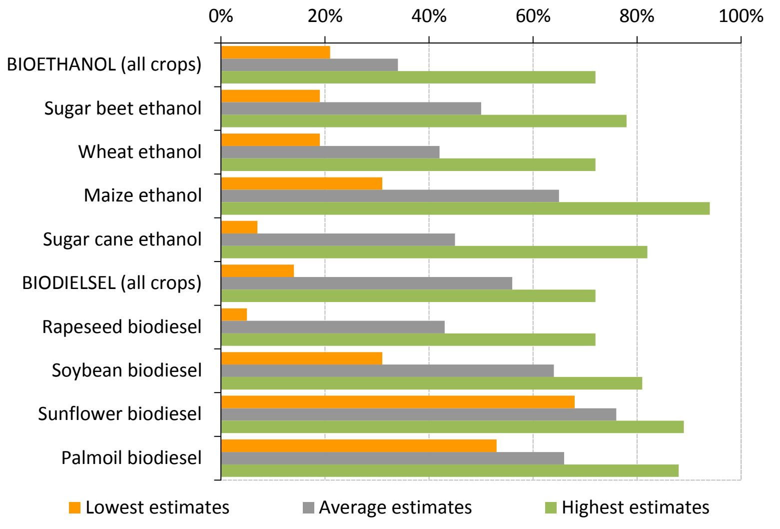
Greenhouse gas emissions

The EU's biofuel policy has been criticised mainly by NGOs and academics, for not taking into account ILUC-related GHG emissions, which result primarily from the oxidation of soil organic carbon and from the burning or decomposition of vegetation. In 2010, the European Commission acknowledged that ILUC can increase the CO_2 emissions of biofuels and recommended addressing this issue under a precautionary approach. The biofuels industry argues that ILUC should not be taken into account, as the modelling used for estimating emissions is not fully reliable and mature.

GHG emissions from biofuel induced land use change account for around 1% of the total emissions from all land use change (124 of 11 777 million tonnes CO_2 equivalent in 2010). Infrastructure expansion and agricultural land expansion for food, feed, fibre, livestock, fuelwood and timber generate by far the greater part of land use change emissions. Compared with GHG emissions from permanent agriculture, emissions from biofuel induced land use change represent 6.6%.

Many studies, three done for different European Commission departments,[10] give estimates for GHG emissions induced by indirect land use change. While the outcomes of the studies are comparable, the results vary a great deal, as shown in figure 2 for a selection of models, mainly because of the complexity and variety of models used for calculating estimates (see box below for more details).

Figure 2 – CO_2 emissions from selected crops induced by ILUC, expressed as % of CO_2 emissions of fuel replaced



Data source: CE Delft (based on calculations from the following models: Econometrica, E4tech, LCFS II, EPA, AGLINK, IIASA, IFPRI BAU, IFPRI FT).

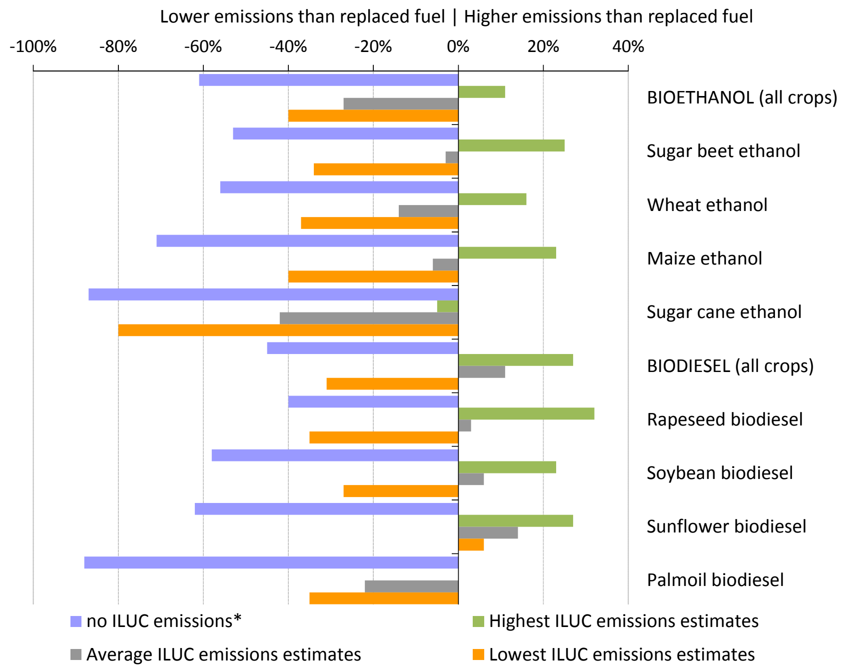
Considering the complexity of ILUC modelling, feedstock-specific estimates should be treated with caution, as the differences between the studies available are much larger than the differences between feedstocks in a given study. A 2011 EP study leaves open whether some feedstocks are preferable in terms of ILUC. The later IFPRI study from the European Commission concludes that 'all ethanol feedstocks have much lower ILUC emission than biodiesel feedstock.' However, a study commissioned in 2013 by the biodiesel industry suggests that ILUC-related emissions attributed to biodiesel are significantly lower than IFPRI estimates.

Modelling ILUC-related GHG emissions from biofuels: a complex process

ILUC cannot be monitored, only modelled. Studies typically use four steps for estimating emissions from ILUC: 1. quantifying the market response to additional biofuel demand (i.e. changes in markets, trade and production), based on economic models; 2. translating market response into displaced land use due to biofuels, based on economic models; 3. determining GHG emissions of displaced production, taking into account land type (e.g. grassland, forest, peatland) and world region, based on biophysical models, and 4. relating the GHG emissions to the final biofuel output, taking into account the agricultural yield (crop) and the energy yield (efficiency of conversion of crop into fuel), based on life-cycle analysis. As a result, ILUC emission modelling faces major challenges: the quantification of ILUC emissions requires coupling several models from different scientific realms (economic, biophysical, technical); data requirements are very high unless simplified approaches are used; and underlying assumptions made at many stages of the process can have significant impacts on results.

A comparative analysis of net CO_2 emissions of biofuels, shown in figure 3, suggests differences between energy crops, with average net emission estimates ranging from -42% for sugarcane ethanol to +14% for sunflower biodiesel. Negative percentages suggest that once ILUC estimates have been taken into account, a biofuel produced from a given energy crop emits less GHG than the fuels it replaces; positive percentages suggest it emits more GHG than the fuel it replaces.

Figure 3 – Net CO_2 emissions of biofuels produced from selected crops, expressed as % of CO_2 emissions of fuel replaced



*based on typical GHG reduction savings from Renewable Energy Directive

Data sources: Directive 2009/28/EC, CE Delft (based on calculations from the following models: Econometrica, E4tech, LCFS II, EPA, AGLINK, IIASA, IFPRI BAU, IFPRI FT).

Although estimates vary, most studies on the subject suggest that ILUC effects in the GHG assessment of biofuels can be significant. Many experts argue that, in spite of shortcomings in terms of scope, consistency and data, studies allow the determination of a reasonable minimum range in terms of GHG emissions.

The US Environment Protection Agency included quantitative ILUC emissions in its regulation on renewable fuels[11] in 2010, following a thorough consultation process.

Other impacts

The EU's biofuels policy supports jobs, especially in rural areas. The bioethanol industry claims to have created 70 000 direct and indirect jobs since the EU introduced its biofuels policy, while the biodiesel sector claims that there are 220 000 direct and indirect jobs in the EU biodiesel production chain.

At global level, socio-economic consequences are more ambiguous. Though biofuel support policies can provide a source of income to people in developing countries, they can also induce the displacement of smallholders or forest dwellers because of large-scale land acquisition. This is a concern particularly in countries where land ownership is not secure.

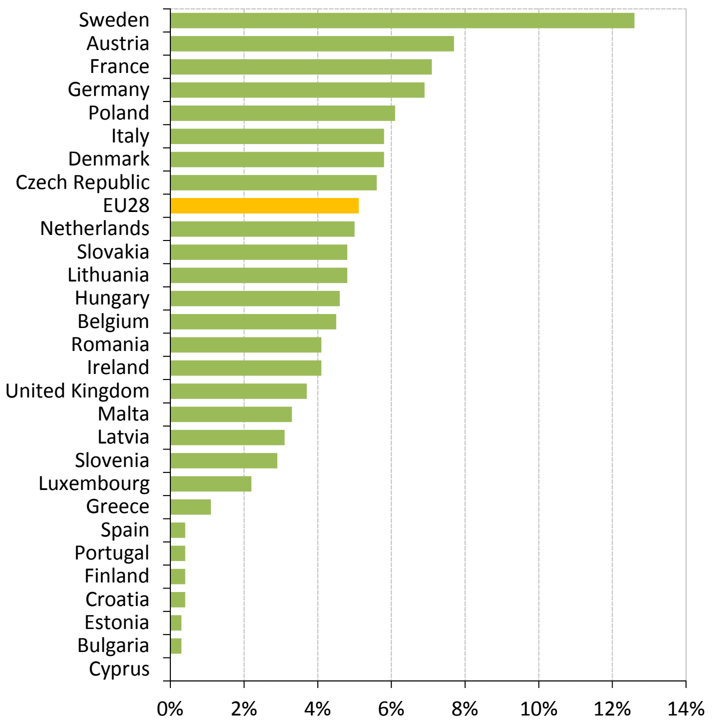
Energy crops have consequences on the environment as well. They can have beneficial effects in some areas because certain types of farming practices contribute to habitat management. However, the replacement of natural ecosystems by monoculture can have negative effects on the environment, such as soil erosion, water shortage, pollution from pesticides and overuse of fertilisers. Biodiversity can be threatened when valuable habitats (e.g. rainforest) are cleared to create energy crop plantations.

Review of the EU's biofuels policy

In October 2012, the Commission presented a legislative proposal to amend the Renewable Energy Directive and the Fuel Quality Directive, with a view to minimising GHG emissions induced by ILUC while preserving existing investments in biofuel production.

Based on an impact assessment, the Commission proposed several changes: limiting the share of conventional biofuels that can be included in the 10% renewable energy target for transport to five percentage points (5% being the level achieved at the time of the proposal, as shown in figure 4); introducing reporting of estimated emissions caused by indirect land use change; promoting biofuels from feedstocks that do not create additional demand for land, by counting their contribution towards the 10% target multiple times.[12] The proposal also seeks protection for existing investments until 2020.

Figure 4 – Share of renewable energy in transport (2012)



Data source: Eurostat 2012

For the period after 2020, the Commission argues that food-based biofuels should not receive public support and that no new targets for renewable energy or for the GHG intensity of fuels used in transport should be set. It advocates focussing instead on improving the efficiency of the transport system and on developing further, and deploying, electric vehicles, advanced biofuels and other alternative fuels.

In its first reading resolution of 11 September 2013 on the proposal amending the Renewable Energy and Fuel Quality Directives (rapporteur Corinne Lepage, ALDE), Parliament expressed the opinion that it is necessary to take the impact of ILUC on GHG emissions into account while providing certainty for investment. It opted for a limit on the share of land-based biofuels to 6% of final consumption in energy transport, while promoting advanced biofuels by introducing a 2.5% sub-target by 2020. However, the rapporteur did not receive a mandate to begin trilogue negotiations with the Council.

In its position adopted in December 2014, the Council increased the maximum share of conventional biofuels in transport energy from 5% to 7%, and lowered the advanced biofuels sub-target proposed by Parliament to 0.5 percentage points of the 10% target. It also allowed for the multiple counting of advanced biofuels towards the 20% general renewable energy target (and not merely towards the 10% renewable energy in transport target). Favouring a more ambitious approach, some Member States such as Denmark and Luxembourg oppose the idea of multiple counting of renewables towards the overall renewables target, as does the Commission (see statement). However, a blocking minority of Member States[13] maintains that the 7% conventional biofuels cap is the lowest acceptable level that would ensure investment stability. In October 2014, Italy adopted its own national target for advanced biofuels as of 2018.

European Parliament

In its position of 17 December 2008 on biofuels, Parliament highlighted the need to take ILUC into account.

In a resolution of 17 February 2011 on rising food prices, Parliament listed the growing production of biofuels among factors contributing to rising food prices.

In its resolution of 5 February 2014 on the 2030 framework for climate and energy policies, Parliament stressed the importance of biofuels and regretted the Commission's lack of willingness to ensure the continuation of the Fuel Quality Directive after 2020.

The draft recommendation for second reading of 18 December 2014 on the proposal (rapporteur Nils Torvalds, ALDE) is scheduled to be voted upon by the Environment, Public Health and Food Safety Committee at its meeting on 24 February 2015. The rapporteur's draft is broadly based on Parliament's first reading resolution (6% cap on conventional biofuels, 2.5% sub-target for advanced biofuels, consideration of ILUC factors) while stressing the need for a policy which maintains the efforts beyond 2020.

Developments in the biofuels sector

Almost 99% of biofuels currently used in EU road transport come from food and feed crops. Advanced biofuels, which are derived from plant material without an alternative use as food, are not yet produced on a large scale in the EU. Some demonstration plants have been built, for example to produce biofuels from used cooking oils. Commercial-scale production of advanced biofuels in the EU is currently practised by only a few plants: one in Crescentino (Italy) produces cellulosic bioethanol derived from dry plant matter since October 2013,[14] while another in Lappeenranta (Finland) turns leftovers from pulp production into biodiesel since January 2015.

In principle, advanced biofuels produced from waste and residues have many advantages over conventional ones produced from food crops. Advanced biofuels do not induce any ILUC effects and therefore have lower net CO_2 emissions. A study published in 2014 by environmental NGOs and advanced biofuels companies suggests that all the wastes and residues that are available sustainably in the European Union have the technical potential to supply 16% of road transport fuel in 2030, generating GHG savings of more than 60%. The study argues that if this resource is fully used, up to €15 billion of additional revenues could flow into the rural economy annually, and up to 300 000 additional jobs could be created by 2030.

However, large-scale investment in advanced biofuel production is still lacking, mainly as a result of policy uncertainty, investor attitudes to risk and the fact that technological developments remain in their early stages. Projects that have received EU funding have also been affected by such a lack of investment.[15] Technical challenges remain, for instance in finding energy- and cost-efficient ways of producing biofuel from wood waste. In the US, where the government has set a production target for cellulosic bioethanol, actual production in 2013 was less than 0.1% of the initial target.

The sustainability of feedstocks and processes used for producing advanced biofuels still needs to be assessed. A study published in 2013 by the IEEP identifies 14 potentially sustainable advanced biofuels feedstocks out of the 18 feedstocks listed in the Commission proposal to amend the current biofuel directives. However, the study suggests that the achievement of feedstock sustainability requires that specific safeguards be in place for each type of feedstock. The performance of advanced biofuels (including in terms of net GHG emissions) is not always superior to that of conventional ones. As a result, it is important to consider the full impact of advanced biofuels, in particular the complete lifecycle of GHG emissions as well as the indirect environmental, social and economic impacts. When producing biofuels from waste and residues, it is also important to make sure that policy respects the waste hierarchy[16] and does not incentivise waste production.

Stakeholders' views

The European biodiesel board, representing the European biodiesel industry, supports setting the conventional biofuels cap no lower than 7% and stresses the need to fully reconsider the concept of ILUC accounting. It expresses concerns over the support given to electricity use in transport.

The European renewable ethanol industry association ePure highlights the need for a stable policy framework needed to restore investor confidence. It advocates low-ILUC conventional biofuels being excluded from the proposed 7% cap, so as to promote the best performing conventional biofuels. It supports the setting of a 0.5% sub-target for advanced biofuels but warns that this would require an investment of €3 billion in the context of relative uncertainty about the shape of the policy after 2020.

Copa-Cogeca, representing EU farmers and agri-cooperatives, advocates removing the proposed conventional biofuels cap, the proposed multiple counting of advanced biofuels and the ILUC-related aspects from both Directives. It also calls for maintaining support for biofuels from arable crops beyond 2020.

The environmental NGOs Transport & Environment, BirdLife Europe and European Environmental Bureau call for the introduction of ILUC factors in the sustainability criteria applied to biofuels as a way to phase out high-ILUC biofuels. They also call for the cap on land-based biofuels to be tightened to no higher than 5%. They advocate sustainability criteria for advanced biofuels, in order to avoid negative environmental impacts.

Friends of the Earth Europe advocate a complete phasing out of conventional biofuels, in order to stop deforestation and land conflicts in third countries.

Main references

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Biofuels: indirect land use change and climate impact / H. J. Croezen at al., CE Delft, June 2010

Indirect Land Use Change and biofuels / EP, Policy Department A, February 2011

The sustainability of advanced biofuels in the EU/ Bettina Kretschmer, IEEP, March 2013

Endnotes

[1] These figures relate only to pure biofuels and biofuels blended within mineral fuels. They do not reflect imports of feedstocks subsequently transformed into biofuels in the EU, for which no data are available.

[2] The Renewable Energy Directive specifies mechanisms for dealing with direct land use change arising from the cultivation of feedstocks, but does not take into account indirect land use change.

[3] Biofuel Policies and Food Grain Commodity Prices 2006-2012: All Boom and No Bust? / Harry de Gorter et al., AgBioForum, 16:1, 2013.

[4] Can biofuels policy work for food security? / Chris Durham, Grant Davies and Tanya Bhattacharyya, Defra (UK Government's Department for Environment, Food & Rural Affairs), 2012; Biofuel cropping systems: carbon, land, and food / Hans Langeveld, John Dixon and H. van Keulen, London: Routledge, 2014.

[5] Low food prices were previously seen as a threat to food security. See 'Agriculture commodity prices continue long-term decline,' press release on the 2004 FAO report The State of Agricultural Commodity Markets.

[6] EuropAfrica, a platform of development NGOs, defines land grabbing as 'taking possession and/or controlling a scale of land which is disproportionate in size in comparison to average land holdings in the region.'

[7] It is not clear, however, if these expressions of interest led to purchases and to actual land cultivation.

[8] For an overview, read the FAO High Level Panel of Experts on Food Security and Nutrition (HLPE) report on food security and nutrition (June 2013), pp.84-5.

[9] Commission staff working document accompanying document to the renewable energy progress report (SEC(2009) 503 final).

[10] Global trade and environmental impact study on the EU biofuels mandate, by IFPRI for DG TRADE; Indirect Land Use Change from increased biofuels demand: comparison of models and results for marginal biofuels production of different feed stock, by JRC-IE for DG CLIMA, Impact of the EU biofuels target on agricultural markets and land use: a comparative modelling assessment, by JRC-IPTS for DG AGRI.

[11] Renewable Fuel Standard Program (RFS2): Final Rule (for details on ILUC, see EPA Lifecycle Analysis of Greenhouse Gas Emissions from Renewable Fuels).

[12] Under the Commission proposal, 14 feedstocks would be counted at four times their energy content and four feedstocks at twice their energy content.

[13] Bulgaria, Czech Republic, Estonia, France, Hungary, Poland, Romania, Slovakia and Spain.

[14] Another cellulosic bioethanol plant is planned to start production in Strážske (Slovakia) in 2017.

[15] The Kemi project by Finnish company Vapo, one of five advanced biofuels projects which had been awarded funding in 2012 under the NER 300 programme promoting low carbon demonstration projects, has been scrapped in 2014. According to the project leader, the company was unable to secure purchasing agreements with end users, given the likely regulatory changes for the period after 2020.

[16] Here it means preferring prevention, reuse and recycling of waste over recovery (e.g. for energy production).

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