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Ensuring the sustainability of bioenergy and minimising the risk of carbon debt

By:
Ben Allen
Kamila Paquel
Catherine Bowyer
David Baldock
Silvia Nanni
Martin Nesbit

Disclaimer: The arguments expressed in this report are solely those of the authors, and do not reflect the views of any other party.

Corresponding author: Ben Allen ballen@ieep.eu

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Institute for European Environmental Policy
London Office
11 Belgrave Road
IEEP Offices, Floor 3
London, SW1V 1RB
Tel: +44 (0) 20 7799 2244
Fax: +44 (0) 20 7799 2600

Brussels Office
Quai au Foin, 55
Hooikaai 55
B- 1000 Brussels
Tel: +32 (0) 2738 7482
Fax: +32 (0) 2732 4004

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Précis

Bioenergy will continue to play a role in helping to decarbonise the EU's energy sector. To date the legitimacy of this role has been undermined by doubts about the sustainability of the feedstocks used and, among other implications, the real impact on net GHG emissions levels as a result. Some forms of biomass can offer a positive contribution to the low carbon energy transition if used appropriately, whereas other do not. For bioenergy to realise its full potential as part of the EU's low carbon energy transition its sustainability must be ensured with only sustainable forms and sources of biomass used as a source of energy. Avoiding any net GHG emissions is likely to be impractical in most cases. Whilst this should remain the ultimate goal, effort should be focussed on ensuring that any impacts are minimised, on improving or maintaining the carbon sustainability of supply and production chains, and on ensuring that bioenergy is provided with appropriate incentives linked to its contribution to energy decarbonisation (rather than over- or under-rewarded). Multiple factors influencing the carbon footprint of the commercial bioenergy supply chain should be considered as part of this approach, such as sourcing, transportation, conversion efficiency and accounting. To arrive at a lower carbon bioenergy system may require a combination of different actions and approaches, potentially brought together in a package of measures which provides policymakers and the wider public with a high degree of confidence that significant real reductions in net GHG emissions are being achieved. This package should include robust and workable sustainability criteria to guide operators in the sourcing of biomass, and in choosing appropriate deployment scales, and to drive efficiency in conversion and transportation. Allied to this is the need for coherent and complementary accounting frameworks that recognise the carbon benefits and impacts of biomass within the sectors in which it is used, as well as those in which it is produced. The geographic differences in approaches taken between the EU, the Member States and third countries needs to be addressed and a workable approach established, particularly if the EU is to continue to rely on imported biomass as a significant source of energy for many years rather than on an exceptional basis.

Summary and key messages

Context:

In the global context of the recently signed Paris Agreement (UNFCCC, 2015), *the EU and Member States are considering the future policy framework* intended to deliver their climate and energy ambitions up to 2030. The 2030 Climate and Energy Package[1] and the Energy Union Communication (COM(2015)572) set out the broad principles under which future policy is being developed. Whatever form these future policies may take, bioenergy is likely to play a role in Europe's transition towards a low-carbon economy beyond 2020.

While there are differing views on the longer-term role for biomass in a fully decarbonised energy system, sustainably sourced biomass, used as a replacement for fossil fuels, can help to reduce GHG emissions and increase energy security in Europe in the short term. It is partly on this basis that public support for bioenergy deployment is justified.

There are currently some advantages to using biomass as a source of energy. Unlike many renewables, biomass provides a storable energy solution with the ability to be used in existing fossil infrastructure. ***As a transition technology, bioenergy is therefore already helping many countries to reduce their reliance on fossil fuels, and it can play a role in supporting the deployment of other renewables as improvements in more energy efficient and renewable production modes develop.*** Investments in the forestry sector can also provide an important contribution to the economic vitality of rural communities. With the right management in place, the sustainability and viability of managed forests can be improved alongside their contribution to carbon sequestration.

This report focuses on the carbon sustainability of biomass energy in relation to the key objectives of the EU policies that guide and incentivise its use[2]. it does not address some important wider issues, including the local economic impacts, and the biodiversity impacts, of biomass production.

There are continuing and legitimate concerns over the carbon impact of using certain types of biomass for energy, and the difficulty of establishing the time frame and scale of these impacts on emissions, whether positive or negative. Some Member States, such as the UK, Denmark and Belgium have adopted relatively ambitious sustainability standards for bioenergy (based on COM(2010)11) and some end users have rigorous sustainability processes in place. However, there remains a gap in the current EU regulatory framework, which does not address biomass sustainability in a consistent and demonstrable way across the EU and across different end users. ***For bioenergy to realise its full potential as part of the EU's low carbon energy transition, the sector must be able to demonstrate to civil society, regulators and consumers that it is delivering GHG reductions in a sustainable way.***

This report therefore considers the types of approaches that would be necessary to ensure sustainability through a regulatory approach. Other aspects of environmental, social and economic sustainability are of course crucially important to the broader sustainability and acceptability of bioenergy, as are the regulatory requirements in the countries from which biomass is sourced. Questions relating to these aspects of bioenergy need to be addressed (and any relevant policy or legislative response integrated with measures adopted to manage carbon sustainability); but they are outside the scope of this report.

Improving carbon sustainability through policy interventions

No form of renewable energy is sustainable by default, each having to demonstrate its contribution to carbon savings over its lifetime, and its compatibility with the long-term decarbonisation agenda. To validate the GHG savings of bioenergy and its contribution to lower carbon emissions globally, ***it is essential to demonstrate how GHG emissions can be reliably reduced as an inherent part of the cycle of bioenergy production within a satisfactory timescale*** and that they are lower than those

[1] http://ec.europa.eu/clima/policies/strategies/2030/index_en.htm
[2] The Renewable Energy Directive (RED) (2009/28/EC) and the implementing policies of Member States

from the energy sources they replace. The large-scale adoption of biomass for energy and the accompanying impact on natural resources has attracted considerable attention and criticism. Amongst the more controversial issues have been the uncertain net contribution of specific types and uses of biomass to carbon reductions; the possible competition with alternative material uses; and availability of sustainably sourced biomass in comparison to current and future demand. Some forms of biomass can offer a positive contribute to the low carbon energy transition if used appropriately, whereas other do not. ***Policy should ensure that only sustainable forms and sources of biomass are used as a source of energy.*** Without sufficient policy guidance there is a risk that even if sustainable biomass pools are available, that demand could be met also from unsustainable sources.

Unlike other renewable energy sources, biomass produces GHG emissions at the point of combustion for every unit of biomass used. Therefore, an issue which is central to the carbon sustainability of bioenergy is the difference between the emissions of carbon at the point of combustion and the removal of atmospheric carbon through the past growth and assumed future growth associated with the supply chain for the feedstock. This difference will be a period of years and is a measurement referred to commonly as the 'carbon debt period'. To address these issues through policy requires an understanding of the level of carbon removals and sequestration that can legitimately be used to counterbalance the emissions from energy production. These in turn require a reasonable understanding of what would happen if the biomass and the land associated with its production were not used for energy (the counterfactual) and the relevant characteristics of the types of biomass being used (definitions).

- ***Counterfactuals need to be sufficiently sophisticated and take into account a considerable range of variables including a local and more generic element.*** If they are too crude they will be misleading and the policy foundations are likely to be eroded relatively quickly with uncertainty for the public interest and the sector; too specific and they become impractical to be used when developing effective policy.
- ***Developing a consistent and flexible set of definitions then embodied in relevant legislation that recognise local conditions, practices, markets and economic sectors*** *would help to facilitate the creation of common understanding for policy implementation, ensure a degree of legal certainty for investors and improve monitoring and reporting.*

To establish the carbon sustainability of bioenergy, policy should focus on ensuring biomass is used for energy where it provides the greatest contribution towards overarching climate goals and improving the allocation of both emissions and removals to provide better assurance as to the dependability of GHG savings. To achieve this, two sets of parallel initiatives are necessary. The first is the introduction of EU wide legislative sustainability criteria (some approaches are described in this report) to provide a baseline and level playing field reflecting the context in which the biomass is sourced and consumed. The second is to improve the accounting for carbon and GHG emissions to provide a more explicit framework for measuring the impact of different supply chains and policies as well as providing incentives for using more carbon beneficial pathways.

Sustainability criteria for biomass used for energy

The three approaches set out below could form a package of criteria used to ensure the sustainable sourcing, deployment and use of biomass for generating renewable energy in the EU.

- **Approach #1 Sustainable sourcing:** The policies incentivising the use of biomass should ***provide guidance on the types and locations from which biomass may be considered more sustainable***. Only those feedstocks that are considered to be sustainable would qualify for public support. Sustainable sourcing has three components:
    - the type of ***feedstocks*** that are collected (e.g. genuine wastes, residues, thinnings and surplus low grade wood fibre);
    - the ***location*** from which these feedstocks are sourced (e.g. managed forest);
    - and the ***management*** of forests and other feedstocks (e.g. where carbon stocks are maintained and enhanced).
- **Approach #2 Sustainable deployment:** The carbon impacts of using biomass for energy is affected both by the overall level of deployment and the scale and intensity at which harvesting

of biomass take place. Making sure that deployment is within sustainable limits through adherence to sustainability criteria, and/or quantified limits where possible, is one route to minimising these risks and provides a clear signal to operators and society of the role of bioenergy within a wider and more diverse renewable energy sector. In combination with other sustainability criteria, ***setting limits to the contribution of biomass energy as a proportion of overall renewable energy share could help to minimise carbon impacts and provide space for other RES forms***.

- **Approach #3 GHG saving requirements:** Improving carbon sustainability is a question of ensuring that GHG emission savings will be ambitious and sufficient when compared to relevant fossil fuel baselines. ***Setting a GHG emission intensity requirement[3], whereby bioenergy production in a plant would have to meet an absolute emissions threshold rather than a saving relative to a fossil fuel baseline,*** would be one route to meeting this requirement. Respecting the differences in the installations that use biomass, it would be appropriate to set different GHG emission intensity requirements on this basis. This would help to drive best practice and improve efficiency across all types of bioenergy plant and bioenergy end users. Such an approach would need to take account of the variations in different energy systems, sourcing patterns and different regional situations. This approach could be strengthened through the use of Best Available Technique (BAT) approaches employed to deal with other industrial emissions and allowing for a more tailored approach in different contexts.

Improvements in accounting of LULUCF sector activities relating to bioenergy

The sourcing and use of biomass from the LULUCF sectors is subject to specific carbon accounting rules under the UNFCCC. The LULUCF sectors are amongst the few that can sequester carbon as part of climate mitigation activities, as opposed to only reducing their emissions. In the proposed EU accounting framework for the period to 2020 there is the potential to use some of this sequestration to offset emissions in other sectors. It is therefore necessary to have a robust LULUCF policy that accurately recognises and rewards the potential from the sector whilst maintaining the stringency of climate mitigation commitments in other sectors. Such a policy could include:

1. ***Robust accounting rules for domestic and imported emissions and removals*** consistent with UNFCCC rules. They should be prepared and maintained ensuring the *accuracy, completeness, consistency, comparability and transparency* of relevant information used in estimating emissions and removals from the LULUCF sector.
2. ***Binding domestic emission targets at EU and Member State level*** set under the LULUCF pillar translated into national quotas to be met over a 10-year compliance period. Additional targets on imported biomass could be considered in the longer term, and a satisfactory understanding of how imported biomass production is treated in the UNFCCC inventories of exporting parties also needs to be developed.
3. ***Multiannual commitment periods (10 years) with shorter compliance periods*** (5 years aligned to Paris Agreement "ambition cycles") in order to account for and adapt to fluctuations in emissions and removals from the LULUCF sectors.
4. ***Credible monitoring, reporting and verification procedures*** as part of the EU mechanism for complying with the EU's commitments under the UNFCCC and implemented domestically as part of the governance system of the future EU climate and energy framework. The sinks and emissions triggered by the EU but occurring outside of its borders, could also be reported in the national GHG inventories but not accounted for (to avoid double counting under UNFCCC), a process of parallel reporting.
5. ***A specific regulation on imported GHG emissions and removals from solid biomass for energy purposes*** aimed at reducing unaccounted emissions and removals from the LULUCF sector that are imported into the EU in the form of solid biomass.

[3] Calculated using a well-defined LCA type exercise

1 Introduction

In the global context of the recently signed Paris Agreement, the EU and Member States are considering the future policy framework intended to deliver their climate and energy ambitions up to 2030. However this framework develops, it is likely that bioenergy will continue to play a significant role in Europe's transition towards a low-carbon economy beyond 2020.

Bioenergy is unlike other renewables. It is a storable energy solution with the ability to be used in existing fossil infrastructure. As a transition technology, bioenergy is already helping countries to reduce their reliance on fossil fuels. The acceptability of using biomass for energy in the EU rests on its sustainability as a renewable and low carbon energy source. In many cases it is, and has the simultaneous benefits of supporting new markets in the forest sectors; yet there are legitimate concerns in civil society over the potential expansion of the large-scale use of biomass for energy and the potential impacts this may have on carbon balances in forests.

A key challenge in assuring the sustainability of bioenergy is the difficulty in demonstrating the full nature of its impact on greenhouse gas (GHG) emissions (both positive and negative). This is exacerbated by the gap in the current EU regulatory framework, which does not address the sustainability of biomass used for energy in a consistent and demonstrable way, and in the different approaches adopted by Member States, some of which are more comprehensive than others.

To date, the EU bioenergy debate has largely been divisive and polarised and there are many models of bioenergy use being adopted across the EU. Yet as Europe considers which route to take in the post 2020 period it is important for those who seek to deliver constructive environmental outcomes to work together to ensure policy makers are better informed about the choices on offer and the risks and opportunities they present. This report is offered as a contribution to this debate. It has been informed and funded through a dialogue with a key industrial player in the bioenergy sector, Drax.

The report focuses on the carbon sustainability of biomass and only touches briefly on some other aspects of environmental sustainability and the types of approaches that would be necessary to ensure this sustainability through a regulatory approach. Other aspects of social and economic sustainability are of course crucially important to the acceptability of bioenergy, as are the regulatory requirements in the countries from which biomass is sourced. Questions relating to these aspects of bioenergy need to be addressed, but are outside the scope of this report. Equally, ensuring the sustainability of bioenergy is not simply a regulatory question. The suppliers, processors, generators and consumers of renewable energy from biomass have a critical role to play in any future development. However, these organisations and the investments that support them respond to policy drivers and must comply with regulation at EU and national level. Delivering a low carbon transition in the energy sector depends in part on providing investment security; a robust, clear and predictable policy is therefore critical to ensure resources are devoted to delivering genuinely sustainable and GHG reducing bioenergy.

2 Understanding the context of bioenergy and carbon

In the EU the main piece of legislation promoting renewable energy sources (RES) is the Renewable Energy Directive (2009/28/EC) (RED). The binding targets set by the directive have given a significant boost to the development of RES sectors, including bioenergy. The new renewable energy directive and sustainable bioenergy policies, anticipated under the 2030 Climate and Energy Framework is likely to see an expanded RES share in the energy market. Bioenergy is expected to play a significant role in this development.

Unlike many renewables, biomass provides a storable energy solution with the ability to be used in existing fossil infrastructure. As such it can help transition fossil energy generating facilities towards more renewable supply bases and provides support for the operation of more intermittent renewable modes. Often bioenergy is also seen as offering significant benefits in terms of improving the security of EU energy supply, by virtue of decreased reliance on imported fossil fuels but also in terms of diversifying supply patterns, expanding the diversity of energy sources and the countries upon which the EU relies for its energy raw materials.

As part of the low carbon energy transition, biomass, used as a replacement for fossil fuels, is promoted with the intention of reducing GHG emissions and helping to decarbonise the EU energy system. Some forms of biomass can be carbon beneficial in this respect and tend to include fibre that is surplus to existing market demands and maintaining carbon stocks and ecosystem function; other forms are not. Therefore, care is needed in the sourcing and deployment of biomass in order to ensure that the right forms of biomass are used as a sustainable source of energy.

Sustainability, and the extent of GHG emissions reductions, depends on many factors including the type and origin of biomass, its other potential uses, the counterfactuals in land and forest management, and the nature of the energy source replaced (where applicable). The scale, nature and time horizons for carbon fluxes in forests are also important, particularly as these relate to the emissions and removals of carbon in the land use, land use change and forestry (LULUCF) sectors and the contribution these sectors also make to overarching climate goals. This will vary depending on existing use, management practices and extraction rates.

Regardless of the end use, there are potential risks associated with a large expansion in the use of biomass, including: questions over the availability of sustainably-sourced biomass in comparison to current and potential future demand; and a range of possible environmental impacts on air quality, biodiversity and water resources. For energy use, there are specific risks relating to the aim of reducing GHG emissions, including:

- uncertain net contribution of certain types and uses of biomass to carbon reductions and the methodology used to calculate life cycle GHG emissions;
- indirect land use change driven by increased future demand for certain feedstocks above expected sustainable supply; and
- possible competition with alternative material uses for biomass that may have better overall carbon profiles;

Minimising these risks should be a key aim of the policies that promote biomass deployment, regardless of the end use.

2.1 Carbon debt and the challenges for policy

Carbon debt is perhaps the most challenging of the sustainability issues confronting the use of biomass for energy purposes. Carbon debt is defined generically as ***the imbalance between the carbon footprint, i.e. the emissions generated by a particular use of biomass (in this case energy) and the removals or sinks that can be used to counteract these generated emissions***[4]. If there is a time gap between emissions and removals then a carbon debt can occur. Where sustainable biomass is grown for the express purpose of producing energy biomass, there can be a benefit as the carbon removals in the forest happen and are accounted before emission in the energy sector.

When material is extracted from a forest there is an inherent change that occurs both in terms of the reduction of stored carbon and in the patterns of removal of carbon dioxide associated with that component of the forest. Forests naturally sequester and emit carbon dioxide through their growth; therefore changing the management of a forest stand can increase sequestration or increase emissions, depending on the approach taken. The emission footprint of using biomass for energy is therefore the impact of the changes in removals of carbon from the forest and the release of carbon dioxide back into the atmosphere through the process of extraction, transportation and combustion. Characterising and allocating emissions is a critical aspect of identifying carbon debt, accounting for it and whether the energetic use of biomass results in carbon removals or emissions. Policy action is required to address the uncertainty in this area and the potential for bioenergy to be offset by removals in a systematic and dependable way over an appropriate timescale as a means of meeting EU renewable energy targets.

Two key questions for policy are:

- '*How much of the cycle of removal and storage is available and can be legitimately used to counterbalance a given volume of woody material and the emissions associated with its use for energy?'*; and
- *'What is the GHG emission figure that needs to be counterbalanced?'*

The level of complexity of addressing these questions is linked to the variability of biomass types (typically only a fraction of the actual harvested forest biomass), their growth patterns, location, collection and extraction. This variability is compounded further by the question of the counterfactual i.e. what would have happened if the material had not been harvested and used for energy generation? Is the presumption that nothing will disrupt the biological process of regrowth (i.e. fire, disease, storms) correct? Had the forest been harvested, what uses would material have been put to? The answers to these questions change the basis for calculating the emissions.

There is also a perception that the whole forest is available to offset the biomass extracted and used for energy. To deliver low carbon economies, forests and their potential to remove and store carbon are becoming increasingly relied upon by society, through LULUCF accounting, to counterbalance emissions from other sources. In current accounting frameworks, the carbon sequestered in existing forests may have already been used to balance removals in other sectors. Only if it has been 'banked' for energy use, can it be used legitimately to account for the emissions released at the point of burning, or if the carbon would have been lost through combustion without energy recovery.

With such challenges, the question then is not so much about eliminating carbon debt entirely, however desirable, but one of minimising the risk of carbon debt in practice and accounting for it correctly. Policy measures should therefore focus on identifying and using biomass for energy where it provides the greatest contribution towards overarching climate goals and improving the allocation of both emissions and removals to provide better assurance as to the dependability of GHG savings.

[4] Based on the definition of carbon debt in the Oxford English Dictionary

2.2 Carbon accounting between sectors

To be confident that carbon sustainability of bioenergy has been ensured, it must be possible to account for the carbon removals and emissions throughout the sourcing, production and use of the material involved and more specifically allocate those removals and emissions correctly to the sectors that produce them. For bioenergy this is particularly important as the incentives to promote the use of biomass for energy are made primarily on the basis of carbon saving potentials.

Within the EU legislative framework for delivery of the EU's greenhouse gas targets, carbon and GHG emissions from large bioenergy installations are accounted for in sectoral terms under the EU Emissions Trading System (ETS) (Directive 2003/87/EC). For forest biomass, emissions and removals are accounted for through a separate mechanisms, the Land Use, Land Use Change and Forestry (LULUCF) sector (Decision No 529/2013/EU). Both aim to secure delivery of the emissions and removals required under the UNFCCC accounting framework to deliver European and Member State climate commitments, namely those under the Kyoto Protocol and under the Paris Agreement (UNFCCC, 2015). Put more simply, in the LULUCF sector the carbon sequestered and emitted throughout the growth of a forest is accounted for; often this is a net removal of carbon. When biomass is harvested the accounting rules assume 'instant oxidisation', i.e. the burning of the biomass with the carbon thus released. These count as emissions from the LULUCF sector. When forest biomass is in practice transferred for use in the ETS sector (i.e. in a large bioenergy facility) the emissions and removals of carbon from the forest biomass are treated as having already been accounted for. The biomass is therefore considered to be 'zero carbon' and its use in the energy sector carries no emissions from the use of the biomass itself.

Thus zero carbon rating of forest biomass for energy is unhelpful in reducing emissions since it provides no incentive to drive the efficiency of combustion or sourcing of sustainable biomass from a carbon perspective in the ETS sector, other than that which is required to varying degrees under national law. This is problematic and reinforces the need to ensure carbon sustainable production and sourcing of biomass throughout the supply chain. Promoting energy conversion efficiency could be achieved in different ways with a straightforward policy option being through compliance with Best Available Techniques (BAT) on the basis of existing BAT reference documents, such as the BREF for Large Combustion Plants under the Industrial Emissions Directive (2010/75/EU). A capacity threshold for the biomass conversion unit for this requirement to apply would need to be established, for example at 2 MW[5].

From a global accounting and reporting perspective, the relationship between ETS and LULUCF accounting is consistent and has allowed bioenergy to use the carbon sequestered in biomass with relatively little competition for the carbon resource in accounting terms. However, this could change, reinforcing further the need to demonstrate sustainable sourcing. In July 2016 the European Commission set out new legislative proposals for accounting of non-ETS sectors[6] for 2021-2030 (the Effort Sharing Regulation, (ESR), formerly Effort Sharing Decision (No. 406/2009/EC)) and a proposal for a decision to address GHG emissions from the LULUCF sector. The two proposals mean that the accounting frameworks would remain separate but include an element of flexibility between the LULUCF, ETS and ESR sectors. In practical terms, this could see more pressure placed on the LULUCF sector to provide additional sequestration to offset carbon emitted in the ETS or ESR, i.e. there could be greater demand, and thus competition, for the carbon stored in forests and to maintain carbon stocks in situ, both for EU forests and those in other countries subject to the Paris Agreement.

More detail on the impacts and possible options for a separate LULUCF pillar are set out at the end of this report. A further consideration is that the EU's commitments under the Paris agreement are for domestic abatement, in other words without reliance on the purchase of carbon credits from other economies under the Clean Development Mechanism or Joint Implementation. The application of this domestic mitigation commitment creates some risks for the use of biomass sourced outside the EU, since the sequestration (and thus mitigation) occurs outside the EU.

[5] BREF for Large Combustion Plants covers combustion installations with a rated thermal input > 50 MW.
[6] Sectors not included within the ETS or LULUCF accounting and reporting frameworks, e.g. buildings, industrial energy use.

2.3 The counterfactual

Consideration of the counterfactual can be an essential element in effective policy design as in this case, systematically assessing which assumptions can be made about the expected impact when a policy is put in place and what would have happened in its absence. Sometimes the counterfactual is spelt out explicitly in such assessments of policy impact, but very often it is assumed or rather, neglected. This can give rise to misunderstandings at best and very weak analysis where the counterfactual is overlooked. However, it is not easy to establish what would have happened in the absence of any particular activity and usually more difficult to pin down what would have occurred in the absence of a particular policy. Robust counterfactuals are easier to predict where the options involved are narrow, the timescales for implementation are relatively short and there is good information on the systems involved.

The question of bioenergy use, and more specifically the impacts of changes in the utilisation of biomass for energy supply, raises more counterfactual issues than occur in most other parts of the energy supply equation. Many of these are difficult to resolve, especially as so many variables are involved, differences in local conditions can be critical and data availability is often a long way short of what's required to be precise. Arguments over the counterfactual have contributed to the lack of consensus on bioenergy and the consequences of a growing bioenergy sector and also on the merits of different policy options to address risks. Three examples can be given of where counterfactual issues are important:

1. **The alternatives by which energy would be generated if it were not generated using biomass**. Comparisons with fossil alternatives, such as burning coal, are often made and make sense in some rather specific circumstances, for example over a short time period in large combustion plants where variable amounts of biomass can be used in co-firing. More generally though, the alternatives to biomass combustion will consist of a mixture of different energy sources that will very likely change over time, particularly in response to policies aimed at delivering a progressive decarbonisation of energy supply. It is therefore more relevant and robust to consider a changing supply mix and to recognise that the carbon intensity comparator becomes more demanding over time as a result of the impact of decarbonisation policies on the alternatives to biomass.

2. **What would have happened to materials extracted from the forest (and indeed agriculture, etc.) if they had not been used for bioenergy purposes?** Assumptions in this context vary considerably ranging from a proportion of materials not being removed from the forest at all if the bioenergy demand (e.g. for pellets) had not existed, to changes in the fate of that biomass (e.g. burning as a waste in the forest or left to decompose), or to a diversion from existing and other uses (pulp, paper, or much less commonly sawn wood) depending on the market. Calculating the consequences of diversion is not simple, as market dynamics can change and price levels vary; local context is increasingly recognised as important.

3. Another set of counterfactuals **arises within the forest ecosystem and its management.** In the absence of biomass extraction for energy use and expectations of future extraction, forest managers are likely to choose different management options, ones that affect planting, regeneration, extraction, composition, etc. Even in the absence of management, forests may be subject to climate variation, disease, fire etc. The assumptions made about the future of forest ecosystems can lead to variable LCA results with inherent variations between countries, bio-climatic regions, forest types etc.

Recent studies (e.g. Matthews et al, 2014; Stephenson and Mackay, 2014) underline the importance of giving due weight to the counterfactuals and also show that the contributions of biomass to emission reductions can vary dramatically from negative to a strong positive depending on the assumptions made. Whilst essential to use proxies for practical purposes, the counterfactuals being assessed need to be sufficiently sophisticated and take in to account a considerable range of variables including both a local and more generic element. If they are too crude the policy foundations are likely to be eroded relatively quickly as has occurred in the context of liquid biofuels.

2.4 Definitions and feedstock types

Forest biomass used for energy can be described and classified in a variety of ways, from high/low-value timber, residues, industrial by-products and wastes. For most purposes this is not in any way problematic, but it has sometimes added to confusion in policy discussions. Clear definitions and categories of biomass in relation to policy could be valuable and are a priority, not least to guide operators on the sourcing of sustainable biomass.

Clarity and agreed terms would help to facilitate the creation of common understanding for policy design and implementation, increase the level of legal certainty for investors and improve monitoring and reporting. Having a flexible set of terms that recognise local conditions, specific practices, markets and economic sectors is an important consideration. Visually distinguishing between different material classes following extraction from the forest setting is impractical, therefore traceability and documentation are also important.

At present, forest biomass is defined broadly in relation to three main elements: its physical characteristics (e.g. branch-wood); the activity undertaken to produce it (e.g. thinnings, harvest residues); and the end use (e.g. wood-fuel). However, the terms are not always defined in the same way, sometimes with overlaps between definitions and in usage between different groups who use the terms (forester, policy maker, etc.). A review of key documentation in this context (Forest Europe, 2015; Matthews et al, 2014; OFGEM, 2015, 2016; Oswalt et al, 2014)[7] suggests a wide variety of terminology varying between authors, sectors (and countries) and the context in which they arise. Clear definitions often necessitate both a physical description of the biomass and the means by which it was produced. For example in the UK context, if only the physical properties of wood are considered, stem-wood "*all woody volume above ground with a diameter greater than 7cm over bark*" would include both saw-logs '*material of at least 14cm top diameter*' and thinnings "*roundwood from forest or plantation thinning operation"*. When the process by which the material arises is considered the distinction between categories becomes clearer. Saw-logs are then defined as part of the 'crop' whereas thinnings are grouped within the waste and residues category of biomass.

However, even when using these terms there are categories of biomass that become grouped in ways that are not helpful for determining sustainability criteria. For example, the term residues may include feedstocks that have low carbon profiles, such as bark and branches, or those that have higher carbon profiles and are generally considered unsustainable, such as stumps. Certain generic terminology is particularly problematic when used to set specific restrictions in policy as it can be too imprecise and lack the sophistication needed when determining sustainability in policy. Roundwood, for example, is a term used commonly to describe any woody material in log form. This could include large diameter, high value and high quality saw-log material. Or it could refer to small diameter, short lengths of low-grade timber[8], diseased/damaged trees, tops or thinnings.

Economic value is one means of categorising biomass types through terms such as low-grade roundwood. Using value to classify biomass types has the advantage of integrating existing market conditions into the terminology and thus considerations of competing uses in different contexts. Values can change in response to the market and consequently certain biomass forms can move into different categories over time. In setting out clear definitions of biomass types, value should be used as a context characteristic rather than one of the primary determining factors.

The following factors may provide a dependable characterisation of biomass types for use in policy relating to carbon sustainability:

- The context in which the biomass has arisen, i.e. would harvesting happen anyway and is there surplus fibre (disease, storm damage, low grade timber from clear fell, residues, etc.);
- The physical characteristics of the biomass and suitability for alternative uses;
- The net value characteristics of biomass in relation to potential markets.

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[7] FAO *Forest products definitions* http://faostat.fao.org/Portals/_Faostat/documents/pdf/FAOSTAT-Forestry-def-e.pdf
[8] Of low structural quality or with imperfections that limit its applicability to certain end uses

3 Approaches to address carbon sustainability through policy

In the EU the primary policy driver for the promotion of bioenergy towards 2020 and 2030 is the positive mitigation potential, in terms of GHG emission savings that can be obtained by replacing fossil fuels with (solid) biomass sources. As a consequence, care is needed in the sourcing and deployment of biomass in order to ensure that the right forms of biomass are used as a sustainable source of energy. In addition, the approaches taken to promote the use of biomass for energy need to ensure and demonstrate that genuine savings are being delivered and that through doing so there are no adverse impacts on broader sustainability aims.

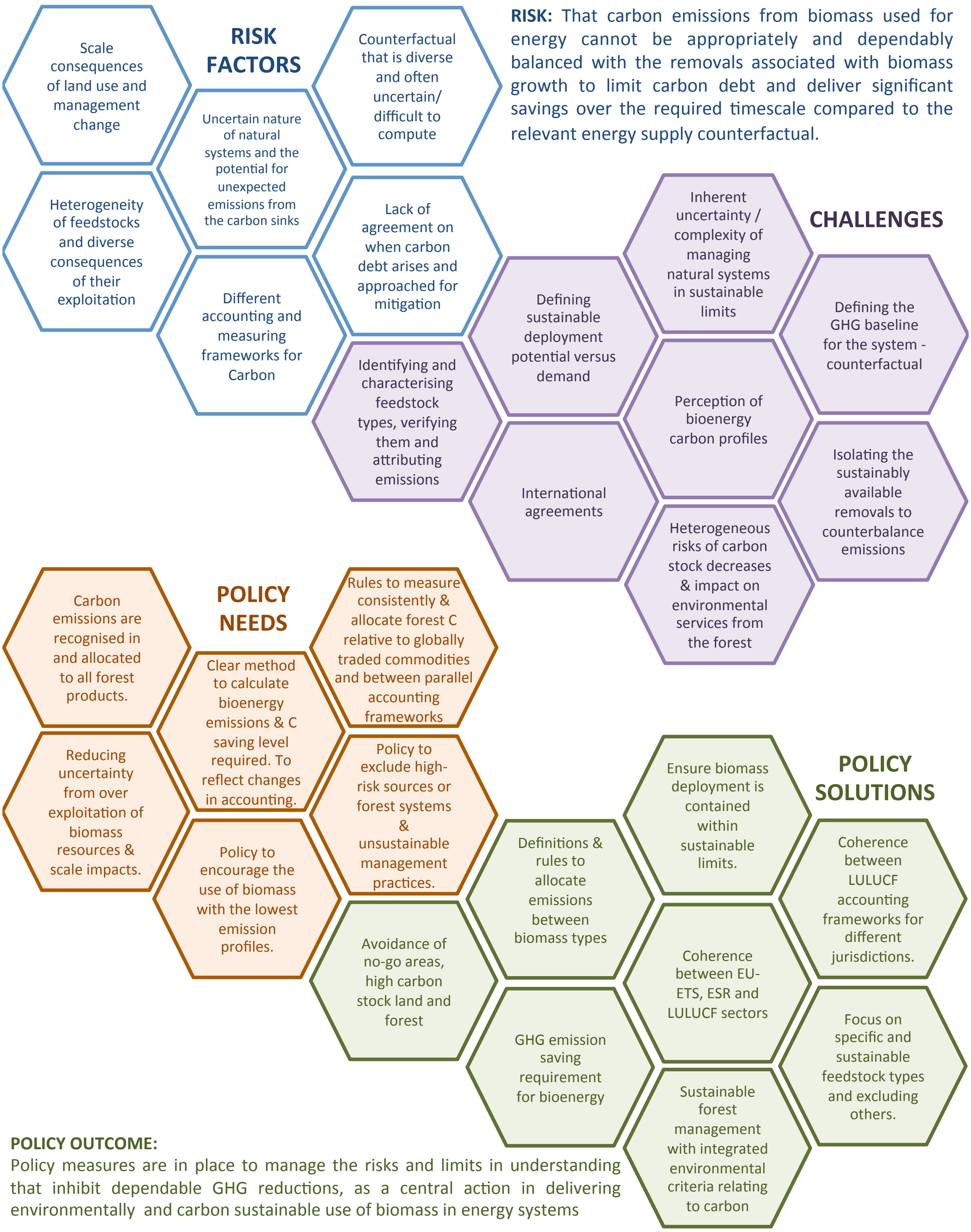
The absence of EU wide legislative sustainability criteria for solid biomass, despite equivalent criteria being in place for biofuels and bioliquids and the adoption of some more rigorous standards in Member States (e.g. the UK Renewables Obligation), has led some to question the rationale for this gap at the European level. There are uncertainties about how far biomass based energy technologies deliver GHG emission savings and whether it is practicable to measure and compare any savings *ex post* given the potential diversity of supply chains and technologies (Bowyer et al, 2012). This has reduced the confidence of investors, operators and administrations alike and is preventing the positive opportunities from genuinely sustainable bioenergy from being realised.

Addressing these uncertainties and ensuring that the use of biomass for energy is delivering against its intended objectives therefore can be seen as a question of risk management. What are the specific challenges that need to be addressed (Figure 1)? What mechanisms can help operators, investors and relevant authorities be confident that GHG emissions savings objectives have been attained and related risks have been minimised or mitigated? In this context, two parallel initiatives are necessary. The first is the introduction of complementary EU wide legislative sustainability criteria to provide a level playing field within the single market, reflecting the context in which the biomass is sourced and/or consumed. The second is to improve the accounting for carbon and GHG emissions to provide a more explicit framework for measuring the impact of different policies as well as providing incentives for using the most sustainable pathways. ***Both sets of activities need to be implemented together and include all of the component approaches***.

In the following sections we outline three complementary approaches for sustainability criteria that could form a package of measures adopted into EU legislation. Each approach is described in relation to the issue it is aiming to address, how it could be implemented and the potential advantages and disadvantages. A summary of the proposed approaches can be found in table form in section 0.

Figure 1: Policy challenges, needs and solutions for improving carbon sustainability of biomass

OVERALL OUTCOME: Delivery of dependable reductions in greenhouse gas emissions associated with using biomass for energy



3.1 Approach #1 – Sustainable sourcing of biomass

Amongst the fundamental aspects of the carbon sustainability of biomass energy supply chains are the type of biomass being used, and from where and how it is sourced. The policy incentivised use of biomass for energy has a direct effect on demand and supply of a wide range of different materials, some of which may not be mobilised at all in the absence of the policy. Sourcing and harvesting patterns across the sector will change in response to the new market but without any standards in place some of the developments may fail to contribute sufficiently to mitigation goals or otherwise be unsustainable, particularly in the long term. In order to avoid such consequences it is rational to focus public support only on those biomass feedstocks that are sustainable. Policy mechanisms are needed to ***set criteria and provide guidance on those types and locations from which biomass can be considered sustainable*** in the light of current knowledge and requirements. Only those feedstocks that are considered to be sustainable would qualify for public support.

The sustainable sourcing of biomass relates to three aspects in particular, each of which can be considered in turn:

- the type of ***feedstocks*** that are collected (e.g. genuine wastes, residues, thinnings and surplus fibre with no viable markets);
- the ***location*** from which these feedstocks are sourced (e.g. existing managed forest);
- and the ***management*** of these forests (e.g. where carbon stocks are maintained and enhanced).

Sustainable feedstocks: There is a range of types of biomass feedstocks that can be considered sustainable for bioenergy use and present a reduced risk of significant carbon debt. Feedstock sustainability is influenced by carbon profiles and, less directly, by market dynamics and the consequences of diverting materials from one use to another.

There are those feedstocks that would otherwise have limited or no existing markets and thus have limited displacement impacts; and there are those types of feedstock that have an overall lower carbon impact than some other forms of woody biomass by nature of their profiles and when considered as part of the overall forest management approach (such as residues like bark or branches). Market and use dynamics vary considerably between forests and countries, whereas carbon profiles tend to follow similar patterns in line with bioclimatic variations. Therefore setting out a specific list of feedstocks can be unsatisfactory from the point of view of accuracy and regulatory clarity. The context and counterfactual is again important here as the management of forests and feedstocks can alter these dynamics in both a positive and negative manner. For example an opportunity for biomass sourcing with low counterfactual carbon risk may exist where there is surplus fibre produced as a result of habitat management or where there is a decline in the market for a particular biomass type that was not the sole driver of the decision to harvest[9]. Opportunities like this vary between individual forests and catchments for a particular market.

Biomass to be sourced only from sustainable areas: like specific types of feedstocks, there are some areas where biomass can be sourced more sustainably from a carbon and environmental perspective than others (such as working forests producing biomass for other end uses, or those that are degraded or neglected) and some, where there are higher risks to sustainability (such as protected areas and old growth forests). Distinguishing these areas requires criteria that are reasonably precise without being too insensitive to varying local conditions. Existing environmental legislation and enforcement within the source country has a clear role to play in ensuring that the relevant areas from which biomass can be sourced sustainable are identified and managed correctly, however there is a case for policy guidance in the importing country under the EU Timber Regulation (EU) No 995/2010)[10]. Policy should provide guidance to focus the sourcing of feedstocks towards areas that are sustainable whilst still allowing a degree of choice for operators, with the criteria framed so as to be applicable across administrative boundaries and in different contexts. An example of this can be

[9] For example, low grade timber that results alongside the harvesting of high quality saw log grade timber.
[10] To ensure forest biomass (for all uses) has been harvested in compliance with legislation applicable to the country of harvest.

seen in the UK Renewables Obligation[11] which defines protected land and the types of forest from which biomass cannot be sourced by reference to the Timber Standard for Heat and Electricity (DECC, 2014).

Being clear on the guiding criteria for sustainable sourcing areas requires an understanding of the level of biomass that can or should be extracted from a given forest and sustainable management practices that do not undermine the maintenance of carbon stocks or the functioning of the ecosystem[12], which are highly site specific. The Commission's recommendations to Member States for solid biomass sustainability criteria (COM(2010)11) as adopted by some Member States provide a useful guide, although carbon debt is not a specific consideration. These are a direct transposition of Articles 17 and 18 of the RED, the relevant parts of which are summarised as follows:

- Avoidance of: high biodiversity areas (Art.17(3)); high carbon stock land (Art.17(4); un-drained peatland (Art.17(5));
- Compliance with the relevant agricultural regulations of the EU for agricultural raw materials (which may include short rotation coppice) (Art.17(6))

Biomass from sustainably managed forests: The benefits of choosing a sustainable feedstock and sourcing it from a sustainable area could still be undermined in carbon terms through unsustainable land management practices at the site. Forest systems have been providing a multifunctional resource used in construction, paper, fibre and energy since they first came under management, with the precise end use determined closer to the point of harvest than of planting. The management of forests clearly has an effect on the quantity and nature of the biomass produced over a period of time. Some practices, such as thinning of stands to promote increased growth in the remaining trees, removal of diseased trees or management of fire risk gives rise directly to material ancillary to the principal harvest. Providing that sustainable management practices are in place and maintained the carbon impact of using this biomass for energy can be low or even positive, and improve the overall health of the forest. This is particularly true where forests are neglected and would benefit ecologically from continued management of this kind. The nature of such benefits depends on the counterfactual and whether the management would change as a result of the policy.

Bioenergy sustainability criteria should include a requirement for harvesting in compliance with sustainable forest management (SFM) practice. Yet the key question is what 'sustainable' means in this context and how SFM can be defined in a consistent way between countries[13]. For the purposes of carbon sustainability, SFM should ensure that the extraction of carbon in the form of biomass improves, or does not undermine, the ability of the remaining forest and regrowth of new trees to re-accumulate that carbon in a timeframe that is concurrent with policy targets. This addition to SFM requirements should be established at the EU level as a mandatory requirement for biomass that is counted to national renewable energy targets.

In addition to environmental, economic and social considerations, SFM from a sustainable bioenergy and carbon perspective should include the following requirements:

- use of thinning or small patch felling as opposed to clear felling <u>specifically</u> for energy use other than where clear felling is part of forest regeneration strategy;
- introducing management to ensure carbon stocks are maintained or enhanced over the medium and long terms in line with policy targets;
- avoid harvesting from unsustainable areas (see above);
- avoid harvesting of unsustainable biomass types (see above).

When addressing these requirements, it is necessary to consider appropriate spatial and temporal scales, which in general involves considering whole forests and looking across cycles in the management of stands (Matthews et al, 2014).

[11] https://www.ofgem.gov.uk/environmental-programmes/ro
[12] As acknowledged in existing biofuels sustainability criteria under Article 17(3) of 2009/28/EC.
[13] As noted in (SWD(2014)259). Currently SFM is determined by Member States, who have all adopted the FOREST EUROPE voluntary criteria and indicators. These guidelines however lack baselines, benchmarks or target levels.

Implementation

Guiding criteria for sustainable feedstock sourcing could be written directly into the EU Directive promoting the use of biomass for energy. As the criteria would not be very definitive in setting out a specific list of feedstocks, areas or practices these would need to be developed in each Member State reflecting regional and national conditions. There are multiple legal forms this could take, including through Implementing Acts and reported to the Commission or through national requirements that are sufficiently binding and transparent.

Setting out a series of guiding criteria would provide an adaptable approach across countries. In terms of their regulatory form these criteria would need to be set out list-wise, for example as an Annex to a regulation at EU level, for Member States to then adapt these to their given context, e.g. Table 1. The precise scope and nature of adaptation available to Member States would need to be set out, ensuring sufficient rigour and oversight so that standards are not weakened through interpretation and that their translation is transparent and verifiable in practice.

Table 1: Examples of potentially sustainable biomass categories

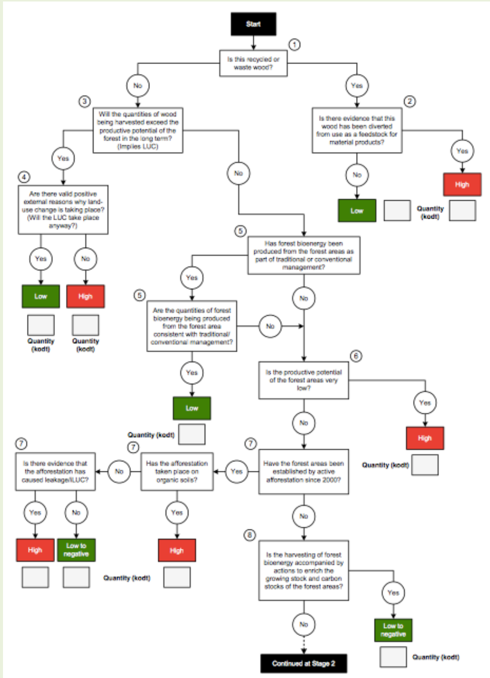
Biomass category	Examples of sustainable biomass
Surplus biomass • surplus to maintaining carbon stocks and ecosystem function • no intended end use and would otherwise be discarded or where there is surplus of biomass post harvest	• Genuine wastes with limited recovery potential • A proportion of harvesting and processing residues
Biomass with potential existing non-energy markets. • harvested if market conditions are favourable and context permit • harvested as part of sustainable forest management to prevent neglect •	A proportion of: • harvesting and processing residues (inc. thinnings) with no/limited markets compared to availability • Processing residues from saw mills and wood processing industry that do not have viable existing markets; • Wastes with potential for recovery but limited markets
Biomass with potential non-energy markets that have declined: where biomass extraction can maintain sustainable forest management.	May include pulp-wood and surplus fibre from felling operations. as well as fractions of the above mentioned biomass categories.
Biomass from sustainable areas: • Avoidance of: high biodiversity areas; high carbon stock soils; un-drained peatland; old-growth forests; etc*. • Compliance with the relevant agricultural regulations of the EU for agricultural raw materials (which may include short rotation coppice)	Biomass from: • Forests planted with the express aim of producing energy biomass; • Some existing working forests with surplus fibre.

Note: *the precise nature of these categories would need to be defined and could include, consideration of ecosystem condition, whether areas are already under management and if that management is contributing towards carbon and other environmental objectives, etc.

For operators, there are well-established routes to monitoring and verifying criteria of this nature2010/C 160/01, 160/02. At present the lack of binding sustainability criteria for solid biomass at the EU level means that there are no formally recognised schemes to report on such criteria, other than those operating in selected Member States. Voluntary scheme certification standards do exist, however, such as the Sustainable Biomass Partnership (SBP) developed to reflect solid biomass sustainability criteria adopted in the UK, Belgium, the Netherlands and Denmark. The specific EU guidance criteria could be translated into easy-to-follow decision trees for use when sourcing biomass with added benefits for evaluators when assessing what has taken place (Box 1). This mechanism could be used to justify its contribution towards national renewable energy targets.

Box 1: Decision tree approach to sustainable feedstock sourcing

Matthews *et* al, (2015) set out a decision tree approach that progresses stepwise through different feedstock classifications and questions around sourcing, intended end use and counterfactuals. The approach goes a long way to describing risk where one specific classification of biomass may be considered low or high depending on the response to the questions asked. It also sets out an approach to choose both sustainable areas (on the basis of management, soil type, etc.) and whether the area is under some form of management. The authors note that this is only provisional in order to illustrate a potential means of making systematic decisions on different biomass sources going to specific projects, such as energy plants.



One of the greatest benefits of this approach is also its major shortcoming (as noted by the authors on pages 26-29), in that the questions asked in the decision key process require/allow evidence to be provided to justify each stage of the process, yet then rely on non-centrally defined terms. Terms such as 'traditional/conventional management' or 'valid positive external reasons' require significant justification in order to satisfy an assessment of low-risk. Despite this criticism, this is probably as far as it is reasonably possible to determine any decisions that need to be applied across a variety of contexts into a workable approach. The authors note that this decision tree process is qualitative and is intended for application as part of a wider assessment of the sustainability of forest management. This is an important point and if this type of decision tree were to be used as a means of implementing policy, then a precautionary approach would be warranted[14], i.e. where evidence is insufficient to justify a low-risk, a high-risk situation should be assumed.

Source: Own compilation based on Fig.2.1 in Matthews et al (2015)

3.2 Approach #2 – Biomass for energy deployed within sustainable limits

The carbon impacts of using biomass for energy is affected both by the overall level of deployment and the scale and intensity of harvesting. Better understanding of these scale impacts is needed although it is being addressed in a growing literature the conclusions of which vary. A key question for policy is whether the mechanisms to incentivise the use of bioenergy should be open-ended in terms of scale, respecting that there are existing market constraints to deployment. If competition, and therefore prices, for biomass increase, then it becomes less viable and attractive in comparison to other renewables.

Taking steps to maintain deployment within sustainability limits is one route to minimising the risk of scale-related impacts arising from using biomass for energy. It provides a clear signal to operators and society of the role of bioenergy within a wider and more diverse renewable energy sector[15]. There are precedents, under Directive (EU) 2015/1513 for biofuels[16], or the limit in the Dutch SDE+ scheme on the wood volumes that can be used to supply a pellet mill[17]. However, limit setting in the form of a cap on biomass use is a relatively crude approach to tackling a complex problem and should only be implemented alongside other criteria that promote the sustainable extraction and use of biomass. Market dynamics need to be born in mind as well.

Setting a limit to the level of biomass used for energy can take a number of forms. A specific measure would not necessarily take the form of a simple ceiling; it could be explicit or implicit and

[14] As set out under Article 191 of the Treaty on the Functioning of the European Union (TFEU) (EU 2012). The precautionary principle enables rapid response in the face of a possible danger to human, animal or plant health, or to protect the environment. In particular, where scientific data do not permit a complete evaluation of the risk, recourse to this principle may, for example, be used to stop distribution or order withdrawal from the market of products likely to be hazardous (see also (European Commission 2000)).

[15] Limits would only apply to the incentivised use of biomass and not total bioenergy deployment – consistent with Title XX (environment) of Article 192 & Title XXI (energy) of Article 194.2 of the Treaty of the Functioning of the European Union.

[16] To limit to 7% the contribution that biofuels made from food and feed crops can make to transport energy generated.

[17] On average <50% of roundwood supplies to a pellet mill by the total volume of round wood harvested in the same year

could be flexible in various ways including exemptions on the basis of documented GHG emissions savings linked to LCA.

- **Implicit limits:** define the operating conditions that naturally curtail deployment, such as well-defined sustainability criteria linked to management, harvesting and extraction approaches, or avoid certain areas and types of forest for sourcing feedstocks. The main advantage of using implicit limits is that it does not rely on a fixed quantitative target and is thus not hampered or constrained by data availability or computational issues. It also complements other forms of sustainability criteria or accounting frameworks and provides flexibility to operators, although the overall policy-supported potential for deployment is not clear, which is a drawback.
- **Relative limits:** are similar to implicit limits and set the overall level of extraction relative to the level of carbon accumulation (or annual increment) within a given forest. The main advantage of this approach is that operators can estimate the overall limit value and that it takes account of the context of each individual forest from which biomass is sourced. This same approach can also be used to define the proportion of biomass sources from areas other than forests, such as in relation to wood processing residues from sawmills or waste. This is inherently best suited to quite limited scale deployment although it can be applied to a suite of forests and sources.
- **Absolute limits:** define a level beyond which biomass use is considered unsustainable and thus can't contribute towards EU renewable energy targets. This gives a clear signal to operators of the market potential. The main challenge is in defining what the limit should be and whether there is sufficient understanding (and data) of the system to set a limit. Setting limits based on an average time period may provide one option to relate the cap to current use patterns.

A critical aspect in setting the terms of this general approach is in determining what it is that is being limited. Options include: the overall contribution being made towards renewable energy targets (in energy contribution or % terms), the overall amount of specific biomass types used (tonnes), or an area limit from which biomass can be sourced (ha or %)[18]. From a carbon sustainability perspective, an overall volume limit of specific feedstock types (tonnes) addresses more closely the concerns around deployment scales relating to unsustainable feedstock use. However, clear definitions of the categories of biomass being limited would be necessary in order for this to be workable in practice, including the unambiguous identification of biomass streams throughout the supply chain. Limiting specific feedstocks in this way can also have much wider ranging impacts on other forest-based sectors for example via competition for specific feedstocks (such as sawmill residues), and may also have a distortive impact on forest management in some cases. In terms of ease of implementation, the energy contribution limit option is more straightforward, with reporting taking place within current procedures at the national or regional level. This would need to be combined with reporting by operators on the different volumes of specific feedstock types used. This would allow national authorities to assess both the overall contribution of biomass to renewable energy targets and understand the types of biomass being used.

In combination with other sustainability criteria, ***limiting the contribution of biomass energy as a proportion of overall renewable energy share could help to limit carbon impacts and provide development space for other RES forms***. Understanding how these limits could be set and implemented remains a challenge. For example on what basis and how would these be balanced across Member States with different supply bases and current RES mixes?

3.3 Approach #3 – GHG saving requirements for bioenergy

Addressing carbon debt is a question of ensuring that carbon emission savings will be sufficient when compared to emissions and existing energy supply baselines. Bioenergy power plants require a constant input of biomass material. Given that the quantity of biomass feedstock consumed is inherently linked to the GHG emission and environmental footprint of the bioenergy system the importance of efficient use is, therefore, critical.

Providing effective assurance that the expected GHG savings are delivered requires consideration of the processing and transport emissions as well as the end use conversion efficiency. These

[18] Given the inherent variability of forest stands (species, growth rates & carbon stock) this last option may not be practical.

requirements are already in place for biofuels and bioliquids under the RED and require a *de minimis* and relative level of GHG savings compared to a fossil fuel comparator using either real-world or default values[19]. The European Commission's report on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling (COM(2010)11) suggested a similar approach should be adopted for solid biomass, but is not binding on Member States. Some Member States that have adopted higher standards for bioenergy sustainability in policy, such as the UK Renewables Obligation, and the policies in Denmark and Belgium, have also set limits and decreasing (and thus more stringent) targets around GHG savings in the solid biomass supply chain.

Including a GHG saving requirement for solid biomass that takes into account different aspects of production and transport would be a step in the right direction. Yet despite their advantages in terms of implementation, relative approaches are subject to variations in the fossil fuel comparator, which can increase or decrease over time. As such they have a number of associated shortcomings, such as the difficulty in determining the fossil fuel comparator[20] or in driving efficiency. Improving efficiency in the energy system should be a focus of all decarbonisation policies. The formation of current EU regulation i.e. with limited coverage of biomass to energy plants in the EU Emissions Trading Scheme (ETS) and the lack of an equivalent measure to the Fuel Quality Directive for biofuels, means that there are few drivers to promote progressive improvements in the efficiency of a biomass plant. End of stack emissions from biomass can vary considerably and are not addressed through the zero carbon rating of the feedstock. Whilst the zero carbon rating is consistent within the UNFCCC accounting framework, it means that key EU instruments that seek to drive efficiency in the energy production system do not apply to biomass. This is because they often rely on a carbon intensity calculation and the assumption of carbon neutrality.

A more robust approach would be ***to set a non-relative GHG emission intensity requirement where a power plant producing bioenergy would have to meet an absolute emissions threshold rather than a saving relative to a fossil fuel baseline.*** In this way the GHG saving requirement would not be subject to variations in, or difficulties in calculating the fossil fuel comparator. Setting the GHG intensity requirement would have to be calculated using a well-defined LCA type exercise. Respecting the differences in the installations that use biomass, it would be appropriate to set different GHG emission intensity requirements on this basis. For example a higher emission intensity reduction requirements would be appropriate for new installations, in order to drive efficiency improvements, than from older or converted facilities. The emission intensity requirements across all types of bioenergy plant would need to be sufficiently ambitious to ensure good practice and could increase over time, whilst not stalling the transition away from fossil supply base.

Such an approach would help to drive best practice and improve efficiency and would need to take account (potentially plant by plant) of the variations in different energy systems, sourcing patterns and different regional situations and actors involved, using a standard approach. This approach could be strengthened through the use of Best Available Technique (BAT) approaches employed to deal with other industrial emissions and allowing for a more tailored approach in different contexts[21]. Whilst this approach may be an improvement over relative GHG emission savings, it does not seek to overcome the complexities of accounting for changes in forest carbon stocks and the impact this has on the overall GHG profile of bioenergy.

Policy measures designed to ensure sustainable sourcing patterns (#1) and deployment scales (#2) coupled with GHG emissions saving requirements (#3), together with clear accounting frameworks form a coherent sustainability package to address carbon sustainability in the energetic use of biomass.

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[19] As specified in Annex V of the RED

[20] Which can vary depending on a given energy plants role in the energy system and energy sourcing within a given region or country

[21] Traditionally carbon emissions were excluded from coverage under such systems given that this was dealt with, for example, through dedicated policy focused on GHG savings. However, bioenergy presents a different situation where the carbon emissions are not material in a formal GHG accounting sense, but where driving efficient use of biomass is critical to the overall carbon footprint.

3.4 Summary table of approaches to improve the carbon sustainability of biomass through policy

Approach	Brief description	C issues covered	C issues not covered	Implementing conditions and issues	Advantages
#1 - Sustainable sourcing of biomass. Guidelines to ensure biomass for energy is produced from **sustainable feedstocks** sourced from **sustainable areas** using **sustainable forest management** approaches.	This approach provides the mechanism to screen and remove high carbon-risk feedstocks from bioenergy supply chains. High carbon risk feedstocks could not be counted towards Member States renewable energy targets and thus not be eligible for support. Carbon impacst ↓	• Overly high attributed GHG emissions from the resulting end use of biomass • Displacement impact; • Elements of counterfactuals; • Sequestration period from older trees; • Some GHG emissions from biomass extraction; • Grow-back period reduced; carbon debt aspect shared amongst other forest biomass users	• GHG emissions; • Appropriate scale; • HCSA • Pre-accounted removals; • Counterfactuals • Accounting	• Definition and identification of areas to avoid (e.g. high carbon stock areas (HCSA); – data availability; Level of environmental enforcement in third countries; verification • Clearly defined guidelines on feedstocks appropriate for bioenergy use; • Effective monitoring, accounting and enforcement – chain of custody & recognition of HCSA in accounting + reporting frameworks. • Parity across different jurisdictions. • Redefinition of SFM in line with carbon aspects & accounting	• Clear and implementable with precedence in existing policy; • Supported by existing environmental acquis • Understood by foresters and forest industry sector; • Coherent with current forest governance framework in EU
#2 – Biomass deployed within sustainable limits	Bioenergy deployment is within sustainable limits. The contribution of bioenergy to overall renewable energy targets is limited. Carbon impacst ↓	• Potential scale impacts	• HCSA; • Accounting • Pre-accounted removals; • Counterfactuals • GHG emissions;	• Associated accounting and reporting framework for biomass for energy use. • Legal basis not clear with regards to TFEU Title 20 and 21	• Clear ceiling for Member States and bioenergy producers. Measurable
#3 - Explicit non-relative GHG saving requirements for bioenergy	In order to count towards EU/MS renewable energy targets, the GHG saving requirement of biomass used would be specified Carbon impacst ↘	• GHG emissions; • Conversion efficiency and transport recognised as a contributing factor; • Linked to accounting but not fully covered; • Possible HCSA	• Appropriate scale; • Accounting • Pre-accounted removals; • Counterfactuals	• Recognition of carbon emissions and removals associated with forest biomass • Needs associated accounting and reporting framework in order to be effective. Reconsideration of carbon profile of biomass which may not be politically agreeable	• Explicit recognition of C saving requirement commensurate with policy objective

Notes: ↓ = Reduced carbon impacts but not avoided entirely. ↘ = Indirectly reduced carbon impacts, but not avoided.

3.5 Impacts of and options for a separate LULUCF pillar

In July 2016 the European Commission set out legislative proposals for accounting of non-ETS sectors for 2021-2030 (Effort Sharing Regulation, ESR). The ESR proposal released as part of the Commission's Energy Union summer package also included a proposal for a decision to address GHG emissions from the land use, land use change and forestry (LULUCF) sector. The two proposals mean that the accounting frameworks would remain separate but include an element of flexibility[22] between the sectors covered. The addition of this flexibility causes some concern over the environmental integrity of the EU climate policy post-2020 and may lead to a lowering in practice of the mitigation effort in the ETS and ESR sectors and greater pressure on the LULUCF sector. Moreover, the domestic nature of the EU's emission reduction targets and the current accounting approaches may lead to geographical asymmetry between sinks and sources of emissions and impact on the choices made around efforts to reduce emissions in the EU.

- *Inter-sectoral flexibility* between LULUCF and ESR sectors in the mitigation frameworks would imply a significantly increased pressure on the domestic removals offered by the LULUCF sector. National policies aiming at increasing carbon sequestration through forests (e.g. to offset emissions from agriculture) could for instance curb the supply and demand of EU-grown forest biomass, encouraging imports of the resource from outside of the EU, and in turn focussing attention on the sustainability of such imports. This could coincide with more stringent regulation of LULUCF emissions and removals in the UNFCCC Parties. International solid biomass markets could then be affected by the new rules on LULUCF accounting.
- *The domestic nature of the binding EU GHG reduction target* of 40% by 2030 compared to 1990 levels is designed to safeguard the environmental integrity of the targets by ruling out any use of international carbon credits to meet them[23]. This implies that the rules for counting carbon sequestration towards targets would reward domestic (i.e. EU) sequestration only and may present an important obstacle to linking forest-based bioenergy carbon footprint (which may be global in nature) to the LULUCF policy measures at EU level. Under this scenario there is a risk of land-use-related carbon leakage resulting from the geographic asymmetry[24] between sinks and sources of emissions when they fall under different legislations with non-consistent approaches to LULUCF emissions and removals accounting. With the Paris Agreement in place, the risk of this *sui generis* carbon leakage should be significantly reduced through common approaches to accounting and reporting.

The potential flexibilities within the LULUCF sectors between countries, and the inter-sectoral fungibility between LULUCF and ESR sectors have implications for the carbon sustainability of forest biomass used for energy. In order to address these risks, there are six key elements that need to be part of a revised LULUCF pillar.

[**Note:** *Some of these elements have been included in the proposals to integrate the land use sector into the EU 2030 Climate and Energy Framework (COM(2016/479) that was released during the drafting of this text.*]

1. **Robust accounting rules for domestic and imported emissions and removals.** The LULUCF pillar would account for the domestic emissions and removals in line with the LULUCF Decision (No. 529/2013) and consistent with rules established by the UNFCCC in 2005 and 2011. EU Member States should prepare and maintain their accounts ensuring the ***accuracy, completeness, consistency, comparability and transparency*** of relevant information used in estimating emissions and removals from the LULUCF sector. Such activities should be conducted in line with guidance provided in relevant Intergovernmental Panel on Climate Change (IPCC) guidelines for national GHG inventories, including on methodologies for accounting for non-CO_2 GHG emissions adopted under the UNFCCC framework.

   Although in principle the LULUCF pillar will not cover any of the imported emissions and removals from LULUCF sector[25], the Paris Agreement has ensured that there are reasonable grounds to assume that

[22] Fungibility of the carbon emissions and sequestration
[23] Carbon credits traded previously under the UNFCCC proved considerably ineffective (Kollmuss et al, 2015).
[24] Under current accounting rules, when woody biomass is harvested from forests, the timber is assumed to be oxidised to the atmosphere instantaneously as CO_2'(Kuikman et al, 2011). If biomass is not harvested in the same accounting area, there is a geographic asymmetry between the sinks and the carbon emissions observed
[25] e.g. emissions and sinks imported in harvested wood would remain invisible to the EU accounting system.

many parts of the world will implement restrictive measures regulating the climate change aspects of the LULUCF sector, including the carbon debt aspect of forest biomass. This could improve the environmental integrity of imported forest bioresources, but would not be sufficient to account for the related activities such as processing and transport. While the former should, in principle, be reflected in the inventory of the exporting state, maritime transport emissions will not be. The EU system could adopt the principle that only biomass imports from Paris Agreement parties with binding targets, and with LULUCF accounting approaches that are sufficiently robust, could be considered equivalent to domestic biomass. However, this still leaves open the question of whether mitigation associated with such imports meets the "domestic" nature of the EU targets.

2. **Binding emission targets at EU and Member State level** set under the LULUCF pillar translated into national quotas to be met over a 10-year compliance period. The target would cover domestic emissions and removals only, and would not affect the LULUCF sector activities outside of the EU (which in a robust framework would be covered by emission reduction targets in the regions of their origin). Emission reduction targets are in principle an effective GHG emission mitigation tool provided they result from a strict approach to setting baseline for targets and are sufficiently ambitious to deliver the mitigation benefits.

   In the longer term an additional EU binding target on GHG emissions from imported biomass could be considered. This would need to be coherent with the GHG emission reduction targets for the same biomass in the source country and the accounting frameworks would need to be harmonised. Ensuring this approach is workable in practice may present considerable challenges as the destination of the materials being exported, or even whether they are exported or not, is often subject to market conditions and can change multiple times within the year. There is also a question of competence and burden in terms of monitoring and reporting, and their ability to influence the sector.

3. **Multiannual commitment periods with a review clause.** Annual fluctuation of emissions and removals from the LULUCF sectors justify a relatively long commitment periods (e.g. 10 years) for meeting the emission reduction targets. Compliance checks could be aligned with the 5-year "ambition cycles" under the Paris Agreement (UNFCCC, 2015) allowing a regular opportunity to review the measures and targets, if required. In order to keep the systems transparent, the LULUCF accounting should not allow the transferal of commitments to future periods, although it may be desirable to transfer removals between compliance periods (5 years), i.e. banking of removals, to account for fluctuations in emissions and removals over the compliance period[26].

4. **Credible monitoring, reporting and verification (MRV) procedures** are essential for an effective LULUCF pillar. MRV would be part of the EU mechanism for complying with the EU's commitments under the UNFCCC. Domestically it should constitute a part of the governance system of the future EU climate and energy framework (as a part of the Energy Union strategy) (COM(2015)080 final). The MRV under the LULUCF pillar could be based on the current methodological guidance prepared by the IPCC in the context of the UNFCCC[27], with updates and enhancements in order to reflect the latest scientific advances, international climate commitments and past experience.

   Based on the same methodologies, the sinks and emissions triggered by the EU but occurring outside of its borders, could also be reported in the national GHG inventories but not accounted for (to avoid double counting under UNFCCC), a process of **parallel reporting.**

[26] In this text a commitment period is the period in which a Member State is required to account for emissions and removals relating to a target (10 years, 2021-2030). A compliance period is that in which the progress towards fulfillment of commitments is checked (5 years, 2021 – 2025; 2026-2030)
[27] http://www.ipcc-nggip.iges.or.jp/home/2013KPSupplementaryGuidance_inv.html

Parallel reporting

Crediting the use of imported biomass energy with a contribution towards the EU's 2030 targets, whether directly or indirectly, fails to address the domestic nature of those targets. The European Council's 2014 decision effectively commits the EU to domestic emissions reductions to the required level. Inclusion of LULUCF in the EU's target system affects whether those emissions reductions should be considered as gross or net of sequestration; but in order to count, the sequestration would need to occur within the EU. However, if the EU treats biomass imports differently to domestic biomass production, it may be reducing the economic effectiveness of its mitigation policies, and it may also create trade policy risks (failure to provide equal treatment to imports). Carbon emissions would still be emitted in the EU from biomass combustion, but it would be benefiting from sequestration elsewhere (e.g. in the US).

A 'Parallel reporting' measure could be a first step to addressing these problems, by enhancing the effectiveness of the EU LULUCF accounting and addressing the geographical asymmetry between emission sources and sequestration inherent to forest bioenergy produced in EU from non-EU biomass. It would require **EU Member States to report on the emissions and removals from imported biomass alongside the EU emission and removal inventory.** This could reflect the calculus based on the reporting in the country of origin of biomass, provided it has ratified and observes the Paris Agreement. Alternatively, the accounting obligation could be delegated to the biomass importer, who would be bound to apply the methodology established under the EU's LULUCF pillar and be subject to independent verification. With **parallel reporting** in place the EU would ensure greater transparency of its mitigation efforts and increase understanding of emission and sequestration flows to inform future policy making. Provided that common approaches and methodology (possibly developed under the UNFCCC) are used, the parallel accounting could:

- prevent the risk of double counting (e.g. accounting for GHG emission sinks in both US and EU),
- link the EU and the international systems of carbon accounting (with a view of integrating the international carbon markets in the long term),
- prevent regulatory inefficiencies (such as duplication of national reporting),
- increase the environmental integrity of global mitigation efforts in the long term, and
- allow the EU to monitor total emissions from imported biomass, enabling it to adopt further measures (for example, through an automatic adjustment to Member States' ESR targets, or an automatic reduction in the ETS cap) to ensure that the full "domestic" EU mitigation commitment was delivered.

To achieve this, the scope of the LULUCF Decision (or any new measures regulating the sector) could be widened to enable reporting on emissions and removals triggered but taking place outside of the EU).

5. **A specific regulation on imported GHG emissions and removals from solid biomass for energy purposes**. Similarly to the expected impacts of the EU Timber Regulation (*Regulation (EU) No 995/2010*) on illegal logging, a new measure adopted by the EU in the context of the 2030 climate framework could aim at reducing unaccounted emissions and removals from LULUCF sector that are imported to the EU in form of solid biomass for energy sector. The new legislative tool could put an obligation on the operators in the EU to certify that:
   - the biomass they are using comes from a country that is a Party to the Paris Agreement and actively implements it;
   - and LULUCF accounting methods in the country of origin of the biomass have been duly applied in line with the UNFCCC methodology.

   Any imports of resources from a LULUCF sector that fail to meet these requirements would put an obligation on an operator to account for the LULUCF emissions and sinks that are attributable to the resources it imports using the methodology adopted in the EU (through a third party certification system). Any failure to deliver the certificate would result in excluding the non-certified biomass from the renewable energy sources category.

   'Accounted' biomass could be defined as biomass collected in compliance with LULUCF accounting rules, as guaranteed by the country of origin being an active Party to the Paris Agreement, or with the EU LULUCF accounting rules, as confirmed by the external certifier. The tool could take the a form of a regulation ensuring that it would be legally binding in all EU Member States, who would then be responsible for laying down effective, proportionate and dissuasive penalties in addition to enforcing the implementation of the tool.

4 References

Literature

Bowyer, C, Baldock, D, Kretschmer, B and Polakova, J (2012) *The GHG emissions intensity of bioenergy: Does bioenergy have a role to play in reducing GHG emissions of Europe's economy?* Institute for European Environmental Policy, London.

DECC (2014) *Timber Standard for Heat & Electricity: Woodfuel used under the Renewable Heat Incentive and Renewables Obligation.* . URN 14D/025, UK Department for Energy and Climate Change (DECC), London.

Forest Europe (2015) *State of Europe's Forests 2015*. Forest Europe, Madrid.

Kollmuss, A, Schneider, L and Zhezherin, V (2015) *Has joint implementation reduced GHG emissions? Lessons learned for the design of carbon market mechanisms*. Stockholm Environment Institute, Stockholm.

Kuikman, P, Matthews, R, Watterson, J, Ward, J, Lesschen, J P, Mackie, E, Webb, J and Oenema, O (2011) *Policy options for including LULUCF in the EU reduction commitment and policy instruments for increasing GHG mitigation efforts in the LULUCF and agriculture sectors. SYNTHESIS REPORT*.

Matthews, R, Mortimer, N, Lesschen, J P, Lindroos, T J, Sokka, L, Morris, A, Henshall, P, Hatto, C, Mwabonje, O, Rix, J, Mackie, E and Sayce, M (2015) *Carbon impacts of biomass consumed in the EU: quantitative assessment Final report, project: DG ENER/C1/427 Part A: Main Report*.

Matthews, R, Mortimer, N, Mackie, E, Hatto, C, Evans, A, Mwabonje, O, Randle, T, Rolls, W, Sayce, M and Tubby, I (2014) *Carbon impacts of using biomass in bioenergy and other sectors: forests*. DECC project TRN 242/08/2011 Final report: Parts a and b, Forest Research, North Energy Associates, Surrey, UK.

OFGEM (2015) *UK Solid and Gaseous Biomass Carbon Calculator: Renewables Obligation: User manual for the Solid and Gaseous Biomass Carbon Calculator. Version 2.0*.

OFGEM (2016) *UK Renewables Obligation: Sustainability Criteria - Ofgem Guidance*. Ofgem, UK.

Oswalt, S N, Smith, W B, Miles, P D and Pugh, S A (2014) *Forest Resources of the United States, 2012: A Technical Document Supporting the Forest Service Update of the 2010 RPA Assessment. Gen. Tech. Rep. WO-91*. U.S. Department of Agriculture, Forest Service, Washington DC.

Stephenson, A L and Mackay, D J C (2014) *Life Cycle Impacts of Biomass Electricity in 2020: Scenarios for Assessing the Greenhouse Gas Impacts and Energy Input Requirements of Using North American Woody Biomass for Electricity Generation in the UK.* Department of Energy and Climate Change, London, UK.

UNFCCC (2015) *The Paris Agreement*.

Legislation and policy

Regulation (EU) No 995/2010 of the European Parliament and of the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market, OJ L 295, 12.11.2010

Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (Text with EEA relevance)

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

Directive (EU) 2015/1513 of the European Parliament and of the Council of 9 September 2015 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.

Decision No. 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol.

Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020)

Decision No. 529/2013/EU of the European Parliament and of the Council of 21 May 2013 on accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry and on information concerning actions relating to those activities.

COM(2010)11 - Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling.

COM(2010)160 - Communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels.

COM(2015)080 final - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank. A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy

COM(2016)479 - Proposal for a Regulation of the European Parliament and of the Council on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry into the 2030 climate and energy framework and amending Regulation No 525/2013 of the European Parliament and the Council on a mechanism for monitoring and reporting greenhouse gas emissions and other information relevant to climate change.

SWD(2014)259 - Commission staff working document. State of play on the sustainability of solid and gaseous biomass used for electricity, heating and cooling in the EU.