WWF

BRIEFING PAPER

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EU bioenergy policy

Ensuring that the provisions on bioenergy in the recast EU Renewable Energy Directive deliver genuine climate benefits

Bioenergy has a role to play in decarbonisation of the EU energy system. But the sustainability criteria for bioenergy proposed by the European Commission in its recast of the EU Renewable Energy Directive are deeply flawed. Stricter rules are needed to ensure that bioenergy used in the EU delivers genuine climate benefits over the fossil alternative.

SUMMARY

EU bioenergy policy has been the subject of fierce debate for over a decade, with much of the controversy stemming from a failure to distinguish between whether something is sustainable in an ecological or commercial sense and whether it is 'low carbon' (i.e. delivers GHG savings over the short to medium term, in pursuit of the 1.5°C goal).

Some types of bioenergy, for example those produced from agricultural wastes and residues, municipal organic waste, industry residues (e.g. from saw mills and paper mills) and smaller forest harvest residues such as tops and branches can be significantly lower carbon than fossil fuels, provided the feedstocks have no other use – meaning that they are exploited in line with the EU waste hierarchy and the principle of cascading use.

However it is now clear that bioenergy from purpose-grown agricultural crops, stemwood (i.e. tree trunks) and coarse forest harvest residues such as stumps is unlikely to be 'lower carbon' than conventional fossil fuels in the sense described above and in many cases will be counterproductive in climate terms.

The European Commission's proposed bioenergy sustainability criteria, which are based on LULUCF accounting, GHG criteria that only cover process emissions and sustainable forest management (the latter, incidentally, questionably interpreted), will not exclude such feedstocks and so will not ensure that bioenergy used in the EU delivers genuine climate benefits.

Instead, the EU should apply GHG criteria based on a comprehensive lifecycle assessment that includes all relevant factors, including biogenic (i.e. combustion) emissions, changes in above and below ground carbon stocks, forgone sequestration, emissions from ILUC, methane emissions from stored wood fuel and emissions resulting from any displacement effects. Given the urgency of tackling climate change and the ambition of the Paris Agreement the assessment should involve a climate-relevant timeframe, for example the next 10-20 years.

In the absence of such an approach the EU should exclude from eligibility for subsidies or other policy incentives those types of bioenergy that are unlikely in most circumstances to comply with such GHG requirements. This means:

1. Phasing out subsidies and incentives for **purpose-grown biofuel crops**, which are unlikely to be a good use of land from a climate perspective. For pragmatic reasons WWF accepts that this could be done gradually, for example in line with the Commission's proposal of an initial reduction in the cap on food-based biofuels from 7.0% to 3.8%;
2. Phasing out subsidies and incentives for the use of **stemwood and stumps**. Less coarse harvest residues such as tops and branches should remain eligible for these but only if used in installations employing high efficiency co-generation (i.e. combined heat and power).
3. Ensuring that **wastes and residues** only benefit from subsidies or incentives if they have no significant alternative uses, whether for food, animal feed or bio-based materials (the cascading use principle). This means for example removing molasses and tall oil from the list of 'advanced' biofuel feedstocks in Annex IX of the Renewable Energy Directive.

In addition to the above, the EU should set strict efficiency requirements – and apply these and the other sustainability criteria to all users of biomass fuels over 1MW in size. The proposed 20MW threshold is far too high and risks creating perverse incentives to build medium-sized plant.

Genuinely low carbon bioenergy from wastes and residues will remain a rare commodity in the EU relative to total energy demand. Bioenergy is therefore unlikely to be a major factor in the decarbonisation agenda or in overall EU energy security, and the majority of EU energy supply in 2050 will need to come from sources such as wind and solar.

The EU heat and transport sectors will for the most part need to be electrified, or supplied through synthetic low carbon fuels produced from renewable electricity, for example hydrogen or, possibly, fuels made by combining that with CO_2 from direct air capture. Research and development of such options, which need not compete for land with food production or carbon sequestration, should be a high priority.

The fact that certain types of bioenergy are high carbon should not be construed as an argument in favour of fossil fuels. On the contrary, it is an argument for energy efficiency, changes in lifestyles and consumption, the rapid deployment of low carbon technologies such as wind and solar and investment in the new options described above.

The EU agriculture and forestry sectors have a critical role to play in relation to climate change. But it is in the efficient and sustainable production of food and timber and the storing of carbon in landscapes. Not, primarily, in providing material to burn.

INTRODUCTION

Late last year the European Commission published its proposals for a recast Renewable Energy Directive, part of a package of legislation aimed at ensuring 'clean energy for all Europeans'[1]. In addition to covering issues such as national support schemes and community energy projects the proposal set out detailed criteria on the sustainability of bioenergy, meaning biofuels, bioliquids and solid and gaseous biomass fuels.

The draft legislation is now under negotiation in the European Parliament and Council and has already provoked strong reactions from stakeholders. This is nothing new: EU bioenergy policy has been the subject of fierce controversy for over a decade, with decision makers bombarded on all sides by competing claims[2] and left with the impression that the subject is impenetrably complex.

Much of the confusion in the debate stems from a failure to distinguish between whether something is sustainable in an ecological or commercial sense and whether it is 'low carbon', meaning that it delivers GHG savings over the short to medium term. Something can be sustainable in the former sense and yet be counterproductive as a means of tackling climate change in the next ten to twenty years. Examples would include the use of agricultural land for purpose grown biofuel crops and the harvesting of stemwood (i.e. whole trees) for heat and power – something that is happening on an increasingly large scale[3].

This briefing paper summarises the evidence on the impacts of various types of EU bioenergy use, focusing on the climate aspects[4]. It then assesses the policy proposals put forward by the European Commission and considers what changes to those may be necessary to ensure that bioenergy used in the EU is genuinely sustainable from an ecological, social and climate perspective. It does not attempt to cover the entire global biomass sector (much of which consists of traditional subsistence fuelwood in developing countries), and is without prejudice to whatever bioenergy policies may be appropriate in third countries. Instead it considers the specific question of what types of bioenergy should actively be *incentivised*, for example through subsidies, blending mandates or other policy incentives permitted under EU law.

CONTEXT & EVIDENCE

The broader context

Before considering the European Commission's recent proposals on the subject, it is important to examine the broader context. EU bioenergy policy does not operate in a vacuum, and is intimately connected with a range of other economic, social and environmental issues. In many cases these have changed in recent years, and justify a fresh approach: Examples include:

- **Accelerating climate change**. 2016 was the warmest year since reliable record-keeping began, in the nineteenth century, and average global temperature is already close to the target of 1.5°C above pre-industrial levels that was included in the Paris Agreement. Very rapid emissions reduction in all sectors is now essential – with what happens in the next 10 or 20 years being particularly critical.
- The **need for 'negative emissions'** as soon as possible. Few plausible scenarios exist for meeting the targets agreed in Paris that do not involve significant 'negative emissions' (i.e. increased carbon sequestration, *in addition to* rapid emissions reduction). Pending the deployment at scale of technologies such as bioenergy with carbon capture and storage

[1] https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition

[2] For recent examples relating to Finnish and UK policy see the following letters and references therein: http://www.bios.fi/publicstatement/publicstatement240317.pdf, https://www.chathamhouse.org/sites/files/chathamhouse/publications/2017-04-05-ResponsetoIEABioenergy.pdf, http://www.eubioenergy.com/wp-content/uploads/2015/03/Response-to-IEA-critique-of-CH-report_final.pdf and http://www.pfpi.net/wp-content/uploads/2017/03/Scientists-bioenergy-letter-March-15-2017.pdf.

[3] Over 5 million hectares in the EU are currently devoted to biofuel crops (https://ec.europa.eu/agriculture/markets-and-prices/medium-term-outlook_en). On the forestry side a 2016 report for the European Commission noted that "current EU imports [of bioenergy] from the southeast [US are] dominated by wood pellets based on dedicated pulpwood (about 60- 75%, mostly softwood pulpwood, but also hardwood pulpwood…)" (http://bookshop.europa.eu/en/environmental-implications-of-increased-reliance-of-the-eu-on-biomass-from-the-south-east-us-pbKH0116687/). The same report notes that "…according to the National Renewable Energy Action Plans, biomass used for heating, cooling and electricity would supply about 42% of the 20% renewable energy target for 2020. If this is to be achieved and the present renewables mix stays in place, the amount of biomass used for energy purposes in the EU would be equivalent to today's total wood harvest in the EU. It is therefore highly likely that EU will have to import increasing amounts of biomass and thus increase the pressure on global forest resources". For information on the impacts outside the EU see for example the extensive evidence amassed by US NGOs (e.g. https://www.dogwoodalliance.org/wp-content/uploads/2017/05/NRDC_2014-2017Booklet_DigitalVersion-resize.pdf).

[4] EU bioenergy policies should also take full account of broader socio-economic and environmental impacts, but must *at a minimum* ensure that bioenergy delivers carbon benefits over fossil fuels.

(BECCS) – itself the subject of various concerns[5] – one of the few cheap and practical approaches available is to accelerate reforestation and forest restoration[6]. The EU should therefore be arguing for – and pioneering – a massive programme of such activities, *alongside emissions reduction*. This should start immediately and be carried out in a socially and ecologically responsible way.

- **Ongoing high rates of deforestation** and forest fragmentation. Far from forest cover increasing, over a hectare of tropical rainforest is currently either destroyed or significantly degraded every second[7], and since the mid-1960s more than half of the world's tropical rainforest has been lost[8]. Deforestation and forest degradation may account for anything up to 20% of global GHG emissions[9], and experts estimate that 80% of global deforestation is due to agriculture[10].
- **Growing demand for food and fibre**. With one report from WRI predicting this will rise by 70-80% by 2050[11], pressure on land resources (and hence forests) seems likely to increase significantly, even with optimistic assumptions on future agricultural yields (and the extent to which those remain unaffected by climate change).
- The **scale of energy demand**. The same WRI report, using OECD figures, estimates that it would take all of the world's harvested biomass – including all crops, all wood and all biomass grazed by livestock – to meet just 20% of global energy demand in 2050[12]. Given that we will still need food and fibre, and barring a massive increase in algae farming, sustainable bioenergy is therefore unlikely to be a major factor in the decarbonisation agenda or in overall energy security. The situation in the EU is likely to be similar, with genuinely low carbon bioenergy from wastes and residues making at most a modest contribution to total energy supply[13]
- **Dramatic falls in the cost of wind and solar**. In many parts of the EU wind and solar are now competitive with new fossil plant (although still face barriers to deployment due to weak carbon prices, fossil fuel subsidies and the volume of fully depreciated old coal plant on the system).

Taken together, the above factors argue for the EU to take a more cautious approach to bioenergy policy than hitherto, particularly as regards types of feedstocks that will not deliver near-term climate benefits or that compete for land with food production or carbon sequestration. Caution is also necessary because there are very big differences between types of bioenergy when it comes to their environmental impacts.

Bioenergy from agricultural crops

One of the simplest examples of EU bioenergy use is the production of what are sometimes called 'conventional' or 'first generation' biofuels – for example biodiesel made from oilseed crops such as rape, or ethanol and methane made from starch rich crops such as maize. Such fuels can be used in place of fossil sources and so can result in reduced emissions of fossil CO_2 to the atmosphere.

However the use of land for purpose-grown biofuel crops comes with an opportunity cost, in that it reduces the amount of land available for other activities, including carbon sequestration. And as numerous studies make clear, reforestation will typically sequester many times more carbon from the atmosphere per hectare (both above and below ground) than could be saved in emissions by using the same area of land for biofuel production. The same will often be true of simply letting land revert

[5] https://www.sei-international.org/mediamanager/documents/Publications/Climate/SEI-WP-2016-08-Negative-emissions.pdf
[6] Restoration of other high carbon habitats such as wetlands also has potential.
[7] http://www.scientificamerican.com/article/earth-talks-daily-destruction/
[8] Global Canopy Programme (2015): Achieving Zero (Net) Deforestation: What it means and how to get there (http://forest500.org/sites/default/files/achievingzeronetdeforestation.pdf)
[9] See http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568329/EPRS_BRI(2015)568329_EN.pdf and https://ec.europa.eu/jrc/en/science-update/reporting-greenhouse-gas-emissions-deforestation-and-forest-degradation-pan-tropical-biomass-maps
[10] Wageningen University and Research Centre. "Agriculture is the direct driver for worldwide deforestation." ScienceDaily. ScienceDaily, 25 September 2012. www.sciencedaily.com/releases/2012/09/120925091608.htm
[11] Searchinger and Heimlich, 2015, World Resources Institute (http://www.wri.org/publication/avoiding-bioenergy-competition-food-crops-and-land)
[12] Based on an OECD baseline estimate of energy demand and on all harvested biomass currently delivering just over 200EJ/year, although action on energy efficiency would improve the situation somewhat. A different paper (http://www.sciencedirect.com/science/article/pii/S1364032114000677) notes that "All harvested biomass used for food, fodder, fibre and forest products, when expressed in equivalent heat content, equals 219 EJ/year" and compares that to current world primary energy supply of about 550 EJ/year. An IEA estimate suggested that replacing 10% of petrol and diesel with biofuels by 2020 would require 43% and 38% of cropland area in the United States and Europe respectively (http://www.cti2000.it/Bionett/All-2004-004%20IEA%20biofuels%20report.pdf).
[13] The potential for bioenergy from wastes and residues is discussed further in the report "Wasted" (https://europeanclimate.org/new-report-wasted-1-5-biofuels-made-from-waste-and-residues-could-produce-several-hundred-thousand-jobs-across-europe/). See also http://www.nature.com/nclimate/journal/v4/n2/full/nclimate2097.html for a review of estimates of biomass from wastes and residues.

to forest, grassland or other vegetation through natural succession[14].

This argument – based on 'forgone sequestration' – applies regardless of whether the crop in question is a food crop, an energy crop or a dedicated forest plantation. Even the very fastest growing energy crops such as sugarcane are unlikely to offer carbon benefits compared to returning land to a high carbon natural habitat such as forest.

For the same reason, the conversion of forest, wetland, peatland or grassland to cropland will typically lead to significant carbon losses, both above and below ground, and therefore where there is agricultural land that cannot or will not be abandoned to reforestation the best use of that land from a climate perspective is likely to be food or feed production. Devoting it to purpose-grown biofuel crops will on aggregate reduce the amount of land available for food or feed production globally and so increase pressures on deforestation (the problem of indirect land use change, or ILUC[15]).

For both these reasons, and given the growing demands on land described above, any large scale diversion of agricultural land to purpose-grown biofuel crops is likely to be sub-optimal from a climate perspective, and a poor use of subsidies justified on climate grounds[16]. This is before considering other important issues such as local climate regulation, flood prevention, desertification and biodiversity – issues that (in the case of land not needed for food production) would typically also argue for subsidies to be targeted at reforestation, or allowing land to revert to natural, high carbon ecosystems.

This is not to say that the agricultural sector has no role to play in clean energy provision. Some types of bioenergy derived from agricultural wastes and residues are clearly positive from a climate perspective and should be encouraged – provided that the feedstocks have no other use and their extraction does not negatively affect soil fertility or carbon content. For example, producing biogas from the anaerobic digestion of short-lived wastes and residues such as slurry can be very 'low carbon' – not least because doing so can reduce emissions of the potent greenhouse gas methane.

Forest-based bioenergy

Another potential form of bioenergy is the use of wood from standing (i.e. existing) forests. But it is increasingly clear from academic research that the dedicated harvesting of trees for energy purposes is not only *not* carbon neutral but can in fact be highly carbon intensive[17]. Indeed over the sort of timescales that matter for climate change targets and policies, namely between now and 2050[18], such an approach is likely to be counterproductive as a means of reducing emissions.

For example a critical review of the scientific literature by Joint Research Centre (JRC) of the European Commission[19] concluded that "…the use of stemwood from dedicated harvest for bioenergy would cause an actual increase in GHG emissions compared to those from fossil fuels in the short-and medium term (decades), while it may start to generate GHG savings only in the long-term (several decades to centuries), provided that the initial assumptions remain valid". Similar conclusions were reached by the European Academies Science Advisory Council, which in a recent report stated that "Increasing the carbon storage in existing forests is a cost-effective measure to decrease net carbon emissions, but EU policies

[14] E.g. see Righelato & Spracklen, 2007 "Carbon mitigation by biofuels or by saving and restoring forests" (http://user.iiasa.ac.at/~gruebler/Lectures/skku_2009/readings/righelato_biofuels_afforestation_comp_science2007.pdf) or Evans, Ramage, DiRocco and Potts, 2015 "Greenhouse Gas Mitigation on Marginal Land: A Quantitative Review of the Relative Benefits of Forest Recovery versus Biofuel Production" (http://pubs.acs.org/doi/pdfplus/10.1021/es502374f). Note that in the latter paper the high rates for miscanthus are unlikely to be realistic as they assume yields roughly three times higher than those currently being achieved in the EU (e.g. see Searle and Malins, 2014 (http://www.sciencedirect.com/science/article/pii/S0961953414000026)). Note also that only above ground biomass was considered, and so the true figures are likely to be even more supportive of carbon sequestration over biofuel production.

[15] For clarity, we distinguish in this paper between ILUC and forgone sequestration, although in some studies the former is taken to include the latter.

[16] Models that suggest that certain types of conventional biofuels such as maize-based ethanol deliver significant climate benefits over fossil fuels typically reach such conclusions only because they assume that there are large areas of completely unused land available that could not be reforested or support any significant natural vegetation but that can nevertheless produce high yields of bioenergy feedstock, or that there is no opportunity cost to the use of agricultural land (or residues such as starch that have other uses) for biofuel production despite agriculture being responsible for most of the deforestation that takes place globally (see earlier references).

[17] For example see Holtsmark, 2013 (http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12110/full) and other references therein. See also the main text and conclusions sections of the report for DG Energy by Matthews, R. et al (2014) "Review of literature on biogenic carbon and life cycle assessment of forest bioenergy" (https://ec.europa.eu/energy/sites/ener/files/2014_biomass_forest_research_report_.pdf) and the summary of that and other studies in Annexes 7 and 8 of the European Commission bioenergy impact assessment (https://ec.europa.eu/energy/sites/ener/files/documents/1_en_impact_assessment_part4_v4_418.pdf).

[18] On current trends we are likely to breach the 1.5°C target well before then (https://www.ipcc.ch/publications_and_data/ar4/wg1/en/spmsspm-projections-of.html).

[19] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC70663/eur25354en_online.pdf

are currently biased towards the use of forest biomass for energy with potential negative effects on the climate over the short to medium term"[20].

The reason that dedicated harvesting of forest biomass is counterproductive as a means of climate change mitigation is partly this 'carbon debt' issue, meaning that it can take a very long time for the carbon released when forests are harvested for bioenergy to be recaptured by new growth, and that during that time there will be a climate impact through radiative forcing. But this is compounded by a number of other factors, namely:

- The fact that emissions of CO2 and methane per unit of energy are higher when burning wood than when burning conventional fossil fuels such as coal and gas[21];
- The fact that there will be an additional release of carbon from stumps, roots, other residues and soil that would not have occurred had the trees not been cut down for energy purposes at that point in time[22];
- The fact that the trees would have carried on sequestering carbon – something that will now not happen, or will happen at a lower rate for a significant period[23]; and
- The fact that there can be significant emissions of methane from wood pellets or wood chips while they are in storage[24].

This means that something that might well be sustainable in an ecological or commercial sense, and would be low carbon over a suitably long time period, will be counterproductive as a means of addressing climate change in the next ten or twenty years. Arguments against this conclusion based on the fact that carbon stocks in EU forests can at the landscape level be held constant – or even increase – despite a certain level of harvesting for bioenergy purposes are irrelevant, as are arguments based on the fact that forests sequester carbon at progressively slower rates as they mature.

However it is certainly true that in many if not most cases forests are not harvested solely for bioenergy purposes. And where that is the case there will inevitably be wastes and residues produced alongside the main product or products.

Those produced in saw mills and paper mills (sawdust, black liquor etc.) should in principle be an acceptable feedstock for bioenergy purposes provided they are not being used by other industries such as the wood panel, chemical or clothing industries – industries that could result in higher economic benefits and/or the carbon contained in the feedstocks being 'locked up' for longer in wood-based products (i.e. the principle of cascading use'[25]).

The 'grey area' in carbon (and other) terms is the use for bioenergy of forest harvest residues, which depending on who is classifying them can include anything from twigs and leaves to stumps, tops and branches – or even stemwood (i.e. tree trunks) that were not suitable for timber or other products. For such feedstocks the key question from a climate perspective is how long, post harvesting, the carbon they contain would have remained in the forest before returning to the atmosphere[26].

For coarser residues such as stemwood and stumps, decay can take many years and the carbon 'half-life' can be considerable. Even residues that are less coarse such as tops and branches can under certain circumstances take decades to rot down completely[27], although a large part of the carbon within them may have been released within 10-20 years. This issue was reviewed by the European Commission JRC review mentioned above, which looked at a range of different harvest residues and end uses and concluded that the use of harvest residues for energy would offer no benefits over fossil fuels over a 10-year timeframe and only modest benefits over a 50-year one (meaning they would still not 'carbon neutral' at that point). Other reasons for caution when it comes to the use of

[20] http://www.easac.eu/fileadmin/PDF_s/reports_statements/Forests/EASAC_Forests_web_complete.pdf

[21] Intergovernmental Panel on Climate Change (2006), Guidelines for National Greenhouse Gas Inventories, Vol. 2 (Energy), Table 2.2, pages 2.16–2.17 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf).

[22] There will also be emissions associated with production and transport of bioenergy, although this is also true of fossil fuels.

[23] In commercial forestry, trees are generally harvested before they reach full maturity, and the trees that replace them, if indeed the forest is replanted, are initially very small, and so sequester carbon slowly. While the rate of carbon sequestration in the forest as a whole slows down as the forest matures, at the level of a tree the rate of sequestration increases with age: bigger trees sequester more carbon than smaller trees.

[24] Mirjam Röder, Carly Whittaker and Patricia Thornley, 'How certain are greenhouse gas reductions from bioenergy? Life cycle assessment and uncertainty analysis of wood pellet-to-electricity supply chains from forest residues', *Biomass and Bioenergy* 79, 2015.

[25] See http://bookshop.europa.eu/en/cascades-pbET0416305/, http://www.wwf.eu/?263091/Cascading-use-of-wood-products-report and the EU Waste Framework Directive (2008/98/EC).

[26] The use of alternative counterfactuals – for example that the materials in question would otherwise have been burnt at the roadside or removed for forest fire prevention purposes – could of course be used to justify their use for bioenergy, but may not reflect common practice before the advent of EU bioenergy subsidies, would be near-impossible to police effectively and/or is something that would be best addressed at the local level, separately from EU-wide climate policies.

[27] https://aaltodoc.aalto.fi/bitstream/handle/123456789/15923/isbn9789526061887.pdf?sequence=1&isAllowed=y

forest harvest residues for energy purposes include that (i) the extraction of residues may increase the need for artificial fertilisers and/or may reduce the rate of growth in the replanted forest – and hence the rate at which carbon is recaptured from the atmosphere[28]; (ii) it may be difficult to police exactly which residues are removed from a forest, where they are taken and for what purpose[29]; and (iii) that extraction of dead wood can have major impacts on biodiversity (and with it the resilience of forests).

Many of these issues are best addressed nationally or locally, through policies on sustainable forest management, but taken together, and in light of the increasing urgency of reducing emissions, they suggest that only the use of shorter-lived forest harvest residues should actively be encouraged by EU level climate policies, and even then only in highly efficient applications that offer significant near-term carbon benefits over fossils fuels. This would be in line with the opinion of the European Environment Agency Scientific Committee on Greenhouse Gas Accounting in Relation to Bioenergy[30], which states that:

"*It is widely assumed that biomass combustion would be inherently 'carbon neutral' because it only releases carbon taken from the atmosphere during plant growth. However, this assumption is not correct and results in a form of double-counting, as it ignores the fact that using land to produce plants for energy typically means that this land is not producing plants for other purposes, including carbon otherwise sequestered. If bioenergy production replaces forests, reduces forest stocks or reduces forest growth, which would otherwise sequester more carbon, it can increase the atmospheric carbon concentration. If bioenergy crops displace food crops, this may lead to more hunger if crops are not replaced and lead to emissions from land-use change if they are. To reduce carbon in the air without sacrificing other human needs, bioenergy production must increase the total amount of plant growth, making more plants available for energy use while preserving other benefits, or it must be derived from biomass wastes that would decompose and neither be used by people nor contribute to carbon sequestration.*"

Other sources of bioenergy

In addition to feedstocks arising directly from agriculture or forest-based industries there are a number of other sources of bioenergy that are of potential value in a bioenergy context. Municipal or industrial organic waste, for example, if treated separately from other waste streams, may well be a low carbon feedstock for bioenergy production, for example through anaerobic digestion or combustion.

However the best option from a climate perspective will in general be to encourage the shift to a circular economy and reduce the extent to which waste arises in the first place, rather than to subsidise the combustion of waste for energy. Care should therefore be taken to ensure that any policies in this are consistent with the EU waste hierarchy and with circular economy principles, and do not reduce incentives to recycle or affect food or feed security[31].

EU POLICY IMPLICATIONS

European Commission proposals

Under the Commission's proposals, the EU's approach to bioenergy sustainability in the recast Renewable Energy Directive would rest on three main pillars:

a. A requirement that bioenergy deliver a certain level of GHG savings relative to fossil fuels;

b. A requirement that forest bioenergy come from forests that are 'sustainably managed'; and

c. A requirement that forest bioenergy come from countries or areas subject to some form of LULUCF accounting.

The first requirement, on GHG performance, only covers emissions from processing and transporting the material. It does not therefore take into account the majority of the relevant factors, namely forgone sequestration, emissions from ILUC, changes in above and below ground carbon stocks, methane emissions from stored wood fuel or – perhaps most

[28] See, for example, Buchholz, T. et al. (2014), 'Mineral soil carbon fluxes in forests and implications for carbon balance assessments', GCB Bioenergy, 6:4, DOI: 10.1111/gcbb.12044; Achat, D. L. et al (2015), 'Quantifying consequences of removing harvesting residues on forest soils and tree growth – A meta-analysis', Forest Ecology and Management, 348 (http://dx.doi.org/10.1016/j.foreco.2015.03.042) or Achat, D. L. et al (2015), 'Forest soil carbon is threatened by intensive biomass harvesting', Nature Scientific Reports, 5, DOI:10.1038/srep15991 (https://www.nature.com/articles/srep15991).

[29] http://www.pfpi.net/wp-content/uploads/2016/03/Report-to-SEC-on-Enviva-March-14-2016.pdf

[30] The www.eea.europa.eu/ds_resolveuid/FT87KIBQX1

[31] See https://www.zerowasteeurope.eu/downloads/the-potential-contribution-of-waste-management-to-a-low-carbon-economy/

importantly – the emissions from actually burning the biomass in the first place ('biogenic emissions'). Indeed it is because the GHG criteria in the RED are inadequate that the EU has been forced in recent years to introduce a 7% cap on certain types of potentially high carbon feedstocks (although the cap in question does not include feedstocks used for biogas).

The second requirement, on sustainable forest management, is for the reasons described above not particularly relevant to the question of whether any specific bioenergy feedstock is lower carbon than fossil fuels. Sustainable forest management is extremely important for other reasons, but is not a solution to the bioenergy issue and the EU Renewable Energy Directive is not the appropriate vehicle for policy on that subject. WWF would also not support the questionable interpretation of sustainable forest management included in the Commission proposals.

The third requirement, related to LULUCF accounting, will not ensure that bioenergy used in the EU is lower carbon than fossil fuels. The reasons for this are explained in detail in the annex, but essentially relate to the fact that the Commission's proposed rules on LULUCF are not rigorous enough to ensure that all relevant emissions are counted, either in the EU or elsewhere, and do not provide sufficiently strong incentives to prevent the harvesting of types of bioenergy feedstock that would be counterproductive from a climate perspective. It should also be noted that Member States such as Finland are lobbying hard for the Commission proposals to be weakened, in order that they be able to increase harvesting of forests for bioenergy and other purposes without having to record that fact in their accounts.

For the reasons described above, the European Commission's proposals on bioenergy sustainability are inadequate and risk leading to a further expansion in the use of types of bioenergy that offer no carbon benefits over fossil fuels. This would not only be counterproductive from an emissions perspective but also risks undermining investment in things that offer a longer term solution, meaning wind, solar, electrification and storage.

WWF policy recommendations

The EU needs to ensure that any growth in bioenergy use after 2020 delivers genuine carbon benefits over a timeframe that reflects the growing urgency of tackling climate change and the need to meet temperature goals set in the Paris Agreement.

On that basis WWF believes that the GHG criteria in the Renewable Energy Directive, which require that bioenergy deliver a certain level of saving over fossil fuels, should be based on a comprehensive lifecycle assessment that includes not just process and transport emissions but also (as appropriate) biogenic emissions, changes in above and below ground carbon stocks, forgone sequestration, emissions from ILUC, methane emissions from stored wood fuel, emissions resulting from any displacement effects (for example the diversion of feedstocks in use by other industries) and any other relevant factors – for example the impact on regrowth rates of reduced soil fertility. The methodology used for the assessment, including the issue of system boundaries, must be standardised and credible. Given the urgency of tackling climate change the criteria should also require that the required saving be delivered within a climate-relevant timeframe, for example the next 10-20 years.

In the absence of such an approach the EU should exclude from eligibility for subsidies or other policy incentives[32] the use of those types of bioenergy that would be unlikely in most circumstances to comply with such GHG requirements. This means:

1. Phasing out subsidies and incentives for **purpose-grown biofuel crops**, which are unlikely to be a good use of land from a climate perspective. For pragmatic reasons WWF accepts that this could be done gradually, for example in line with the Commission's proposal of an initial reduction in the cap from 7.0% to 3.8%;
2. Phasing out subsidies and incentives for the use of **stemwood and stumps**. Less coarse residues such as tops and branches should be eligible for support but only if used in installations employing high efficiency co-generation (i.e. combined heat and power)[33].
3. Ensuring that **wastes and residues** only benefit from incentives or subsidies if they have no significant alternative uses for food, animal feed or bio-based materials (the cascading use principle). This means for example removing molasses and tall oil from the list of 'advanced' biofuel feedstocks in Annex IX.

[32] For example blending mandates for fuel providers, tax incentives etc.

[33] This is without prejudice to any rules on sustainable forest management that may be applied at national or local level, for example requirements under certification schemes to leave smaller residues in the forest to maintain soil fertility and support biodiversity. The EU should monitor extraction of tops and branches in order to assess risks to sustainability. If such risks are identified, the EU should consider excluding tops and branches from eligibility for subsidies or incentives.

Such an approach would have the benefit of being relatively easy to apply and enforce and should in principle ensure that all bioenergy used in the EU were significantly lower carbon than conventional fossil fuels. It would build on the approach taken for advanced biofuels, where only certain feedstocks are deemed to be eligible, and would be consistent with the best available scientific advice.

There are a number of other changes that should be made to the Commission proposals, as follows:

- **Co-firing** of biomass risks undermining the phasing out of coal and so should not be eligible for subsidies or other incentives
- Minimum **efficiency standards** should apply to all installations using biomass fuels over a certain size, for example 85% conversion efficiency for residential or commercial installations and 70% for industrial applications. And the minimum threshold for this and for other sustainability criteria should be 1 MW, with no exceptions for security of supply. The proposed 20MW threshold is too high and risks creating perverse incentives to build medium-sized plant.
- The existing rules on sourcing of biofuel feedstocks from **areas of high biodiversity** should be extended to forest biomass.
- The **possibility for MS to impose stricter sustainability criteria** is welcome but should be extended to biofuels and bioliquids as well as biomass fuels.
- Similarly, the **review clause** proposed by the Commission is positive but should be backed up by effective monitoring and should apply equally to the rules on biofuels and bioliquids.

Having reformed its own bioenergy policy regime, the EU should press for similar rules to be applied internationally. If the rest of the world were to adopt the EU's current or proposed future approach – for example if China were to shift from burning coal to burning wood from Russian forests – the impact on the climate and on natural ecosystems could be extremely damaging

RELATED ISSUES

Alternatives to bioenergy

Bioenergy has until recently been seen as an important means of decarbonising sectors such as heat and transport. But by definition, heat and transport cannot be decarbonised through the use of types of bioenergy that are higher carbon than the fossil fuels they replace. And as this paper makes clear, the volumes of genuinely low carbon bioenergy are unlikely to be significant compared to global energy demand (see 'context' section above).

The use of bioenergy in certain sectors (for example power generation, space and water heating, cars and vans) should therefore not be encouraged, in light of risks that it could lead to investment in assets that will later become stranded, and delay the transition to wind and solar (and electrification) that needs to happen in those sectors. Indeed the vast majority of EU transport energy and heat demand will in future need to be met (directly or indirectly) through sources such as wind and solar. Technologies for doing this are in some cases and/or places already available, for example electric vehicles supplied from the grid and district heating systems with storage supplied from low carbon sources such as large scale marine heat pumps.

However other alternatives to bioenergy will also be needed if the EU is to meet its commitments under the Paris Agreement – for example to decarbonise certain forms of transport such as aviation and shipping and various high temperature industrial processes. One option in this context may be an increase in the use of hydrogen produced from renewable electricity and water (i.e. 'power to gas'). Or, possibly, if this is combined with direct air capture of CO_2, the production of energy-dense liquid fuels (power to liquids). The use of solar or wind power to create synthetic fuels is likely to be a far more efficient use of land than biofuel production from purpose-grown crops[34] and can occur alongside other productive uses of land or on arid land that has no value for food production or carbon sequestration.

However such technologies – and in particular direct air capture of CO_2 – are currently very expensive and therefore, as with wind and solar,

[34] A study by Germany's main environmental protection agency published in September last year found that e-fuel production using wind or solar power delivered far higher GHG savings per hectare than biofuels: https://www.umweltbundesamt.de/en/publikationen/power-to-liquids-potentials-perspectives-for-the

considerable further global investment in research and development is required to bring down costs and/or develop alternatives[35].

Jobs and growth in rural areas and the role of agriculture and forestry in climate change mitigation

The need to avoid high carbon types of bioenergy doesn't mean that all EU land and forests should be untouched nature reserves. As noted above, global demand for food and fibre is expected to increase dramatically over the coming decades and there will be major opportunities for those working in the rural economy in future the without an expansion in bioenergy production.

Forestry, for example, is a key economic sector in many Member States, and there is scope for ongoing use of the EU's 'working forests' provided that that is done sustainably. In addition, the use of wood in long-lived products or in buildings may in some circumstances deliver GHG benefits, if it replaces carbon intensive materials such as steel and concrete and if a high proportion of the harvested wood is used for that purpose. A largely wooden building was recently completed for the University of British Columbia that reaches to over fifty metres high, and use of Cross-Laminated Timber (CLT) in construction is an increasingly common practice[36].

Similarly there are huge potential climate benefits from the wider use of agricultural techniques that increase the carbon content of soils, and from the restoration of grasslands, forest and other natural, high carbon ecosystems. Payments under the Common Agricultural Policy, which still absorbs close to 40% of the entire EU budget, could be reoriented to reward such activities by farmers and land managers, rather than, as they do at present, rewarding farmers for keeping farmland clear of vegetation. Such a reorientation could also be done in such a way as to greatly boost employment in the agriculture sector, for example by ending the disproportionate transfer of funds to large, mechanised farms and by taking all dimensions of sustainability into account in the design of policy schemes.

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[35] For a relatively positive assessment of potential future costs see: https://www.researchgate.net/publication/313842230_Long-Term_Hydrocarbon_Trade_Options_for_the_Maghreb_Region_and_Europe-Renewable_Energy_Based_Synthetic_Fuels_for_a_Net_Zero_Emissions_World. Other papers (e.g. http://www.sciencedirect.com/science/article/pii/S1876610211003900) suggest direct air capture of CO_2 could be prohibitively expensive. Further research is needed in this area.

[36] https://www.sciencedaily.com/releases/2016/09/160930145847.htm. See also http://waughthistleton.com/dalston-lane/

ANNEX

LULUCF accounting and bioenergy

Under current EU and international rules, emissions from biomass are considered to be zero at the point of combustion – on the assumption that all of the associated emissions (in the Land Use, Land Use Change and Forestry (LULUCF) sectors) will have been properly accounted for when the forest or crop was harvested (and/or that all carbon released into the atmosphere will be recaptured through subsequent growth).

But even in the EU, which has worked hard to develop an effective LULUCF regime and can rightly be considered a world leader in the field, the carbon accounting in the LULUCF sector is inadequate. This is partly because calculating changes in landscape carbon stocks is complex and involves a certain level of uncertainty, but also because of the idiosyncratic way in which accounting is carried out in certain LULUCF sectors in the EU. In the forest management sector, for example, instead of carbon stocks being compared with a fixed historical level (as is the case for all other emissions sectors), they are compared with a projected future 'forest reference level' determined by the relevant Member State. Member States have in many cases set forest reference levels that bear little relation to historical harvesting levels (for example see figure 1, below) and so large volumes of wood can be harvested without it ever showing up as a debit in the country's carbon accounts.

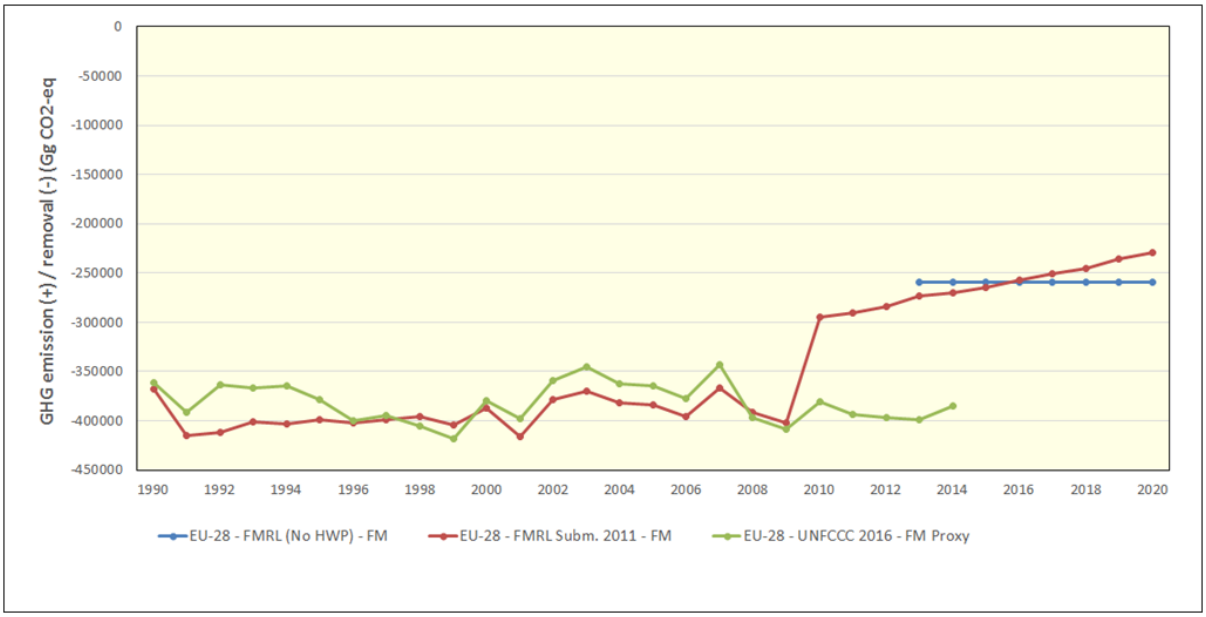

Figure 1: The EU forest reference level in blue, which is based on levels set by Member States following introduction of the EU Renewable Energy Directive in 2009, bears little relation to actual harvests in green (the red line is a modelled result).[37]

The Commission's latest proposal on LULUCF, if adopted in its existing form, would be a significant improvement on the current rules. And rigorous LULUCF accounting is clearly a fundamental underpinning to global efforts to tackle climate change and is essential for a wide variety of different purposes. But even if the Commission's proposals were adopted unchanged – something that seems unlikely given the fierce opposition to it from Member States such as Finland that want to increase harvesting of forests for bioenergy and other purposes without recording that fact in their accounts – it cannot ensure that bioenergy used in the EU delivers genuine carbon savings over fossil fuels and is not therefore a solution to the problem of bioenergy sustainability. This is for a number of reasons:

[37] Graph reproduced from European Commission LULUCF impact assessment 2016 (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016SC0249).

- The rules on forest management fail to take adequately into account the question of what harvested wood is used for. To take a hypothetical example, if effective policies by Member States led to a 50% reduction in paper use (which would be a good thing from a climate perspective) all of the trees not used for paper production could simply be burned for energy instead, without that even registering in the LULUCF accounts. This would make no sense in climate terms, for the reasons set out in the main paper, but from a LULUCF perspective would be acceptable. This is an example of a broader point, which is that:
- LULUCF is an (extremely important) accounting and reporting system, but not at present a policy driver[38]. The Commission has proposed that there be a 'no-debit rule' for the LULUCF sector, but this would not provide an incentive in the LULUCF sector equivalent to the carbon targets in the sectors covered by the Effort Sharing Regulation. Policy measures are therefore needed outside of the LULUCF sector (in agriculture, transport, industry etc.) to ensure that the right action to reduce emissions actually happens. Under LULUCF rules, for example, the use of agricultural land for purpose grown biofuel crops would create no debit and so have no carbon 'cost', despite that practice being sub-optimal from a climate perspective (see main paper).
- Under the Commission's LULUCF proposals for forest management, Member States would be allowed to take account of the age class structure of their forests, which in many cases are still relatively young. This means that higher harvests of wood will be possible in future, without that counting as a debit, simply because more trees are expected to be, from a forestry perspective, 'ready to harvest'. Decisions on harvesting may be perfectly rational and economic but are not relevant to a climate change policy or carbon accounting perspective, where the issue at stake is the amount of carbon stored in forests.
- The Commission's proposed LULUCF rules (for forest management and other LULUCF sectors) will only apply within the EU. Few countries have an effective system of carbon accounting in place and it is extremely unlikely that all those countries currently exporting wood pellets to the EU or those that may wish to do so in future will implement LULUCF accounting rules strict enough to ensure that there is no incentive to harvest trees for export, in the form of wood pellets.

Theoretically, if it were possible to measure carbon stocks perfectly accurately, if LULUCF rules were applied rigorously in every country in the world, and if the LULUCF sector were fully integrated with all other sectors and – most importantly – subject to the same targets, such that there were no longer a perverse incentive on Member States or any economic operator to harvest forest or crops for energy rather than reduce emissions elsewhere, then LULUCF rules might be effective in ensuring that only genuinely low carbon types of bioenergy were used. But none of these conditions is likely in the near future. And there are also very good reasons for keeping the LULUCF sector separate, and subject to separate targets, namely:

- Merging the sectors or allowing offsetting between them as the Commission has proposed could greatly reduce the incentive to decarbonise 'difficult' sectors such as industry or agriculture. Indeed there would be a strong incentive simply to maintain and extend forest carbon stocks, as the negative emissions thus generated would (in the short term) likely be a cheaper way of meeting EU GHG targets than achieving emissions reductions elsewhere – particularly given that EU forests are growing back after centuries of over-harvesting and are therefore a major carbon sink (i.e. a source of carbon sequestration). Such 'negative emissions' are vital, and should be strongly incentivised, but should only count towards targets if they are additional to what would have happened anyway – and should not be pursued at the expense of emissions reductions in other sectors. If that happened, then once the potential for reforestation and forest restoration in the LULUCF sector were exhausted, sectors such as industry and agriculture could be faced with the task of decarbonising at impossibly high rates.
- Storage of carbon by forests and land is not permanent, or at least not in the same way that emissions reductions in other sectors can be. For example changes in levels of forest carbon due to disease, fire or human intervention are an ever present risk, and mean that storing carbon in forests cannot be treated in exactly the same way as a permanent change in the energy efficiency of a building, or the dismantling of a coal-fired power station and its replacement with a wind farm.

[38] As the report for DG Energy by Matthews et al puts it: "Existing EU and international accounting systems for biogenic carbon in forests and harvested wood, supporting international efforts to limit GHG emissions, serve very specific purposes and are unsuitable for more general application as calculation methods for assessing the GHG emissions associated with forest bioenergy" (https://ec.europa.eu/energy/sites/ener/files/2014_biomass_forest_research_report_.pdf)

For all the reasons above, LULUCF accounting in the land use sector is not a solution to the problem of high carbon bioenergy, something that can only be addressed through effective sustainability criteria within bioenergy policy. The IPCC itself recognises that "the IPCC approach of not including these emissions in the Energy Sector total should not be interpreted as a conclusion about the sustainability or carbon neutrality of bioenergy"[39].

[39] http://www.ipcc-nggip.iges.or.jp/faq/faq.html, question Q2.10.

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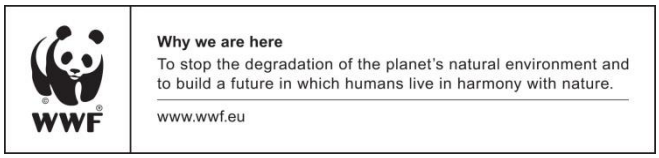

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