Burnable Carbon

What is still burnable in a circular, cascading, low carbon economy?

A European Environmental Bureau position paper
As adopted by the EEB Board on 14 June 2017

Background

1) This paper sets out a vision as to how to fight climate change while respecting the carrying capacity of the planet, maintaining biodiversity of ecosystems and meeting the demands of present and future generations. The agendas of climate change mitigation and resource efficiency are broadly mutually reinforcing: improving recycling brings climate benefits and improving energy and material efficiency should be overarching objectives under both. Sometimes the same instrument can be used to achieve both aims. Globally, the EU has been claiming to lead the way in both areas.

2) At the same time, though, conflicts have emerged between these agendas of climate change mitigation, resource efficiency and nature conservation. These conflicts require thorough analysis and solutions, in particular regarding the expanded use of biomass for energy.

3) Bioenergy plays a significant role, within appropriate limits, in mitigating climate change by replacing fossil fuels and should continue to do so but it is evident that clear and unacceptable negative impacts on for instance biodiversity and emissions of greenhouse gases occur in a number of cases and must be avoided. Conflicts related to the use of food and land-based crops for biofuels have already been well documented and the European biofuels policy was amended in April 2015 to limit its negative impacts.

4) Nevertheless, risks related to unsustainable land use and wasteful resource use for energy production still remain, both for biofuels and for other kinds of bioenergy. These risks come on top of existing pressures on land and forests from existing unsustainable patterns of production and consumption. The risks persist especially for the period after 2020 as the future of current rules for food based biofuels are unclear and for the time being there are no sustainability requirements for other kinds of bioenergy than biofuels in the transport sector, and even these are inadequate.

5) These concerns are compounded by the current context in the EU whereby environmental protection is being generally downgraded in favour of a very regressive economic agenda. At the moment, the Juncker Commission remains, at least formally, committed to a climate, energy and a circular economy/waste agenda. In both areas of climate change mitigation and the circular economy, major packages with new measures are to be debated, including the new circular

economy package and various pieces of legislation under the new 2030 Climate and Energy Framework. Other relevant policy initiatives of the Commission include the Heating and Cooling strategy, a Communication on the Decarbonization of Transport and a Communication on Waste to Energy in 2016.

6) A regulatory system with measurable and quantifiable criteria needs to be put into place that prevents 'bad' bioenergy and promotes 'good' bioenergy, especially for the period post-2020. The purpose of this document is to identify policies which distinguish between negative and positive uses of bioenergy with a view to discouraging the former and promoting the latter, in particular by identifying what is burnable carbon.

Why do we need to define what is still burnable?

7) In the context of climate change mitigation, it has become increasingly clear that burning of fossil fuels cannot continue at the current rate due to the impacts of the carbon emissions in the atmosphere. Research showing which fossil reserves should remain underground if global warming is to be kept below the previous threshold of 2 degrees Celsius has grabbed the attention of investors who are concerned about so-called stranded assets[1]. These reserves are often called 'unburnable carbon'. The concept requires sticking to a carbon budget of 1000 Gt of cumulative carbon emissions since pre-industrial times.

8) The internationally agreed target in the Paris Agreement, entering into force on 4 November 2016, of limiting climate change to well below 2 degrees Celsius and pursuing efforts to stay within 1.5 degrees Celsius (Paris COP21) decreases the carbon budget even further. The budget does not differentiate between emissions from fossil or biogenic sources, just refers to additional carbon released into the atmosphere, though obviously if emissions come from biogenic sources, the amount of carbon absorbed by the biomass during its growth and other gains from and losses to the atmosphere of GHGs arising directly or indirectly from the use of bioenergy also needs to be taken into account.

9) In the context of reducing our resource consumption and moving to a circular economy, burning of resources is not just a matter of emissions but also a matter of resource use. This is also relevant in the case of biomass, which is increasingly burned for energy production as part of the efforts to switch to renewable energy sources. Burning is what also differentiates biomass from other renewable energy sources. If energy can be produced without losing all the other values of the biomass and having regard to the cascading use principle, this would obviously be one of the preferred options from the point of view of the circular economy.

[1] The geographical distribution of fossil fuels unused when limiting global warming to 2 °C, Nature 517, January 2015.

10) Bioenergy systems that make use of organic wastes whose disposal constitutes a problem for society can be win-win situations. Examples of such systems are biogas production from the anaerobic digestion of urban residual waters, urban biowastes, manure and industrial biowastes (and eventually some types of thermal gasification when this technology is feasible for commercial use).

11) Biomass also has the potential to contribute to more sustainable resource use and climate change mitigation through longer lasting material uses and through substitution of emission intensive materials. As biomass resources are limited, conflicts can and do arise between increasing material and energy uses of biomass as well as with the need to feed a growing population.

12) The limits of biomass supply are well illustrated by the estimates in one study that meeting only 20% of the world's assumed energy demand by 2050 with bioenergy would require an amount of biomass that equals all the biomass harvested today for food, feed, energy and materials[2]. To answer the challenges of the growing demand for biomass there is a growing interest in the development and application of the cascading use principle that would seek to determine a hierarchy of use for biomass resources. The purpose of that is to maximise the value of a limited amount of biomass resources, improve efficiency and manage demand.

13) Bioenergy is nevertheless expected to play a major role in most EU Member States' plans to achieve their renewable energy targets for 2020. Bioenergy makes up about 65% of the EU's current renewable energy use and more than 90% of the renewables in the transport sector as biofuels. The consumption of biomass for energy in the EU has grown from 60 Mtoe consumed in 2005 to 105 Mtoe consumed in 2013 and is further expected to reach at least 140 Mtoe (5.86 EJ) by 2020.[3]

14) The question arises which forms of biomass are available for energy but also for other uses, in which quantities and which systems, and which can be used without undermining the EU's objectives in the area of climate, resource efficiency, air quality and biodiversity. What is available as a feedstock now, and what could be available in the future, that will promote a sustainable development of energy systems?

15) Answering these questions requires consideration of policy aims and societal objectives in various fields.

16) The EU has domestically committed to halting biodiversity loss and the degradation of ecosystem services by 2020[4]. Internationally the Aichi Biodiversity Targets of the Convention on Biological

[2] Avoiding bioenergy competition for food crops and land, World Resource Institute, 2015

[3] AEBIOM Statistical report 2015.

[4] The EU Biodiversity Strategy to 2020.

Diversity[5] commit the EU to for example restore at least 15 % of degraded ecosystems and protect at least 17 % of terrestrial areas.

17) Maintenance and restoration of ecosystem services also requires its share of land and biomass resources. This is a particularly pressing need since forest habitats of European importance with a favourable conservation status dropped from 17 % of habitat types in the period 2001-2006 to about 15 % in the period 2007-2012 and agriculture has been identified as the most prominent pressure on terrestrial ecosystems in Europe during the last decade[6].

18) Bioenergy has implications for human health. In 2010, domestic heating was responsible for about 43% of the harmful particulate matter $PM_{2,5}$ emissions in the EU[7] of which roughly 74% were from solid biomass[8], meaning that wood burning in domestic stoves and boilers for heating was responsible for about 32% of harmful $PM_{2,5}$ emissions. By 2030, emissions from domestic heating are expected to be reduced by around 33% compared to 2010, mainly as a result of new Ecodesign standards coming into force. However, domestic heating is expected to remain by far the largest source of primary $PM_{2.5}$ emissions, with a share of 39% in 2030, some 80% of which is accounted for by solid biomass[9] (thus 31% of the total $PM_{2.5}$ emissions).[10] In addition to health impacts, biomass burning causes emissions of soot (black carbon) which exacerbates climate change, as it is the second most important contributor to global warming after CO_2[11]. On the other hand, use of bioenergy is in some cases enabling a more rapid phase-out of fossil fuels, which cause severe health problems and via climate change are devastating from a health and welfare-point of view.

19) Outdated large combustion plants, especially coal plants, that do not meet state-of-the-art environmental performance requirements, such as for air pollution or energy efficiency, and do not make efficient use of the fuel burned are using biomass conversion as a way of extending their lifetime and maintaining profits[12]. In these cases biomass is used to hold back the more profound changes needed in the energy system as whole.

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[5] Aichi Biodiversity Targets: https://www.cbd.int/sp/targets/.

[6] The Mid-Term Review of the EU Biodiversity Strategy to 2020 – Commission Report 2015.

[7] Policy Scenarios for the Revision of the Thematic Strategy on Air Pollution, IIASA, March 2013, page 18.

[8] IIASA, personal communication, 2016.

[9] IIASA, personal communication, 2016.

[10] Policy Scenarios for the Revision of the Thematic Strategy on Air Pollution, IIASA, March 2013, page 18.

[11] Jeff Tollefson, Nature, 15 January 2013.

[12] Large, coal fired power stations that have very low energy efficiency and that do not meet the air emission requirements stemming from the Industrial Emissions Directive (2010/75/EU) sometimes use conversion to biomass use or co-firing of biomass with coal as a way to extend the lifetime of the plant and to make it more profitable through renewable energy support schemes. For example the Drax power station in England is being converted to use more biomass even though it has old, inefficient boilers and while it does not even meet the emissions standards set for large combustion plants in 2006.

20) With regard to the impacts of bioenergy on climate change, the combustion of different kinds of biomass for energy releases roughly 500 Mt of CO2e from European smokestacks on an annual basis[13]. Some of this comes from bioenergy systems which, when changes in carbon stocks and of other greenhouse gases in the land use sector and avoided fossil fuel combustion are taken into account, result in a net decrease in CO2e, whereas some comes from systems which contribute to a net increase in CO2e emissions when those same factors are taken into account.

21) Under existing accounting rules, these emissions from burning biomass are not accounted for in the energy sector but are assumed to be accounted for in the land and forestry sector. However, the accounting rules for this sector are full of loopholes which allow a significant proportion of bioenergy emissions to be ignored.[14] What is left is a system where there are inadequate biodiversity and social safeguards and highly problematic carbon accounting for the largest source of renewable energy in the EU. As a consequence of these defects, a system of policies and subsidies that is meant to drive emission reductions could be having precisely the opposite effect.

22) Unlike most other renewable energy sources, the EU's bioenergy use involves imported resources, even if not to the same extent as fossil fuel energy.[15] Pellet imports from North America are expanding[16] and one-third of the feedstocks for biofuels are already imported[17] from all over the world. The environmental impacts of this sourcing should be considered, and appropriate regional and local solutions should be promoted when combining the energy security aspirations of the EU's Energy Union Strategy with other pieces of EU energy policy.

23) At the same time, the alternatives to carbon-based sources of energy that require burning are gearing up and providing new opportunities. Renewables such as wind and, in particular, solar, combined with the further electrification of different sectors, and energy storage possibilities in the form of synthetic fuels, are quickly becoming cost competitive as technologies become cheaper and more efficient while coping better with future stresses for the energy sector like water scarcity. A study in Belgium[18] showed that power generation with biomass (wood pellets partly from South-Eastern US) is likely to be more costly to the governments and consumers than with solar or wind. At the same time, it should be noted that in some sectors such as aviation or

[13] National Inventory Submission 2015 of the EU to the UNFCCC, which includes emissions from biomass combustion as 'a memo item' and which are not included in the total emissions of the energy sector.
[14] See e.g. 'Why LULUCF cannot ensure that bioenergy reduces emissions' (July 2016).
[15] Imports of fossil fuels (gas, solid fuels and oil) from non-EU countries in 2013 accounted for around 53% of total gross inland energy consumption in the EU (EEA Overview of the European energy system), whereas biomass imports represent around 4% of the EU's bioenergy gross inland consumption according to the AEBIOM Statistical report 2015.
[16] AEBIOM Statistical report 2015
[17] Renewable Energy Progress report Staff Working Document, 2013
[18] Our Energy Future: Analysis of the impact of large biomass on the energy mix in Belgium, 2015.

shipping it will be more challenging to find alternatives to the use of liquid fuels.

24) On three-quarters of the world's land, solar PV systems today can generate more than 100 times the useable energy per hectare than bioenergy is likely to produce in the future even using optimistic assumptions. This difference in the land conversion efficiencies shows that it takes a large amount of productive land to yield a small amount of bioenergy, and why bioenergy can so greatly increase global competition for land[19].

25) Energy efficiency is also gearing up to be the next major game changer in the energy sector which is based on outdated business models of power plant companies trying to maximize electricity sales[20]. A shift in the business model of the energy sector to reduce reliance on baseload electricity production and better accommodate input from variable sources is needed, allowing a transfer to electricity production based fully on renewable energy.

26) As current EU policies for renewable energy have not given specific attention to the different qualities of different kinds of renewable energy sources or different kinds of bioenergy, there is an increasing pressure to use any available biomass and waste streams for energy generation as a seemingly easy option. After the controversies with food based biofuels in the transport sector, biofuels from residues and waste are of increasing interest not only in power and heat production but also in transport. In order to shed light on which kinds of bioenergy applications or end uses should be prioritised, it is nevertheless crucial to have an overview of which sources or feedstocks would be acceptable for energy generation (electricity/industry/heating/transport), and under what kind of conditions.

Defining and managing burnable carbon

27) In light of the challenges identified above, the question about 'unburnable carbon' should now be turned around. What is 'burnable carbon' (particularly biomass) which can be relied upon to provide a long-term secure input into a fully fossil-free, renewable energy system (transport, heating and electricity) while enhancing or at least not degrading biodiversity? The sources[21] of biogenic burnable carbon should be identified with indications of potential amounts available, timelines for their availability and most efficient uses.

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[19] Avoiding bioenergy competition for food crops and land, World Resource Institute, 2015 "The analysis calculated that on 73 percent of the world's land, the useable energy output of PV would exceed that of bioenergy by a ratio of more than 100 to 1. For the remaining 25 percent of the world's land, the average ratio is still 85 to 1 and the lowest ratio is 40 to 1."

[20] For example: EON Banks on Renewables in Split from Conventional Power, Bloomberg, 1 December 2014

[21] In the context of this paper, 'sources' encompasses not just the type of biomass but all aspects relevant to whether it can be considered sustainable or not.

28) The logical consequence of identifying what is 'burnable carbon' is that a) policies should be oriented to supporting the use of such energy sources, and b) all other sources are per definition either non-burnable or there is doubt about whether they are burnable or not, in which case they should be discouraged or at least (where there is doubt) not encouraged by policies and should be categorised as high risk investment choices in a world where ambitious climate, circular economy and biodiversity policies are adopted and enforced.

29) The EEB, together with other NGOs have already set out the basic principles on the kind of safeguards needed to ensure sustainable bioenergy use in Europe. These include a cap to limit the use of biomass for energy to levels that can be sustainably supplied; ensuring efficient and optimal use of biomass resources; include correct carbon accounting for biomass use for energy; and to introduce comprehensive, binding sustainability criteria.

30) Defining what can be considered as 'burnable carbon' in the long run is needed to get a more concrete understanding about what kinds of bioenergy use can meet these principles.

31) Global estimates of biomass availability (and land availability) for energy use vary widely in research studies, all the way from ≈ 30 to over 1000 EJ/yr. At present, global bioenergy use is roughly 50 EJ/yr[22]. The heat content of the total biomass harvested worldwide for food, fodder and fibre is about 219 EJ/yr.[23]

32) The wide range of estimates is due to various factors: assumptions on yield increases, consideration of other constraints on the area needed for food, feed or nature conservation, and geo-political considerations.[24] For example, a big potential for the increase of cropland in global modelling is seen in the savannahs of Sub-Saharan Africa[25], an area which includes some countries facing a high degree of political instability and the related effects on sustainable land management practices and governance.

33) The various global studies and estimates have so far not led to a consensus on the magnitude of future biomass potential or even the methodologies to estimate them but there is a higher level of agreement in literature over lower level potential estimates than on the higher ones.[26] It is worth noting that the intermediate estimates of sustainable bioenergy potentials such as 160 – 270 EJ/y[27] would correspond to the amount of biomass currently harvested globally for food, fodder and fibre.

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[22] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3778854/.
[23] http://www.ipcc.ch/pdf/special-reports/srren/Chapter%202%20Bioenergy.pdf
[24] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3778854/.
[25] http://www.nature.com/nclimate/journal/v5/n5/full/nclimate2584.html.
[26] http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12205/abstract
[27] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3778854/.

34) Some studies, while pointing to the significant potential of bioenergy to mitigate GHGs if resources are sustainably developed and efficient technologies are applied, also warn of significant trade-offs or note that especially the higher estimated availabilities imply significant and quite optimistic developments in land tenure and governance, and increased productivity of agriculture, forestry and livestock management.[28]

35) In studies estimating biomass potentials for energy in Europe, the highest variations stem from different assumptions on land availability. The two most important assumptions in this respect are about expected future "land release" from agriculture as production shifts elsewhere and due to the importance given to maintaining existing areas of fallow land as a key part of sustainable agriculture.[29]

36) For woody biomass, technical and economic potential estimates of wood availability for all uses in Europe are less varied. The differences for availability for energy use stem from differing assumptions on the development of competing, material uses of wood and on the level of environmental safeguards applied.

37) The EEB, together with BirdLife and Transport & Environment, commissioned a number of studies on the availability of biomass resources while respecting sustainability limits. A description of the main findings and the assumptions on which the studies were based are included for information in the Annex to this paper.

The 2050 outlook for burnable carbon

38) The majority of known fossil fuel reserves is 'unburnable carbon' that needs to stay underground if we want to have a reasonable chance to limit global warming. Peat should be considered to be equally 'unburnable' and categorized as a non-renewable energy source[30]. This requires Europe to show a leading example and set out a path to net zero emissions by 2040.[31]

39) An energy transition to 100% renewable energy while cutting overall energy consumption means that radical transformation of the whole new energy system is unavoidable. This also means more careful planning of what kind of renewable energy is needed where, especially when it comes to bioenergy.

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[28] See for example section 8.2.5 in http://www.ipcc.ch/pdf/special-reports/srren/Chapter%202%20Bioenergy.pdf.

[29] Biomass Futures Deliverable 3.1. Biomass availability & supply analysis

[30] See IPCC Task Force on National Greenhouse Gas Inventories, Frequently asked questions Q2-7.

[31] This would be in line with the 'Earth Statement' which the EEB has endorsed and which sets out a vision for a zero carbon society by 2050, and reflects the notion that the EU with its historic responsibility for emissions should firm up its global leadership by moving ahead of this target.

40) Biomass is a carbon based renewable energy source which often fits quite readily with the existing energy infrastructure and therefore may help development of systems that include more of variable sources of renewable energy.

41) The EU policy framework for the next decade (2020 – 2030) which will be decided in the coming few years is crucial to steer Europe in the right direction on climate and energy, the circular economy and many other policies, and to ensure that the EU is on the right track towards 2050. This requires a better alignment of climate and energy policies with the other sustainability policy priorities.

42) Better coherence is also needed in the modelling of future climate and energy scenarios to get a more accurate picture of the impacts on land, nature, biodiversity and ecosystems which are currently not assessed with the same level or preciseness as the energy sector.

43) For bioenergy, the demand needs to be re-directed to the kinds of biomass sources that are burnable also in the longer term and not just a "transition phase" or a temporary solution.

44) Biomass resources need to be used in the most efficient way possible and the right kinds of uses of them in the energy and other sectors incentivised to make the most of our planet's limited resources. Due to low energy efficiency, the use of biomass for electricity production alone, i.e. without Combined Heat and Power, should be phased out. Biomass use in a biorefinery context, where a range of products such as materials, food and energy are created, can maximize the biomass efficiency and make the most of the unique characteristics of biomass. But this is only the case if the residues from such biorefineries are returned to the soil, which is not always the case (sometimes they are incinerated). In countries with much livestock[32]and a lot of manure, straw is needed to mix with the manure in biogas plants, and here the surplus straw should be prioritised for use in biogas plants.

45) In small scale use of bioenergy, the emission limit values and energy efficiency requirements for boilers and stoves are a first step in the right direction, but further policy measures are required to ensure that there is no trade-off between Europe's bioenergy policy and air quality objectives. All larger installations generating energy from biomass should comply with air emission requirements that correspond with best available technique for new installations[33].

[32] This sentence is not meant to imply that having a lot of livestock is a good thing or that the EEB supports it, but rather, taking the quantity of livestock as a given (as was done e.g. in relation to the background studies), to point the merits of using surplus straw for biogas production.

[33] As defined in the Best Available Techniques Reference Documents (BREFs) developed under the IPPC Directive and the IED. The EEB advocates that only the BAT requirements for new installations, irrespective of the kind of energy source used, can be truly considered to be 'best available technique'.

46) The results of the recent EU economy wide assessment detailing if and how biomass resources are used in line with the cascading use principle[34] should feed into the development of policies promoting this principle, in a way that is in line with the goal of achieving net-zero emissions by 2040 at the latest.

47) Such an evaluation is needed to identify where support for bioenergy use is still needed. Support should be prioritised for bioenergy production that can on top of energy production deliver other co-benefits in the different policy areas. Good examples are biogas production from wastes that produces digestate that can be used to return the nutrients to the soil, use of grass and hay that should be harvested for nature conservation reasons or the use of clover from good crop rotation for biogas.

48) The efficient sustainable use of bioenergy, carried out in a way that enhances biodiversity and resilience, should be supported through research, development and appropriate subsidies.

49) To make progress towards the different, important policy aims on climate change, resource efficiency, biodiversity and environmental protection, the following actions can be considered as low risk options:

- Absolute savings in energy consumption and increased energy efficiency in all sectors of society.
- The EU needs to set out a path to net zero emissions by 2040 and net negative emissions after that, without resorting to unproven negative emissions technologies. Energy generation from coal and peat should be phased out by 2030 due to their high emissions and other environmental damage.
- Cut all subsidies to fossil fuels.
- Promotion and protection of proven carbon sinks and stocks.
- The promotion of renewable energy sources like wind and solar which are not exhaustible and do not emit carbon during generation, located and constructed in a way that minimises environmental impacts together with an interconnected and more flexible electricity network.
- Move from an agricultural production policy (the Common Agricultural Policy) in the EU to a food and consumption policy (e.g. Food and Stewardship Policy) to limit and scale down the environmental pressure on ecosystems caused by European consumption patterns and trade policies, including by supporting low emissions farming systems, significantly reducing meat production and consumption and thereby freeing land for other purposes, including nature conservation, food production and sustainable bioenergy production.
- Measures to improve biodiversity and environmental protection in Europe, including stricter environmental policies, better implementation of existing environmental policies, improved coherence between biodiversity and relevant sectoral policies, more environmentally friendly

[34] 'Cascades: study on the optimised cascading of wood', BTG Biomass Technology Group B.V. et al for European Commission, July 2016.

financial, fiscal and procurement policies and effective transparency and public participation[35].

- Measures to promote the circular economy and cascading use of biomass such as targets and indicators on resource efficiency, measures to expand the life time of products, including that of biobased products, targets to reduce food waste, ban on landfilling of organic waste and separate collection of it.
- Promotion of sustainable bioenergy systems, as elaborated in the following paragraph.

50) From a cross sectoral perspective bioenergy meeting the following principles should be considered to be burnable as part of a renewable energy mix and promoted as part of a future EU renewable energy policy:

- The overall amount of biomass used for energy[36] should not exceed the EU's 'fair share' of global biomass resources based on what the ecosystems can sustainably supply, taking account of the demands from other sectors and the extent to which these demands are sustainable, and should ensure that the total ecological footprint of Europe is not further expanded but rather decreased
- Only bioenergy sources that produce very low or even negative net GHG emissions, or significantly reduce net GHG emissions in comparison to the energy sources or system they substitute or other practically available alternatives, should be used, taking into account the direct and indirect carbon emissions from forests and land use as well as from the production life cycle of the bioenergy and the other energy sources or system in question.
- The time frame for evaluating the climate impact of bioenergy should be compatible with emissions scenarios for limiting warming to well below 2°C and pursuing efforts to limit temperature rises to 1.5°C.
- Energy production should not cause biodiversity degradation or the displacement of food production from agricultural land where this would, or would be likely to, have significant negative impacts, including through indirect land use changes.
- Any increase in forest harvest level for bioenergy purposes should only be allowed where it can be demonstrated, as a necessary but not sufficient condition, that this delivers significant net carbon benefits within relevant timeframes.
- The use of residues does not significantly harm soil quality, nutrients balance or carbon stocks of the soil or cause loss of biodiversity. Use of biomass for energy does not cause significant displacement of other, more efficient uses of biomass, including material uses.
- Waste biomass is used in line with the waste hierarchy as defined by Article 4 in the Waste Framework Directive and does not conflict with other aims of the EU waste policy, in particular moving the society towards a true circular economy.
- Bioenergy used does not drive the growing cultivation of invasive species.

[35] For more details see: Nature Legislation – Fit for purpose and in need of action

[36] Energy demand for land use and biomass is defined in the context of other sectors which need to be equally aligned with EU's ecological footprint and sustainability requirements.

51) Bioenergy that does not meet these principles should not be considered to be burnable carbon and should not be supported by public policies.

52) All of the biomass sources identified to be burnable to a certain extent nevertheless also require specific criteria in terms of quality and quantity to ensure their use for energy is in line with the principles above.

53) Policies and criteria are needed by 2020 to steer the bioenergy demand towards these biomass sources and to discourage and/or exclude the 'unburnable biomass carbon' from energy use. Legally binding sustainability criteria should be set to define what kind of bioenergy can be promoted or incentivised, including through being counted towards the EU's 2030 renewable energy targets or eligible for financial support. Such criteria could provide the basis for, at a later stage, developing criteria which determine what kind of bioenergy can be produced at all (irrespective of whether it is promoted or incentivised).

ANNEX: Summary description of studies commissioned by the EEB and others on the available quantities of sustainable bioenergy

1) The EEB has worked with BirdLife Europe and Transport & Environment on a number of studies on the availability of biomass sources while respecting sustainability limits. Studies have been carried out on land availability for energy crops[37], biomass from forestry[38] and on waste streams[39] as well as a general review of these studies and other available science[40].

2) These studies on biomass availability for energy use have used the following criteria and constraints to come to an assessment on the sustainable potential in Europe:
   i. Exclusion of biomass sources that already have existing other uses e.g. for wood products, animal husbandry, composting[41] and land care to avoid displacement;
   ii. Technical and economic constraints on forest harvests, no new policies to activate forest owners for additional harvest and a 5% increase in forest areas left outside of harvesting operations;
   iii. A maximum of 70% removal of forest residues from harvesting sites and stricter limits on poor soils and peatlands;
   iv. No stump extraction;
   v. 33% of agricultural residues left on land to maintain soil condition;
   vi. Minimum displacement of food production from existing agricultural land due to energy production in order to minimize negative impact to the environment including through indirect land use changes (ILUC);
   vii. Majority of existing fallow land assumed to remain out of production on the basis of agronomic and environmental importance;
   viii. Increased recycling targets for municipal solid waste and packaging waste and phase out of landfilling according to the EC 2014 waste package proposal;
   ix. Food waste generation reduced by 30% by 2025.

3) The results of the studies suggest that when the above assumptions are made, on the basis of current trends and assuming business as usual in relation to competing uses, within a decade or so the EU will be using an amount of bioenergy equivalent to all of its sustainable potential, taking into account EU objectives for biodiversity and improved waste management. The results also suggest that the EU is currently not using biomass for energy in the most effective manner, and

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[37] Policy briefing: Space for energy crops, 2014

[38] Policy briefing: Forest biomass for energy in the EU, 2014

[39] Wasted – Europe's untapped resource, 2014

[40] Summarized in: How much sustainable bio-energy does Europe have in 2030?: https://www.transportenvironment.org/sites/te/files/publications/How%20much%20sustainable%20biomass%20available%20in%202030_FINAL.pdf

[41] While this paragraph simply describes the criteria and constraints assumed in the study in estimating the sustainable potential in Europe, it has been subsequently pointed out that use of anaerobic digestion may be preferable to (more sustainable than) composting in that it produces a renewable source of energy while yielding a residue that can still be spread on arable land and contribute to carbon storage in the soil.

that there is a mismatch between the types of biomass the EU is currently using and those types identified as forming the EU's sustainable potential. For example AEBIOM estimated that in 2013, 70% of EU bioenergy came from forests and forest industries and 17% from agriculture, whereas 40% of 2030 sustainable biomass comes from forests or forest industries and 52% from agriculture identified as sustainable potential.[42]. The studies did not look into impacts of major societal life style changes such as if unsustainable competing uses e.g. meat consumption were reduced, which would increase the potential scope for bioenergy.

4) The final results (see Table 1 below) show that the potential of burnable carbon for energy use in 2030, if competing land uses and methods of bioenergy production remain unchanged, is less than the estimated demand for bioenergy in scenarios by the European Commission.

5) The potential availability of burnable carbon for energy use estimated in these studies and based on the aforementioned assumptions translates into 45% of the EU's 2020 renewables target (20%) or 30% of the 2030 renewables target (27%), assuming average conversion efficiencies and that targets for energy efficiency are met. Currently bioenergy makes up about 65% of the EU's renewable mix. The potential decreases from 2020 to 2030 mostly due to increasing competing demands for biomass from other sectors as well as due to increased levels of recycling. Obviously reductions in e.g. meat production and consumption could allow for a greater bioenergy component.

Biomass source	**Low risk quantity suitable for energy use (Mtoe) in 2030**
Agricultural waste	52.4
Non-forest / industrial woody residues	42.6
Manure	18.9
Forest harvesting residues	10.4
Ligno-cellulosic waste	8.1
Forest stemwood	7.6
Energy crops[43]	7.4 *(equivalent to 1.34 Mha of land used for energy crops)*
Sewage	3.0
Used Cooking Oil	1.2
Landfill gas	0.5

Table 1. Biomass sources with the most potential and feasibility to be 'burnable carbon' for the production of energy and fuels according to the aforementioned study and associated assumptions

[42] See: http://www.aebiom.org/library/statistical-reports/statistical-report-2015/

[43] Energy crops are defined as agricultural energy crops, meaning crops that are grown exclusively or primarily for the purpose of producing biomass for energy purposes in an agricultural rather than a forestry context.

6) Competing sectors place most demand on forest stemwood, on woody residues and on sewage in 2020 – 2030. The study did not look in detail at the possibilities of increased production of biomass e.g. in forests that if carried out in a sustainable way would have the potential to increase sustainable biomass supply including potential for energy purposes. While in some cases it would be possible to increase production and supply in a sustainable manner, in other cases this would come at the expense of biodiversity and/or climate objectives.

7) While various constraints on biomass availability for energy use were applied in the studies, no major shifts in competing demands, land use and production and consumption patterns for which there are currently no clear policy guidance, were assumed. Significant shifts in global consumption or production patterns would affect biomass availability, by increasing or decreasing its availability. In either case, increases or decreases cannot automatically be assumed to be for the direct benefit of another specific sector as there are also growing demands for land as a carbon sink, for ecosystem restoration, as a source of resources for a biobased economy or to increase food production.

8) Table 2 summarises the identified low risk potential of biomass for energy use and the projected demand for bioenergy in various scenarios by the European Commission and NGOs. The preliminary analysis shows that there is still a significant discrepancy and trade-offs between long-term decarbonisation scenarios, aims to improve resource efficient biomass use (i.e. reducing the burning of valuable renewable resources) and estimates of sustainable biomass supply that will need clarification.

9) However, the Greenpeace Energy [R]evolution scenario for EU27[44] assessed that moving to 100% renewable energy by 2050 is feasible also with a limited amount of bioenergy from residues and waste, matching the low risk potential identified as burnable in the studies commissioned by the EEB, BirdLife Europe and T&E. The advanced Energy [R]evolution scenario assumes that Europe would have around 40% of renewable energy by 2030 and that bioenergy would be used primarily for dispatching in the electricity sector, heating and aviation, shipping and other heavy transport.

[44] Greenpeace Energy [R]evolution for EU27, 2012

POTENTIAL (Mtoe)	2020	2030
Technical potential of biomass for energy (after excluding the demand by other sectors)	318	287
Low environmental risk potential of biomass for energy according to the aforementioned study and associated assumptions	172	152
DEMAND (Mtoe)	**2020**	**2030**
National Renewable Energy Action Plans 2020	140	-
EU 2050 Roadmap Reference Scenario (2013)[45]	153	163
Commission 2030 impact assessment reference scenario	-	178
Commission 2030 impact assessment GHG40/EE/RES30 scenario	-	192
Greenpeace Energy [R]evolution scenario for EU27 (2012)	-	154

Table 2: Potential and demand scenarios for bioenergy in EU28 in 2020 and 2030

[45] An update to the EU Reference Scenario 2016 was published in June 2016 but as it does not include aggregated figures on total bioenergy demand, the 2013 reference scenario has been used here for comparison.