Biofuel ExChange:
Pursuing change in biofuels policy and developing alternatives

Institute for European Environmental Policy

THE SUSTAINABILITY OF ADVANCED BIOFUELS IN THE EU

Assessing the sustainability of a list of wastes, residues and other feedstocks set out in the European Commission's proposal on Indirect Land Use Change (ILUC)

Final version

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Date prepared: March 2013

The report should be cited as follows: Kretschmer, B, Allen, B, Kieve, D, Smith, C (2013) *The sustainability of advanced biofuels in the EU: Assessing the sustainability of wastes, residues and other feedstocks set out in the European Commission's proposal on Indirect Land Use Change (ILUC).* Biofuel ExChange briefing No 3. Institute for European Environmental Policy (IEEP), London.

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Acknowledgements:
We are grateful for useful comments received from Martin Alm (EFPRA), Victoria Junquera (EPFL), Chris Malins, nova-Institut, Antonin Pepin, Daan Peters, Stephanie Searle, Ronald Steenblik. Any remaining errors are our own.

We thank the Esmée Fairbairn Foundation for funding this work as part of the Biofuel ExChange project ('Pursuing change in biofuels policy and developing alternatives').

For more information: www.ieep.eu/minisites/pursuing-change-in-biofuels-policy-developing-alternatives/

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EXECUTIVE SUMMARY

This report is set in the context of the European Commission's recent proposal[1] to mitigate indirect land use change (ILUC) impacts from transport related biofuel feedstock. For this purpose, amendments to the Renewable Energy Directive (RED) and the Fuel Quality Directive are proposed, including increased incentives for advanced biofuels. In particular, it is proposed to count certain feedstocks, mostly wastes and residues but also other selected feedstocks, such as dedicated energy crops, at a level of two or four times their energy content towards meeting the RED's 10 per cent target for renewable energy in transport by 2020.

This is a welcome initiative to reduce ILUC impacts and promote more innovative approaches to support low carbon liquid fuels. Wastes and residues in principle have many advantages over first generation feedstocks, most of which are food crops. But sustainability is a critical issue. The report is offered as an information source, particularly for those involved in the debate on advanced biofuels by:

- Considering definitions of individual feedstocks which are clearly vague in the Commission proposal;
- Examining their existing uses; and
- Identifying potential necessary environmental safeguards.

Information on each feedstock has been presented in a summary factsheet of one page.

Sustainability assessment	Feedstock
Potentially sustainable (contingent on safeguards)	Algae (4x)
	Biomass fraction of mixed municipal waste (4x)
	Biomass fraction of industrial waste (4x)
	Straw (4x)
	Animal manure and sewage sludge (4x)
	Tall oil pitch (4x)
	Palm oil mill effluent and empty palm fruit bunches (4x)
	Bagasse (4x)
	Grape marc and wine lees (4x)
	Nut shells (4x)
	Husks (4x)
	Cobs (4x)
	Used cooking oil (2x)
	Animal fats (Category 1 and 2) (2x)
Likely unsustainable	Bark, branches, leaves, saw dust and cutter shavings (4x)
	Non-food cellulosic material (2x)
	Ligno-cellulosic material except saw logs and veneer logs (2x)
Unclear	Crude Glycerine (4x)

Note: This overview should be read in conjunction with the factsheets (Section 4) that contain information on existing uses and ensuing risks from their potential diversion as well as proposed safeguards to mitigate the risks.

[1] Proposal COM(2012) 595 final of 17.10.2012 for a Directive of the European Parliament and of the Council amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources.

Based on our review, the list of potential feedstocks has been grouped into three categories of potential sustainability. At this stage, a large number fall into the potentially sustainable category, as shown in the table. This highlights the uncertainties surrounding many of the feedstocks proposed and underlines the importance of introducing appropriate safeguards in EU legislation.

The feedstock specific safeguards included in the factsheets are complemented by a more general set of environmental safeguards set out in Section 5. All safeguards are intended to assist in preventing the use of the feedstocks proposed from bringing about new impacts, direct or indirect, with negative environmental, social or economic consequences.

A number of principles are proposed:

- Ensure clear definitions

The ILUC proposal in its current form lacks clear definitions for several feedstocks. These are important: first to establish more precisely the materials involved and ensure the policy is workable; second to allow potential risks and appropriate mitigating safeguards to be identified; and third, to improve consistency of definitions across the EU-27 Member States. The latter is necessary to ensure that the same advanced biofuels are eligible for multiple (double or quadruple) counting across the EU and that appropriate safeguards are enforced EU-wide. All this is essential for the functioning of the internal market in advanced biofuels.

- Adhere to the waste hierarchy

The overall waste hierarchy, as set out in the Waste Framework Directive, which is to prefer prevention, re-use, recycling (and composting of materials) over recovery (for example for energy) and, eventually, over disposal (ie landfill or incineration without energy recovery) should be followed in all cases. This means only non-recyclable and non-compostable waste should be utilised for energy recovery, unless energy recovery can be justified for reasons of technical feasibility, economic viability or environmental protection. It has been demonstrated, for example, that anaerobic digestion of food waste generally is superior to composting in terms of greenhouse gas (GHG) savings (ERM, 2006). In other words, incentives to use wastes and residues as biofuel feedstock must not counter ongoing efforts to reduce waste and increase recycling rates.

- Consider the complete lifecycle GHG emissions that arise from wastes and residues

It is suggested that the Commission monitors research undertaken on the relative lifecycle emissions of different biomass use pathways, taking into account different energy and non-energy uses. While the GHG methodology set out in the RED and the FQD accounts for transport and processing emissions other, potentially significant, emission sources are neglected. In particular, the RED and FQD methodology considers wastes and agricultural residues to be ‘zero emission’ up to the point of their collection. This ignores the impacts on soil carbon stocks that can be as the extraction of residues increases. The system boundaries of the methodology should be extended by taking into account changes in soil carbon stock from agricultural or forestry residue extraction.

- ***Assess current uses of feedstocks and evaluate indirect environmental, social and economic impacts of diverting residue towards biofuel production***

    The list of feedstocks eligible for multiple counting (or any other targeted support measures) needs to be kept under review in light of continuing research and analysis. The availability of low-carbon alternatives for different applications needs to be taken into account. Another consideration when prioritising between different uses is the economic value added that can be generated per unit of biomass input. The 'built in' market mechanism that higher feedstock prices can typically be paid in industries producing higher-value products may very likely be distorted by new incentives in the energy sector, thereby affecting other uses. At the same time, a higher economic added value use does not necessarily lead to greater environmental benefits or GHG savings. There is a strong public interest to be pursued alongside market considerations.

- ***Mitigate the environmental impacts of certain advanced conversion pathways***

    The processing of biomass into biofuels via advanced biochemical or thermochemical conversion pathways can require relatively high energy inputs, which are addressed in the GHG methodology. However, other environmental impacts resulting from the processing of biomass through advanced conversion technologies such as water consumption in processing should be investigated and if necessary be addressed by safeguards.

- ***Consider impacts outside the EU***

    The incentives provided for the use of particular wastes and residues under the RED should not lead to the increased import of wastes and residues, or other feedstocks, where this will cause environmental, social or economic impacts in countries outside of the EU.

The report concludes by identifying the need for an inventory of bio-resources across the EU. One of the great challenges when compiling the factsheets was the lack of robust and reliable information about the extent to which different feedstocks are already being used whether for bioenergy or other industrial applications. Such information is needed to understand whether surplus volumes exist that could be taken up by the biofuel sector without resulting in negative environmental or other impacts. If the Commission and Member States are to have a solid basis of evidence on the potential for advanced biofuel production based on wastes and residues, it will be important to establish an inventory of the bio-resources available and their sustainability for different applications.

1 INTRODUCTION

This report aims to provide information to assist understanding of the potential environmental consequences of an advanced biofuel industry relying on mainly wastes and residues as their feedstock base. In pursuit of this aim the report:

- Considers definitions for the feedstocks proposed for double and quadruple counting which are vague in the Commission's ILUC proposal;
- Examines their existing uses;
- Considers the sustainability profile of these feedstocks and whether there are 'hidden' environmental risks from using these resources and diverting them away from existing uses;
- Identifies potential environmental safeguards that could govern the use of certain feedstocks, making them more sustainable.

This report is set in the context of the European Commission's recent proposal[2] to mitigate indirect land use change (ILUC) from transport related biofuel feedstock. One of the proposed amendments to the Renewable Energy Directive (RED)[3] and the Fuel Quality Directive (FQD)[4] set out in this proposal is to increase incentives for advanced biofuels. In particular, it is proposed to count certain feedstocks, mainly wastes and residues and other selected feedstocks (such as dedicated energy crops), at a level of two or four times their energy content towards meeting the 10 per cent target for renewable energy in transport by 2020. However, the sustainability of some feedstocks and the volumes of biomass that would be available for the biofuel sector are unclear. The impact assessment accompanying the Commission's proposal does not provide the background analysis necessary to understand better the contribution an advanced biofuels industry could make towards meeting EU transport fuel needs or the targets set out in the RED and FQD.

Section 2 of the report addresses initial questions with regard to the definition of waste products under EU law and how this definition has evolved and Section 3 discusses the prioritisation of biomass sources between energy and non-energy uses and between different energy uses.

Section 4 contains one page summary factsheets on all the feedstocks listed in the Commission's proposal, outlining existing uses, environmental risks and suggested environmental safeguards. The compilation should be seen as an initial screening exercise of the proposed list as a number of important considerations could not be addressed at this stage. For example, the factsheets do not provide estimates of volumes available or of the

[2] Proposal COM(2012) 595 final of 17.10.2012 for a Directive of the European Parliament and of the Council amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources.

[3] 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 and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, OJ L140/16, 05/06/09.

[4] Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC, OJ L140, 5.6.2009.

costs involved in mobilising the feedstocks. This is particularly relevant for wastes and residues which as yet do not have a well established production infrastructure. When estimating volumes of wastes and residues, both current and projected future volumes should be considered, as the future availability of some wastes and residues may be reduced as a result of waste prevention efforts. Furthermore, the limited sustainability assessment undertaken in this study takes only a partial consideration of how sustainability risks are affected by different level of volumes mobilised. Some wastes and residues may be considered sustainable as long as their mobilisation is contained within certain limits and volumes, but risks may multiply if mobilisation goes beyond such limits. Finally, we have considered currently existing uses in the sustainability assessments. The focus has been mainly on existing technologies but a range of future biomass applications is under development, with varying lead times for reaching maturity. These could not be evaluated here.

Section 5 puts forward general environmental safeguards applying to the whole list and section 6 provides some concluding remarks in relation to the study undertaken and next steps.

2 THE DEFINITION OF 'WASTE' IN EU POLICY

The European Commission has indicated the types of feedstocks that can be counted at multiple times their energy content towards the RED target (see Annex 1). However, there remains some uncertainty around the definitions of individual feedstocks as well as what constitutes a 'waste' (relevant for those feedstocks that are labelled specifically as wastes); neither of which are accounted for in the RED or the FQD currently.

In the ILUC proposal this has been addressed to some degree in Article 2(1) by reference to the European Waste Framework Directive (EWFD)[5] definition of waste. The EWFD (Article 3(1)) states that waste means 'any substance or object which the holder discards or intends or is required to discard'. Although helpful in general terms, this definition does not provide the necessary detail on which to assess individual feedstocks. No further reference to the EWFD is made in the Commission's proposal. However, several other aspects of the EWFD are relevant in defining what constitutes waste and how it is used in relation to defining biofuel feedstocks. These are:

- Article 2(1)(f) explicitly excludes from the Waste Framework Directive's scope 'faecal matter, straw and other natural non-hazardous agricultural or forestry material used in farming, forestry or for the production of energy from such biomass through processes or methods which do not harm the environment or endanger human health'. In addition, Article 2(2)(b) excludes (to the extent that they are covered by other EU legislation) 'animal by-products including processed products covered by Regulation (EC) No 1774/2002, except those which are destined for incineration, landfilling or use in a biogas or composting plant'.

- Article 3(4) defines bio-waste as 'biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants'.

- Article 6 offers a broad definition of when a waste ceases to be waste, stating that this is 'when it has undergone a recovery, including recycling, operation and complies with specific criteria to be developed'. However, these criteria are still in development. Although background work has been done on biodegradable waste (one of the main potential renewable energy feedstocks) this may not result in a proposal for specific end-of-waste criteria. It is also relevant to note that recovery of waste as defined by Article 3(15) encompasses operations that have as their principal result the useful substitution of waste for another material that would otherwise have been used to fulfil a particular function. Annex II of the Directive further clarifies that recovery includes 'use principally as a fuel or other means to generate energy', but only includes incineration if it reaches a specified energy efficiency threshold.

- There are no definitions of municipal or industrial waste provided within the Directive.

The ILUC proposal provides one further clarification in stating that '[s]ubstances that have been intentionally modified or contaminated to meet that definition are not covered by the

[5] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives

term waste'. Within or outwith the EWFD there is currently no harmonised definition of food waste in Europe. A recent European Parliament Resolution[6] specifically noted that a separate definition of food residuals for biofuels or biowaste would be useful to identify waste that can be reutilised for energy purposes.

Despite the additional information provided in the EWFD there remains a lack of clarity over the definition of a waste both as it relates to EU waste policy and how that may be translated into the policies governing the sustainability of EU biofuels. As a consequence, it may be difficult to determine if a substance prior to its use as a biofuel feedstock was a true waste or was in fact intended to be used as (by-)product.

This issue of demarcation between a waste and a (by-)product is challenging and has been the subject of recent debate in relation to compostable materials[7]. We do not attempt to overcome the problem in this report. Instead we focus on the relative sustainability of the different 'wastes' and 'residues' given their existing uses. As a general safeguard to account for the potential confusion between definitions, reference has been made to the now well-established waste hierarchy[8] to ensure that a feedstock is always used in the most environmentally compatible way possible, in other words in line with that hierarchy (see Sections 3 and 5).

The different status of the waste and residues listed in the Commission's ILUC proposal and in the RED and FQD are important. Both the RED and FQD make mention of the proposed residues in the annexes relating to GHG calculations (Annex V, part C, 18 and Annex IX, part C, 18 respectively). This is an indicative list and the text is the same in both directives: 'Wastes, agricultural crop residues, including straw, bagasse, husks, cobs and nut shells, and residues from processing, including crude glycerine (glycerine that is not refined), shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of those materials.'

For wastes, neither the RED nor the FQD are clear. However, the ILUC proposal now includes a list of feedstocks, among them some labelled as wastes, in response to calls for clarity from Member States, and a restatement of the residues that appeared in the RED and FQD. Significantly, this list now appears as inclusive, ie it omits phrases such as 'including' or 'for example' which were incorporated in the text of the FQD and RED. Of course, this is only a proposal so the final legislative text may be clearer and this would be welcome. A completely rigid list would have clear drawbacks as new information and technologies emerge. Nevertheless, changes in the list could be brought about after the Directive is adopted. A delegated act clause is included in the ILUC proposal (Article 2(2)(c)) empowering the Commission to adopt delegated acts concerning the list of feedstocks, for example to expand the list.

[6] European Parliament Resolution of 19 January 2012 on how to avoid food wastage: strategies for a more efficient food chain in the EU (2011/2175(INI)), http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P7-TA-2012-0014+0+DOC+XML+V0//EN&language=EN

[7] http://www.endseurope.com/30196/eu-member-states-at-odds-over-compost-rules?referrer=bulletin&DCMP=EMC-ENDS-EUROPE-DAILY:

[8] The waste hierarchy stipulates to prefer prevention, re-use, recycling (and composting) over (for example energy) recovery and eventually over disposal (ie landfill or incineration without energy recovery).

3 PRIORITY USES FOR WASTES AND RESIDUES

The feedstocks included in the Commission's list have other potential uses, both existing (and established) uses and others that may hinge upon the future development of conversion technologies. Uses other than for biofuels include energy as well as non-energy applications.

Energy versus non-energy uses

The feedstock factsheets aim to identify some of the main and existing non-energy uses of wastes and residues. These are often diverse and may depend greatly on local circumstances. They include the use of biomass for the production of bio-chemicals and bio-plastics. For example animal fats have a number of well-established uses in the chemicals industry. Converting different feedstocks to chemicals or substances for alternative uses can often require advanced biochemical or thermochemical processes. However, many of these technologies are not yet operating at a commercial scale in the EU. Some uses are particularly relevant since they have the potential to provide environmental benefits such as the use of straw as a soil improver. In these cases (excessive) diversion could have a direct bearing on the environmental credentials of using these feedstocks for biofuels. Some potential safeguards to mitigate risks are proposed where relevant.

An important consideration in determining the merits of using a particular feedstock for energy or non-energy purposes is the level of the GHG savings per unit of biomass that can be attained by replacing traditional, mainly fossil based feedstocks in one or the other sector. Another consideration is the availability of low-carbon fuel alternatives for the transport sector. There exist currently few alternatives to effectively decarbonise the aviation sector and certain modes of shipping, which may serve as an argument for using certain volumes of biomass for transport fuel production in preference to other uses. Of course, as in road transport, demand reduction and modal shift have advantages as routes to reducing GHG emissions in these sectors and so should be prioritised[9]. Similarly, certain chemical applications may rely on biomass as a low-carbon alternative input.

Biofuel versus other energy uses

Many of the feedstocks proposed by the Commission are or could be used for heat and electricity generation, through simple combustion (solid feedstocks) or from biogas, rather than to produce biofuels, predominantly via advanced conversion technologies. In most cases, the factsheets do not address which of these energy uses should be prioritised. This again would need to be determined by taking into consideration the existence of low-carbon alternatives and relative GHG saving potentials per unit of biomass. A range of low-carbon alternatives exists for electricity and, to a lesser extent, heat generation, though these may vary geographically and may be more limited for some applications. A fuller discussion of this issue in order to recommend priority uses would require a detailed analysis of lifecycle emissions and energy system modelling, taking into account the availability of other low-carbon alternatives in the different sectors and indeed in different regions of Europe.

[9] See also Skinner (2013) for a discussion of alternatives of reducing CO_2 emissions from the UK transport sector.

Nevertheless, some of the environmental risks and safeguards identified in this report will be applicable, no matter what the feedstock is used for ultimately. Furthermore and where applicable, non-energy and energy uses for biomass materials should be combined over time by cascading the different uses. This is most relevant for woody (ligno-cellulosic) biomass that can be used in the pulp, paper and board industry, with energy recovery following recycling loops within these sectors (Mantau, 2012; Keegan *et al*, 2013).

4 ASSESSING THE SUSTAINABILITY OF FEEDSTOCKS PROPOSED FOR MULTIPLE COUNTING

This section includes a series of summary factsheets for the feedstocks specified in the Commission's ILUC proposal for double and quadruple counting. The factsheets follow the order of the ILUC proposal, starting with those proposed for quadruple counting. They include the following information:

<table>
<tr><th colspan="2">Feedstock (2x/4x = the number of times their energy content is counted towards the RED)</th></tr>
<tr><td>Picture</td><td>Name of feedstock and description of material concerned.
Geographical distribution within the EU.</td></tr>
<tr><td colspan="2">Existing uses
Other energy and non-energy uses are highlighted. In most cases this is limited to established primary uses and not potential future uses that still require technological development (see Section 3).</td></tr>
<tr><td colspan="2">Risk of diversion of existing uses / Environmental risks
Signals whether an increased use of the particular feedstock for energy recovery triggered by the proposed incentives in the RED appears likely to pose environmental risks because existing uses are disrupted. For feedstocks that are neither wastes nor residues, this section is entitled 'Environmental risks' and refers to risks from cultivation of, for example, algae and (ligno-)cellulosic crops.</td></tr>
<tr><td colspan="2">Is the resource primarily domestic (EU) or likely to be imported?
This signals whether large scale imports might occur with ensuing sustainability risks.</td></tr>
<tr><td colspan="2">Environmental safeguards?
An initial set of environmental safeguards are spelled out that may be appropriate (and essential) to address the risks identified.</td></tr>
<tr><td colspan="2">Conclusion: sustainable alternative?
The final section of the factsheet offers a concluding but preliminary sustainability assessment as to whether the feedstock can be considered:
• Likely sustainable;
• Potentially sustainable (contingent on safeguards);
• Likely unsustainable.</td></tr>
<tr><td colspan="2">References: Provided where they support the analysis</td></tr>
</table>

The compilation of factsheets should be understood as simply an initial screening exercise. Several important considerations could not be addressed at this stage. For example, the factsheets do not provide estimates of volumes available or of costs of mobilising the different feedstocks. Furthermore, the sustainability screening takes only limited consideration of how sustainability risks are affected by the volumes which could be mobilised, in particular in the context of wastes and residues. Some wastes and residues may be considered sustainable as long as their mobilisation is contained within certain limits, but risks may multiply beyond such limits.

4.1 Algae (4x)

Definition: Microalgae are generally single-celled whereas macroalgae (seaweeds) are multicellular plant-like organisms. Algae are found in both marine and fresh-water environments around the world and may be harvested from wild stocks or cultivated. Given a lack of further definition, the ILUC proposal is assumed to cover algae from all sources, but not microcrops such as *Lemna* spp.

***Geographical distribution*:** Macroalgae production is generally limited to coastal areas although inland cultivation is possible in contained tanks. Large scale microalgae production in cultivated open systems is limited to warmer climates; however, closed systems may be employed elsewhere.

Existing uses

Algae are currently used in small quantities for a wide range of products, including pharmaceuticals, cosmetics, food and feed, and as a fertiliser [1][2].

Environmental risks The potential environmental risks relate to the origin of the algae and are dependent upon whether wild harvested or cultivated resources are used and the amounts needed. The environmental implications associated with cultivated resources will differ depending on whether they are grown in the sea or on land and will depend on the cultivation system used; both negative and positive effects may occur [3]. There are large potential risks to marine and coastal wildlife, wave dynamics and coastal sedimentation associated with large scale wild harvesting of macro algae from both the shoreline and the intertidal environment [3]. Algae grown in closed systems and open ponds have significant fresh water and nutrient requirements. Heterotrophic algae also require added sugars, bringing a significant risk of diverting food-based sugar sources to fuel production.

Is the resource primarily domestic (EU) or likely to be imported?

Algae are a high moisture content, low density feedstock which can biodegrade rapidly and, as such, are not suitable for transport over longer distances without drying. Artificial drying of algae is economically and environmentally costly, thus unless algal biomass can be dried naturally, processing it is likely to be constrained to the immediate vicinity of biomass production facilities.

Environmental safeguards?

The environmental impacts associated with large-scale algal production, especially in open systems, are little unknown and research and development (R&D) should be encouraged to understand what these impacts could be. Recommended safeguards include:

- Committing to a large scale R&D programme, over several seasons, examining *environmental* issues in several promising algal production systems [2].
- Clearly defining which 'algal biofuel' production systems are covered under the RED, as associated sustainability impacts vary widely.
- Developing sustainability standards appropriate for the most sustainable and economically viable algal feedstocks aligned to the standards currently in place for terrestrial biomass in the RED.
- Investigating the effectiveness of using waste streams to provide nutrients, water and organic carbon sources in the growth of algae [2].

Conclusion:

Potentially Sustainable (contingent on safeguards). Subject to further research and if appropriate sustainability standards are developed and included within the RED.

References:
[1] NNFCC (2012) Macroalgae Factsheet http://tinyurl.com/aydpqq6
[2] NNFCC (2011) Microalgae Factsheet http://tinyurl.com/bgefcv8
[3] Smith C and Higson A (2012) Research Needs in Ecosystem Services to Support Algal Biofuels, Bioenergy and Commodity Chemicals Production in the UK. http://tinyurl.com/dxk82lb
Image copyright: *Lea via Flickr*

4.2 Biomass fraction of mixed municipal waste (4x)

Definition: *'Biomass fraction of mixed municipal waste, but not separated household waste subject to recycling targets under Article 11(2)(a) of Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives'* (ILUC proposal). The relevant article of the Waste Framework Directive [1] refers to 'paper, metal, plastic and glass', which leaves food waste and green waste (ie garden waste) as eligible municipal waste streams. It could be construed that biodegradable plastics and non-separated card and paper are also part of the definition.

***Geographic distribution*:** EU-wide with the highest concentration in densely populated areas.

Existing uses

Composting, in compliance with waste management policy, is a major non-energy use of the biomass fraction of mixed municipal waste is composting.

It is worth noting that the availability of municipal waste for energy generation will be affected by ongoing prevention and recycling efforts and should therefore be falling over time.

Risk of diversion of existing uses

Risk that increased incentives for energy recovery of these waste streams might counteract efforts to prevent, re-use and recycle waste, ie adhere to the waste hierarchy (see below). However, a UK based study found that Anaerobic Digestion can actually provide higher net carbon savings than composting [2].

Negative environmental impacts minimised as long as pollution deriving from the storage, transport and processing of waste resources is prevented.

Is the resource primarily domestic (EU) or likely to be imported?

Significant imports are highly unlikely given the low energy density.

Environmental safeguards?

Safeguards are required that ensure any use of this waste stream is in line with the waste hierarchy, which prioritises: prevention > re-use > recycling or composting > energy recovery > disposal (landfill or incineration without energy recovery). This means only non-recyclable, non-compostable municipal solid waste should be available for energy recovery, unless energy recovery can be justified for reasons of technical feasibility, economic viability or environmental protection. This requires cooperation between policy makers from different departments in order to prevent conflicts between the objectives of energy and waste policies.

Conclusion:

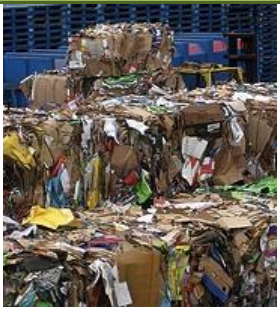
Potentially sustainable (contingent on safeguards). Only non-recyclable, non-compostable waste should be considered a sustainable biofuel feedstock

References:

[1] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0030:EN:PDF

[2] Environmental Resources Management (2006). *Carbon Balances and Energy Impacts of the Management of UK Wastes*, Final Report for Defra R&D Project WRT 237, http://www.fcrn.org.uk/sites/default/files/ERM_Carbon_balances_and_energy_impacts_of_waste.pdf

Image copyright: MamaPyjama's via flickr

4.3 Biomass fraction of industrial waste (4x)	
	***Definition:*** This category may encompass a range of waste streams, without further definition provided in the ILUC proposal. An indicative, non-exhaustive list includes: waste paper, cardboard and wood, for example used in packaging and transport; food waste occurring at the production stage (though some of this, such as animal fats falls under another biomass category) and also retail stages (supermarkets). ***Geographic distribution***: EU-wide

Existing uses

Industrial waste paper and cardboard is to a large extent recycled in the EU's paper and pulp industry, reducing the potential available for the energy sector [1] [2]. Waste wood can be recycled in the board industry. The potential for energy recovery of waste wood could be reduced where waste wood is contaminated. Composting is an existing use of food waste. Food waste should furthermore decrease over coming years as a result of ongoing prevention and recycling efforts.

Risk of diversion of existing uses

An increased diversion of paper and cardboard may reduce the resource base of the pulp and paper industry by distorting well-established recycling loops within that industry.
As with municipal waste, there is the risk that increased incentives for energy recovery of these waste streams might counteract efforts to prevent, re-use and recycle waste, ie adhere to the waste hierarchy (see below).

Is the resource primarily domestic (EU) or likely to be imported?

Significant imports are highly unlikely given the low energy density.

Environmental safeguards?

Safeguards are required that ensure any use of these waste streams is in line with the waste hierarchy, which prioritises: prevention > re-use > recycling or composting > energy recovery > disposal (landfill or incineration without energy recovery). This means only non-recyclable, non-compostable industrial waste should be available for energy recovery, unless energy recovery can be justified for reasons of technical feasibility, economic viability or environmental protection. This requires cooperation between policy makers from different departments in order to prevent conflicts between the objectives of energy and waste policies.

Conclusion:

Potentially sustainable (contingent on safeguards). Only non-recyclable, non-compostable waste should be considered a sustainable biofuel feedstock

References:
[1] Mantau, U (2012) *Wood flows in Europe (EU27)*, project report for ECPI and CEI-Bois. Available at: http://tinyurl.com/a7k82xs
[2] Elbersen, B, Startisky, I, Hengeveld, G, Schelhaas, M-J, Naeff, H and Böttcher, H (2012) *Atlas of EU biomass potentials. Deliverable 3.3: Spatially detailed and quantified overview of EU biomass potential taking into account the main criteria determining biomass availability from different sources*. Available at: http://tinyurl.com/azk3vst
Image copyright: crabchick via flickr

4.4 Straw (4x)

Definition: Straw refers to the dry stalks of crops that remain following the removal of the grain and chaff during the harvesting process and can encompass cereal straw, maize stover, oilseed rape straw.

***Geographical distribution*:** EU-wide relevance, but in line with current cultivation patterns.

Existing uses

Examples of existing uses of straw within and outside the agricultural sector include: soil improver, animal fodder and bedding, mushroom production, horticulture; material for thatching or other building purposes and burning for heat and electricity [1][2].

Risk of diversion of existing uses

Direct impacts of straw removal on soil functionality, most importantly reduction of soil organic matter; nutrients; potential impacts on fauna resulting from modifications to stubble heights and straw management; animal welfare impacts when no suitable alternatives employed [1]

Is the resource primarily domestic (EU) or likely to be imported?

Significant extra-EU trade is unlikely given the low density of straw. Eurostat data shows that trade across bordering regions within the EU takes place (see also [1] for anecdotal information on trade dynamics, for example between DE and AT, UK and FR).

Environmental safeguards?

The most important risk to mitigate is the depletion of soil carbon and other nutrients, eg by requiring biorefinery operators to investigate the local humus balances in regions where plants are to be installed and commit to only sourcing agricultural residues where these are not depleting soil organic carbon or other soil nutrients. Key recommended safeguards:

- Strengthening environmental safeguards through cross compliance (Common Agricultural Policy, CAP) in the form of specific requirements in relation to soil organic matter
- Providing advice and support to farmers on sustainable straw use (under CAP Rural Development policy)
- Including soil carbon in the GHG accounting framework (in the RED)

Conclusion:

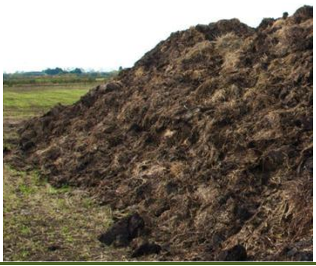
Potentially sustainable (contingent on safeguards)

References:

[1] Kretschmer, B, Allen, B and Hart, K (2012) *Mobilising Cereal Straw in the EU to feed Advanced Biofuel Production. Report produced for Novozymes*. Institute for European Environmental Policy (IEEP): London.

[2] WWF (2012) *Smart use of residues: Exploring the factors affecting the sustainable extraction rate of agricultural residues for advanced biofuels*, WWF EU briefing Paper.

4.5 Animal manure and sewage sludge (4x)



Definition: Animal manure includes liquid manure and slurry as well as solid manure and dung. The former are most suitable for anaerobic digestion (AD), the latter either for blending with wet sources for AD or use for generation of heat and power. Sewage sludge is more appropriate for AD processing.

***Geographical distribution*:** EU-wide relevance. Animal manure is concentrated in regions dominated by (intensive) livestock farming. Sewage sludge is concentrated in more densely populated areas.

Existing uses

Both animal manure and sewage sludge are used as organic fertilisers subject to EU regulations.

Risk of diversion of existing uses

Soil organic matter depletion could occur where large quantities of existing manure and sludge are diverted towards energy use; the characteristics of the manure are also relevant. There is also the potential risk of substitution by inorganic fertilisers where 'natural' fertilisers are diverted towards energy production.

An associated risk is the expansion of maize cultivation into existing cropland or permanent pasture to co-feed AD plants (as happened on a large scale in Germany). Maize cultivation creates risks for soil and water from erosion and nutrient leaching.

Is the resource primarily domestic (EU) or likely to be imported?

Primarily domestic.

Environmental safeguards?

Traditional manure management should not be diverted to an extent that would lead to a decline in soil organic matter and a reduction in available organic fertilisers. The use of AD on farms could result in a by-product suitable as a fertiliser and should be promoted over complete removal of sludge and manure from the farm system. Strengthening environmental safeguards through cross compliance (CAP) in the form of specific requirements in relation to soil organic matter is needed (as for other residues, see for example straw).

To counter risks from maize cultivation expansion there could be a requirement for a more diverse feedstock basis in AD generation eg via promoting the use of more environmentally beneficial crops combined with a cap on maize or other cereal grain input. For example, the 2012 German Renewable Energy Sources Act (EEG) caps the input of maize or other cereal grain in electricity from biogas production to 60 per cent and pays bonuses for the use of certain wastes and residues and other biomass, eg landscape management material, catch crops etc [1].

Conclusion: sustainable alternative?

Potentially sustainable (contingent on safeguards)

References:

[1] Biomass ordinance 2012, Annex 3 on 'Substances for substance tariff class II and their energy yield':
http://erneuerbare-energien.de/files/english/pdf/application/pdf/biomasse_verordnung_en_bf.pdf

4.6 Palm oil mill effluent and empty palm fruit bunches (4x)

Definition: Palm oil mill effluent and empty palm fruit bunches are by-products of the palm oil processing industry. Typically, for every tonne of fresh palm bunches processed, 0.65 tonnes of palm oil mill effluent will be produced [1] and around 0.2-0.22 tonnes of empty fruit bunches, the residues remaining after threshing the fresh fruit bunches [2].

Geographic Distribution: Palm oil production, and hence production of empty fruit bunches and palm oil mill effluent, is centred upon Malaysia and Indonesia which account for 85 per cent of global production [3].

Existing uses

Empty fruit bunches are solids and may be composted, used as a mulch or fertiliser on the plantation [4], or used as paper and fibreboard material. Empty fruit bunches may also be incinerated and the ash used as a fertiliser [4][5]. On-plantation burning is largely banned due to negative air quality impacts [3]. Leaving empty fruit bunches to decompose can result in methane emissions [5]. Research is underway to assess the suitability of empty fruit bunches for biofuels and chemicals [2][6]. Palm oil mill effluent is a liquid material and must be treated in open ponds or lagoons before discharge. In some cases, palm oil mill effluent may be illegally dumped in water courses, causing aquatic pollution [5]. Some mills currently treat effluent through anaerobic digestion, producing a fuel, and a fertiliser from this material [5] and in some cases it may be recycled back into the ground directly as a fertiliser. There has been some research on using palm oil mill effluent as an animal feed [6].

Risk of diversion of existing uses

Both empty fruit bunches and palm oil mill effluents are currently considered waste materials. While a range of potential uses exist, it is considered that the supply of empty fruit bunches and palm oil mill effluent is in excess of current utilisation [7].

Is the resource primarily domestic (EU) or likely to be imported?

As a wet material, palm oil mill effluent is likely to be too bulky to import. There is no information on to what degree empty fruit bunches are imported into the EU.

Environmental safeguards?

Overall, empty fruit bunches and palm oil mill effluent materials would be preferable if be derived from plantations that adhere to a recognised certification scheme to guard against land use change. Palm oil mill effluent should only be used for biofuel production where the supply of biogas from AD exceeds the mills process energy needs. Likewise, empty fruit bunches are underused as a fertiliser source on some plantations, and have the scope to reduce inorganic fertiliser use. This and AD of effluents are potentially valuable routes to cutting the GHG impacts associated with palm oil biodiesel production. A greater understanding of the benefits of fertiliser derived from empty fruit bunches and the markets for other products is needed.

Conclusion: sustainable alternative?

Potentially sustainable (contingent on safeguards)

References:

[1] http://www.americanpalmoil.com/sustainable-pome.html

[2] Kerdsuwan, S, Laohalidanond, K (2011) *Renewable Energy from Palm Oil Empty Fruit Bunch,* http://tinyurl.com/acnorrx

[3] Global Bio-Pact Project. Newsletter 3, July 2011, http://tinyurl.com/ckhkt7z

[4] Wright, A (2011) Global-Bio-Pact Case Study: Socio-Economic Impacts of the Palm oil chain in Indonesia GBI; Report of the FP7 Global-Bio-Pact Project (FP7-24505)8

[5] Panapanaan, V *et al* (2009) Sustainability of palm oil production and opportunities for Finnish technology and know-how transfer, http://tinyurl.com/bbm4qsl

[6] Heuzé V., Tran G., Bastianelli D., Lebas F., 2012. Palm oil mill effluent. Feedipedia.org. A programme by INRA, CIRAD, AFZ and FAO. http://www.feedipedia.org/node/15395, last updated on June 2, 2012.

[7] Tanaka, R. (2006) Utilization of oil palm empty fruit bunches as 'solid materials', http://tinyurl.com/ak4xab4

Picture of empty fruit bunches from http://www.etawau.com/OilPalm/OilPalm.htm

4.7 Tall oil pitch (4x)

Definition: Tall oil pitch is a highly viscous residue from the distillation of crude tall oil. Crude tall oil stems from crude sulphate soap, which is (along with black liquor) a by-product of the conifer based paper pulp making process.

Geographical distribution: regions with a strong pulp and paper industry

Existing uses

According to [1], tall oil pitch is predominantly used as a process fuel by tall oil processors. It is also marketed as a substitute for heavy fuel oil [2] and, outside of energy use, as a material for the chemicals industry, *inter alia* as: a component in the production of rubber goods; cardboard sizing; a binding component in asphalt processing and in other construction materials [3]; printing inks; emulsifiers; tackifiers [4]; candle production. Material uses of pitch stabilise its price whereas, demand for pitch as an energy source depends on the prices of traditional fuels [5].

Risk of diversion of existing uses

Substitution of existing uses as an input in the chemical industry and as a process fuel by potentially unsustainable alternatives, such as heavy fuel oil (see also section 3).

Is the resource primarily domestic (EU) or likely to be imported?

(Raw) tall oil and its resulting products are being traded.

Environmental safeguards?

Unclear. A potential safeguard would be to ensure that sufficient quantities are available for current use as a process fuel replacing heavy fuel oil and chemical input before incentives are available for channelling supplies into the biofuel market.

Conclusion: sustainable alternative?

Potentially sustainable (contingent on safeguards). It could be considered a sustainable alternative if volumes of tall oil pitch outstrip existing uses, but such data could not be obtained.

References:

[1] The Pine Chemicals Association, Inc. (2001): http://www.epa.gov/hpv/pubs/summaries/tofars/c13056.pdf
[2] UCY Energy: http://www.ucy-energy.com/english/tall_oil_1.htm
[3] Lesokhimik: http://lesokhimik.com/tall-oil-pitch/
[4] New Zealand Institute of Chemistry (NZIC): http://nzic.org.nz/ChemProcesses/forestry/4G.pdf
[5] *Pers comm* with Thilo Schneider, UCY Energy (supplier of tall oil products)

4.8 Crude Glycerine (4x)

Definition: Crude glycerine (also crude glycerol) is a by-product of biodiesel production and the processing of animal and vegetable fats and oils. It can also be synthesised. Biodiesel production yields around 10 per cent crude glycerine output. Crude glycerine can be upgraded or refined to yield glycerine, removing methanol and other impurities, a process that is relatively expensive, at least at a small scale, and there is a lack of refining capacity in the EU currently. The increase in biodiesel production is expected to create a substantial oversupply of (crude) glycerine [1]-[5].

***Geographic distribution*:** The largest quantities derive from biodiesel production, so arise in line with biodiesel processing facilities.

Existing uses

With the growing biodiesel industry, large quantities of crude glycerine have become available triggering research into new uses for this residue material. In its raw form crude glycerine has a limited number of existing uses as a result of impurities and requires processing. Its use as animal feed is being researched [4][5]. Other options include thermochemical or biological conversion for usage in the chemical or related industries [6]. Composting and combustion are other disposal methods [4]. Refined glycerine has a vast amount of uses as an additive in the food, cosmetics and pharmaceutical industry, to name a few, and new uses continue to be developed.

Risk of diversion of existing uses

Unclear, but expected to be low given the large availability due to biodiesel production and currently underdeveloped (higher-value) uses. A problematic aspect of an increased economic value of crude glycerine might be the resulting improved profitability of biodiesel production, a biofuel with recognised ILUC risks.

Is the resource primarily domestic (EU) or likely to be imported?

Unclear but given the large scale biodiesel production in the EU, a domestic oversupply is anticipated, making imports unlikely.

Environmental safeguards?

Policy recognising and regulating the ILUC risk from biodiesel.

Conclusion: sustainable alternative?

Unclear.

The environmental risks of using crude glycerine as a biofuel feedstock appear limited from the research carried out here. However, extra incentives to increase the use of crude glycerine as a biofuel feedstock are not welcomed because of uncertain impacts on the profitability of biodiesel production. Were glycerine use to increase the latter, it would not constitute a viable ILUC mitigation measure given the ILUC risk associated with biodiesel.

References:

[1] http://biofuelstechnologyllc.com/Crude_Glycerine.html

[2] http://ugr.ucr.edu/files/SeanBrady.pdf

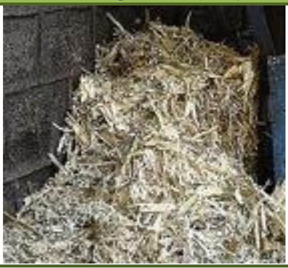
[3] http://www.cranfield.ac.uk/automotive/research/projects/environment/page24781.html

[4] http://www.extension.org/pages/29264/new-uses-for-crude-glycerin-from-biodiesel-production

[5] http://www.biodieselmagazine.com/articles/7553/growing-demand-for-glycerin-to-keep-up-with-supply-increases

[6] http://www.biotechnologyforbiofuels.com/content/5/1/13

4.9 Bagasse (4x)



Definition: Bagasse is the fibrous residue from the sugarcane crushing process.

Geographic distribution: Sugarcane production areas, ie virtually no domestic EU relevance

Existing uses

Bagasse is typically used in the sugarcane industry, ie as a process fuel in the production of sugar and ethanol. It has a significant volume as a fuel in its own right, rather than a waste. Using co-generation technology widely applied in the Brazilian sugarcane sector, electricity is produced which is fed into the grid. According to the Brazilian sugarcane industry association UNICA, the resulting electricity amounts to almost 30 per cent of all residential consumption in the State of São Paulo. It is the third most important electricity source in Brazil (after hydroelectricity and natural gas) [1]. Paper and board production is another potential use. The LIIB methodology [2] is promoting the use of bagasse as an animal feed as part of its proposed sugarcane-cattle integration model, to reduce the demand on land from feed production and hence seeking to produce ILUC-free biofuel.

Risk of diversion of existing uses

There are established existing uses of bagasse, which might be disrupted by an increased conversion of bagasse into advanced biofuels. Therefore, it will have to be established what the relative emission saving potential are of the different options. At the same time, the economics of using bagasse as a low-cost electricity source will probably secure the resource base for this purpose for the time being. Data from a biomass-fired power plant in Ribeirao Preto (PIERP), Brazil, show drastic price increases for bagasse in 2012, approaching the level of woodchips, and tight supply.

Is the resource primarily domestic (EU) or likely to be imported?

Bulky feedstock therefore imports highly unlikely.

Environmental safeguards?

There is a need for better understanding of the relative emission saving potentials of using bagasse as an advanced biofuel feedstock as opposed to its other uses including in the energy sector (see also Section 3).

Conclusion: sustainable alternative?

Potentially sustainable (contingent on safeguards). Only if it is found that advanced biofuels production provides higher GHG savings than existing uses.

References:

[1] UNICA news 06/06/2012: http://english.unica.com.br/noticias/show.asp?nwsCode={198A7CD0-31F1-4096-852D-66BFBA9D539F}

[2] http://en.wikipedia.org/wiki/Bagasse

[3] LIIB (2012) Low Indirect Impacts Biofuel methodology – version zero, http://rsb.epfl.ch/files/content/sites/rsb2/files/Biofuels/Working%20Groups/II%20EG/LIIB%20methodology%20-%20Version%200%20-%20July%202012.pdf

[4] Pers comm Mr. Hilario Cavalheiro, PIERP Biomass-fired thermoeletric plant

4.10 Grape marc and wine lees (4x)

Definition: Grape marc, also known as '*pomace*', is the residue that remains after the pressing of fresh grapes [1]. 'Wine lees' refers to the sediment remaining in the vessels used in wine production [1], consisting of dead yeasts and other solid particles precipitated during the fermentation process.

Geographic distribution: Follows the distribution of major wine growing regions in the EU

Existing uses

Grape marc and wine lees have a variety of existing uses both within and outwith the wine-making industry. They can be further pressed to produce Ripasso [2] and piquette [1] wines; and the marc can be distilled to produce 'grape marc spirits' [3] including 'Grappa'. The marc, lees and vinasses can also be used to produce a variety of culinary ingredients such as grape seed oil; natural red food colouring (Oenocyanin); xylitol (a sweetener) tartaric acid and cream of tartare [4]; as well as health products (red grape polyphenols and anthocyanins); and natural preservatives. Composted marc can be used as an organic fertiliser [5]; a soil mulch; and a peat or perlite substitute when blended into soil in combination with other biomass [6].

Risk of diversion of existing uses

The primary risk of diversion relates to impacts on the food and wine industry through the potential reduction in liqueur and grape spirit production, with potential social impacts on the many traditional and small-scale producers. Composted marc could be displaced by peat and synthetic fertiliser with associated environmental impacts. There is limited risk of increasing consumption of alternative cooking, including palm, oil, as a result of using grapeseed oil for biofuels. However, the fact that grapeseed oil is a high value product should reduce the risk of it actually being used for biofuels and it could be avoided by prior use of the oil as cooking oil before conversion to biodiesel in conjunction with other UCO [7]. Ethanol production from distillation will compete with marc spirit and liqueur wine production. Extraction, post distillation, from the lignocellulosic components of the marc may offer an alternative fuel production pathway but with other potential impacts.

Is the resource primarily domestic (EU) or likely to be imported?

Large volumes of marc and lees are available within the EU. The EU produces 65 per cent of the world's wine, equating to roughly 175m Hl per annum [8][9]. Wine is imported but in liquid form.

Environmental safeguards?

It could be investigated in the relevant regions or Member States whether measures to ensure sufficient supply to traditional and small-scale spirit producers are needed. Integrated production pathways, enabling continued supply of useful by-products for industrial and agricultural use would reduce the impact of feedstock diversion.

Conclusion: sustainable alternative? *Potentially sustainable (contingent on safeguards)*

References

[1] Council Regulation (EC) No 479/2008 of 29 April 2008 on the common organisation of the market in wine, Annex I, Definitions, OJ L 148, 6.6.2008

[2] Johnson, H and Robinson, J (2005) The World Atlas of Wine, pp. 168–169 Mitchell Beazley Publishing ISBN 1-84000-332-4

[3] Regulation (EC) No 110/2008 Of The European Parliament And Of The Council of 15 January 2008 on the definition, description, presentation, labelling and the protection of geographical indications of spirit drinks and repealing Council Regulation (EEC) No 1576/89, Official Journal L 39/16, 13.2.2008

[4] Salgado, J M, Rodríguez, N, Cortés, S and Domínguez, J M (2010) Improving downstream processes to recover tartaric acid, tartrate and nutrients from vinasses and formulation of inexpensive fermentative broths for xylitol production. *J. Sci. Food Agric* 90, 2168–2177.

[5] Barana, A, Çaycıa, G, Kütüka, C, Hartmann, R (2001) Composted grape marc as growing medium for hypostases (Hypostases phyllostagya) *Bioresource Technology* 78(1), 103–106.

[6] Inbar Y, Chen Y, Hadar Y, (1986) The Use Of Composted Separated Cattle Manure And Grape Marc As Peat Substitute In Horticulture. Acta Hort. (ISHS) 178, 147-154, http://www.actahort.org/books/178/178_19.htm

[7] Locke, M, Firm Uses Grapeseed Oil as Biofuel, USA Today. Posted online 5.9.2007. Available at: http://tinyurl.com/cn54vws

[8] EC (2011) Estimated yearly production reduction, EC Agriculture and Rural Development, Wine Market. http://tinyurl.com/d2rhnlx

[9] EC What is the current situation of the European Union's wine sector? EC, Agriculture and Rural Development, http://ec.europa.eu/agriculture/markets/wine/index_en.htm, accessed 15.01.2013

[10] Gevirtz, L (2012) 'Great European wine grapes, just not many to harvest', 25.09.2012, Reuters, http://tinyurl.com/clcby2w.

Image Copyright Budd, J, http://jimsloire.blogspot.co.uk/2010/01/didier-hauret-cosmetics-and-alternative.html

4.11 Nut shells (4x)

Definition: Nut shells are the outer hard casing of nuts. This category is understood to include almonds, though the proposal does not specify this. The largest source of nutshells in the EU is from almond, walnut and hazelnut production.

***Geographical distribution*:** Almonds are almost exclusively grown in Spain, Italy and (less so) in Greece; hazelnuts in Italy, Spain and some in France; walnut production is more dispersed (foremost in Romania, France and Greece) [1]. It is not always clear, however, whether nuts are shelled in their country of origin or in the country of consumption.

Existing uses

Walnut shells are used extensively in manufacturing processes for deburring, carbon and corrosion removal and polishing in a wide range of industries [2][3][5][6][7], as they do not cause pitting and scratching[4]. They are also used in the removal of paint and graffiti [6]. Nut shells are used by the cosmetics industry and in the form of pellets and briquettes for heat and power in biomass boilers, (almonds, particularly in Southern Europe) [9][10]. Further uses include: filler in dynamite and paint thickening agent (walnuts); composting; loose-fill packing material for fragile items [8].

Risk of diversion of existing uses

The displacement of walnut shells as soft abrasive media in manufacturing, cleaning, polishing and the cosmetics industry may lead to the increased use of alternatives such as silica which is associated with human health risks including silicosis (lung disease). Non-biodegradable alternatives may also be used to replace walnut shell media. The use of nutshells for biofuels could displace nutshells used in biomass boilers and lead to fossil fuel being used in substitution, an issue of potential relevance in parts of Southern Europe.

Is the resource primarily domestic (EU) or likely to be imported?

Nuts are imported into the EU, though predominantly shelled. Significant volumes of almond, walnut and hazelnut shells are available within the EU.

Environmental safeguards?

Unclear. Safeguards would need to ensure that sufficient quantities are available for current use as a blasting media and for other industrial applications where it has displaced more harmful media in terms of environmental or other impacts (eg human health).

Conclusion: sustainable alternative?

Potentially sustainable (contingent on safeguards). It could be considered a sustainable alternative if volumes of nutshells outstrip existing uses, but such data could not be obtained.

References:

[1] All production figures are FAOStat data for 2010.

[2] Sandblasting Equipment» Blast Material Abrasive Material - Soft "Nut Shells" - Multi Use – Edged, Esska website, http://tinyurl.com/bpj5rt7, accessed 28.01.2013

[3] I.Shor, *Tumbling & Vibratory Media,* website of Shor International Corporation https://www.ishor.com/TumblingMedia.php Accessed 28.01.2013

[4] *Walnut Shell Media / Walnut Shell Grain Synonyms*, Website of Reade International Ltd http://www.reade.com/home/816 Accessed 04.02.2013

[5] *VAC Walnut Blaster Service*: *135i/335i/535i Intake Valve Carbon Cleaning* http://tinyurl.com/cylexg7

[6] *Blast Abrasives,* Website of Guyson International Ltd, UK, http://tinyurl.com/abldknp

[7] Jet Blast Turbine Engine Cleaning Media, Website of Dennis Dawson Company, http://tinyurl.com/aruzc4m

[8] Nutshell, Wikipedia page, http://en.wikipedia.org/wiki/Nut_shell, accessed 08.02.2013

[9] Hinge, J., Alikangas, E, Nibbi, L, Vagonyte, E, (2011) Waste Not, Want Not: Europe's Unexploited Biomass, http://tinyurl.com/3dumbrb, accessed 04.02.2013

[10] *Almond shell briquettes* , item for sale, website of Biomass Briquette Systems LLC, http://www.biomassbriquettesystems.com/listings/forsale/almond-shell-briquettes, accessed, 04.02.2013

Image copyright: Conanil via flickr

4.12 Husks (4x)

Definition: Husks (also known as hulls) are the protective outer coating of seeds, nuts, grains or fruit. In the case of wheat, the husk is separated from the kernel during the threshing procedure. Once removed the husk becomes a constituent of the 'chaff' and is regarded as an agricultural residue. This is thought to primarily refer to the leafy outer layer surrounding the ear of the maize (corn) plant. A wider definition of husks could include other plant residues remaining after processing, including olive core and pulp (which can also be referred to as non-grape marc and lees) [1].

***Geographic distribution*:** Follows the geographic distribution of particular crops

Existing uses

Given the wide variety of husks produced as agricultural residues, their use and potential application is equally varied. Within the EU, husks are used in the following ways: Maize husks are often mixed with other parts of the maize plant for silage to be used as high energy livestock feed [2]. Maize husks are also used, together with other parts of the maize plant, as a substrate for anaerobic digestion (AD). The digestate from the AD is often returned to the land as an organic fertiliser. Wheat husks are used as a constituent of bran pellets for a high fibre animal feed [3]. Olive husks can be composted [4] or used as a solid biomass fuel [5][6]. Rice husk is also used as biomass in boilers to generate steam to be used in the rice milling process [6][7]. The extraction of tricin, a valuable anti-cancer chemical, from winter wheat husks, is undergoing current research [8].

Risk of diversion of existing uses

Conversion to liquid biofuels as opposed to onsite combustion to provide heat or power [5][6][7] may lead to an increase in on-farm use of fossil fuels. Current fodder uses may have to be substituted.

Is the resource primarily domestic (EU) or likely to be imported?

Unlikely to be imported as a biofuel feedstock given low energy density. Furthermore, imported grains (eg rice) tend to be imported without husks.

Environmental safeguards?

There is a need for better understanding of the relative emission saving potentials of using husks as a biofuel feedstock as opposed to fodder use or other forms of energy processing (see also Section 3).

Conclusion: sustainable alternative?

Potentially sustainable (contingent on safeguards)

References:

[1] Olive husk, Tatano Company website, F.lli Tatano s.n.c.
http://www.tatano.com/326/3/Olive_husk/1 Accessed 24.01.2013

[2] Finke, C, Moller, K, Schlink, S, Gerowitt, B, Isselstein, J (1999) The environmental impact of maize cultivation in the European Union: Practical options for the improvment of the environmental impact.- Case study Germany - Research Centre for Agriculture and Environment, Georg-August-University of Göttingen, Germany, 1999

[3]http://www.tis-gdv.de/tis_e/ware/futter/pellets/weizenkl/weizenkl.htm

[4] Alfano, G, Belli, C, Lustrato, G, Ranalli, G (2008) Pile composting of two-phase centrifuged olive husk residues: technical solutions and quality of cured compost. *Bioresour. Technol*. 99 (11), 4694–4701.

[5],Olive husk, (List of 239 machinery products for sale, for bioenergy use or processing of olive husk, website of Alibaba.com, Hong Kong, http://machinery.alibaba.com/olive-husk.html , accessed 24.01.2013

[6] Panoutsou, C (2006) The role of bioenergy in the national legislation and implementing EU directives – Greece, EUBIONET 2, Intelligent Energy Europe

[7] APEIS and RISPO (2003) Use of Rice Husks as Fuel in Process Steam Boilers, Summary of the Practice, Good Practices Inventory, http://tinyurl.com/b4j2qzb

[8] Moheba, A, Grondinb, M, Ibrahimc, R, K, Roya, R, Sarhanb, F (2013) Winter wheat hull (husk) is a valuable source for tricin, a potential selective cytotoxic agent, Food Chemistry 138(2–3), 931–937

4.13 Cobs (4x)

Definition: A cob is the central, fibrous core of a maize ear to which kernels or grains are attached. Isolated cobs are a by-product from the harvesting of grain maize kernels for food, chemicals or biofuels use.

***Geographic distribution*:** EU-wide and in line with maize cultivation patterns. Largest production in France, Italy, Romania and Hungary.

Existing uses

Maize cobs may be left in the field to slowly decompose or harvested for a variety of products. As a component of maize stover, they are used for the production of energy and heat. They may be used as a forage material for livestock (as silage) or for the production of platform chemicals such as furfural [1] where a high hemicellulose content is desirable. Cobs also find uses in some niche cosmetic products [2] and for burring, cleaning and polishing applications in the manufacture of metal and plastic items as well as jewellery [3]. Cobs are bulkier and have higher water content than other parts of the stover and grain which favours existing on-farm uses [4].

Risk of diversion of existing uses

Little is known about what the environmental impact is from harvesting maize cobs. Cobs have a low nutrient value relative to other stover components (notably leaves and stems), and this, together with their slow biodegradability means that they are thought to be less valuable as a source of soil organic material and nutrients, meaning the risk for soils from diversion is limited. This needs verification because, if they do act as nutrient sources, removal would necessitate the use of other, potentially inorganic, fertilisers in their place. Existing chemical markets for cobs could be met through substitution with other hemicellulose-rich biomass materials. Diversion from heat and power uses would require a substitute such as other forms of biomass, other renewables, or fossil fuels.

Is the resource primarily domestic (EU) or likely to be imported?

Due to relatively low cob yields per hectare and low energy density of cobs, it is unlikely that such a feedstock will be imported to the EU on any scale.

Environmental safeguards?

There is a need to identify the importance of cobs as a soil improver or nutrient source, and if positive to:

- Try to mitigate the removal of other stover components which could provide valuable soil nutrients and organic matter;
- Strengthen environmental safeguards through cross compliance (Common Agricultural Policy) in the form of specific requirements in relation to soil organic matter;
- Include soil carbon in GHG accounting framework (in the RED).

Conclusion: sustainable alternative?

Potentially sustainable (contingent on safeguards)

References:

[1] Furfural is a chemical produced by the thermal treatment of hemicellulose sugars. Over 60 per cent of furfurals are used in the production of furfural alcohol, which can be used in the production of resins, wetting agents and adhesives.

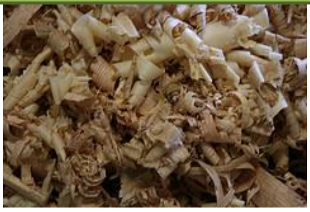
[2] Solo Beauty (2013) *Dermologica Skin prep Scrub 75ml*, Solo Beauty Ltd, UK http://www.solobeauty.co.uk/index.php?page=shop.product_details&flypage=flypage.tpl&product_id=33&category_id=8&option=com_virtuemart&Itemid=86 Accessed 04.02.2013

[3] *UKGE* Metal Barrelling Machines (Lapidary) for Tumbling and Polishing Metal and Jewellery – UKGE Ltd http://www.ukge.co.uk/uk/barrelling.asp

[4] Corn Cobs for Biofuel Production http://www.extension.org/pages/26619/corn-cobs-for-biofuel-production

Image cropyright: andrewmalone via flickr

4.14 Bark, branches, leaves, saw dust and cutter shavings (4x)



Definition: This category covers both primary woody residues, such as bark, and branch leaves, as well as processing residues, such as saw dust and cutter shavings. Primary residues can include forest biomass as well as woody biomass on non-forest land, such as prunings and cuttings from permanent crops (eg olives, vine) and orchards.

***Geographic distribution*:** EU-wide relevance with forestry residues concentrated in (mostly Northern European) Member States with large forest cover and prunings from vineyards, orchards, olive cultivation etc concentrated in Mediterranean Member States.

Existing uses

Saw dust and cutter shavings: Processed into wood pellets and briquettes for domestic biomass boilers [1]; used for fibreboard and paper production; composting, mulch and soil protector; animal bedding, pet bedding; packaging; direct combustion. Bark, branches and leaves: natural decompostible material left in forests, chipped to produce wood chipping, small scale and localised wood fuel, direct combustion, paper processing including for process heat [2], bark chips (barkdust) used as mulch. Betulin, abundant in the bark of several common species including the birch, is used in the pharmaceutical industry as a precursor for other chemicals used in the treatment of certain cancers and HIV [3][4]. Cork, the outer bark of the *Quercus suber* is also used widely in the drinks industry and for flooring, the majority of the world's supply is from the EU, particularly Portugal [2].

Risk of diversion of existing uses

Loss of fallen deadwood would have associated impacts on carbon and biodiversity balances [5]. Reduction in soil organic matter and moisture content would result from diversion from mulch. A number of existing uses result in wood remaining as a solid component in the environment (ie fibreboard), diversion and processing would introduce risks of negative overall carbon balances. Extraction rates can have an impact on overall carbon balance in forests, given renewal times [6].

Is the resource primarily domestic (EU) or likely to be imported?

Unlikely. Primary imports usually would be of timber or higher density pellets.

Environmental safeguards?

It should be ensured that the extraction rates of bark, branches and leaves permit adequate quantities to remain in forests at sustainable levels; that suitable alternatives are available for the compost industry and soil mulch processing; and that the paper pulp industry is not deprived of feedstock resulting in demand for higher-grade wood, with consequential diversion from other industries.

Conclusion: sustainable alternative?

Likely unsustainable if based on diverting current uses but may be further resource available if cost barriers removed.

References:

[1] BEC Information Sheet No. 1, Wood Pellets and briquettes, Forestry Commission, England, http://tinyurl.com/5mbd3z, accessed 29th January, 2013.

[2] Pinto, P C, Sousa, A, Silvestre, A J D, Neto, C P, Gandini, A, Eckerman, C, Holmbomb, B (2009) Quercus suber and Betula pendula outer barks as renewable sources of oleochemicals: A comparative study. *Industrial Crops and Products* 29, 126–132.

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4.15 Used cooking oil (2x)

Also known as recovered vegetable oil or waste vegetable oil, used cooking oil is typically collected from catering establishments and industrial food processors as a waste from food production. It may also be collected from domestic households where a collection infrastructure exists.

Geographical distribution: EU-wide relevance but availability concentrated around urban areas.

Existing uses

Used cooking oils may be used in a range of different products: biofuels, combustion and animal feeds. A small amount is used by the oleochemical industry [2]. The Animal By-Products Regulations impact on what markets used cooking oils can be used for, for example, used cooking oils arising from meat production must not be used for certain applications such as animal feeds.

Risk of diversion of existing uses

The amount of used cooking oil available for industrial use is limited by the collection infrastructure in place, and any controls imposed as a result of the composition of the material A considerable potential for increasing UCO collection is thought to exist. There are major environmental benefits associated with the utilisation of used cooking oil, especially from domestic properties. These include the prevention of water contamination and drain blockages and the diversion of this material from landfill where methane emissions may result from uncontrolled anaerobic digestion [2]. Beneficial health and social impacts may also occur by decreasing the number of cooking cycles; too many cycles, for example, can lead to the formation of carcinogenic materials [1].

Is the resource primarily domestic (EU) or likely to be imported?

Used cooking oil can be imported into the EU easily, with low level controls in place controlling its import. Anecdotal evidence suggests that there may be issues with virgin oils being either burned or being contaminated with small quantities of used cooking oil so that the oil feedstock can be classified as used cooking oil and thus qualify for extra-incentivisation [3].

Environmental safeguards?

Safeguards need to be introduced in order to ensure that oils are not simply fried to make them 'used' and qualify for the extra incentives which waste and residue materials would attract.

Conclusion: sustainable alternative?

Potentially sustainable (contingent on safeguards). While the use of used cooking oil for biofuels is a sustainable idea, appropriate safeguards need to be introduced in order to ensure that oils are not burned simply to qualify for incentives.

References:

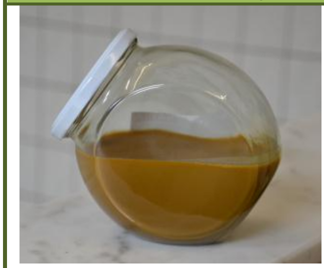
[1]http://www.biodieselmagazine.com/articles/8924/first-biodiesel-plant-in-bali-indonesia-undergoes-commissioning

[2] http://www.wastebook.org/fats.htm

[3] Personal communication with NGO source.

Image copyright: darleeneisms via flickr

4.16 Animal fats (Category 1 and 2) (2x)



Definition: Rendered animal fats are obtained by the rendering (crushing and heating) of animal by-products. There are three distinct categories of tallow products, as defined by the Animal By Products Regulations (ABPR) [1]. Category 3 materials are derived from materials which could otherwise enter the food chain. Category 2 materials are derived from low risk material such as animals that have died on-farm and their manure. Category 1 material carries a risk which cannot be treated with heat/pressure sterilisation and transformed into a safe product usable in the feed chain or as fertiliser. It is for example derived from material deemed to carry a BSE/TSE [2] risk such as spinal and brain material.

Geographical distribution: EU-wide relevance, with production localised around livestock rendering plants.

Existing uses

Tallow can be used in a variety of different markets, depending upon its category. Lower category materials (Cat 1 and 2), can be used in a very limited number of applications including the production of heat for the rendering process and biodiesel production in ABPR compliant facilities, whilst higher category materials (Cat 3) may also be used in the production of animal and pet foods and in the oleochemical industry, for example soap, cosmetics, detergent and lubricants [3]. The Commission's ILUC proposal only refers to Cat 1 and 2 animal fats.

Risk of diversion of existing uses

EU tallow production is constrained by the size of the EU livestock populations so utilisation of tallow for biodiesel production versus energy generation may have some effects on GHG savings if fossil fuels are used as an energy source in place of tallow. This could be overcome by using other renewable energy sources in place of the tallow.

Is the resource primarily domestic (EU) or likely to be imported?

The import and export of Cat 1 and 2 tallow to and from the EU are subject to very strict requirements, eg sterilisation under pressure, marking, and are only allowed for certain safe purposes. However, there are proposals to allow the import of non-sterilised Cat 1 tallow from third countries (mainly Brazil, Canada, US, Uruguay and Argentina) for the oleochemicals industry. There are no plans to lift the export restriction for EU produced Cat 1 tallow [4]. Cat 3 tallow is widely traded throughout the world.

Environmental safeguards?

Safeguards are needed to ensure that excessive amounts of Cat 3 tallow, currently used in the feed and oleochemicals industry, are not utilised within the biodiesel industry or downgraded unnecessarily to Cat 1 if incentives for biofuels production are more attractive than its use in chemical markets. This is because the closest fat to tallow is palm oil, and reduction in the amount of Cat 3 tallow available might result in increased use of (potentially unsustainable) palm oil. The establishment of a robust chain of custody, and the use of chemical markers within Cat 1 and 2 tallow should in principle be able to prevent this from occurring.

Conclusion: sustainable alternative?

Potentially sustainable (contingent on safeguards). Certification schemes need to be able to trace the cat 1 and 2 tallow back to an individual rendering plant and include traders, brokers and intermediate storage facilities.

References:

[1] Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (Animal by-products Regulation)

[2] BSE is Bovine spongiform encephalopathy, TSE is Transmissible spongiform encephalopathies.

[3] Ecofys (2012) 'Status of the tallow market', http://tinyurl.com/busd948

[4] Industry source; *Image: Industry source*

4.17 Non-food cellulosic material (2x)

Definition: Non-food crops grown for the purposes of bioenergy production. These include crops such as *Miscanthus*, other energy grasses, certain varieties of sorghum and industrial hemp [1], but exclude crops with high lignin content, such as wood products.

***Geographic distribution*:** Limited cultivation but EU-wide potential, currently mainly produced in UK, Poland, Italy (miscanthus) and Finland (reed canary grass) [2].

Existing uses

Where crops are grown specifically for bioenergy purposes there are no other significant existing uses. However, a differentiation may need to be made between the use of dedicated energy crops for heat and power generation as opposed to those for biofuel production. Certain varieties of *Miscanthus are* used as ornamental plants in horticulture, as well as animal bedding [3]. Many current industrial uses exist for hemp including in the textiles, food and paper industries.

Environmental risks

The fact that **energy crops require agricultural land** over and above existing crop production puts into question their ability to mitigate ILUC. Wider environmental impacts such as on water and biodiversity depend on previous land use and the specific crop requirements. Perennial crops may provide some benefits for biodiversity and soil structure when replacing annual crops but negative impacts would likely result from the conversion of permanent grasslands and semi-natural habitats to accommodate energy crops or indirectly to accommodate food and feed crops [4].

The primary risk of diverting this feedstock from existing energy production (heat and power) is a potential reduction in GHG savings through the biofuel conversion process that may require more process energy. Heat and power generation would then need to use other renewable energy sources.

Is the resource primarily domestic (EU) or likely to be imported?

There is potential for this feedstock to be imported, however cultivation within the EU is more likely.

Environmental safeguards?

- It should be clarified that the 'non-food' category covers both food and feed crops (as using animal feed crops would have ILUC impacts similar to conventional biofuels).
- Environmentally friendly management practices are needed to prevent perverse environmental consequences.
- In order to avoid ILUC risks, energy crops should only be grown on a certain scale and on land where the impacts on production or the environment can be minimised, or at least contained within a level consistent with existing practices.
- Include energy crops within the Commission's proposed five per cent cap.

Conclusion: sustainable alternative?

Likely unsustainable. Safeguards especially needed in relation to land use. Relative GHG performance of biofuel and heat and electricity applications to be considered (see Section 3).

References:

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[2] Elbersen, B, Startisky, I, Hengeveld, G, Schelhaas, M-J, Naeff, H and Böttcher, H (2012) *Atlas of EU biomass potentials. Deliverable 3.3: Spatially detailed and quantified overview of EU biomass potential taking into account the main criteria determining biomass availability from different sources*. Available at: http://tinyurl.com/azk3vst

[2] Royal Horticultural Society (2013) Miscanthus sinensis var. condensatus 'Cosmopolitan', description of plant and usage in horticulture, http://tinyurl.com/ch6mp54, accessed 29th January 2013

[3] Kretschmer, B, Watkins, E, Baldock, D, Allen, B, Keenleyside, C and Tucker, G (2011) *Securing Biomass for Energy – Developing an Environmentally Responsible Industry for the UK now and into the Future*. IEEP: London.

4.18 Ligno-cellulosic material except saw logs and veneer logs (2x)

Definition: Dedicated woody energy crops such as Short Rotation Coppice (SRC) and Short Rotation Forestry (SRF).

***Geographic distribution*:** Limited cultivation but at present EU-wide potential Current cultivation is concentrated in Sweden, Poland, UK, Denmark (willow) and Italy (poplar) [1].

Existing uses

Where crops are grown specifically for bioenergy purposes there are no other significant existing uses. However, a differentiation may need to be made between the use of dedicated energy crops for heat and power generation as opposed to those for biofuel production. SRC willow (*Salix sp.*) is also used to provide a continual supply of fencing and building material.

Environmental risks

The fact that **energy crops require land** to be grown (and this may be agricultural land especially for SRC) puts into question their ability to mitigate ILUC. Wider environmental impacts such as on water and biodiversity depend on previous land use. Perennial crops may provide benefits for biodiversity and soil structure when replacing annual crops but negative impacts would likely result from the conversion of permanent grasslands and semi-natural habitats. Potential risks for biodiversity and hydrological conditions arise from eucalyptus, a non-native species [2]. The primary risk of diverting this feedstock from existing energy production (heat and power) is a potential reduction in GHG savings through the biofuel conversion process that may require more process energy. Heat and power generation would then need to use other renewable energy sources.

Is the resource primarily domestic (EU) or likely to be imported?

There is potential for this feedstock to be imported, but it is more likely, due to economic reasons, that dedicated lingo-cellulosic crops would be grown within the EU and close to refineries.

Environmental safeguards?

- Careful siting of SRC and SRF is required to avoid ILUC impacts, particularly when planting on existing cropland. Energy crops should only be grown on land where the impacts on production or the environment can be minimised, or at least contained within a level consistent with existing practices.
- Take into account wider environmental consequences, most notably on biodiversity and water availability through changes in growth practices.
- Include energy crops within the Commission's five per cent cap.
- Relative GHG performance of biofuel and heat and electricity applications needs to be considered (see Section 3).

Conclusion: sustainable alternative?

Likely unsustainable. Safeguards especially needed in relation to land use. Relative GHG performance of biofuel and heat and electricity applications to be considered (see Section 3).

References:

[1] Elbersen, B, Startisky, I, Hengeveld, G, Schelhaas, M-J, Naeff, H and Böttcher, H (2012) *Atlas of EU biomass potentials. Deliverable 3.3: Spatially detailed and quantified overview of EU biomass potential taking into account the main criteria determining biomass availability from different sources*. Available at: http://tinyurl.com/azk3vst

[2] Kretschmer, B, Watkins, E, Baldock, D, Allen, B, Keenleyside, C and Tucker, G (2011) *Securing Biomass for Energy – Developing an Environmentally Responsible Industry for the UK now and into the Future*. Institute for European Environmental Policy (IEEP), London.

5 GENERAL ENVIRONMENTAL SAFEGUARDS

This final section offers concluding remarks on general safeguards to guide policy and incentives aimed at increasing the use of mainly wastes and residues for advanced biofuel production. In order to debate with any authority the relative merits and risks of using certain feedstocks presented in the ILUC proposal, satisfactory evidence on their existing uses and potential future supply is needed. However, accurate and publicly available information on existing uses and the ensuing risks of their diversion to the biofuel market is often limited. Where such information is lacking, general safeguards can help to prevent perverse impacts arising from incentivising a particular feedstock. These general comments on safeguards should be read in conjunction with and seen as complementary to the feedstock-specific safeguards proposed in the factsheets in Section 4. Together they are put forward with the view of ensuring that the use of the feedstocks proposed to benefit from additional incentives does not create new indirect impacts with negative environmental, social or economic consequences.

Ensure clear definitions

Clear definitions are a precondition both for understanding the issues and then gathering appropriate evidence on the different feedstock sources in order to guide incentive levels and formulate more specific safeguards. The ILUC proposal in its current form lacks such definitions and it is unclear if these will be included in the final legislative texts or be provided by the Commission in the future.

This document has attempted to clarify the boundaries of several different feedstock categories but necessarily is preliminary and has relied significantly on 'expert opinion', more so for certain feedstocks than for others. The importance of clear definitions is: first to establish more precisely the materials involved and ensure the policy is workable; second to allow potential risks and appropriate mitigating safeguards to be identified; and third, to improve consistency of definitions across the EU-27 Member States. The latter is necessary to ensure that the same advanced biofuels are eligible for multiple (double or quadruple) counting throughout the EU and that eventual safeguards are enforced EU-wide. All this is important for the functioning of the internal market in advanced biofuels.

Where clear definitions are not provided and where there is a lack of evidence to support sufficient assessment of environmental risks, the **precautionary principle**[10] should be followed.

Adhere to the waste hierarchy

The overall waste hierarchy, as set out in the Waste Framework Directive, which is to prefer prevention, re-use, recycling (and composting of materials) over recovery (for example for energy) and, eventually, over disposal (ie landfill or incineration without energy recovery) should be followed in all cases. This means only non-recyclable, non-compostable waste should be utilised for energy recovery, unless energy recovery can be justified for reasons of

[10] The precautionary principle as it relates to EU law, is covered in Article 191 of the Treaty on the Functioning of the European Union (EU) and as set out in the common guidelines issued by the Commission COM(2000)1. http://europa.eu/legislation_summaries/consumers/consumer_safety/l32042_en.htm.

technical feasibility, economic viability or environmental protection. It has been demonstrated, for example, that anaerobic digestion of food waste generally is superior to composting in terms of GHG savings (ERM, 2006). Similar analyses would have to be undertaken for a range of wastes and residues that are compostable to make the case for their processing into biofuels. In other words, incentives to use wastes and residues as biofuel feedstock must not counter ongoing efforts to reduce waste and increase recycling rates. This includes the need for safeguards to ensure that a newly created market for wastes and residues does not lead to an increased production of wastes and residues solely for the purpose of biofuel production and to prevent material from being wrongly labelled as 'waste', particularly where this results in a feedstock being more valuable than the virgin product (see for example the use of used cooking oil).

Consider the complete lifecycle GHG emissions that arise from wastes and residues

It is suggested that the Commission monitors research undertaken on the relative lifecycle emissions of different biomass use pathways, taking into account different energy and non-energy uses. While the GHG methodology set out in the RED and the FQD accounts for transport and processing emissions other, potentially significant, emission sources are neglected. In particular, the RED and FQD methodology considers wastes and agricultural residues to be 'zero emission' up to the point of their collection. This ignores the impacts on soil carbon stocks that can be significant as the extraction of residues increases[11]. The system boundaries of the methodology should be extended by taking into account changes in soil carbon stock from agricultural or forestry residue extraction.

Assess current uses of feedstocks and evaluate indirect environmental, social and economic impacts of diverting residue towards biofuel production

It is outside the scope of this report to investigate which could be considered the priority uses for the different feedstocks and therefore promoted by policy measures. In many cases this will be related to the volumes available and whether these change in reaction to new patterns of incentives. For residues and those wastes that cannot be prevented, re-used or recycled, the setting of priorities could distinguish between different recovery options, such as energy versus non-energy (for example chemical uses) and between different forms of energy recovery, such as liquids for transport versus heat and electricity generation. It is therefore suggested that the Commission monitors research undertaken on the relative lifecycle emissions of different biomass use pathways in order to review the list of feedstocks eligible for multiple counting (or any other targeted support measures) in light of new findings which will emerge over time.

An important consideration to be taken into account is the availability of low-carbon alternatives to the individual materials in different applications. Another consideration is the economic value added that can be generated per unit of biomass input. The 'built in' market mechanism that higher feedstock prices can typically be paid in industries producing higher-value products may very likely be distorted by new incentives in the energy sector, thereby affecting other uses. At the same time, a higher economic added value use does not

[11] RED Annex V, part C, paragraph 18 states that '[wastes], agricultural crop residues, including straw, … shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of those materials.'

necessarily lead to greater environmental benefits or GHG savings. There is a strong public interest to be pursued alongside market considerations.

Mitigate the environmental impacts of certain advanced conversion pathways

The processing of feedstocks into biofuels via advanced biochemical or thermochemical conversion routes can require relatively high energy inputs, which are addressed in the GHG methodology. However, other environmental impacts resulting from the processing of biomass through advanced conversion technologies such as water consumption in processing should be investigated and if necessary be addressed by safeguards[12]. Any significant environmental risk should be taken into consideration in relation to the environmental sustainability of feedstock use.

Consider impacts outside the EU

The incentives provided for particular waste and residue use under the RED should not lead to the increased import of waste and residues, or other feedstocks, where this will cause environmental, social or economic impacts in countries outside the EU.

[12] IEA (2010) refer to the higher water consumption in the production of advanced compared with conventional biofuels, referring specifically to lignocellulosic ethanol. However, the major part of water consumed would be for feedstock cultivation, so that biofuels from wastes and residues should have a reduced water footprint. Local impacts on water quality and availability should nevertheless be monitored.

6 CONCLUSION: NEED FOR AN INVENTORY OF EU BIO-RESOURCES

This brief survey provides an overview of the wastes, residues and other feedstocks that could be utilised on a larger scale for biofuel production if the European Commission's proposed ILUC directive goes forward. This is clearly an important set of feedstocks with potentially significant advantages over the first generation feedstocks, principally agricultural crops. The principle of using more wastes and residues must be welcomed. However, there are several issues which need to be addressed, some generic, others specific to individual feedstocks, as the factsheets illustrate clearly. Whilst this is only a rapid review of a broad topic, initial conclusions or lines of investigation can be drawn for most feedstocks. More work remains to be done, not least on sustainability considerations and the likely volume and patterns of supply but it is possible to focus the debate on some key issues.

A great challenge when compiling the factsheets was the lack of reliable information about the extent to which wastes and residues are being used at present. Such information is needed to understand whether there are surplus volumes that could be taken up by the biofuel sector without causing some of the negative displacement effects identified in the factsheets. The Commission or potentially other funding bodies could consider commissioning research to create a European inventory of the bio-resources available for different applications in order to gauge the contribution that an advanced biofuels industry can make to meet the EU's renewable energy targets.

In parallel, perhaps even more usefully, regional resource assessments could be made. They would allow for much finer definitions of particularly waste and residue feedstocks and assessments of their existing uses. Such regional assessments could also take into account considerations of how sustainability risks are affected by volumes of feedstocks mobilised. As an example, in regions where forests tend to be undermanaged, such as in parts of the UK, the further mobilisation and use of certain forms of forestry residues may well be sustainable within limits. The case of agricultural residues such as straw has similar characteristics. Sustainable extraction rates can only be determined on a sufficiently local level that allows the prevailing climatic and biophysical conditions to be taken into account.

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ANNEX 1 LIST OF WASTES AND RESIDUES ELIGIBLE FOR QUADRUPLE AND DOUBLE COUNTING AS PROPOSED IN THE ILUC PROPOSAL

The following is the list of feedstocks eligible for double and quadruple counting as contained in Annex IX of the proposal.

Feedstocks whose contribution to the 10% renewable energy in transport target is proposed to be counted ***four times*** their energy content:

(a) Algae.

(b) Biomass fraction of mixed municipal waste, but not separated household waste subject to recycling targets under Article 11(2)(a) of Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.

(c) Biomass fraction of industrial waste.

(d) Straw.

(e) Animal manure and sewage sludge.

(f) Palm oil mill effluent and empty palm fruit bunches.

(g) Tall oil pitch.

(h) Crude glycerine.

(i) Bagasse.

(j) Grape marcs and wine lees.

(k) Nut shells.

(l) Husks.

(m) Cobs

(n) Bark, branches, leaves, saw dust and cutter shavings.

Feedstocks whose contribution to the 10% renewable energy in transport target is proposed to be counted ***twice*** times their energy content:

(a) Used cooking oil.

(b) Animal fats classified as category I and II in accordance with EC/1774/2002 laying down health rules concerning animal by-products not intended for human consumption.

(c) Non-food cellulosic material.

(d) Ligno-cellulosic material except saw logs and veneer logs.