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Proposals for a Reform of the Renewable Energy Directive to a Renewable Energy and Materials Directive (REMD)

Going to the next level: Integration of bio-based chemicals and materials in the incentive scheme

Authors: Michael Carus (nova-Institute), Lara Dammer (nova-Institute), Andreas Hermann (Öko-Institut) and Roland Essel (nova-Institute)

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Proposals for a Reform of the Renewable Energy Directive to a Renewable Energy and Materials Directive (REMD)

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0 Executive Summary

The presented reform proposal aims at creating a level playing field for bio-based chemicals and materials with bioenergy and biofuels in Europe. It is fundamentally different from other reforms of the Directive being currently discussed because it opens the perspective to not only look at energy, but also at bio-based materials.

The proposal is based on the insights that the support system for bioenergy and biofuels created by the RED and the corresponding national legislations is one of the main reasons hindering the bio-based material sector from developing – and therefore the whole bio-based economy.

It is time to understand that the RED stems from a time when biomass was available in abundance and it made sense to create the framework, but that today biomass is a highly valuable raw material that should be allocated in the most efficient way possible. At the moment, the legislation causes serious market distortions for bio-based feedstocks that have been reported by a multitude of companies. Unfavourable framework conditions combined with high biomass prices and uncertain biomass supplies deter investors from putting money into bio-based chemistry and materials.[1]

Furthermore, several problems with the current framework have been become apparent over the last few years, as for example the fact that some Member States are not on track with meeting their quotas or that feedstock bottlenecks have appeared due to the increased and unbalanced demand for biomass.

This reform proposal aims to offer solutions to all these issues, while improving the generation of value added, employment, innovation and investment in Europe. All of these criteria can be better fulfilled by industrial material use than by energy use (of the same amount of biomass). The strengthening of the bio-based material sector will contribute to the desired industrial renaissance recently communicated by the European Commission, while still reducing greenhouse gas emissions and contributing to a strong climate policy of the EU. Furthermore, it aims at lessening the dependence on public subsidies while still using, preserving and expanding the existing structures in place for bioenergy and biofuels.

The revolutionary proposal calls for an opening of the support system to also make bio-based chemicals and materials accountable for the renewables quota of each Member State. The basic idea is to transform the RED into a REMD – a "Renewable Energy and Materials Directive". It does not intend to establish a new quota for the chemical industry. Instead, it proposes that the material use of a bio-based building block such as bioethanol or biomethane should be accounted for in the renewables quota the same way as it counts for the energy use of the same building block, e.g. fuel. Other building blocks, such as succinic acid, lactic acid, etc. could be accounted for based on a conversion into bio-ethanol equivalents according to their calorific value. Reduction of greenhouse gas emissions could also be the basis for such a conversion.

Six more evolutionary proposals complement this comprehensive idea of a REMD. They focus especially on resource efficiency by restricting bioenergy's share of the RED quotas, strengthening solar and wind power within the European renewables framework and by including more CO_2-based fuels in the quota. It is proposed to abolish multiple counting within the quota, except for raw materials stemming from cascading or recycling processes. Furthermore, in the future representatives of the material sector should also be heard for any reform concerning energy won from biomass.

Finally, the reform paper addresses the current debate about sustainability certifications for biomass used for any purpose. It points out that sustainability certifications for the energy sector were only implemented hand in hand with considerable incentives. This aspect is often forgotten in the discussion. The paper proposes installing the same sustainability criteria for biomass used for materials that are required for the use of energy, if the same incentives are applied. In such a context, an expansion of today's sustainability schemes to cover more criteria would be welcome.

The paper is completed by two Annexes: One includes statements of companies that feel the negative impacts of the distorted market for biomass caused by the RED; and the other presents comprehensive background information on all statements of the main paper as well as the specifics of industrial material use.

1 Introduction

Why should there be another reform paper concerning the Renewable Energy Directive (RED)? Because it is fundamentally different from others and proposes a true development of the RED towards a Renewable Energy and Materials Directive (REMD), which would mean opening the Directive for bio-based chemicals and materials.

The bioenergy and biofuels sector has gotten into troubled waters; investments are stagnating. The effects on global food prices, pressure on ecosystems, and direct as well as indirect land use changes (LUC and iLUC) are more in the focus of public debate than the previous growth and future opportunities and investments. This is partly due to the fact that all of the sector (with some exceptions in the wood heating market) is strongly dependent on incentives. If those are reduced, many companies might face bankruptcy and new investments will stop.

At the same time, the "true" bio-based economy does not pick up speed. This is caused, among other things, by the framework conditions created by the RED, which systematically prevent new developments and investments in the higher value added applications such as bio-based chemicals and materials by only supporting energy use of biomass. The European Union is one of last regions worldwide that has not implemented a level playing field – in the U.S., bio-based chemicals are eligible for the same support programmes as biofuels under the Farm Bill since February 2014.

1 "Whereas world capacity for biobased chemicals and materials is rapidly growing, Europe clearly lags behind. Lux Research, a Boston based company, expects a doubling of global biobased capacity in 2017 to 13.2 Mton. But Europe's share will drop from 37% in 2005 to 14% in 2017." *(www.biobasedpress.eu/2014/03/biobased-chemicals-european-share-drop-sharply/)*

The RED was conceptualized at a time when biomass was available in abundance. Today it is a challenge to generate the most value added and the highest reductions of GHG emissions with a limited amount of biomass. The goal should be to increase resource efficiency and cascading use towards a circular economy. Today's RED is mostly blocking such developments; only a comprehensive reform can change this.

This means also facing a second challenge: The existing infrastructures of bioenergy and biofuels should be used, preserved, and expanded. By promoting new material applications of biomass, more value added can be created and new investments attracted.

This paper is a contribution to reach these goals. It has been created over the course of two years in continuous exchange with leading experts of Europe's bio-based economy.

2 The Renewable Energy Directive (RED) and Its Goals

The Renewable Energy Directive (RED)[2] created the very first EU legal framework for the use of renewable energy in the three areas of electricity, heating/cooling and transport. The goal is to meet 20 % of the EU's overall energy demand ("gross final energy consumption") through renewable energy by 2020, along with a minimum of 10 % of transport demand. It also defines a specific level of its final energy demand that each individual state must cover through renewables by 2020. These quotas are binding for Member States and the EU is free to impose sanctions on any state that does not meet these objectives.

These regulations were created before a backdrop of both increasing awareness of a pressing need for worldwide climate protection as well as steeply increasing prices of fossil energy, which made the dependence of Europe on energy exporting countries clearer than ever.

The RED held solutions for both these issues: The obligatory reductions of greenhouse gas emissions from the energy sector were the EU's contribution to the reduction goals set forth in the Kyoto Protocol from 1997, which came into effect in 2005. With its 20 % goal, the EU's plans exceed the reduction targets of the Kyoto Protocol.

At the same time, the alternative ways of locally and regionally producing energy that were heavily incentivized through the RED and its subsequent national legislations seemed to offer some degree of independence from energy imports in a time when "oil peak" was frequently talked of and the "fracking boom" had not yet started. These circumstances helped to find a broad consensus for necessary action.

Even a third purpose was served with the energy support programmes: Since the 1990s, new market opportunities for agricultural products had been searched for in order to support the struggling agriculture, which produced too much and faced a continuing decline of prices and employment. Energy served as a very attractive outlet for these biogenic materials. Thus, the RED was able to generate massive effects with relatively few mechanisms and within a relatively small amount of time: In 2012, energy from renewable sources was estimated to have contributed 14.1 % of gross final energy consumption in the EU28, compared with 8.3 % in 2004, the first year for which this data is available.

The successfully implemented bioenergy and biofuel industry used the incentives very well, creating an amazing dynamic in technology development, investment and logistics and last but not least, a reduction of CO_2 emissions.

2 European Parliament and the Council 2009: Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, Brussels, 2009-04-23.

3 Time for a Reform

As shown above, the original intentions of creating the RED cover a broad range of important objectives and it has indeed led to significant, positive results in the change of the European energy landscape. However, several points of criticism make it clear that there is a necessity to introduce comprehensive reforms to the legislative framework. These points are, among others:

Most Member States are not on track to meeting the targets set out in the RED – reduced and non-binding targets for 2030?

A recent report has shown that most Member States are lagging behind on fulfilling the RED renewables quotas under the current conditions (European Commission 2013). This endangers the ambitious climate goals of the EU and can have negative impacts on its credibility in the struggle to keep the 2°C goal of the Kyoto Protocol.

Several Member States question the planned increase of the renewables quota by 2030 and would prefer to avoid technology obligations. Accordingly, the European Commission introduced a proposal in early 2014 to increase the GHG reduction from 20 % (in 2020) to 40 % in 2030 (baseline 1990), but decreased the target for the share of renewables in the total energy supply mix to 27 % in 2030 (instead of formerly discussed 30 %) and renounced any binding quota for the Member States (European Commission 2014). The European Parliament continues to insist on binding quotas on renewables for the Member States. This has given ground for on-going heated debates. This paper proposes another solution that could make it possible to increase binding targets as planned but to fulfil them in more ways than is possible today (see Chapter 6).

Bioenergy and biofuels are expected to make up 60 % of the overall quota and almost 90 % of the transport quota.

That is the result of a study by the Joint Research Centre of the European Commission from end of 2011 (JRC 2011). Although bioenergy used to serve as an appropriate outlet for the overproduction of agricultural goods in the 1990s and can be a sustainable energy source in local or regional contexts, this overwhelming share in the overall renewable quota was probably not planned when the Directive was devised and leads to several further negative consequences.

Experts estimate that the EU's demand for wood pellets will strongly increase to 29 million tonnes by 2020, from 8 million tonnes in 2010. Two-thirds of the pellets will be imported from abroad. (Reuters 2013)

Feedstock bottlenecks

The logistics needed to fulfil the RED quotas with biomass are quite elaborate and show more and more defects. The most staggering effect is the enormous increases in imports of wood pellets into the European Union, which is environmentally questionable and is also economic madness. It is already clear that many countries will only be able to fulfil their quotas, if at all, by importing great amounts of wood pellets, biodiesel and bioethanol from North and South America as well as from Asia[3]. The direct and indirect land use changes (LUC and iLUC) incurred by these mechanisms have been widely discussed in the EU, but no solution has been found so far. Furthermore, the development of

3 If electricity from wood pellets were to reduce CO_2 emissions, then the reduction would be highest if the wood were to be used in its country of origin – because transports would no longer be necessary and because the energy supply mix in typical wood exporting countries is often worse in terms of CO_2 intensity. This means that the export to Europe only contributes to reducing European emissions, but not to a global reduction. On a global level, reduction potentials are left untapped.
There are justified doubts whether any CO_2 is saved at all, when no longer only waste streams of the woodworking industry are used for pellets. Now, even fresh trees are processed into pellets and the forest needs decades to regrow the CO_2 stores. (EcoWatch 2013)

the second generation lignocellulosic fuels is proving to be extremely difficult and expensive, with several big players leaving the sector over the last few years after the projects became more and more expensive and showed less and less promise of success. Other second-generation raw materials such as side streams have very limited availability and would need to be transported quite far, too, if they were to be utilized on big scale.

Market distortions between energy and other uses of biomass

There has been widespread criticism of the biofuels and bioenergy policy of the EU creating food shortages and exacerbating existing food crises. But another sector is also massively affected by this framework: The industrial material use of biomass (for a definition and an explanation of what constitutes industrial material use of biomass, please see Annex II, Chapter 1). Due to the massive support policy for bioenergy and biofuels, the allocation of biomass is distorted. Multiple counting for certain feedstocks makes this problem even more pressing, even though a recent study has shown that multiple counting has not led to significant technological improvement (ePURE 2013). The non-level playing field between energy and material use of biomass creates negative impacts, which are illustrated in more detail in Chapter 5, among others **hindering resource efficiency, innovation, employment and investment in Europe**.

Reforming the RED is hardly a new idea since the Directive has been under heavy and controversial discussion for a while now. The iLUC proposal from 2012 (European Commission 2012) constituted one big step in the direction of a reform, but the debate is still on-going and will not lead to a substantial change in the framework.

Despite all of the on-going discussion, this paper presents some aspects that have been completely absent from the political debate about the RED so far. It presents approaches to solutions for most of the problems previously mentioned above, while following a number of criteria that aim at ensuring that the reform proposal is driven by real, rational and scientifically sound objectives.

4 Criteria for a Redesign of the RED

The objectives guiding a political reform proposal should be clear in order to make the motivations behind said proposal transparent. When developing the ideas behind this paper, the following overarching policy goals for Europe were taken into consideration:

- Guaranteed food security
- Increased climate protection
- Increased resource efficiency – circular economy and cascading use
- Increased value added creation
- Increased employment generation
- Strengthen innovation
- More investment and production in Europe

We propose these criteria as the basis of any discussion about the reform since they are widely accepted by mainstream political debate and are defined by several official EU policy documents.

Creating incentives, policy should prefer those biomass pathways that lead to better climate protection, higher resource efficiency, more value added and jobs, strengthened innovation and renewed investments in Europe.

As mentioned above, the current legislative framework strongly favours the energetic uses of biomass as compared to industrial material use. The following matrix in Table 1 evaluates which of the possible uses of biomass has the potential of best fulfilling selected defined criteria. Food and feed are exempted from this evaluation, since they play a special role and should always have priority in the allocation of biomass. So this matrix is only concerned with what happens with biomass after food (and feed) security has been guaranteed.

Criterion	Fulfilled by			
	Bioenergy	Biofuels 1. Generation	Biofuels 2. Generation	Industrial material use
Climate protection	+ to ++	+	+ to ++	+ to ++
Resource efficiency (cascading, circular economy)	–	–	–	+/– to ++
Value added	+	+	+	+ to +++
Employment	+	+	+	+ to +++
Innovation	+	+	++	+ to +++
Independence from incentives	– to +	–	– –	– to ++
Commercial operation possible also on small and medium scale (local feedstock, less capital)	+/– to +++	+/–	–	+/– to +++

Table 1: Criteria matrix for a Redesign of the RED

Explanations to Table 1

In terms of **climate protection**, the different uses of biomass are at least equal, with several studies showing considerably higher potential for greenhouse gas reductions through material use of one tonne of biomass compared to energy use of one tonne of biomass (see Annex II, Chapter 6).

Especially for **resource efficiency**, the current support system in the RED is not beneficial at all. There are no incentives for multiple (cascading use, see Annex II, Chapter 10) or circular use of resources and materials. Quite the contrary: Financial incentives make it attractive, for example, to incinerate quality wood, which under "normal" (meaning non-influenced by the RED) circumstances would never be economically viable.

The creation of **gross value added and employment** is much higher for industrial material use per tonne of biomass or cultivation area, because of the much longer and complex value added chain (see Annex II, Chapter 4).

Material use with its manifold applications and complex processing chains furthermore has the potential to generate much more **innovation** and subsequently attract **investments** to Europe, if the framework conditions were favourable. Compared to that, the innovative power of bioenergy and biofuels is more limited, with investments going considerably back over the last few years.

Bioenergy (except parts of the wood to heat market) and biofuels heavily **depend on strong incentives**. Bio-based chemicals and materials today only exist in niche markets because of very specific high performance pathways and/or the willingness of the market to pay

GreenPremium prices (Carus, Eder & Beckmann 2014). Comparably small incentives could boost all of the sector, making many bio-based chemicals and materials profitable: material production chains are much closer to being competitive than biofuels due to their higher added value – especially if biomass prices are not artificially inflated by one-sided subsidies for energy use.

Especially second generation biofuels are only profitable on **large scale**, with the need of high investment volumes and a huge biomass supply, which can be realised best at big harbours only. For bio-based chemicals and materials, the situation is different. Because of the higher value added creation, also small scale production could be profitable (see Annex II, Chapter 12), allowing a local feedstock supply and specific process routes.

And finally, in energy there are a lot of green alternatives apart from biomass to meet the demand, such as solar and wind. In materials, alternatives for carbon supply are very limited and the worldwide demand is increasing even faster than for energy due to higher living standards.

5 The Current Effects of the RED on the Industrial Material Use of Biomass

A comprehensive analysis of hurdles carried out by nova-Institute (Carus et al. 2014) shows that the RED (associated with the FQD [Fuel Quality Directive 9870] in the transport sector) is one of the main causes[4] of the longstanding and systematic discrimination between material and energy uses. The RED hinders the development of material use by providing comprehensive support to energetic uses of biomass that is not balanced by comparable incentives for the material use. The impact is unfair competition for biomass as pressure on established biomass uses in the material sector and significant potentials for innovation, value creation, and climate protection that remain untapped.

Unfavourable framework conditions combined with high biomass prices and uncertain biomass supplies deter investors from putting money into bio-based chemistry and materials – even though these would produce higher value at greater resource efficiency (see Annex II, Chapter 4). This may also constrain the development and operation of integrated bio-refineries

In order to realise the potential of bio-based chemicals and materials, to establish a level playing field there is a need for a new political framework.

Therefore, the proposed reform measures seek to amend the RED in order to **reduce market distortion between material and energy use and to prevent future misallocations of biomass (due to economic and ecological criteria)**.

The market distortion covers the following points:

- Cultivation areas – increasing land prices; this is especially a problem for industrial niche crops (fibre, dye, pharmaceutical).
- Increasing prices for biomass – too expensive for bio-based chemicals and materials to compete with petrochemical products.
- Residues and waste – strong incentives for biofuels, which is lost for many industrial material uses.
- Output focus of biorefineries: Because of the existing incentives, bio-refineries produce almost only biofuels. From an economic point of view, almost no biofuels should be produced, but high-value chemicals. And because of this incorrect focus, the operations depend heavily on incentives. (Piotrowski et al. 2014)

Conclusion: Insecure availability of areas/biomass for other sectors than bioenergy or biofuels.

The following Table 2 shows examples, for which the framework of the RED has already created conflicts about biomass use. Annex I includes detailed explanations for these examples and statements of concerned industries that have witnessed a market distortion because of the RED and that feel detrimental impacts on their businesses.

Although market distortion and misallocations affect the whole biomass sector, market distortion is becoming particularly visible in the case of supposedly unused residues.

Product	Competition for	Competition to
Surfactants, other chemicals (Oleochemistry)	Animal fats, vegetable oils	Biodiesel
Epichlorohydrin, acrylic acid and acrolein	Glycerol	Glycerol-based fuels (e.g. biomethanol in gasoline blends) and fuel additives (e.g. GTBE)
Bio-ethanol for chemicals	Sugar, starch, cellulose	Biofuel sector, fossil-based ethanol for chemicals
Bio-based chemicals/building blocks	All kinds of biomass, especially residues from forest and agro industries	Biofuel & bioenergy sector
Natural Fibre Composites, insulation material, technical textiles, speciality pulp & paper	Agricultural areas	Biofuel & bioenergy sector; especially biogas
Pulp & Paper and cellulose fibres for textiles, nanocellulose	Wood	Bioenergy (heat & electricity) from burning wood (and 2nd generation biofuels in the future?)
Pine chemicals (e.g. rosin, etc.)	Tall oil (by-product from pulp & paper)	Biodiesel
Furniture, panel and other construction materials (woodworking industry)	Wood	Bioenergy (heat & electricity) from burning wood (and 2nd generation biofuels in the future?)
Potting soil, growing media	Bark (wood), green waste for compost	Bioenergy (heat & electricity) from burning wood (and 2nd generation biofuels in the future?), biogas

Table 2: Cases in which the RED has already created conflicts of biomass use (see Appendix I)

4 Above all the RED is one major cause that can be relatively easily addressed through political reform. A tax on fossil carbon used by the chemical industry would be probably a more suitable solution. Today the worldwide chemical industry pays no taxes on crude oil or natural gas. However, this approach can only be implemented on a global level, since considerable market distortion would otherwise result.

Co-products, residues and waste

In the context of the RED, a feedstock used to produce a biofuel for transportation can either be classified as a product, a co-product, a residue or a waste. For a feedstock classified as a residue or a waste, it will be easier for the fuel producer to fulfil the sustainability criteria of the RED. Furthermore, the double counting mechanism depends on the use of a residue or a waste, and in some Member States there is also a direct link to eligibility for state aid for instance in the form of tax benefits. In other words, from the fuel producer's perspective, feedstocks classified as residues or wastes are of great interest.

The RED does not include any definitions of residue or waste and, as a result, there is today not one harmonized way of implementation. Several member states have chosen to define the terms in accordance with already existing environmental legislation, such as the Waste Framework Directive, while others have created definitions believed to be suitable for RED purposes. This has resulted in feedstocks being classified differently in different member states, i.e. a feedstock which in one member state is seen as a co-product can very well be labelled as a residue in another. In the iLUC proposal, the importance of feedstock classification still remained; however, the proposal still did not include a binding harmonisation of terms with the Waste Framework Directive. The proposal did contain a definition of waste, but none for residue. The latter is also not defined in the Waste Framework Directive. Therefore, discrepancies between definitions of residues would remain with such an approach, as would the non-harmonisation and the negative impact on non-energy applications.

6 Reform Proposals

6.1 Introductory Remarks

In different recent publications of the European Commission and the European Parliament, they showed that they are aware of the existing market distortion and the need for a reform of the existing policy framework.

> "**Bio-based products:** granting access to sustainable raw materials at world market prices for the production of bio-based products. This will require the application of the cascade principle in the use of biomass and eliminating any possible distortions in the allocation of biomass for alternative uses that might result from aid and other mechanisms that favour the use of biomass for other purposes (e.g. energy). (p. 10)
> In addition and based on preliminary assessments, the Commission will wherever necessary propose measures to eliminate price distortions that prevent EU firms to have access to key inputs for industry at international market prices. The Commission will ensure policy neutrality in access to biomass for different purposes to enable efficient application of the cascade principle in the use of the biomass to ensure an efficient and sustainable use of natural resources. Also if deemed necessary, it will consider measures to enable industry to have access at global market prices to key inputs such as bio-ethanol or starch for bio-based industrial activities emerging from traditional sectors such as chemicals, paper and other forest-based industries. (p. 15)" (European Commission 2014b)

A larger share of industrial material use of biomass gets tailwind from one of the latest main targets of the European Commission which is that a 20 % share of GDP should be generated by industrial production (manufacturing) in the EU by 2020, compared to 15.1 % in 2013:

> "The objective of revitalization of the EU economy calls for the endorsement of the reindustrialisation efforts in line with the Commission's aspiration of raising the contribution of industry to GDP to as much as 20 % by 2020." (European Commission 2014b)

An increasing use of biomass in bio-based chemicals and materials would be very well in line with strengthening the industrial production in the European Union.

In a report on the Commission's Bioeconomy Strategy, the European Parliament also stressed the need to design bioeconomy policies "in order to ensure a cascading use of biomass" and therefore to develop "a legal instrument that will pave the way for a more efficient and sustainable use of this precious resource" (European Parliament 2013, see also Annex II.9).

However, the political and practical implementation of these insights is still lagging behind in Brussels and the Member States. While many Asian countries and the U.S. (since early 2014 see Annex II, Chapter 13) have started to create a level playing field for bio-based chemicals and materials, Europe has nothing to show for in terms of comprehensive reforms or strong instruments. DG Enterprise and Industry for instance focuses on norms and standards, labelling, public awareness and public procurement for bio-based products. All of these are important topics for an establishment of a long-term market of bio-based materials and products, but barely help in the everyday competition for biomass and market access. They will not be enough to trigger large-scale effects and investment.

Strong instruments would mean making bio-based materials and products economically attractive for the industry or end consumers – as was successfully accomplished for bioenergy, biofuels, solar, wind, and electric cars.

Now is exactly the right time to change the framework and attract new investments to Europe. The capacity and investment crisis in parts of the bioenergy and biofuels sector could be overcome with the following reform proposals: With the right incentives, a transformation of existing structures of bioenergy and biofuels production towards the industrial material use of biomass could be initiated now, leading to greater value added and a much lower subsidy level. This is a challenge and a great opportunity at the same time!

The following part will focus exclusively on reform proposals for a redesign of the RED.

In principle, also other strong measures are conceivable, such as a tax on fossil carbon used by the chemical industry. Today the worldwide chemical industry pays no taxes on crude oil or natural gas. However, this approach can only be implemented on a global level, since considerable market distortion would otherwise result.

Bio-based chemicals and materials could (and should) be integrated in the Emission Trading System (ETS) with increased prices for fossil CO_2. Another idea is the limitation of the CO_2 footprint of plastics and other materials, which could be beneficial for bio-based materials. But none of these ideas are really developed for a concrete implementation.

Incentives for energetic and material biomass utilization linked to CO_2 reduction could be realised via the RED reform proposed in this paper.

6.2 A genuine level playing field for material and energy uses, involving an expansion of the RED into a Renewable Energy and Materials Directive (REMD) to include new bio-based material use in the existing RED quotas

At the moment, the quotas set out in the RED can only be fulfilled by energy and fuels since it was developed for these products. Would it not be possible to open this for other applications?

The basic idea of our proposal is to include industrial material use of biomass, such as bio-based chemicals or materials, in the RED overall quotas and also in the fuel quota. This would make producing bio-based materials an additional option of fulfilling the RED quotas; it is not meant as a replacement. From a technical and legal point of view, it is relatively simple to open up the RED quota in this way (see below).

That means that the member states get the additional option to fulfil their RED quota for renewable energy and fuels not only by solar, wind and bioenergy or biofuels and electric cars, but also by new investments in bio-based chemicals and materials. That does NOT mean a new quota for chemicals – it is only an additional option to fulfil the existing quota.

This would involve recasting the RED as a Renewable Energy and Materials Directive (REMD) and would live up to the RED's initial goal of reducing greenhouse gas emissions. Material uses of biomass cut greenhouse emissions by a comparable amount to biofuels, at least – per tonnes of biomass resp. per hectare, each compared to its petrochemical counterpart.

But what would this inclusion actually look like? For example, the RED quota should count chemicals and polymers made from ethanol (via ethylene) produced from certified sustainable biomass in the same way as it counts bioethanol as a fuel. Of course the sustainability of the biomass used for the bioethanol has to be certified such as in the case of biofuels (see Chapter 7) and also the requested CO_2 reduction has to be confirmed[5].

Just as bio-based ethanol, methane also is a fuel as well as a bio-based building-block for chemicals and polymers. In those cases it is easy to open the quota 1:1 for material use. All other bio-based chemicals such as succinic or lactic acids or many others can be converted into bioethanol (or biomethane) equivalents on the basis of their calorific value and could then be counted for the quota in the same way as bioethanol resp. biomethane. That would be the simplest and most pragmatic means of including them – but on the other hand not very fair because the economic value of a chemical building-block can strongly differ from its energy content. It would be preferable from a climate policy perspective to calculate values on the basis of the greenhouse gas emissions that are prevented (per tonnes of biomass or cultivation area), but this would surely be less admissible in law than calculating on the basis of calorific value.

Of course, correlating calculation systems would also have to be developed for other industrial material uses of biomass in order to include them in this system – see Chapter 1 in the Annex II for an overview of all material uses that would have to be included.

However, attention must be paid to ensuring that there is no double counting over the long, complex material value chains, from e.g. building block/monomer via polymer to plastic.

Expanding the RED into a REMD would give Member States the additional option to fulfil their target quotas with bio-based chemicals and materials and create the necessary conditions for their chemical and material industries. This could be of great interest to some Member States that wish to implement appropriate measures to strengthen industrial innovation and investment in their country, while also fulfilling their RED quotas. It is also an interesting option in order to solve all the issues explained above.

The proposal addresses one problem especially: It would make it even possible to again define higher shares of renewables that are obligatory for the Member States to reach. This decision is currently highly controversial, and this proposal presents a solution: By opening the quota for non-energy uses of biomass, Member States would gain additional options for reaching their renewable shares. Instead of only energy, they could fulfil their quotas with chemicals and materials, too.

The REMD should include bio-based and CO_2-based chemicals and materials. It must not fall into the trap of only providing funding for fuels, as was the case for biomass, when setting the political framework conditions for a CO_2-based economy. It should ensure from the outset that CO_2's energy and material uses are treated equally (see proposal in Chapter 6.3.6).

It is up to the individual Member States whether they take up this option and how they apply the new Directive in practical terms. The important thing is less the introduction of quotas as they were set for fuel than reducing investment risks by supporting pilot and demonstration plants or by helping to establish the first commercial plants using new technologies, or by applying even more stronger instruments.

Which plants should be included?

The introduction of such an REMD would require an examination of plants qualifying for the scheme. From the point of view of promoting technological innovation and greater emissions reductions, it would make sense to count only new material plants. On the other hand, this would do nothing to alleviate the competition between existing material processes and the energy sector for raw materials (e.g. crude tall oil, animal fats; see Table 2) and the reform might well not achieve its goal. This requires further discussion. New plants and increases in capacity since 2009 (the year the RED was introduced) or 1990 (the base year for emissions reductions) could potentially be included retroactively.

The legal framework

If the RED[6] is expanded into an REMD, it should be investigated whether the existing legal competence for passing RED 2009/28/EC would also cover regulations for material uses of biomass (e.g. its inclusion in the overall RED quota).

Like many energy bills enacted before the Treaty of Lisbon came into force, the RED 2009/28/EC is based on Article 95 of the Treaty establishing the European Community (TEC) (Internal Market) and Article 75 of the TEC (Environment)[7]. According to Article 192 §1 (ex Article 175 TEC) in conjunction with Article 191 of the Treaty on the Functioning of the European Union (TFEU)[8] , the EU has jurisdiction for environmental protection. Of the objectives which EU policy on the environment should pursue according to Article 191 §1 TFEU, it is the first em dash on "preserving, protecting and improving the quality

5 Definition of absolute GHG reduction targets per tonne of biomass or unit of land: The percentage GHG targets in force for biofuels cannot be easily applied to long material production chains. If material and energy use are to be compared, the respective greenhouse gas reductions must be converted into absolute values per unit of biomass or per hectare. First investigations show that most forms of material use easily compete with the best biofuels (Carus et al. 2010). Other questions are, if and how the carbon storage effect should be taken into account with bio-based products, and whether GHG reduction targets could potentially be set at the building block level.

6 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, Official Journal of the European Union L 140 of 5.6.2009.

7 Cf. explanations of the legal basis in Directive 2009/28/EC (source in FN 8).

8 Consolidated Version of the Treaty on the Functioning of the European Union, Official Journal of the European Union C 115 of 9.5.2008; p. 49.

of the environment" and the third em dash on "prudent and rational utilisation of natural resources" that are of relevance to regulations governing the material use of biomass. Cascading use of biomass (i.e. first material use and only then energy use) contributes to rational utilisations of biomass as a natural resource, since material use comes before a raw material is "lost" through burning. Therefore, the EU has the legal competence to regulate the corresponding material use of biomass on the basis of Articles 191 § 1 and 192 TFEU. Since the RED is based on Article 192 TFEU (ex Article 175 TEC), it is possible to introduce a corresponding regulation on biomass use into the existing RED. The inclusion of material uses for biomass in the RED quota is covered by the environmental jurisdiction of Articles 191 & 192 TFEU. Material uses of biomass are just as effective as energy uses at reducing greenhouse gas emissions, which was the RED's initial objective. The goal of reducing greenhouse gas emissions is to protect the climate and the environment, as stated in the first em dash on "preserving, protecting and improving the quality of the environment". These foregoing explanations demonstrate that regulations on the material use of biomass can be integrated into the existing RED and thus an "REMD" would require no alterations to the legislative basis.

Equal treatment as soon as possible

Given the current economic climate in Europe, it makes less sense than ever to systematically rank material use of biomass behind energy use, which creates less value and is more dependent on subsidies. Developing the RED into an REMD as described above would be a landmark on the road towards establishing a level playing field for both sectors.

This would lead to new investments in innovative material plants, greater resource efficiency and more value created from biomass. It is a challenge to use, preserve and expand the existing structures of bioenergy and biofuels while achieving these goals.

6.3 Six evolutionary proposals: Reform of the RED to reduce competition for land, market distortion and biomass misallocation, along with promoting improved land-use efficiency

In addition to the comprehensive reform proposal presented above, we suggest six measures related to the RED that have the potential to contribute to a level playing field. Some of them can be implemented alongside with the comprehensive REMD idea, but some of them could even be implemented if the comprehensive reform does not take place.

6.3.1 Listening to representatives of the bio-based materials sector

Whenever the RED is revised, it should not just be the bioenergy and biofuel associations who have a say. Input should also be more widely sought from associations and representatives involved in industrial material use of biomass in order to avoid the new Directives having negative side effects, especially additional market distortions that have an impact on material use. This would have made it possible to anticipate the undesirable outcomes with animal fats, crude tall oil and bark, for example, in advance and prevent those raw materials from being included in the iLUC proposal list of multiple weighted residues.

The hearings should be held not just on the first draft, as has been usual in the past, but also on the final proposal.

6.3.2 Restricting bioenergy's share of the RED quotas

Bioenergy and biofuels are expected to make up roughly 60 % of the overall quota and about 90 % of the transport quota by 2020 (JRC 2011).[9] If one were to restrict the bio-energy share of the overall quota and the transport quota to 40 – 50 % and 80 % respectively, for example, a significant amount of pressure would be removed from biomass. The authors suggest that this kind of regulation would be more useful than limiting the share of first-generation biofuels[10]. The quotas would then have to be filled with a larger amount of solar and wind power and other renewable sources. Limitations on the biofuel share of the transport sector would need to be lower for the time being since alternatives such as electric cars and CO_2-based fuels are not yet sufficiently widely available on the market. When they are, then the biomass share of the quota should be reined in accordingly. However, earlier restrictions on the biomass share could help electric cars and CO_2 to break through more quickly.

6.3.3 Increasing land-use efficiency through higher shares of solar and wind energy

Solar and wind power harness far greater amounts of energy per unit area or, put differently, use far less area to utilize the same amount of energy than biomass. This is true for heat, electricity and transport (see Annex II, Chapter 5). Solar and wind energy should therefore receive a higher share in fulfilling the total quota (see 6.3.2).

This would make it attractive to develop land-efficient solar and wind energy while (meeting the same quotas) reducing the pressure on agricultural land. Special incentives should also be created for electricity from energy storage facilities, as these are important for the further development of solar and wind energy and are capable of gradually replacing increasingly scarce biomass for storage and base load operation. Also CO_2-based fuels have huge storage potential (power to gas), see 6.3.6.

6.3.4 Differential counting to optimize resource efficiency

To date, the differential counting of various fuels in the quota is intended to steer technology development, in particular to support new lignocellulosic and algae-based technology (the so-called second and third generations count double). This whole counting should, however, be reconsidered and redesigned to deliberately avoid market distortions that are harmful to material use or resource efficiency. A new approach to counting would seek the most sensible allocation of biomass between the energy, transport and material sectors, i.e. the most resource-efficient, environmentally friendly and highest value solution (see Table 1).

From our point of view, multiple counting should be avoided, because the impacts on market distortion are larger than foreseen. Multiple counting for certain feedstocks such as residues and waste makes competition problems even more pressing for other applications (see Annex II, Chapter 10). A recent study has also shown that multiple

9 "By far the largest so-called renewable energy used in Europe is wood. In its various forms, from sticks to pellets to sawdust, wood (or to use its fashionable name, biomass) accounts for about half of Europe's renewable-energy consumption. In some countries, such as Poland and Finland, wood meets more than 80 % of renewable-energy demand. Even in Germany, home of the Energiewende (energy transformation) which has poured huge subsidies into wind and solar power, 38 % of non-fossil fuel consumption comes from the stuff. After years in which European governments have boasted about their high-tech, low-carbon energy revolution, the main beneficiary seems to be the favoured fuel of pre-industrial societies." (Economist 2013)

10 Second and third generations are often less resource efficient than the first generation (food crops), see Annex II, Chapter 8 and Carus & Dammer 2013.

counting has not led to significant technological improvement (ePURE 2013). Furthermore, multiple counting reduces the volume of production and investment and therefore also the realised CO_2 reduction.

As an exception, double counting in the REMD should be restricted to specific biomass, which is related to especially high CO_2 reduction. For example biogenic raw materials from cascading use, recycling processes ("circular economy") or secondary streams should count double as energy, fuel or bio-based material in the REMD quota.

If the RED were not to be expanded to the REMD, we propose: Biomass – fresh biomass crops, waste and residues – that can be used for higher-value purposes (including the aforementioned animal fats, crude tall oil, crude glycerine and bark) should either be excluded from the RED quotas or else only be included with a maximum single counting.

6.3.5 Increasing resource efficiency through cascading use

The RED does not offer any incentives for cascading use and is therefore not conducive to promote a circular economy and resource efficiency. The new REMD should make cascading utilization of biomass far more attractive than the direct use of fresh biomass. The REMD's quota rules should include double counting for biomass that comes from a cascade, recycling or secondary streams. Such a regulation would require a pragmatic framework and is crucial for improved resource efficiency in Europe.

The double counting is justified by the fact that a cascading use leads to an – at the minimum – double substitution of fossil counterparts – first by replacing a conventional product, possibly even several times in case of recycling, and at the end of the life, a fossil energy source will be substituted by the same material (see for a more detailed schematic explanation Annex II, Chapter 9).

6.3.6 Inclusion of CO_2-based fuels and chemicals in the quota

CO_2-based fuels (solar fuels, power to gas, power to liquid) as well as CO_2-based chemicals and polymers are in their infancy, but experts expect them to be commercially available between now and 2020.[11] Their swift inclusion in a renewable fuels quota (instead of the national biofuel quotas) would, firstly, help this new technology to break through quickly and, secondly, reduce the pressure on biomass and land.

CO_2 fuels and chemicals require hardly any extra land aside from the land needed to produce renewable power and are therefore extremely land-efficient. This also helps to reduce the pressure on land (see also Annex II, Chapters 5 and 7).

Hence, CO_2-based fuels produced using power from renewable sources should be included in the RED transport quota and count double.

Today, in several Member States, "biogenic CO_2" stemming from biomass incineration is treated as a biogenic raw material. "Renewable hydrogen" produced with renewable energy such as solar and wind will fall into the "renewable liquid and gaseous fuels of non-biological origin" category, which would mean that they could be counted quadruple, according to the pending European Commission's proposals from October 2012 (European Commission 2012).

Combining biogenic CO_2 with renewable hydrogen to renewable methane or liquid renewable fuels is already accepted in different Member States for fulfilling the national quota. With the pending European Commission's proposal this would be officially accepted on EU level and for all Member States.

Our proposal goes two steps further:

1. Following the RED logic, there is no reason for not also including fossil CO_2 if renewable energy or hydrogen is used to upgrade it to methane or liquid fuels. The RED is not limited to biomass – solar, wind, electric cars are included anyway. And: The European Commission's proposal of October 2012 also accepts fuels from algae farms as renewable fuels, even if they are fed with CO_2 from flue gas produced by coal incineration.
2. CO_2-based chemicals and polymers should be fully integrated in the REMD quota (see Chapter 6.2). For chemicals and polymers, the energy needed to utilize the CO_2 could be much lower than for fuels, in some cases not even the reduction of CO_2 is necessary.

Whether double or quadruple counting should be applied has to be discussed in the framework of the future of multiple counting (see Chapter 6.3.4).

These proposed changes would be built into Member States' national legislation. Individual countries can then use their considerable room for manoeuvre to put these proposals into practice in a comprehensive and country-specific manner.

This kind of reform to the RED would be a first step towards equal treatment for energy and material uses of biomass, could avoid evident misallocation of biomass, and would reduce the pressure on biomass and land.

7 Two Sides of One Coin: Sustainability Certification and Incentives for Bio-based Products

As a future target for a sustainable world, all kinds of biomass for all sectors – such as food, feed, material and energy – should be certified for their sustainable production. Today, as a first step, biofuels on the European market have to prove the sustainability of their feedstock (based on a very limited set of criteria) – if they want to be eligible for the incentives of the RED. In the near future this procedure will be expanded to the use of solid or gaseous biomass for bioenergy, again in the context of receiving incentives from the RED. However, this expansion will only be on a voluntary basis of each Member State, because the Commission does not intend to take further and binding action in the area of sustainability of biomass for the period to 2020.

For other biomass uses, such as food, feed and also industrial material uses, there are no binding certification schemes in place yet.

For bio-based chemicals and materials, which should be accountable for the proposed expanded REMD quota, the proof of sustainability of the used biomass should be obligatory as it is for biofuels today.

Paradoxically, various initiatives and committees – for example INRO in Germany, GreenDeal in the Netherlands and CEN on a European level – are currently discussing on national and European levels which comprehensive sustainability criteria (many more than for biofuels) should be applied to the neglected area of bio-based chemicals, materials or products – without discussing any incentives.

The following table shows, how the sectors of biofuels, bioenergy and industrial material use of biomass are treated (or are planned to be treated) concerning the sustainability of their feedstocks, depending on different incentive schemes. In comparison, also the petrochemical sector (fuels and chemicals) is added.

11 The proportion of CO_2-based fuel produced using geothermal electricity is already 5% in Iceland. In 2013 for example Audi AG (Germany) invested in CO_2-based fuel production using excess wind energy and CO_2 originating from biogas incineration for electricity. Meanwhile, about 20 of those pilot facilities are operating in Germany.

	Industrial material use, CEN TC 411 on bio-based products (draft version 2014)	Biofuels	Biofuels	Bioenergy	Bioenergy, proposal for solid and gaseous biomass (draft version 2014)	Fossil-based energy, fuels & products (petro-chemicals)
Incentives	no	no	with RED incentives (accounted for in the renewable fuel quota)	no	with RED incentives on voluntary basis of the Member States (accounted for in the renewable fuel quota)	different subsidies in many countries
Number of environmental criteria	9	0	5	0	7	0
Number of social criteria	6	0	0	0	0	0
Number of economic criteria	1	0	0	0	0	0
Total number of sustainability criteria	16	0	5	0	7	0

Table 3: Sustainability criteria for different sectors and applications (energy and material) (detailed table in Annex II, Chapter 11)

It is interesting to see that bioenergy and biofuels do not have to fulfil any sustainability criteria if they are not counted in the quota. To be accounted for, biofuels have to fulfil five environmental criteria and bioenergy seven criteria according to the last proposal.

For industrial material use, no incentives are implemented today, but due to the recent discussions these materials are supposed to voluntarily fulfil nine environmental criteria, six social and one economic criteria (detailed table in Annex II, Chapter 11) – much more than are obligatory for biofuels and bioenergy with incentives.

Implementing a level playing field between material and energy uses would also mean that obligatory sustainability criteria are only introduced when incentives are provided at the same time. They should not constitute additional hurdles for the industrial material use of biomass.

Within the proposed REMD, the same sustainability criteria should be obligatory for the use of biomass in all applications, if the application is to be accounted for in the quota. In this context, it is desirable to expand the criteria to cover more aspects than they do today for biofuels.

The fact that the petrochemical sector is not obligated to fulfil any sustainability criteria and there is no controversy about this issue is astounding, especially since the large majority of criteria from Table 3 could be applied to petrochemical applications as well. In fact, it would be appropriate to develop sustainability criteria for fossil energy sources, too, and then to impose according taxes on them, for instance. Such criteria could be minimum social standards and wages for workers and environmental burden caused by the extraction, which is higher by a relevant degree in the case of oil shale and shale gas, for example.

> "The main problem I see related to the bio-based content of our products is that there is a pressure to produce biomass in a sustainable way, but no such pressure on fossil raw material. It is costly to show compliance with regulations (e.g. timber regulation) and obtain certificates (e.g. FSC, PFC). Competing fossil-based products do not have these costs. This is a draw back for bio-based products.
> To solve this problem there should be corresponding requirements also on fossil based raw materials. There should be both environmental and social requirements to fulfil. Even though crude oil is not sustainable as such there are more or less environmentally acceptable ways to extract fossil oil and gas. It is urgent to create a more level playing field!" (Haglund 2014)

The paradox of sustainability certification for industrial material uses of biomass

The paradox consists of different aspects:

- Biofuels and bioenergy have to fulfil a very limited set of sustainability criteria – and only if they apply for the incentives of the RED or the corresponding national implementations. These incentives lead to increased biomass costs.
- The petrochemical sector does not have to fulfil any sustainability criteria at all.
- The neglected area of bio-based chemicals and materials does not receive any incentives, suffers from high prices for biomass (also due to the incentives for biofuels and bioenergy) and is in full competition to the petrochemical sector – but this sector should voluntarily fulfil the most comprehensive set of sustainability criteria. This can lead to additional hurdles for the sector, because of higher prices for certified sustainable feedstock, access to those feedstock and costs in the value chain.
- Some representatives of the chemical industry, not discussing any sustainable criteria for their dominating petrochemical feedstock, are part of the process developing complex sustainable criteria for their biomass feedstock. (We think that most of the industry's efforts are honest contributions, but there are some thoughts among bio-based experts that this could sometimes also be a strategy to delay development of the bio-based economy.)
- There is no serious discussion about the fact that sustainability and incentives are inextricably linked for biofuels, but that there is no such link in the debate of bio-based materials and their sustainability. A level playing field needs to consider these aspects, too.

Several factors become apparent when looking at the reasons behind this development. On the one side, there are companies that have been producing bio-based chemicals and materials for a long time and that are established at the market, but can only grow slowly. On the other side, there are companies that have recently developed new bio-based products and are introducing them now on the market. These new products in particular are often more expensive than existing petrochemical products because they have to make up for development costs and new investments in production facilities, because their feedstock is more expensive and because economies of scale can often not be reached in the beginning. In contrast, the petrochemical counterparts are mostly produced in fully depreciated facilities. It is very hard to overcome such hurdles if the political framework does not provide any protection or promotion.

The only possibility to circumvent this difficult situation is to realize a GreenPremium price for the bio-based product. This is in fact possible; there are customers that pay an extra price for a “green, environmentally friendly product” at the same technical performance, because they expect an added emotional and strategic performance (Carus, Eder & Beckmann 2014).

Of course, customers willing to pay these GreenPremium prices (B2B and B2C) require a guarantee from the seller that the desired emotional and strategic performance can be obtained by the product. In particular, this means that the biomass used in the process can show a sustainability certification, since this is something valued highly by NGOs and the public. And if sustainability is taken seriously, a higher number of criteria need to be fulfilled than is currently required from biofuels and bioenergy within the RED schemes (here barriers are also set by the WTO, for instance for determining social criteria).

Within this context, it makes sense that companies participate in initiatives such as INRO or GreenDeal. On the GreenPremium market, they can only benefit from widely accepted certifications that are also approved by NGOs and a critical public.

Conclusion

The current efforts to establish a comprehensive set of sustainability criteria for bio-based chemicals and materials result from the unlevelled playing field between material and energy uses, which means that the material use needs GreenPremium prices in order to survive on the market. These prices can only be obtained with biomass that holds a widely accepted sustainability certification.

This however shows the existing weak points in the energy sector that receives political incentives even if only very few criteria are proven. Or in the petrochemical sector that does not have to fulfil any obligations at all.

As soon as the political framework promotes a level playing field between material and energy uses (e.g. through the REMD proposal) and sustainability certifications become obligatory in order to receive incentives, it is important that both sectors have to fulfil exactly the same criteria. The creation of new, one-sided hurdles should be prevented. In this context, it is desirable to expand the criteria for all sectors – biofuels, bioenergy and bio-based chemicals and materials – to cover more aspects than the five criteria obligatory for biofuels today.

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8 Annex I: The Industry Perspective – Companies suffering from the Bioenergy / Biofuel Policy in the European Union

I.1 Introduction

The following section presents a collection of evidence illustrating the negative effects of the bioenergy and biofuel support on a variety of branches using biomass for industrial material use. Newspaper articles, primary research and most of all statements from directly affected companies clearly show the extent of the market distortion. All of the companies see an unfair competition for their different bio-based raw materials that stems from the Renewable Energy Directive and they see very concrete negative impacts on their businesses.

Product	Raw material	Company or Association	Competition	P
Surfactants, other chemicals (Oleochemistry)	Animal fats, vegetable oils	Emery Oleochemicals (Germany)	Biodiesel	16
Surfactants, other chemicals (Oleochemistry)	Animal fats, vegetable oils	AkzoNobel (The Netherlands)	Biodiesel	16
Epichlorohydrin	Glycerol	Solvay (France)	Glycerol-based fuels (e.g. biomethanol in gasoline blends) and fuel additives (e.g.) GTBE	16
Acrylic acid and acrolein	Glycerol	Arkema (France)	Glycerol-based fuels (e.g. biomethanol in gasoline blends) and fuel additives (e.g.) GTBE	16
Bio-based chemicals / building blocks	All kinds of biomass, especially residues from forest and agro industries	Perstorp (Sweden)	Biofuel & bioenergy sector	16 f.
Composites, insulation, technical textiles, etc.	Agricultural areas	HempFlax (The Netherlands), BaFa (Germany), HempTechnology (UK)	All kinds of agricultural biomass	17
Pine chemicals (e.g. rosin, etc.)	Tall oil (wood)	Arizona Chemical (Sweden), Pine Chemical Association	Biodiesel	18
Pulp & Panel	Wood	Schwarzbauer & Stern	Bioenergy	20
Furniture, construction materials (woodworking industry)	Wood	Pfleiderer (Germany), HDH (Germany), and more	Heat & electricity from incineration (and in the future 2nd generation biofuels?)	20
Cellulose fibres (paper, viscose, lyocell, etc.)	Wood	Heinzel (Germany), Mondi (Austria) Sappi (Austria), Lenzing (Austria) and more	Heat & electricity from incineration (and in the future 2nd generation biofuels?)	20 f.
Potting soil, growing media	Bark (wood), green waste for compost	Industrieverband Garten (IVG) e.V.	Heat & electricity from incineration (and 2nd generation biofuels in the future?), biogas	21
Bio-ethanol for chemicals	Sugar, starch, cellulose	SEKAB Biofuels & Chemicals (Sweden)	Biofuel sector, fossil-based ethanol for chemicals	21

Table I.1: Competition for different types of biomass

I.2 Agricultural biomass: Chemical industry and natural fibre materials

Different branches rely on agricultural bio-based feedstocks and feel the impacts of the one-sided bioenergy support in terms of increasing prices and a distorted competition – for materials as well as for land. We have collected statements from the chemical industry and natural fibre manufacturers that feel those detrimental effects.

I.2.1 Animal fats & vegetable oils

Hermann-Josef Keller, Senior Manager Procurement Oils & Fats at Emery Oleochemicals, Germany, October 2013:

> "Animal fats are the main feedstock of the European oleochemistry. From the fats, we produce fatty acids and glycerol, which are then used as raw materials by other chemical industries. The available amount of animal fats in Europe is limited to 2.7 million t and can only be replaced by palm oil. As a consequence, we can only survive against the competition from Asian palm-oil based fatty acids if we have enough animal fats available locally or regionally.
>
> For ten years, we have been fighting against a distorted competition that originates in one-sided incentives (quotas, CO_2 certificates, subsidies etc.) for animal fats that go to the biodiesel industry – which was already difficult with single counting. The sad fact is that the use of animal fats in the oleochemistry has decreased by ca. 200,000 – 300,000 t during the last ten years. Now, they are practically preparing the finishing stroke for our industry by considering that animal fats – mostly Cat1 and Cat2 [low and medium categories, editor's note] – should be counted double in the quota. This distorts the market to extreme extent and is even susceptible for abuse: In England, Cat3 [high category, editor's note] fats are added to Cat1 fats in order to increase the amounts for fats eligible for double counting. Furthermore, Neste Oil in Finland imported more than 200,000 t of Cat3 animal fats that are collected and mixed in the Netherlands." (Keller 2013a)

Application	Market Segment	2006	2011	2012
Technical	Oleochemistry & soap industry (no subsidies)	840	585	585
Energy	Fuel substitute/captive use burning (no subsidies)	700	277	250
	Biodiesel, subsidies & quota	90	500	525
	Bioelectricity, subsidies & quota	40	100	110

Table I.2: Demand for animal fats in Europe (in 1,000 tonnes) (Keller 2013b)

Peter J. Nieuwenhuizen, Director Future-proof Supply Chains at AkzoNobel, Netherlands, November 2013:

> "Substantial price increases occur whenever governments incentivize one use of a product over another. There is a robust industry utilizing animal fats as raw materials for making products everywhere from household to industrial uses. The latest EU proposal would allow a 'double dipping' of subsidies by the biodiesel industry. The double dipping occurs due to the use of the renewable feedstock, which is itself incentivized through the biofuels quota, and then on top of that using BSE concerns to turn acceptable tallow into a "waste", which makes it unacceptable to use for any other application than for biofuels and also eligible for double-counting. The traditional oleochemicals industry uses all of the available animal fats with the same CO_2 reduction as biodiesel based on a full life cycle analysis. Implementation of these harmful practices will force more use of petroleum to make products or unsustainable palm production." (Nieuwenhuizen 2013)

I.2.2 Glycerol

Thibaud Caulier, Senior Business Development Manager at Solvay's Global Business Unit Emerging Biochemicals, Belgium, August 2013:

> "In recent years, the price of glycerol significantly increased due to the development of new applications for this bio-based feedstock. This already puts bio-based glycerol chemistry in a tough competitive position compared to fossil alternatives. Awarding multiple counting to biofuels produced from glycerol distorts the market and puts the future of high added value bio-based chemistry at risk." (Caulier 2013)

Jean-Luc Dubois, Scientific Director at Arkema, France, January 2014:

> "Arkema has been developing a technology for the conversion of glycerol to acrylic acid (and acrolein). The work was initiated at a time when a high production of biodiesel was expected for Europe, in order to take advantage of the glycerol that would be coproduced. Although the technology is now ready, we are in a situation where the multiple counting system has on one side reduced the volume of biodiesel produced in Europe, and on the other side promoted the "combustion" type applications for the glycerol produced. It diverts any glycerol produced to the fuel sector, generating a lower availability of glycerol on the market and higher prices.
>
> Since glycerol is a very important intermediate, on which many companies had research projects not only for acrolein, acrylic acid, epichlorohydrine and popylene glycol, the conceptualization of fuel policy should also take into account the valuable products that could be made out of it. R&D programmes and investment funds could also be targeted to generate glycerol from biomass and biomass hydrolysates, to restore the high volumes of glycerol that were expected so that the technologies which have been developed could be implemented in Europe." (Dubois 2014)

I.2.3 Bio-ethanol for Chemicals

Urban Svensson, Director Global Procurement at Perstop AB, Sweden, December 2013:

> „Unique materials, future jobs and incomes as well as opportunities for sustainable chemical industry based on renewable raw materials are in danger of going up the smokestack. The nature has provided us from time immemorial with natural medicines, dyes, detergents, tackyfiers, fragrances, flavors etc. And more recently synthetic vanilla (vanillin) derived from sulfite pulp lignin residues, the sugar free sweetener - Xylitol and the cholesterol lowering ingredient - called "plant stanol ester" (marketed as Benecol) the two latter both derived from kraft pulp residues. And there is a lot more to be developed given the right conditions and off course given that the raw material is not burnt or used as fuel.
>
> Perstorp has already launched a series of products based on renewable raw materials and we believe that, at least in theory, 70% of our products, today fossil based, could be produced using bio-based raw materials. We spend over 80% of our

R&D work on developing more efficient and environmentally sound products and processes and we initiated together with peer industries in the Stenungsund pet-chem complex the "Sustainable Chemistry 2030".

Long-term secure supply of raw materials at world-market prices is absolutely crucial for all these projects and initiatives. Bio-ethanol is probably the most important for today's bio based chemical industry but residues from forest and agro industries will grow in importance as well as re-use and recycling of used materials. But these are also in the focus of the fuels and energy sector for their bio-based offers.

A level playing field between uses of biomass in the chemical industry and in fuels and energy is absolutely essential, and the chemical industry has shown strong competitiveness with fuels and energy for fossil raw materials where there is a level playing field.

To summarize, the bio-based chemical industry needs:

- Access to secure supply of raw materials at world market prices – by removal of import restrictions and duties in particular for bioethanol.
- Level playing field with energy & fuels." (Svensson 2013)

I.2.4 Natural fibres

Several manufacturers of natural fibres have reported on how the one-sided support of biomass for energy purposes negatively impacts their businesses, sometimes even driving complete ventures to other countries since agricultural land is no longer available at acceptable prices:

John Hobson, National Sales Manager of Hemptechnology, UK and President of the European Industrial Hemp Association, September 2013:

"Despite the growing demand and interest from automotive and insulation industry, European hemp fibres cannot really profit from this development, in contrast: the whole European natural fibre industry is suffering from the wrong policy framework and the cultivation areas of hemp have been decreasing over the last few years. Recent policy leads to a market distortion regarding feedstock availability and costs: The increasingly high prices for arable land can only be afforded by highly subsidised energy crops. Under the existing policy framework, hemp cannot offer the same profit for farmers, the result is an ever decreasing cultivation area. And on top of that European hemp fibres are completely unprotected from the competition with imported exotic fibres like jute, kenaf or sisal, which cannot even show a sustainability certification like imported biofuels." (Hobson 2013)

Bernd Frank, Managing Director of BaFa – Badische Naturfaseraufbereitung GmbH, Germany, September 2013:

"We sold our BAFA-industrial processing line for hemp to 'Planète Chanvre SAS' in France in the year 2011. There are several reasons, which have moved us to take this step. But the main reason was the amendment of the German biogas production policy, for sure. Since the new EEG in 2004, it was more and more difficult to find farmers for growing hemp. The fields were no longer to pay for us as processor. We could not meet financial expectations of the farmers because of the disproportionate support of the biogas materials.This policy, which prefers the energy use of the material, has lasting disrupted the cultivation of hemp and the hemp industries, which was established since 1996 in Germany.

As Sales Company, we now still exist in Germany as a 100% daughter of 'Planète Chanvre SAS'." (Frank 2013)

Mark Reinders, Wholesale/Business Manager of HempFlax, Netherlands, September 2013:

"Yes I am a victim of the policy, especially the German policy regarding biogas production. In 2009 we had approximately 360 ha of hemp in Emsland (part of Germany close to the factory), last year less than 80 ha and now approximately 100 ha. Most of the lost area went to a biogas plant, which offered 1,200 Euros rent per hectare. We offer now 800-900 Euros financial remuneration per ha, but then the farmer needs to do the work himself. If he is renting out his land to a biogas plant, then the biogas plant is doing all the work (not in a very good agricultural way).

We can't compete on land costing 1,200 Euros per ha if we need to sell our fibres to the Automotive industry and our shives to animal bedding. I have decided that I want to be in control of my own raw material supply. That is the main reason to move production to Rumania." (Reinders 2013)

I.3 Forestal Biomass – Chemical industry, wood-working industry, cellulose fibres, growing media

Wood is the most used renewable raw material in terms of volume and serves as a basis for manifold products – such as pulp and paper, pine chemicals, furniture and construction materials, innovative composite materials, cellulose-based textiles and growing media or potting soils. In the following section, you can find statements from diverse companies that all use materials won from wood to manufacture high value products and who see negative impacts on their business, mostly from the high subsidies for burning wood, but also from classifying by-products of wood processing as "residues" instead of "co-products", which qualifies them for multiple counting in the biofuels quota, even though they serve as valuable raw material for chemicals such as rosin.

I.3.1 Pine Chemicals

Anna Holmberg, Sustainability Policy Director Europe at Arizona Chemical, Sweden, August 2013:

"Crude Tall Oil (CTO) is a versatile chemical and renewable raw material used by Arizona Chemical for over 80 years for a big variety of high value added products. CTO is produced by pulp and paper companies as a co-product of pulp production – so in other words a scarce resource as it does not respond to changes in demand. It is therefore utterly important that a level playing field exists between different buyers on the demand side and all potential buyers must be able to compete for the scarce resource on equal terms.

The incorrect Renewable Energy Directive (RED) classification of CTO as a residue instead of a co-product, which is the case in Sweden and which is being debated in Finland, in combination with existing high incentives for CTO biofuels clearly have tilted the CTO procurement market in favor of biofuels in the last couple of years. Arizona Chemical does not consider that a level playing field exists today.

The double counting mechanism means that the value of the biofuel is doubled. Assuming all other costs remain the same, this converts into the biofuel producer being able to pay a higher price for CTO as they otherwise could. Arizona Chemical is forced to match the price paid by the biofuel producer to be able to procure CTO. If the existing situation prevails, over time, CTO will become too expensive and the chemical industry will be displaced. In approx. 80 % of the cases, the end customer will replace no longer available CTO based products with alternatives from petrochemical sources with a substantially higher carbon footprint.

Including CTO on the Annex IX list of the Indirect Land Use Changes (ILUC) proposal would send a very strong signal to the market, as it declares that CTO is a preferred biofuel feed stock in the EU. It would further imply that, from the political perspective, the preferred use of CTO is for biofuels and not for high value added products. Arizona Chemical argues that the EU should refrain from such political intervention in the CTO procurement market." (Holmberg 2013a)

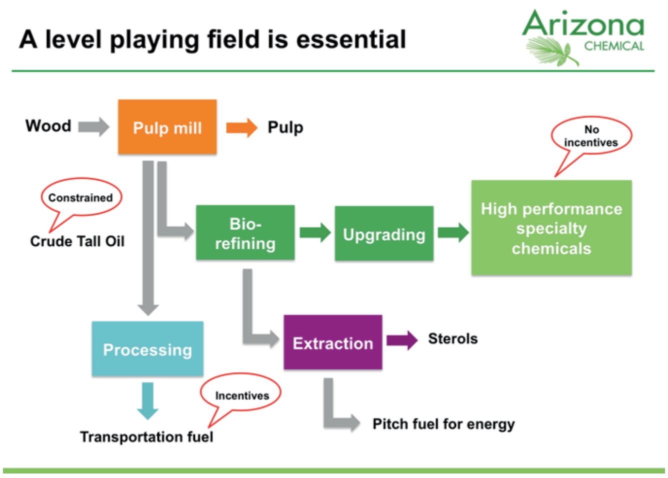

Figure I.1: Maximized value creation from Crude Tall Oil by applying cascading use (Holmberg 2013b)

Charles Morris, President and COO, (World-wide) Pine Chemical Association Inc. (US), January 2014:

"*Pine Chemicals Industry: Established bio-product industry*

The pine chemicals industry is a thriving bio-based business that uses renewable resources responsibly, has a positive impact on the environment, and creates products that add value to society. The pine chemicals industry pioneered the use of sustainable, renewable raw materials to make every day products. Today, pine chemical bio-refineries globally are producing state-of-the-art, low carbon footprint industrial ingredients for hundreds of business-to-business customers.

In a process that begins with managed, sustainable pine forests, the pulp and paper industry produces the co-product Crude Tall Oil (CTO), one of the primary raw materials used in manufacturing pine chemicals. The pine chemicals industry has long used CTO as the foundation for a pipeline of environmentally friendly products that add critical value to other businesses, society, and the bio-economy.

Innovative, high value, biorenewable products

As early visionaries in the efficient use of biomass to create renewable products, the pine chemicals industry has continually made substantial investments in high technology manufacturing and R&D. CTO is biorefined in technologically-sophisticated, capital-intensive fractionation plants that produce high quality, innovative products. Today's pine chemical innovations are contributing to road safety with improved markings and luminosity, reduced fuel consumption due to enhanced materials used in tires, and food additives that decrease cholesterol.

Lower carbon footprint

A recent independent study has shown that diverting CTO from its current use in industrial chemicals to use as a biofuel will neither reduce carbon emission levels nor reduce fossil fuel use. One of the benefits the pine chemicals industry brings to society is that it efficiently uses a renewable biomass resource to create environmentally friendly products that in turn are used to make an array of consumer products.

An independent, peer-reviewed analysis (Franklin 2013) shows:

- The carbon footprint of pine chemicals is 50% lower than substitute products used in the same situation.
- If CTO is used in a transportation fuel, the reduced carbon emissions will be totally offset by the higher emissions of the products that will be substituted for pine chemicals. Additionally, the study shows that the amount of fossil fuel required to manufacture the substitute products offsets any fossil fuel reduction that might occur if CTO were used in fuel.

Implications

The logical conclusion, therefore, is that with no net reduction in carbon dioxide emissions or reduction in fossil fuel consumption from using CTO in biofuels instead of in pine chemicals, there is no benefit derived from policies that would divert its use to fuel. Any shift away from a level playing field driven by free market forces will severely impact the CTO processing industry and cause the loss of high quality jobs, place invested capital at risk, and reduce R&D and innovation." (Morris 2014)

I.3.2 Woodworking industry

The woodworking industry is one of the oldest branches practicing the material use of the biomass wood. Traditionally, different parts of trees are valorised in different applications, with the higher quality wooden parts (logs etc.) being used for high-value material applications, by-products going to lower-value material uses such as paper pulp or particle boards and only the low quality wooden parts being used for energy. With the substantial subsidies being paid for energetic uses of wood, this valorisation becomes less and less relevant. Suddenly, it is more "economic" to burn high-quality wood right away instead of manufacturing high-value products, which leads to strong market distortions and puts extreme pressure on the wood market. As the Economist wrote in an article in April 2013:

> "European firms are scouring the Earth for wood. Europe consumed 13m tonnes of wood pellets in 2012, according to International Wood Markets Group, a Canadian company. On current trends, European demand will rise to 25m-30m a year by 2020." (Economist 2013)

This demand cannot be met by local supplies, making imports necessary – to a region that has traditionally been very rich in forest resources.

> "Imports of wood pellets into the EU rose by 50% in 2010 alone and global trade in them (influenced by Chinese as well as EU demand) could rise five- or sixfold from 10m-12m tonnes a year to 60m tonnes by 2020, reckons the European Pellet Council. Much of that will come from a new wood-exporting business that is booming in western Canada and the American south. Gordon Murray, executive director of the Wood Pellet Association of Canada, calls it "an industry invented from nothing"". (Economist 2013)

This affects cost structures and puts pressure on companies that want to use wood in material applications without any subsidies:

> "Prices are going through the roof. Wood is not a commodity and there is no single price. But an index of wood-pellet prices published by *Argus Biomass Markets* rose from €116 ($152) a tonne in August 2010 to €129 a tonne at the end of 2012. Prices for hardwood from western Canada have risen by about 60% since the end of 2011.
>
> This is putting pressure on companies that use wood as an input. About 20 large saw mills making particle board for the construction industry have closed in Europe during the past five years, says Petteri Pihlajamaki of Poyry, a Finnish consultancy (though the EU's building bust is also to blame). Higher wood prices are hurting pulp and paper companies, which are in bad shape anyway: the production of paper and board in Europe remains almost 10% below its 2007 peak. In Britain, furniture-makers complain that competition from energy producers "will lead to the collapse of the mainstream British furniture-manufacturing base, unless the subsidies are significantly reduced or removed." (Economist 2013)

Research by Prof. Mantau from Hamburg University underlines this trend very clearly. In 2010, for the first time ever, the energetic use of wood surpassed the material use of wood in Germany. This was also supported by climatic reasons (cold winters accelerated the use of energy wood by private households) and the economic crisis in 2009. However, the trends are clearly in favour of energetic uses of wood – in almost all scenarios their volumes surpass those of the material uses of wood, and this is strongly due to the one-sided support mechanisms.

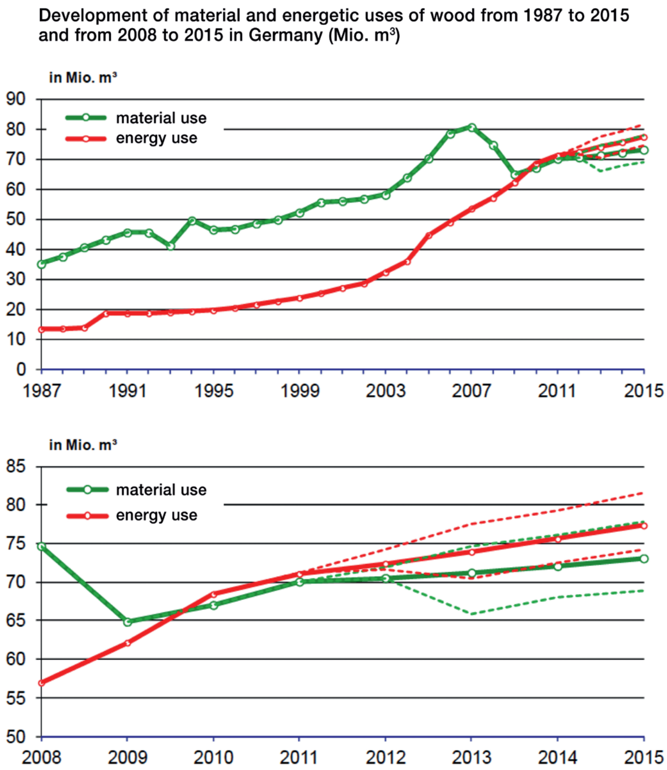

Figure I.2: Material and energy uses of wood 1987–2015 and 2008–2015 in Germany (Mantau 2012)

Peter Schwarzbauer, University of Natural Resources and Applied Life Sciences, Vienna, Austria, and Tobias Stern, Wood K Plus, Vienna, Austria, confirmed in their simulation study that the bioenergy policy has strong impacts on paper and panel industry:

> „Rising fuelwood demand would clearly lead to stronger competition for small roundwood (pulpwood) and sawmill residues between the forest industries and energy consumption leading to increasing roundwood prices and – to some extent – forest product prices. The potential competition for recovered paper (between paper industry and energy use) is not modeled here explicitly, but the model show that a loss of recovered paper (to energy production) would have severe consequences for the paper industry. […]
> Industrial roundwood prices rise more than the prices of forest products made from roundwood and other wood based raw material. […]
> In general, forestry and sawmills would be winners, and the panel and paper industries would be losers of a "wood-for-energy" policy. The main reason for the panel and paper industries' problems is a loss in gross profits (but still positive in absolute terms), because of two developments happening at the same time: a reduction of production and cost increases (roundwood and fiber) beyond the increase of the prices of forest products made from roundwood and/or other wood fiber material." (Schwarzbauer & Stern 2010)

In the following section, we have collected statements by industry representatives who have confirmed these market distortions and the negative effects that they see in their fields of business as well as suggestions for countering measures.

Michael Wolff, Chairman of the General Management of Pfleiderer Engineered Wood Germany, August 2013:

> "Since 2006, the wood market has been steadily developing into a market that is mostly characterized by the demand for energy wood. More and more, sawmill by-products and especially logs are used energetically. This has led to the situation that since 2010, more than 50 % of wood has been used thermally. Aside from some interruptions (Kyrill 2007, economic crisis in 2009), this has resulted in a continuous increase in costs for wood and also in a growing scarcity of wood as a raw material.
> In order to provide enough wood for our furniture industry and our carpenters, it is urgently necessary to change our way of thinking. Wood should be used for materials first and only be burnt as an end-of-life option. This way, one can even influence the CO_2 balance positively and actively protect jobs!" (Wolff 2013)

Dr. Denny Ohnesorge, Managing Director of the Association "Arbeitsgemeinschaft Rohholzverbraucher" ("Association Raw Wood Processing Industry"[1]), Germany, September 2013:

> "The competition between material and energy use leads to the migration of those wood processing industries in Middle-Europe whose raw material costs make up for a high percentage of their total production costs." (Ohnesorge 2013)

Leonhard Nossol, Managing Director of Zellstoff- and Papierfabrik Rosenthal GmbH ("Pulp and Paper Factory Rosenthal"), Germany, September 2013:

> "There is a strong need for a Europe-wide definition of residues and waste since a distortion of the market between material and energy use, as well as the misallocation of wood raw materials already occurs." (Nossol 2013)

Johannes Schwörer, President of the HDH, Hauptverband der Holz und Kunststoffe verarbeitenden Industrie („Head Association of the German Woodworking and Plastic Industries"), Germany, September 2013:

> "In Germany, more wood is being burnt than being used for building. […] Competition between energy and material uses is hard. […] We demand a prohibition of burning those valuable parts of wood that can be used as timber for building or as manufacturing material for furniture." (Gahle 2013)

Cellulose fibre

Alfred Heinzel, CEO Heinzel Holding, Austria, June 2013 (in the context of protesting against a new planned biomass power plant):

> "The Styrian pulp company Zellstoff Pöls AG, in which we are currently investing 125 million Euros, relies on a secure wood supply, usually from domestic sources. In Carinthia (Austria), however, already today 2.5 million solid cubic metres of wood have to be imported and the difference between supply and demand is continuously growing. If a new big consumer is added to the mix now, the wood market will be strongly disrupted. Consequences will be further increasing wood imports, a continuing rise in prices, ecologically counterproductive long-distance transports by lorries and increased emissions." (Austropapier 2013)

Peter J. Oswald, CEO of Mondi Europe & International, Austria, June 2013 (in the context of protesting against a new planned biomass power plant):

> "What has happened, when 178 million Euros were spent to switch only 0.7 % of the Austrian energy demand to CO_2 neutral energy? What has happened, when by this course a green, sustainable and profitable industry was robbed of its basis of existence and instead an industry was created that is still not profitable despite heavy subsidies? What has happened, when this new industry creates only one fifth of the added value and puts six out of seven employees on the street? Let me tell you – it means that we have been barking up the wrong tree. The biomass support in Austria needs to be fundamentally re-designed to be economically and ecologically viable." (Austropapier 2013)

Berry Wiersum, CEO of Sappi Fine Paper Europe, Austria, June 2013 (in the context of protesting against a new planned biomass power plant):

> "I have to warn you: This [a 100 million Euro investment into an existing pulp factory could not be justified if the local wood supplies were to get scarcer and scarcer] would mean the end of the pulp production in Gratkorn and would mean the loss of the paper factory's international standing in productivity and competitiveness. [Also the planned supply of climate friendly waste heat to 20,000 households in Graz would become obsolete.]" (Austropapier 2013)

1 The association Arbeitsgemeinschaft Rohholzverbraucher e.V. (registered association "raw wood processing industry" = AGR) is a voluntary association of enterprises of raw wood utilizing sectors in Germany and neighbouring countries. The association promotes the sustained provision of the renewable resource wood for the wood industry and the society.

Dr. Peter Untersperger, CEO of Lenzing Group, Austria, June 2013 (in the context of protesting against a new planned biomass power plant):

> "The innovative processing of wood and its valuable contents to high-value products such as pulp, paper and cellulosic fibres for manifold applications creates much more added value and many more green jobs. Therefore, wood should always be used in cascades – first as a material, and only at the end of life as energy resource. But while bioenergy is being massively supported by the renewable energy law, we and other users of wood are fighting with rising prices: Since 2005, the costs for our wood supply have increased by approximately 60%. This makes Austria lose competitiveness compared to other production sites." (Austropapier 2013)

In another press statement, Austropapier doubts the legality of the green feed-in tariffs: Indirectly, the renewable energy law prescribes the cascading use of wood, which means it has to be used first in higher-value material uses and should only be burnt at the end of its life. But in practice, the support system withdraws the wood supplies from the material sector. Therefore, the feed-in tariffs should be accordingly modified so that the material sector is not robbed of its feedstock. (Austropapier 2013b)

I.3.3 Potting soil and growing media

Johannes Welsch, Managing Director of Industrieverband Garten (IVG) e.V. ("Industry Association Garden"), Germany, August 2013:

> "The German producers of potting soils and growing media provide approximately 9.5 million m^3 of these products to private households as well as to commercial customers. Moreover, the horticultural industry with about 60,000 companies and 400,000 employees is dependent on reliable, high-quality growing media. Every year, plants worth 8.6 billion Euros are cultivated in those products.
>
> Aside from peat, the most important feedstocks for producing potting soils and growing media are composts from green waste or bark, and also wood fibres. Since peat is a finite resource, more and more alternatives are supposed to be employed. So far, they account for only 15% of the market.
>
> Due to the subsidies for the energetic use of wood, wood chips become scarcer, just as bark and green waste that are suitable for manufacturing composts. If you can find these feedstocks, their prices have increased by up to 30% during last three years. These increases cannot be handed down to the customers, or only to a very small extent.
>
> The peat industry finds itself more and more in competition to agricultural. Areas that were previously used for extracting peat, are increasingly covered by the cultivation of biomass intended for energetic uses.
>
> All in all, the EEG and the RED have a significantly negative impact on the raw material supply for the producers of potting soils and growing media in Germany." (Welsch 2013)

I.4 Additional barriers through import restrictions for bio-ethanol for chemicals

Ylwa Alwarsdotter, Senior Vice President Market Development at SEKAB Biofuels & Chemicals, Sweden, December 2013:

> "The European chemical industry using bioethanol in its production has never been able to fully develop its potential. Instead growth in the bio-based industry is taking place outside Europe, e.g. in Asia and Latin America. The few companies that do produce chemicals based on bio-ethanol in Europe are highly dependent on imports.
>
> There are a number of factors that contribute to the current situation, where bioethanol of the quality needed for chemical conversion is not produced within Europe in sufficient quantities, and the volumes that are available in Europe carry a price much above world market prices. The biggest problem today is however related to European trade and customs policy, which imposes prohibitive import duties on bioethanol due to it being classified as an agricultural product.
>
> Ethanol is perhaps the single most important building block for the bio-based chemical industry. It can be used as a bio-based replacement for ethylene, and as a base chemical for other organic compounds that are used in the manufacture of plastics, paints, solvents, food, cosmetics, pharmaceuticals and materials. We see a lot of demand for bio-based chemical products, for example for bio-based plastics, but instead of being able to expand to meet the demand, we and other producers of bio-based chemicals are struggling to survive.
>
> The problem is that the EU import duty on bioethanol, also for chemical production, is radically higher than in other countries. When producers of bio-based chemicals in the US pay 2.5% duty on their ethanol, we pay the equivalent of 50% duty. We would like of course to buy ethanol for our production on the internal market, and still hope to be able to do so in the future. But, with prices in Europe being up to 60% higher than on the world market, this is just not possible. Our products will compete on the world market and with imports to the EU which carry low or zero duties, so these import duties make all the difference. We also have to compete with fossil-based raw materials and products that can also be imported duty free.
>
> We are often told that there is a solution, since we can apply for authorisation for Production under Customs Control, and then pay a lower duty. SEKAB produces under PCC authorisation today, which means we can survive in the very short term, but we can never invest in new facilities or increase production, since authorisations are given for maximum three years and can be revoked at any time. We are still hoping for a more long-term solution, but if there isn't one, we will have to give up at some point, and leave the bio-based chemical production to companies outside Europe. It would be a shame, since we have a lot of the other things needed for a competitive industry: research, innovation, an educated workforce, and developments where we may be able to convert to domestic biomass from forest source in the future." (Alwarsdotter 2013)

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9 Annex II: Background information and data

II.1 Industrial Material Use of Biomass

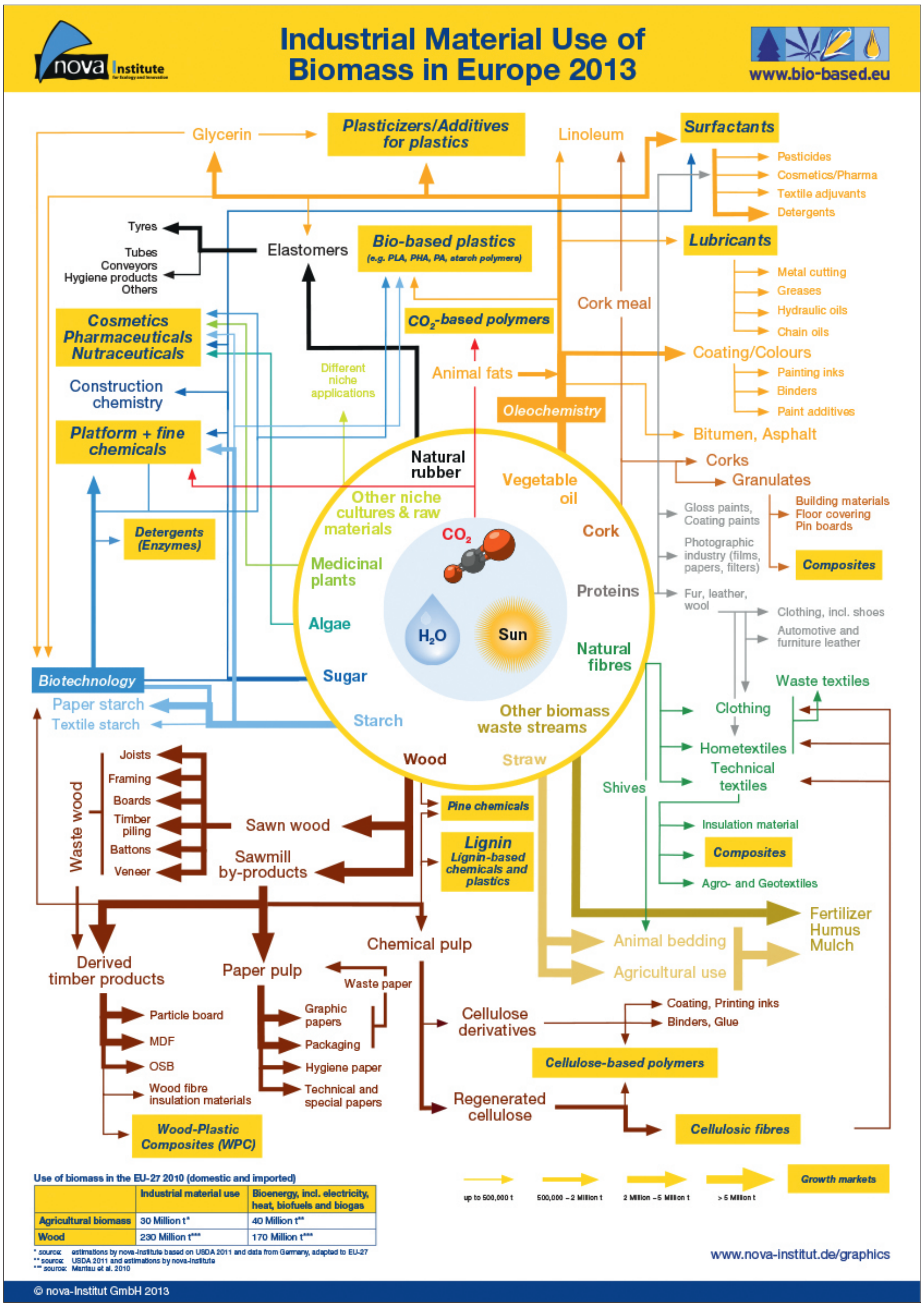
Biomass is generally used in three different sectors: As food or feed, as energy or as materials. For the purpose of this paper, we focus on the material use only and we follow the definition of Carus et al. 2010, which states:

> "In 'material use' biomass serves as a raw material for the production of all kinds of goods, as well as their direct use in products. This distinguishes it from energy use, in which biomass serves purely as an energy source, and from the use for food and feed purposes"

The following Figure II.1 gives an overview of biomass flows for the industrial material use in Europe and their different applications. It covers both domestically produced and imported biomass and the whole process chain from raw material to the final application.

The thickness of the arrows symbolises the amount of biomass involved in the production processes (see legend at the bottom right). The illustration shows that in terms of amounts, wood, starch, vegetable oils and other biomass waste streams are the most important biomass sources. Several applications are identified as important growth markets. These are, among others: bio-based plastics, platform chemicals, wood-polymer composites, surfactants, lubricants, etc.

Figure II.1 shows the complexity and the impressive diversity of the material sector, covering hundreds of applications and dozens of branches.



Use of biomass in the EU-27 2010 (domestic and imported)

	Industrial material use	Bioenergy, incl. electricity, heat, biofuels and biogas
Agricultural biomass	30 Million t*	40 Million t**
Wood	230 Million t***	170 Million t***

* source: estimations by nova-Institute based on USDA 2011 and data from Germany, adapted to EU-27
** source: USDA 2011 and estimations by nova-Institute
*** source: Mantau et al. 2010

Figure II.1: Material use of biomass in the European Union 2013 (www.nova-institut.de/graphics)

II.2 Biomass: Increasing Shares of Bioenergy versus Material Use

The shift in use of biomass for materials towards energy can be seen in almost all European countries. But only for a few Members States it can be proved by existing data. Due to different market studies (Schmitz et al. 2007, Carus et al. 2010, Peters 2010), comparable solid data can be found for Germany. The trend seems to be the same for most countries.

Figure II.2 shows the evolution of the land area devoted to material and energy use in Germany since 1994. Although the area of land given over to material use was initially greater than that for energy use, the comprehensive support system for energy use resulted in a tenfold growth[1] in its land coverage, whereas material use remained almost unchanged. In 2013 the total area for energy and industry was 2,395 ha, of which only 280.5 ha were dedicated to industrial material use, which is only 12 per cent (FNR 2014). It is an interesting question to ask which factors did cause material use to stagnate despite political backing and considerable R&D funding. Chapter II.3 will give a comprehensive answer.

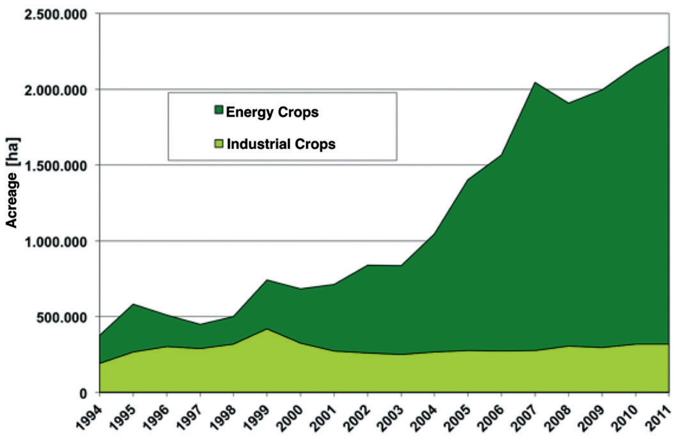


Figure II.2: Cumulative land areas for material use and energy use in Germany (FNR 2012)

Figure II.3 shows that utilization of wood also shifted to energy use. In 2010 the use of wood for energy surpassed its use as a material for the first time in the history of wood utilization in Germany. This was also supported by climatic reasons (cold winters accelerated the use of energy wood by private households) and the economic crisis in 2009. However, the trends are clearly in favour of energetic uses of wood – in almost all scenarios their volumes surpass those of the material uses of wood, and this is strongly due to the one-sided support mechanisms.

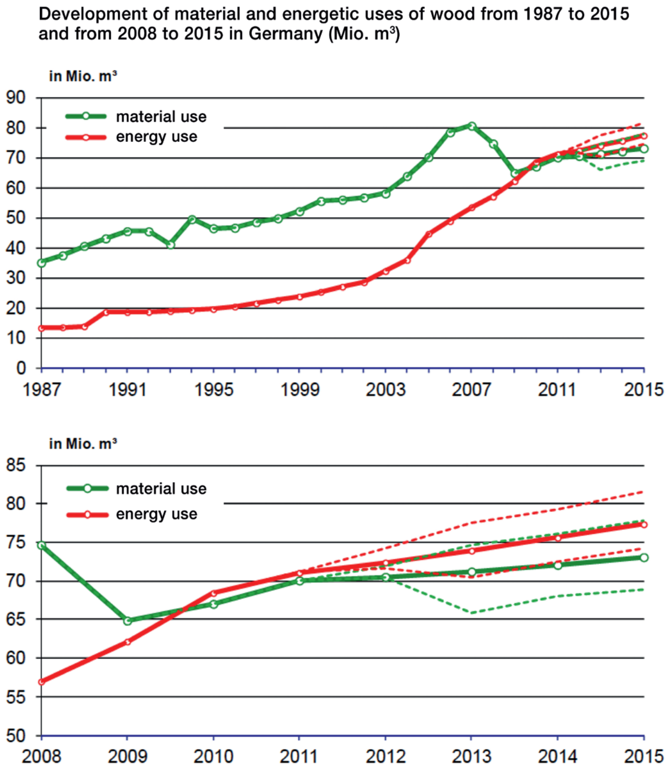


Figure II.3: Use of wood for materials and for energy, 1987–2015 and 2008–2015 in Germany (Mantau 2012)

While this trend is especially strong in Germany, also other countries experience the same developments:

> „The log trade flow in Central Europe has changed the past decade with the "Central West" region having become a larger net importer of logs the past five years as compared to the previous five-year period, and the "Central East" region exporting more logs the past few years than prior to this time. The biggest change occurred in Germany, which traditionally had been a net exporter of logs, but became a net importer in 2009. During the first five months of 2013, Germany was a net importer of two million m^3 of softwood logs, which can be compared to net exportation of 1.6 million m^3 just five years ago." (Wood Resources International 2013)

1 Set-aside land was used at first, but later land was taken out of grain, potato (Lower Saxony) and secondary crops, and pastureland was also converted.

II.3 Non-level Playing Field: The Competition Triangle – Industrial Material Use of Biomass between Petrochemicals and Bioenergy & Biofuels

Although material use of biomass has many advantages over energy use (see Chapters 4 ff. in this Annex, also Table 1 "Criteria matrix" in the main text), it has been stagnating for decades while energy has experienced great expansion. There are specific obstacles and barriers preventing the development of material use, for otherwise this discrepancy is hard to explain. There is an extensive nexus of barriers hindering the development of industrial materials from biomass. We have identified about 50 separate obstacles in a multitude of different sectors (Carus et al. 2014). These range from agricultural, energy, climate, tax and revenue policy to further legal regulations, science and technological development, information, communications, networks, funding and ecology.

The following table shows the incentive systems, used in the EU member states for the support of Bioenergy and Biofuels. In contrast, for the industrial material there are almost no incentives at all for the commercial production. Even if there are, they are implemented only in a few countries, have been valid for a limited time only, or are comparably weak incentives.

The following tables aim to give an impression of the unbalanced support systems. Table II.1 shows the overwhelming number of instruments implemented in high income countries in order to boost renewable energies – many of them targeted at bioenergy. In comparison, the number of support instruments implemented worldwide for the industrial material use of biomass are very few, as shown by Table II.2. The sections following these tables will quantify these claims by illustrating the levels of support for biofuels in Europe and looking more detailed at policies for bioplastics as one example of a material use of biomass.

● indicates national level policy
○ indicates state/provincial level policy

	REGULATORY POLICIES AND TARGETS							FISCAL INCENTIVES				PUBLIC FINANCING	
	Renewable energy targets	Feed-in tariff/ premium payment	Electric utility quota obligation/ RPS	Net metering	Biofuels obligation/ mandate	Heat obligation/ mandate	Tradable REC	Capital subsidy, grant, or rebate	Investment or production tax credits	Reductions in sales, energy, CO_2, VAT, or other taxes	Energy production payment	Public investment, loans, or grants	Public competitive bidding/ tendering
HIGH INCOME COUNTRIES $$$$													
Australia	●	○			○		●	●				●	
Austria	●	●			●		●	●	●			●	
Barbados	●			●								●	
Belgium	●		○	○	●		●		●			●	●
Canada	○	○	○	○	●			●	●	●		●	●
Croatia	●	●						●				●	
Cyprus	●	●			●			●					
Czech Republic	●	●			●		●	●	●	●		●	
Denmark	●	●		●	●		●	●		●		●	●
Estonia	●	●			●						●	●	
Finland	●	●			●		●	●		●	●		
France	●	●			●		●	●	●	●		●	●
Germany	●	●			●	●		●	●	●	●	●	
Greece	●	●			●			●	●	●		●	
Hungary	●	●			●			●		●		●	
Ireland	●	●			●	○	●						●
Israel	●	●	●			●				●		●	●
Italy	●	●	●	●	●	●	●	●	●	●		●	●
Japan	●	●	●	●			●	●	●			●	
Luxembourg	●	●			●			●		●			
Malta	●	●		●				●		●			
Netherlands	●	●		●	●		●	●	●	●	●	●	
New Zealand	●												
Norway	●				●		●	●		●		●	
Oman								●			●	●	●
Poland	●		●		●		●	●		●		●	●
Portugal	●	●	●	●	●	●		●	●	●		●	●
Singapore				●								●	●
Slovakia	●	●						●		●			
Slovenia	●	●						●					●
South Korea	●		●	●	●		●	●	●	●		●	
Spain[1]	●	●		●	●	●		●	●	●		●	
Sweden	●		●		●		●	●	●	●		●	
Switzerland	●	●						●		●			
Trinidad and Tobago	●								●	●			
United Arab Emirates	○		○			○					○	○	○
United Kingdom	●	●	●		●	●	●	●		●	●	●	
United States		○	○	○	●	○	○	●	●	●	●	●	●

Table II.1: Renewable energy support policies in high-income countries (REN21 2013)

Country	Investment incentives	Mandates	Public procurement	Tax incentives for packaging	Bans/Fees for conventional plastics
Thailand	x				
Japan		(x)[a]			
South Korea	x		x		x
Malaysia	x				
China	x				
Brazil	x				
US	x		x		x[b]
Canada					x
Netherlands			(x)[c]	x	
Belgium				x	
Germany			(x)		
Italy			(x)		x
Denmark			(x)		x
Bulgaria					
Israel					x
United Arab Emirates					x

Table II.2: Overview of policy measures implemented to promote the market developments of bio-based materials

a Non-binding target.
b In some States or cities.
c Green public procurement (GPP) is a policy instrument in an EU framework, implemented to some extent by most Member States. Most of them do not cover bio-based products, however, since the environmental advantageousness is controversial. So this is not a support instrument for bio-based materials per se, but can be if designed accordingly.

Volume of biofuel subsidies in the EU

> "The report questions the success of EU biofuel policies in meeting the objectives that Member States have set out to achieve increased energy security, improvements in environmental performance and the generation of additional economic value. The study found that a significant amount of public money, between EUR 9.3 and 10.7 billion in 2011, subsidized the use of conventional biofuels and a small portion to advanced biofuels development. The main subsidy programs supporting the biofuels industry are (a) market price support (the subsidy conferred to biofuel producers from Member States consumption mandates that provide a guaranteed market for their product and push prices upwards), (b) tax exemptions for biofuels, and research and development (R&D) grants (promoting the development of biofuel projects or technologies). Support to ethanol and biodiesel is estimated separately in order to determine the levels of support to each product. Dividing the total subsidy estimate for each product (ethanol and biodiesel) by the number of litres consumed for each in the European Union provides an estimate of subsidy per litre. In 2011, ethanol was subsidized between 48 and 54 euro cents per litre and biodiesel at between 44 and 51 euro cents per litre." (Charles et al. 2013)

Calculations by nova-Institute have compared the amount of subsidies paid for biofuel and biogas production to the revenue generated by them from 2009 to 2013 for Germany only. Table II.3 shows that the highest levels of price support were paid in 2009 and that they have decreased slightly since then. The typical range of support paid in 2013 was between 25% and 80% (2% only for those that were discontinued). Interestingly enough, the level of support for photovoltaic is approximately the same as the one for biofuels and biogas – but not higher.

Policies for Bioplastics

As mentioned, in contrast to bioenergy and biofuels there is no comparable framework of incentives for bioplastics. This is comprehensively confirmed by a recent study by the OECD:

> "However, it is quite obvious that support for bioplastics has been very limited compared to, say, biofuels. And yet both categories of bio-based products aim to fulfil common policy goals. Indeed, there is evidence that bioplastics offer greater job creation and value-added than biofuels. There is no international pattern of support for bioplastics, except that the niche policy of banning single-use carrier bags has received widespread attention. Compared to the major policies that have been applied to biofuels, such niche policies will not stimulate the investments needed for large-scale production and market uptake.
> There are still formidable hurdles for bioplastics to overcome. Within the context of holistic bioeconomy strategies, there is scope for the more considered use of intelligent policy mixes targeted at the development of bioplastics over their whole 'cradle-to-grave' life-cycle, and in concert with other bio-based products, especially biofuels.
> Generally, biofuels policy support is much greater than it is for either bio-based plastics or bio-based chemicals. This is likely to make the development of the bioeconomy uneven, and may disfavour the use of biomass for bioplastics and bio-based chemicals. It may also constrain the development and operation of integrated biorefineries." (OECD 2013)

	Share of the price support compared to revenue		
	2009	**2012**	**2013**
Biodiesel (Rape)			
Pure fuel	20–35%	19–20%	ca. 2%
Addition (quota), real	20–60%	24–41%	24–41%
Addition (quota), max.	50–80%	53–58%	53–58%
Vegetable oil fuels (Rape)			
Pure fuel	20–35%	19–20%	ca. 2%
Bioethanol			
From cereals			
Pure fuel	ca. 45%	ca. 42%	ca. 42%
Addition (quota), real	50–85%	39–52%	39–52%
Addition (quota), max.	70–90%	64–70%	64–70%
From sugar beets			
Pure fuel	ca. 45%	ca. 42%	ca. 42%
Addition (quota), real	50–85%	39–52%	39–52%
Addition (quota), max.	70–90%	64–70%	64–70%
BtL	n.a.	n.a.	n.a.
Biogas (60% maize, 40% manure)	40–80%	60–80%	60–80%
Photovoltaics green field plant	70–90%	58–78%	54–76%

Table II.3: Share of the support for biofuels compared to revenue/level of price support for renewable energies in the years 2009, 2012 and 2013 (Piotrowski 2012, in Carus et al. 2014)

Conclusion: The Competition Triangle

To sum up the results: The existence of a long-standing comprehensive support system for energy from biomass has created a favourable competitive situation compared to fossil energy sources; the latter are also subject to a hefty energy tax. Bioenergy and biofuels have been rendered artificially competitive by means of favourable political framework conditions, while the material use of biomass competes against established conventional materials without any support. Analyses of nova-Institute have shown that the industrial material use of biomass is hindered from entering the market by more than 50 small and big barriers in total (see Carus et al 2014). This state of affairs can be summed up in a "competition triangle", which is shown below and illustrates the following:

Right side: Bioenergy/biofuels and material use competing for biomass

Material use is competing with bioenergy for biomass that is not used for food or feed. As a result of the comprehensive support system for bioenergy and biofuels, which was ultimately created by the EU RED, the prices for biomass and land have greatly increased. This makes access to biomass for material use much harder and more expensive, but this is not compensated for by support measures. This market distortion hinders the competitiveness of producers of materials from biomass.

Left side: Petro-chemical products competing with bio-based products

The bio-based chemistry and plastics industries are exposed to full competition from chemical industry products. Without any accompanying measures, new, bio-based industries must be developed that can prove their viability in the face of the well-established and long-optimized mass production of the chemical industry. Then there are high biomass prices resulting from the promotion of energy use, which are not counteracted by taxes on fossil carbon sources as a raw material for the chemical industry. All of this creates an extremely tough competitive environment.

Upper side: Fossil energy competing with bio-energy/biofuels

Due to the comprehensive support system for the energetic use of biomass, originating from the RED and its national implementations, an artificial competitive situation compared to fossil energy sources has been created over the years. Furthermore, the latter are subject to a substantial energy tax – this makes for extremely favourable, artificially created competitive conditions for bio-energy and biofuels.

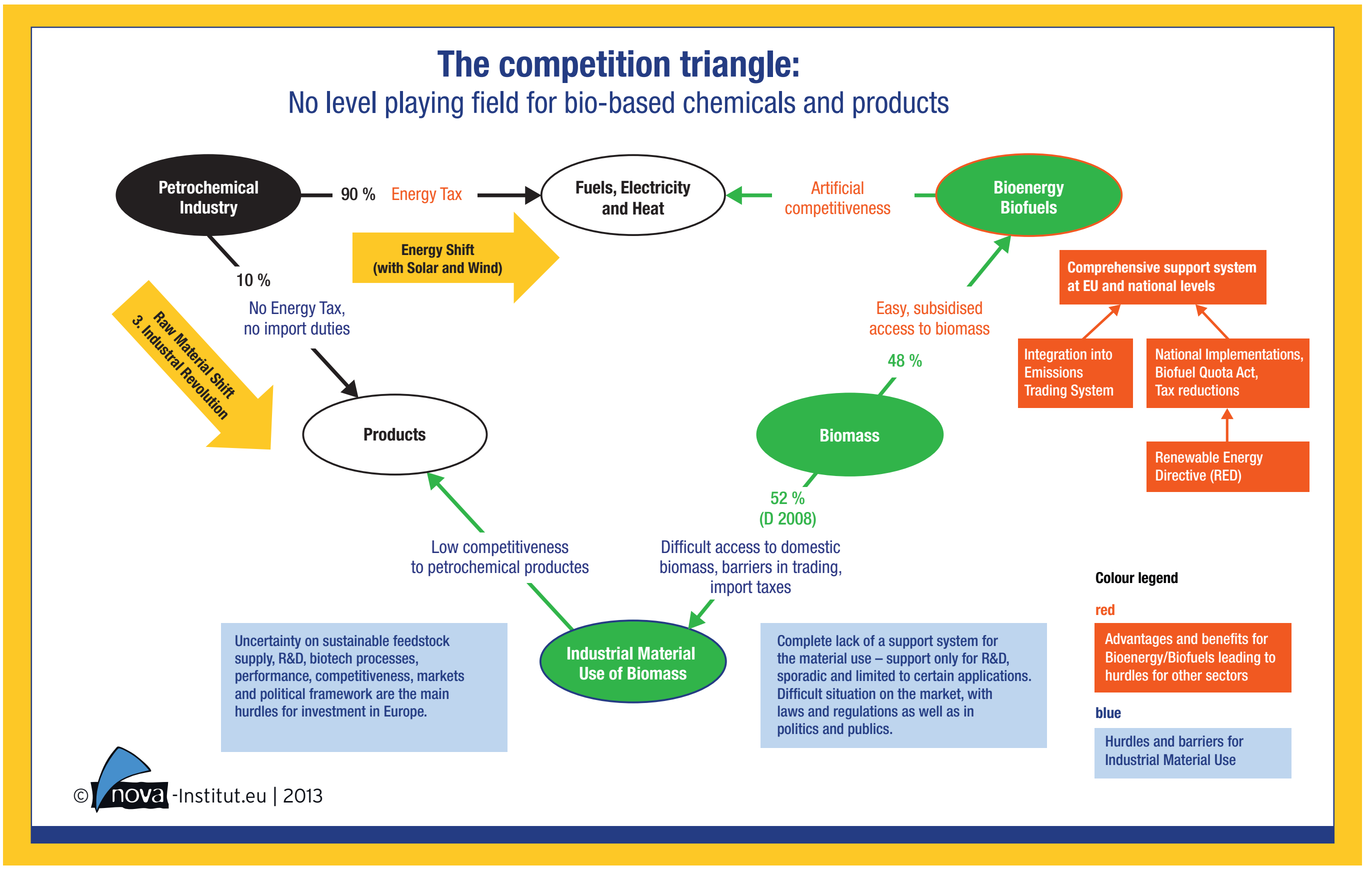


Figure II.4: The competition triangle: Petrochemicals – Bioenergy/biofuels – Material use of biomass (Carus et al. 2014)

II.4 Meta-analysis of Macroeconomic Effects of Bioenergy/Biofuels versus Industrial Material Use of Biomass

In 2012, Fifo-Institute, Cologne (Germany) and nova-Institute, Hürth (Germany) conducted a comprehensive meta-analysis of the major current studies on the economics of material use of biomass. This meta-analytical study of the macroeconomic effects focuses on the question: "How do we assess the economics of material use compared to energy use?" applying the same parameters of added value and the effects on employment. It considers only direct gross effects and does not take account of indirect effects and substitution effects (net effects).

The parameters applied therefore are:

- Direct gross employment,
- Direct gross added value.

The meta-analysis takes account of upstream process stages in the form of primary forestry or agricultural production. It also considers only those production stages in which the macroeconomic effects can be traced back to the raw material and in which the raw material constitutes a significant part of the added value and employment.

The following table shows the results of the studies of the added value and employment generated by energy and material use evaluated in the meta-analysis, as well as our own calculations.

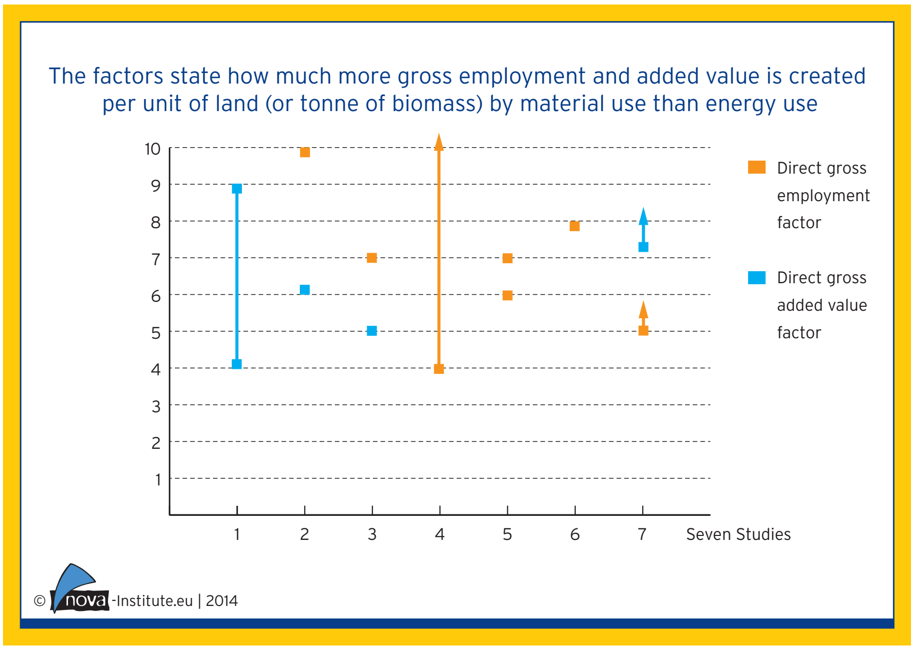


Figure II.5: Comparison of gross macroeconomic effects of material and energy use of biomass (Carus et al. 2014)

Overall, it is apparent that material use promises several advantages over energy use in terms of gross employment (Factors 5-10) and gross added value (Factors 4–9) – in both cases related to the same area of land or amount of biomass. This is largely due to the considerably longer process and value chains for material use – and the higher value of the products.

Study	Contents	Study calculating the factors	Direct gross employment factor*	Direct gross added value factor*
Case study: Gothe/Hahne 2005, after recalculation by nova (Carus et al. 2010)	Regional added value using the example of a German wood cluster	Carus et al. 2010	—	4 to 9
Input-output analysis: Pöyry 2006	Added value and employment in the paper and cellulose industry compared to energy use	Carus et al. 2010	ca. 10	ca. 6
Input-output analysis: CEPI & Pöyry 2011	Added value and employment in the paper and cellulose industry compared to energy use	Dobroschke et al. 2013 (part of Carus et al. 2014)	ca. 7	ca. 5
Input-output analysis: Nusser et al. 2007	Macroeconomic effects of the production and use of renewable resources	Carus et al. 2010	(3–5) to 19	—
Cluster study forestry and wood: Seintsch 2008	Macroeconomic effects of the forestry and wood cluster in Germany	Dobroschke et al. 2013 (part of Carus et al. 2014) Carus et al. 2010	ca. 6 ca. 7	
Case study: hemp insulation compared to vegetable oil fuel (rape), Carus et al. 2010	Comparison of 1 ha of hemp for insulation with 1 ha of rape for vegetable oil fuel	Carus et al. 2010	ca. 8	—
Industrial sector data: Carus et al. 2010, Dobroschke et al. 2013	Employment and turnover in German industy sectors	Dobroschke et al. 2013 (part of Carus et al. 2014) Carus et al. 2010	ca. 5 ≥ 6	ca. 7.5 ≥ 8-9
Typical ranges from the named studies and calculations (recalculations)			(3) **5–10** (19)	**4–9**

* The factors state how much more gross employment and added value is created per unit of land (or tonne of biomass) by material use than by energy use.

Table II.4: Results of the studies of the added value and employment generated by energy and material use evaluated in the meta-analysis, as well as our own calculations

A study of the net effects, on the other hand, were to show a far smaller impact, as these take account of the decline in production caused in a specific sector by expanding production in a different sector. The far higher gross added value and employment one sees are primarily the result of material value chains being considerably longer than energy ones. If one factors in the net effects, then this impact is reduced, since petrochemical value chains for materials are also much longer than those for energy, too. A robust calculation of the net effects was not possible so far due to a lack of data and an uncertain methodology. We estimate that the positive effects of material use would still be visible, but they would tend to be between 1.5 and 2 rather than between 5 and 10. This is supported by Sanders 2014 who calculates the net employment effects of a switch to a bio-based chemical industry in the Netherlands and comes to similar conclusions (see in this Annex, Chapter 12). One final remark is that it is standard practice to give the gross effects when comparing industries and value chains, since the data and methodology problems we have described generally apply.

The British House of Lords has recently published a paper on the bioeconomy in which they also stress the importance of these economic factors:

> "Whilst environmental aspirations for the bio-based industries are important, the job creation possibilities are likely to be at least as important a priority for policy makers ... For every job created in the business of chemistry in the US, 7.6 jobs are created in other sectors (see: *http://www.americanchemistry.com/Jobs*), and on average they are high-paying compared to other manufacturing jobs. Meanwhile, modelling in Europe indicates that bio-based chemicals and plastics production can support many more jobs than biofuels and bioenergy applications." Dr Philp, OECD (acting in a personal capacity, In: House of Lords 2014)

The following figure from the same source shows an overview of different types (or "generations") of bio-based feedstocks, different processing technologies and the portfolio of end products, sorted by the value-added they create:

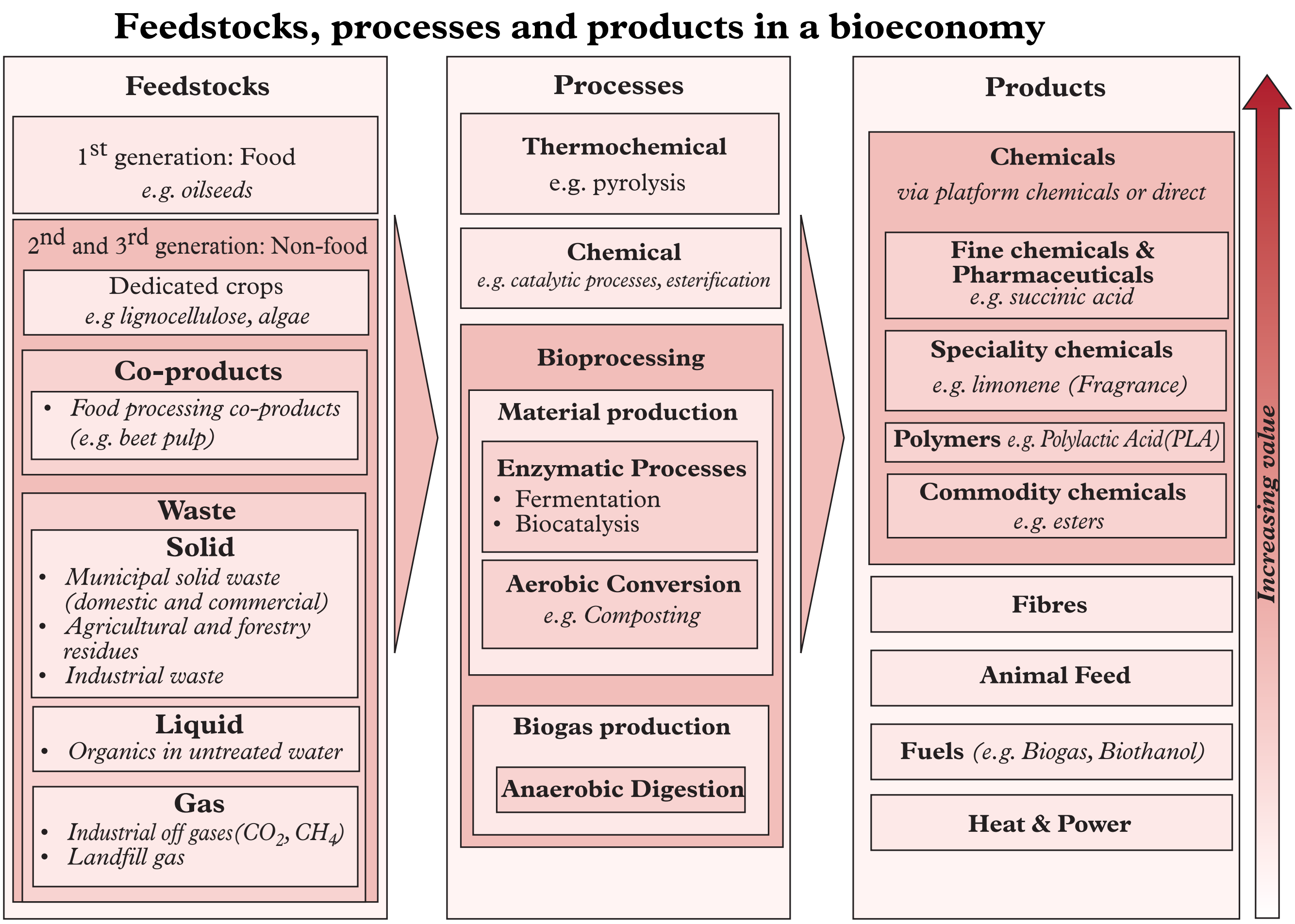


Figure II.6: Bio-based feedstocks, processes and end products sorted by value-added creation (House of Lords 2014)

II.5 Biofuels Versus Solar Electric Car: Efficiency Makes the Difference

The following figure shows the different grades of land efficiency for different biofuel systems (biodiesel from rapeseed, bioethanol from wheat or corn and BTL from lignocellulosic feedstock) compared to the land efficiency of powering an electric car with solar energy – from the field to the wheel.

All assumptions are conservative and widely accepted by experts. The different biofuel systems need 50 to 125 times more land than a solar-electric car system, taking only the direct effects into account (without the production of the PV system and without energy input (tractor, fertilizer, plant protection…) in the agricultural system).

Especially if land is rare, the decision for a land-efficient solar-electric mobility instead of far less efficient biofuels will free large arable areas for the agricultural production.

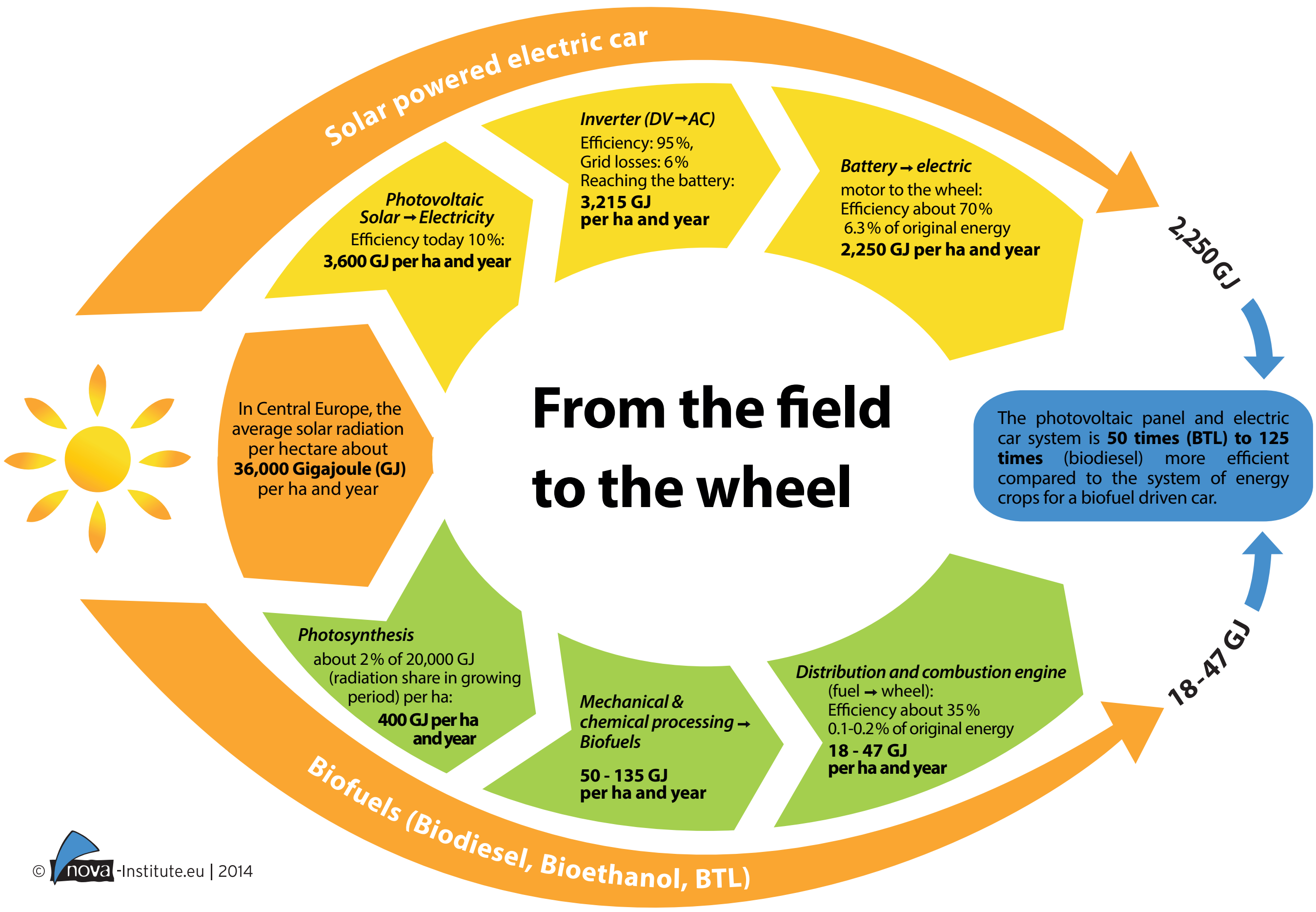


Figure II.7: Comparison of land efficiency of different energy systems from the field to the wheel (nova 2014)

The next figure confirms our findings:

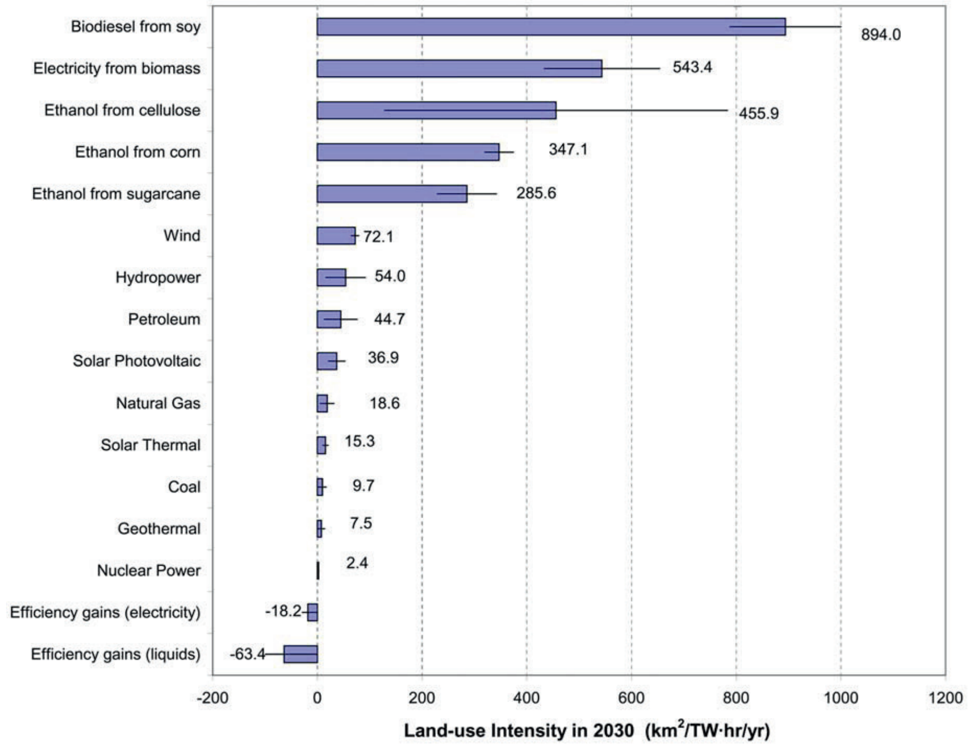


Figure II.8: Land-use intensity for energy production/conservation techniques

Note: Values shown are for 2030, as measured in km² of impacted area in 2030 per terawatt hour produced/conserved in that year. Error bars show the most compact and least compact estimates of plausible current and future levels of land-use intensity. Numbers provided are the midpoint between the high and low estimates for different techniques. Source: McDonald et al. 2009

Not only the land efficiency is superior for solar-electric mobility, also latest cost analyses show the low costs for photovoltaic electricity production, which can compete even with fossil plants in 2020 resp. 2030 without subsidies. In contrast to for example electricity from biogas, which needs long time subsidies to compete.

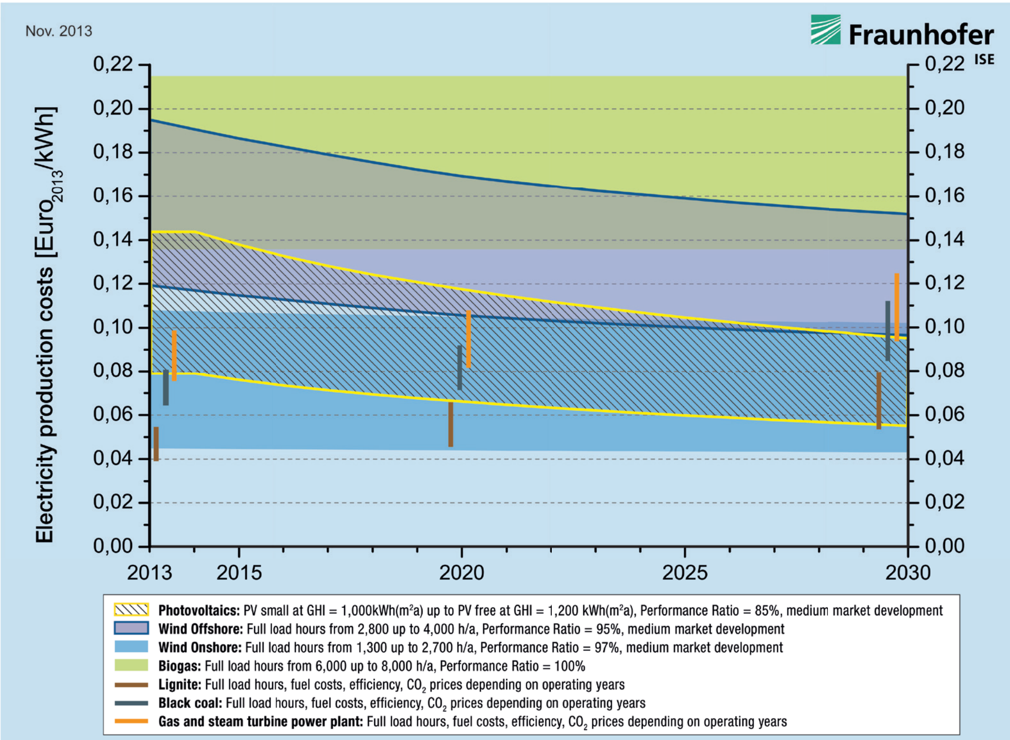


Figure II.9: Learning curve based prognosis of electricity production costs for renewable energy and conventional power plants in Germany until 2030. (Fraunhofer 2013)

II.6 Positive Environmental and Economic Impacts of Increased Biomass Shares for Industrial Material Use Instead of Energy

By means of four future scenarios, we calculated the environmental and economic benefits that would accrue if the available land for renewable resources were increasingly used for materials instead of energy.

The scenarios are based on the assumption that 2.5 million hectares are available for renewable resources in Germany, which reflects the initial situation in 2012. No expansion or reduction in this area is expected between now and 2030. Four scenarios are examined for research into potential development paths:

- Scenario 1 (baseline scenario, 20% material use by 2030)
- Scenario 2 (25% material use by 2030)
- Scenario 3 (50% material use by 2030)
- Scenario 4 (90% material use by 2030)

Scenario 4 is an extreme scenario and is based on very high growth in all areas of industrial material use of biomass. Scenario 4 serves mainly to demonstrate the expected environmental and economic effects if biomass allocation between energy and material usage were to be virtually inverted – from 85:15 today to 10:90 in Scenario 4.

The study calculates and analyses the environmental effects of the various scenarios in the impact categories of greenhouse gas emissions (GHG), cumulative energy demand and acidification potential. The following diagram illustrates the effects on the impact category greenhouse gas emissions. The negative numbers indicate reductions in greenhouse gas emissions in all scenarios.

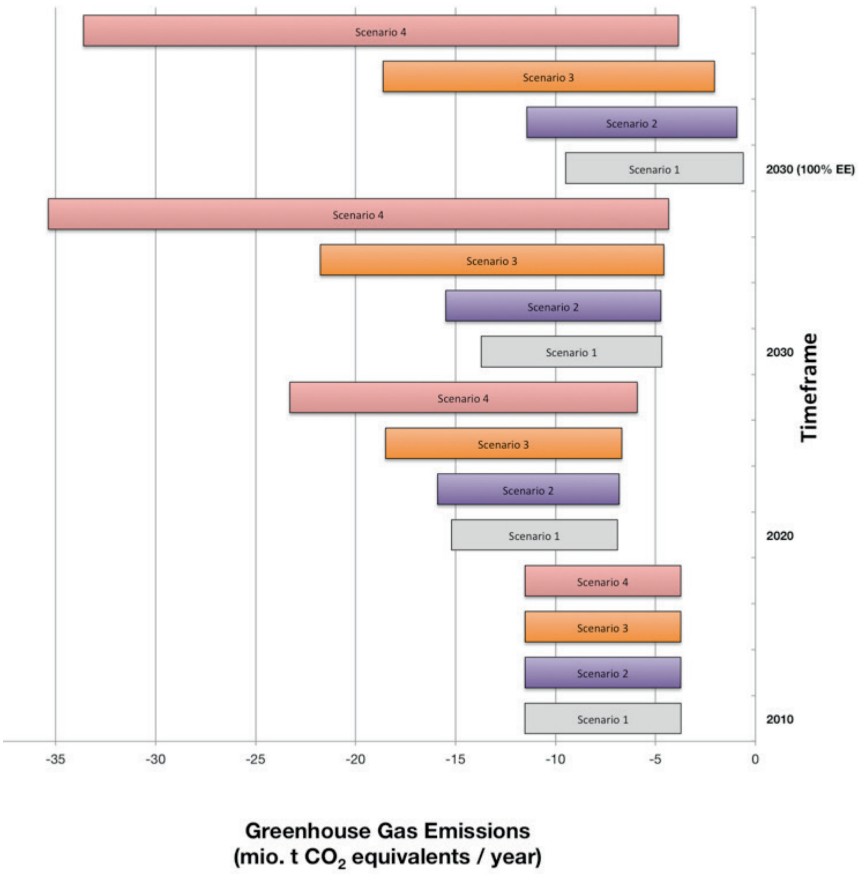


Figure II.10: Evolution of greenhouse gas emissions for the years 2010, 2020 and 2030, and for the year 2030 taking account of a 100% renewable energy scenario (Carus et al. 2014)

The effects in three environmental categories (GHG, cumulative fossil energy demand, acidification potential) show wide ranges for the different scenarios resulting from the broad spectrum of different material uses. What emerges very clearly, though, is that the scenarios with a higher proportion of material use also demonstrate the highest potential for reductions or savings. The best material lines achieve significantly greater reductions than those achieved in the field of energy use. This is partly based on the fact that electricity from biomass has fallen behind environmentally with the rising share of solar and wind power (this is particularly evident in the "2030 (100% EE)" scenario in the figure when all electricity comes from renewable sources).

Overall, the calculation comes to the conclusion that material use of renewable resources has the potential to achieve very positive environmental and also macroeconomic effects. To fully develop this potential, the share of renewable resources used for materials must be increased, which will only be possible if the political framework conditions are altered. The positive effects in terms of added value and employment associated with increased material use are considerable (the values lie between a factor of 4 and a factor of 10, see in this Annex Chapter 4) and are predominantly due to the far longer process and value chains for material use – and the higher value of the products.

Our research findings indicate that a level playing field – or even preferential treatment – for material compared to energy use is called for in order to realize the environmental and macroeconomic potential of material use and to be in a position to make optimal use of limited biomass.

There is therefore a need for politicians to develop, instead of inadequate action plans and goals (separate ones for the bioenergy and bio-based product sectors), national or regional biomass *allocation* plans or land *allocation* plans, which will ensure a less distorted allocation of biomass between the sectors of demand (industry, the oil and energy economy) and, if necessary, re-define the role of biomass in the energy system and at the same time also take adequate account of other claims on land (e.g. nature conservation).

The greatest effects for greenhouse gas emissions reductions could be achieved by explicitly orienting the set of supporting instruments towards these effects, independently of whether the biomass is used for materials or energy. This is the only way to fully realize the ecological potential of biomass use that is revealed by the full spectrum of different uses.

The complete study can be found in Carus et al. 2014.

II.7 High Reduction of GHG Emissions from CO_2-based Fuels – up to 90 %

While carbon dioxide is generally seen as a "climate killer", which should best be avoided or stored underground (carbon capture and sequestration (CCS)), a growing number of scientists and engineers are considering how this virtually limitless source of carbon can be used or recycled as a fuel or chemical feedstock (carbon capture and utilization (CCU)) and the first applications are already running.

Astonishingly, already the first commercial production of CO_2 based methanol (via electrolysis of H_2O to H_2) in Iceland by the company Carbon Recycling is far superior to the best biofuels in terms of GHG reduction: Dr Norbert Schmitz of Meo Carbon Solutions GmbH in Cologne presented the very first ISCC sustainability certification system for CO_2-based methanol from CCU, which sticks closely to the Renewable Energy Directive (RED) guidelines and has only been applied to biofuels to date. If CO_2 is seen as waste without environmental burden then the CO_2-based methanol from this first plant in the world achieves a 90% reduction in CO_2 compared to fossil fuels. Not even second- and third-generation biofuels can achieve equivalent reductions.

If the EU would count CO_2-based methanol and other fuels such as CO_2-based methane and DME as part of the RED quota for renewable fuels, this could provide significant incentives for investors. Such an inclusion should not only be designed for fuels from "green" CO_2 from bio-based feedstocks for example as a by-product of bioethanol or biogas production, being thus virtually "bio-based", but also for fuels from fossil-based – "black" – CO_2 as it is available in large quantities as flue gases from existing power plants, steel mills and many other industries. An important prerequisite would be that only energy from renewable resources, so solar or thermal power, is used in the production of the fuels from CO_2. (Reform proposal on CO_2-based fuels and chemicals in Chapter 6.3.6 of the main text.)

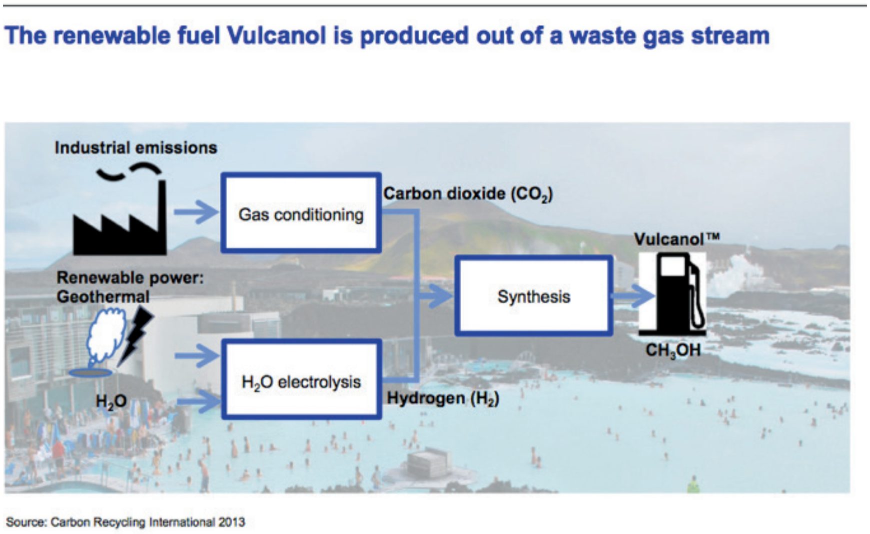


Figure II.11: Schematic production process of CO_2-based fuel (Schmitz 2013)

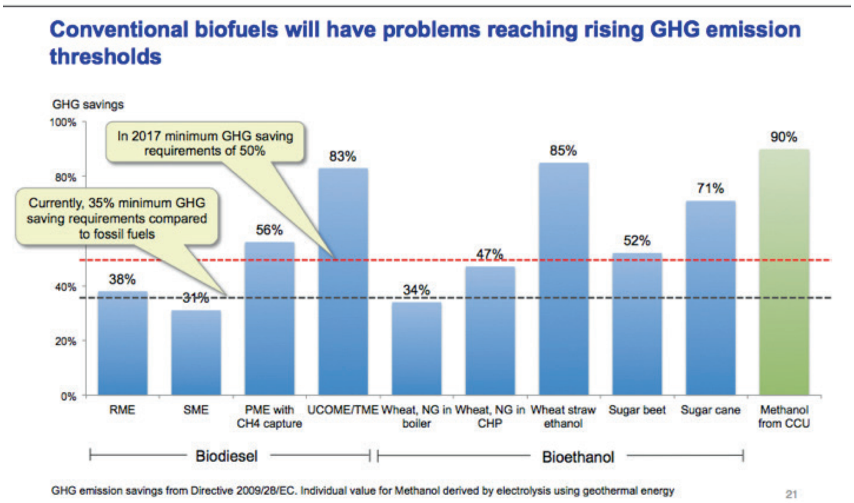


Figure II.12: GHG emission reductions of different renewable fuels (Schmitz 2013)

II.8 Food Crops for Industry?

There is a recent controversial debate about whether food crops should be used for other applications than food and feed, namely for energy or materials. In a paper published in 2013 (Carus & Dammer 2013), nova-Institute made a contribution to this debate by arguing with scientific evidence and by taking a step back from the often very emotional discussion.

The core claim of the paper is: **All kinds of biomass should be accepted for industrial uses; the choice should be dependent on how sustainably and resource efficiently these biomass resources can be produced.**

Of course, with a growing world population, the first priority of biomass allocation is food security. The public debate mostly focuses on the obvious direct competition for food crops between different uses: food, feed, industrial materials and energy. However, the crucial issue is land availability, since the cultivation of non-food crops on arable land would reduce the potential availability of food just as much or even more, as will be discussed below.

It is therefore suggested to take a differentiated approach to finding the most suitable biomass for industrial uses.

In a first step, it must be addressed whether the use of biomass for purposes other than food can be justified at all. This means taking the availability of arable land into account. Several studies show that some areas will remain free for other purposes than food production even after worldwide food demand has been satisfied. These studies also show potential for further growth in yields and arable land areas worldwide.

The second step is then to find out how best to use these available areas. Recent studies have shown that many food crops are more land-efficient than non-food crops. This means that less land is required for the production of a certain amount of fermentable sugar for example – which is especially crucial for biotechnology processes – than would be needed to produce the same amount of sugar with the supposedly "unproblematic", second generation lignocellulosic non-food crops. Also, the long-time improvement of first generation process chains as well as the food and feed uses of by-products make the utilization of food crops in bio-based industries very resource efficient.

Another very important aspect that argues in favour of industrial use of food crops is the flexibility of crop allocation in times of crises. If a food crisis occurs, it would be possible to re-allocate food crops that were originally cultivated for industry to food uses. This is not possible with non-food crops – they can only ensure supply security for industrial applications.

Therefore, political measures should not differentiate simply between food and non-food crops, but that criteria such as land availability, resource- and land efficiency, valorisation of by-products, and emergency food reserves are taken into account. It also means that research into first generation processes should be continued and receives fresh support from European research agendas.

Lastly, a level playing field between industrial material uses of biomass and biofuels/bioenergy is needed in order to reduce market distortions in the allocation of biomass for uses other than food and feed.

The following figure II.13 shows a comparison of land efficiency of different crop types in terms of sugar volumes produced per unit of land.

The complete position paper with detailed arguments and explanations can be downloaded for free at: *www.bio-based.eu/policy*

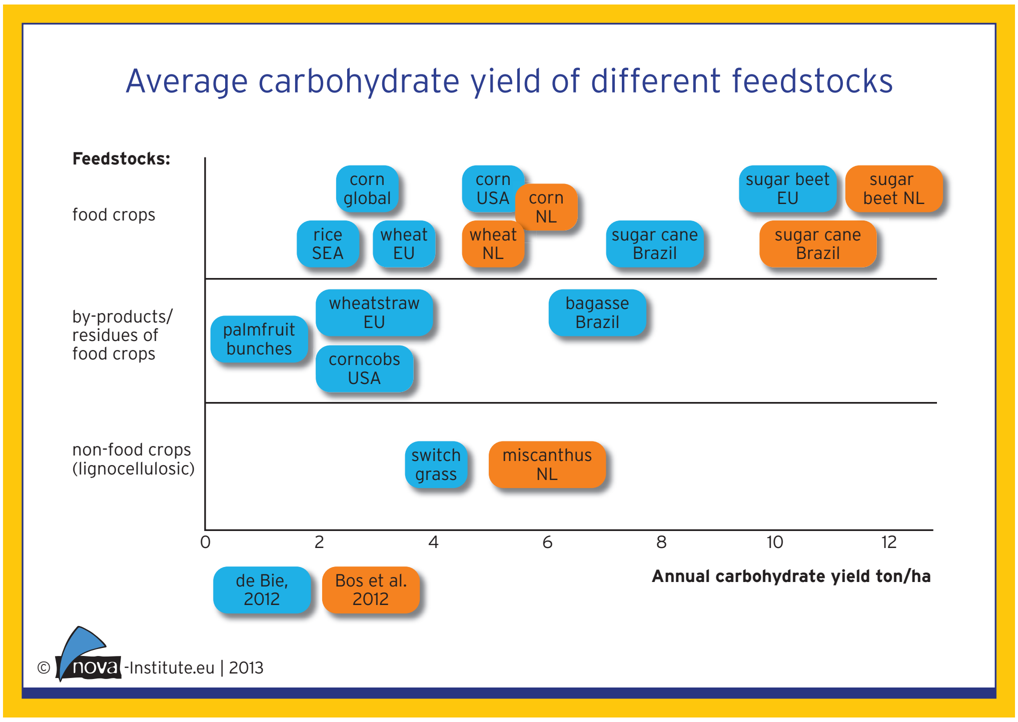


Figure II.13: Annual carbohydrate yield per hectare for different feedstocks (Carus & Dammer 2013)

II.9 Cascading Use of Biomass

Cascading use of resources is a recently widely debated topic in the context of resource efficiency and environmental protection as well as in the context of circular economy. For the purpose of this paper, the focus is put exclusively on biomass.

In 2013, the European Parliament stated that it "Emphasise[d] that bioeconomy policies must be better designed to ensure a cascading use of biomass; call[ed], in this respect, for the development of a legal instrument that will pave the way for a more efficient and sustainable use of this precious resource; stresse[d] that such an instrument should establish a cascading use principle in the 'pyramid of biomass', taking into account its different segments and strengthening it at its highest levels; point[ed] out that such an approach would lead to a hierarchical, smart and efficient use of biomass, to value-adding applications and to supporting measures such as coordination of research along the whole value chain". (European Parliament 2013)

The question of whether single-stage or only multi-stage (see definition above and figure II.14) can be accepted as cascading use is a political matter of major importance. Single-stage cascading use already involves a significant increase in resource efficiency compared to direct energy use and allows for the inclusion of many existing bio-based value chains. Multi-stage cascading use results in a greater increase in resource efficiency, but has so far only been achieved for a very small number of biomass sources or can only be achieved with a limited number of value chains.

Understanding cascading principle as a strategy to increase resource efficiency, both single and multi-stage cascading can be supportive for an overarching efficiency objective. New ways of biomass material use – even if they don't include multi-stage from the beginning – implicate the potential to increase cascading use.

Figure II.14 distinguishes clearly between single-stage and multi-stage cascading use:

As of now, there is no legal framework, not even a binding definition of what is meant by "cascading use". In general it is often shortly described by the phrase "first materials, then energy" – meaning that a resource can first be processed into a material, which can then at the end of its life still be re-used or reycled or finally transformed to energy, for example by incineration. This understanding leaves a lot of room for interpretation and thus also for misunderstanding or controversy.

In order to create clarity in the debate, we propose the following definition of "cascading use of biomass on product level"

Cascading use of biomass *takes place when* ***biomass*** *is processed into a* ***bio-based final product***[2] *and this final product is used at least once more either* ***for materials or energy.***

Cascading use of biomass *is described as* ***single-stage****, when the bio-based final product is directly used for energy.*

Cascading use of biomass *is described as* ***multi-stage*** *when biomass is processed into a bio-based final product and this final product is used* ***at least once more*** *as a material. It is only after at least two uses as a material that energy use is permitted.*

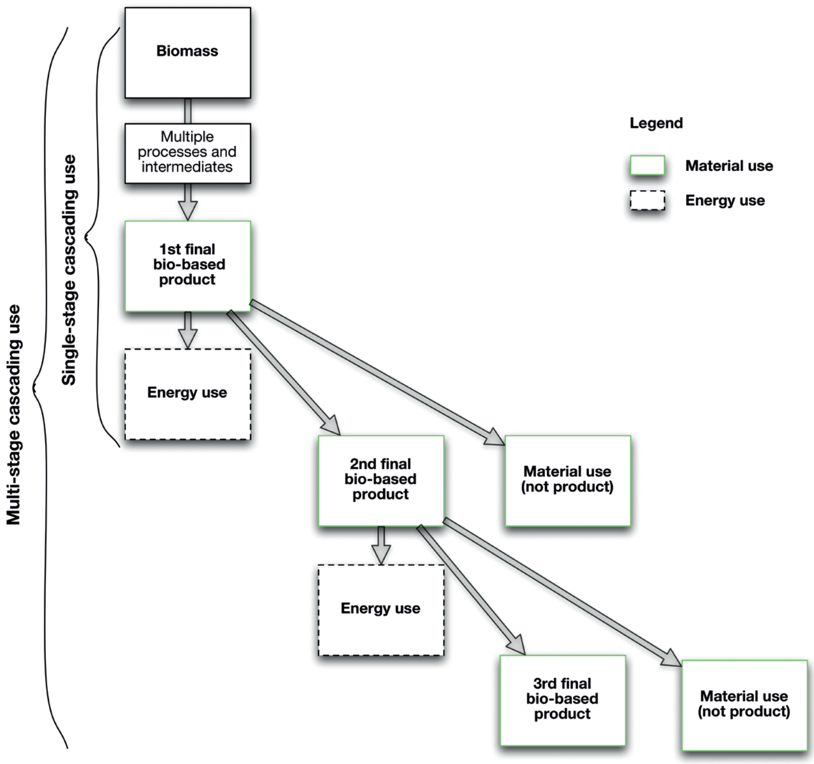


Figure II.14: Distinction between single-stage and multi-stage cascading use of biomass

Note: Between the different stages, all kinds of processes such as re-use, recovery, recycling, up- and down-cycling are included.

2 Final product is defined as a product at the end of a processing chain, which it traded and used by industry and/or consumer for its material or product properties. Process intermediates are not counted as final products. Energy carriers such as wood pellets, biodiesel or bioethanol are explicitly excluded in this context, because they are not materially used (also in a material value chain all three would only be intermediates).
"Mega products" such as houses and cars are not treated as final products, they are combinations of several final products. For example insulation material is used by the industry as a final product for its properties in house construction.
The final product is only required for the first stage, on the second stage final product or any kind of material use in accepted and for some bio-based chemicals or materials the transition between both is smooth.
The terms „bio-based product" and „bio-based content" or „bio-based carbon content" should be used in line with the CEN/TC411 – prEN 16575 Bio-based products.

When looking at the recent discussion about introducing cascading use principles in the legal framework of resource use in Europe, different positions become clear. First of all, the current support system makes energy use of biomass without any prior utilization as a material quite attractive, which is not desirable from our point of view for several reasons, as explained above. One concern could be that a change in frameworks would make it difficult for the established energy systems to obtain enough biomass to still be able to uphold current renewable energy quotas. However, the following quote shows that this does not have to be the case:

> "If you are going to burn it, then why can we not extract the chemicals first?" You can extract a lot of valuable chemicals in very large volume, given the volumes [of biomass] we are talking about, and calorific value [of burning material] is not affected. In fact, in many cases you can end up with a material that is easier to co-fire with coal, for example. I have always believed that for chemicals manufacturing we should sit alongside the energy industry, not try to compete with it but go alongside it, taking some of the higher value products, as we have learned from petroleum." (ADAS 2008, quoted in House of Lords 2014)

Other positions doubt the overall feasibility of cascading use. A recent position paper by several biomass associations stated that "the functionality of a legally binding cascade principle is highly questionable" (AEBIOM 2013). Some concerns are discussed in the following.

First, the paper illustrates that wood is in fact becoming more and more scarce on the European market. Of course – if enough wood were available for all kinds of applications, nobody would have to worry about the possibility that obligatory cascading use would divert a part of the biomass supply to material use. Even though the paper implies that enough wood is grown in the EU to meet all demands, this is belied by the fact that already today, big amounts of wood pellets are being imported to the EU. Experts estimate that the EU's demand for wood pellets will strongly increase to 29 million tonnes by 2020, from 8 million tonnes in 2010. Two third of the pellets will be imported from abroad. (Reuters 2013)

A further concern is that the climate goals will not be reached if the energy sector loses biomass. This is paradox but the wood industry is not to blame: It is much more a deficiency of the political framework, since the material use of one tonne of wood saves at least just as much CO_2 as the energy use of the same amount (each compared to their fossil counterpart), it just is not accounted for in the RED.

Instead of arguing against cascading use and defending the political status quo, it would make much more sense to develop concepts to ensure that those parts of the wood, which can be used as materials, are not allocated to energy (which is exactly what is happening right now).

The paper argues generally against market manipulations such as a legally binding cascade principle, but completely ignores the massive incentives existing for bioenergy, which indeed constitute market manipulations and create visible distortions – to the advantage of the bioenergy. Also the argument that "the largest part of energy from biomass does not receive subsidies, in particular the heating sector" is not viable because it should be easy to agree then to also end the subsidies for the smaller sector (conversion into electricity) in order to create a level playing field. Or – as an alternative – the support could remain as it is, but then the material use should also receive some incentives to create the level playing field.

It is definitely not a sustainable solution to only support the bioenergy sector and at the same time not even to promote cascading use. The resource efficiency and climate protection gains that are achieved by multiple substitutions of raw materials have been proven several times (see also Table II.5 below) So the question left to debate is not whether to support cascading use, but only how to do it. In that regard, the critical remark "in practice, the functionality of a legally binding cascade principle is highly questionable" is indeed justified.

The paper has one valid point, namely that a "legally binding" approach may not be the most appropriate way to get the best results. It is a legitimate question whether this could be effectively regulated at EU level. However, that is the only instrument being discussed in this context, without acknowledging any other potential instruments.

But several other instruments are conceivable that could support cascading use without a "legally binding cascade principle". For example, wood utilized as energy that stems from a cascade could receive double counting in the RED, because the energy substitution is already the second (or even third) substitution after the substitution of the wood-based product before, and perhaps of a second wood-based product after recycling. (See our reform proposals in the main text for more details, Chapter 6.3.4 and 6.3.5.)

The table below illustrates schematically the positive effects of cascading use for reduction of GHG emissions during the lifecycle of biomass utilization, either as material or as energy. It is based on the following assumptions and comes to two main conclusions.

		Material use (bio-based product) with unchanged electricity mix by 2050	Material use (bio-based product) with a strongly increased share of renewables in the electricity mix by 2050	Energy use
1.	**Growth period of the forest (or the agricultural area)**			
1950 to 2010	Sequestration of biogenic carbon	–100	–100	–100
	Cumulative emission effect by stage 1	–100 + 0	–100 + 0	–100 + 0
2.	**Wood harvest and use**			
2010	Emission reduction through substitution of fossil energy carriers			–40
	Emission reduction through substitution of fossil materials	–40	–40	
	Release of biogenic carbon after incineration	0	0	100
	Cumulative emission effect by stage 2	–100 –40 = –140	–100 –40 = –140	0 –40 = –40
3.	**Material use lifetime**			
2010 to 2050	No emission effects			
	Cumulative emission effect by stage 3	–100 –40 = –140	–100 –40 = –140	0 –40 = –40
4.	**Energy use of bio-based product (end-of-life)**			
2050	Emission reduction through substitution of fossil energy carriers	–40	–20	
	Release of biogenic carbon	100	100	
	Cumulative emission effect by stage 4	0 –80 = –80	0 –60 = –60	0 –40 = –40
	Net CO_2 emissions	–80	–60	–40

Table II.5: Schematic GHG balance over cascading lifetime of materials and energy (in tonnes CO_2)

Assumptions

- The substitution of either fossil material or fossil energy carriers amounts to 40% of CO_2 reduction in both cases in 2010.
- In 2050, the substitution of fossil energy carriers will only amount to 20% of CO_2 reduction if the overall energy mix is further decarbonised.
- The only end-of-life option considered is energy use.

Conclusions

- Through the double substitution achieved by material use, more CO_2 is reduced over the whole lifecycle (from-cradle-to-grave) than compared to direct energy use.
- Material use sequesters 100 tonnes of CO_2 during the whole lifetime of a product. Energy use does not have any sequestration effects. Due to this temporary sequestration effect, the atmosphere is burdened with 100 less tonnes of CO_2 during the timeframe under consideration.

Legend

All numbers indicate material flows as tonnes of CO_2. The biomass used for this example thus contains 100 tonnes sequestrated CO_2.

***Green** numbers indicated the amount of "green" carbon that is withdrawn from the atmosphere during plant growth, sequestrated in the biomass and the bio-based product and which is completely released into the atmosphere at the end of the lifecycle without negative side effects (e.g. CH4 release).*

***Black** numbers indicate the amount of "black" carbon stemming from non-renewable and fossil raw materials (mineral oil, coal, natural gas etc.) and which is substituted by "green" carbon through material or energy uses of biomass.*

***Red** numbers indicate the net result of adding the green and the black numbers and therefore the cumulative emission of CO_2 over the lifecycle in question.*

II.10 Waste, Residues and the RED

In the context of the RED, a feedstock used to produce a biofuel for transportation can either be classified as a product, a co-product, a residue or a waste. For a feedstock classified as a residue or a waste, it will be easier for the fuel producer to fulfil the sustainability criteria of the RED. Further, the double counting mechanism depends on the use of a residue or a waste, and in some member states there is also a direct link to eligibility for state aid for instance in the form of tax benefits. In other words, from the fuel producer's perspective, feed stocks classified as residues or wastes are very interesting to use.

The RED does not include any definitions of residue or waste and, as a result, there is today not one harmonized way of implementation. Several member states have chosen to define the terms in accordance with already existing environmental legislation, such as the Waste Framework Directive, while others have created definitions believed to be suitable for RED purposes. This has resulted in feedstocks being classified differently in different member states, i.e. a feedstock which in one member state is seen as a co-product can very well be labelled as a residue in another. In the iLUC proposal, the importance of feedstock classification still remained; however, the proposal still did not include a binding harmonisation of terms with the Waste Framework Directive. The proposal did contain a definition of waste, but none for residue. The latter is not defined in the Waste Framework Directive either. Therefore, discrepancies between definitions of residues would remain with such an approach, as would the non-harmonization and the negative impact on non-energy applications.

The acceptance of animals fats, crude tall oil (a co-product of pulp production), crude glycerine and bark in national RED implementations, sometimes counting double, are concrete examples of how material use is deprived of raw materials; but the affected sectors and companies are starting to react. Annex I includes a table of all cases in which the RED has already created conflicts of biomass use including detailed explanations by the companies that see detrimental effects on their businesses. In case of the waste and residue regulations, some examples are illustrated here.

Animal fats have been used for many decades as a raw material by the oleochemical industry for numerous applications, for example in the pharmaceutical and cosmetics sectors. The RED's inclusion of animal fats has deprived the oleochemical industry of them and led to their being used primarily to produce biodiesel, since the biofuel industry has been able to pay high prices due to the favourable political framework conditions. The oleochemical industry has had to switch to imported palm oil. The two-year period during which they were counted in the biofuel quota directive came to an end on 1 January 2012 in Germany. The Federal Ministry for the Environment (BMU) justified this by announcing that it made no sense if subsidies deprived the oleochemical industry of animal fats by displacing them into the biofuel sector (Weber 2012). The BMU was able to push this through against the wishes of the biofuel sector, but only in Germany. This market distortion will persist for as long as double counting for the quota is permitted in other EU Member States, allowing biodiesel produced in Germany from animal fats, for example, to be exported to Great Britain.

The situation is similar for crude tall oil. It is a co-product of pulp production in Scandinavia in particular; however, it is considered a residue in some Member States. There has been significant investment in crude-tall-oil based biofuels in recent years. Tall oil is used for a variety of chemicals, such as rosin or turpentine. Raw material costs have increased since crude tall oil has been defined as a residue and made eligible for double-counting as well as for high incentives when used for biofuels. The European Commission's iLUC proposal did not list crude tall oil as eligible for double counting. Instead the proposal listed tall oil pitch (a residue of tall oil processing) as eligible for quadruple counting in future. However, Scandinavian firms specialised in the production of biodiesel from crude tall oil in the past few years are currently trying to influence the iLUC draft proposal so that crude tall oil may still be multiple counted as a residue (Holmberg 2013a), see also Annex I.3.1.

There are similarities in the case of crude glycerine. Competition is not fierce at the moment, as crude glycerine has not been used for fuel production on a commercial scale, but this could change if crude glycerine were to be counted quadruple in future transport quotas. The company Solvay wrote on this subject in March 2013:

> "The proposed changes to the RED/FQD in their current form would have harmful consequences for the development of raw-glycerine-based chemical products. As crude glycerine would be overwhelmingly used for fuel production, this raw material would no longer be available for renewable or bio-based chemistry." (Hotter 2013)

One further example is bark, which has been recognised as eligible biomass in the RED-induced German Green Electricity feed-in tariffs since 2012. It is now in short supply as a raw material for the humus industry, which has committed itself to replacing peat with bark in the future. This commitment will now be extremely difficult to implement, since bark is currently mainly used for electricity generation from biomass.

Apart from the existing competitions for different types of biomass illustrated above, we have analysed for which types of biomass conflicts could arise if they were to be (or continued to be) counted multiple in the RED as feedstocks for bioenergy or biofuels. The table below lists the feedstocks that were suggested under the iLUC proposal to be included with double or even quadruple counting for which we see potential conflicts between energy and material uses. A few feedstocks that were listed in the original list are not included. These are the ones for which we did not see any potential material uses that could lead to competition (e.g. tall oil pitch).

Feedstock	Counting in iLUC proposal	Suitable for the production of high-value products	Extraction of high-value products feasible	Comments
Algae	x4	YES	YES	Algae are currently used in a wide range of different products. These range from feed, food and fertiliser uses, to the production of fatty acids, plant oils and other metabolites for use in cosmetics, health foods and pharmaceuticals. Algae are not a waste, but will be a dedicated crop.
Biomass fraction of industrial waste	x4	YES	NO	Alternative usages depend on the definition of this category – paper waste, card board and wood waste can be recycled for material uses (to a certain point, after which fibre lengths are so short that they cannot be recycled any further).
Straw	x4	YES	(NO)*	Straw is a suitable feedstock for the production of high-value products as part of a biorefinery (investigated for example in the BIOCORE FP7 project). Enzymatic or other pre-treatment can provide fermentable sugars (glucose, xylose and others) and lignin as main inputs for industrial material uses.
Palm oil mill effluent and empty palm fruit bunches	x4	NO	YES	Fatty acids as well as metabolites and sugars from the lignocellulosic palm fruit bunches can be a feedstock for uses in oleochemical, chemical and industrial biotechnology applications (for example for lactic acid).
Crude Glycerine	x4	YES	NO	Crude and impure glycerine could be a valuable feedstock for a wide range of applications in the industrial biotechnology sector.
Bagasse	x4	YES	(NO)	Similar to straw, bagasse can provide fermentable sugars and lignin for further processing in a range of industrial applications.
Grape marc and wine lees	x4	NO	YES	Grape marc and wine lees are already used for a wide range of applications in the food industry (grape spirits, liqueurs). They also provide a range of extractables with varying uses such as oils from the seeds, sugars and secondary metabolites.
Nut shells	x4	YES	(NO)	Nut shells are lignocellulosic material and could in principal be used for the same applications as other lignocellulosic feedstocks (see straw). Additionally they are suitable to produce composite materials similar to Wood-Plastic Composites (WPC).
Husks	x4	YES	(NO)	Husks are lignocellulosic material could in principal be used for the same applications as other lignocellulosic feedstocks (see straw).
Cobs	x4	YES	YES	Corn cobs are being used mainly as food additives for poultry. Other uses in industrial biotechnology can be envisaged.
Bark, branches, leaves, saw dust and cutter shavings	x4	YES	YES	Typical uses for saw dust and other woody residues can be found in the pulp and paper industry as well as in the wood-based panel industry. These established industries already face competition from wood pellet production. Additionally, bark is used for mulching (as an alternative to turf) and can be used as a source of high-value extractables (tannins and others).
Used cooking oil	x2	YES	NO	UCO is a valuable feedstock for animal feed, oleochemicals (surfactants, lubricants and others), chemical and future biotechnical processes.
Animal fats	x2	YES	YES	Some animal fats are a valuable feedstock for oleochemicals (surfactants, lubricants and others), chemical and future biotechnical processes.
Non-food cellulosic material	x2	YES	YES	See straw; the feedstock is not a waste but will be planted as a dedicated crop.
Ligno-cellulosic material except saw logs and veneer logs	x2	YES	YES	See straw; the feedstock is not a waste but will be planted as a dedicated crop.

*(NO) means that it is as of yet unclear whether the extraction of high-value products is feasible.

Table II.6: Potential conflicts of use for materials included in the iLUC proposal with a multiple counting.

Notes: "Suitable for the production of high-value products" refers to the conversion of biomass into, for example, chemicals and polymers, which typically attain a higher economic value than biofuels. "Extraction of high-value products feasible" means that the biomass contains (small amounts of) specific ingredients, which could be extracted for the production of high-value products, before using the biomass for energy purposes. It is therefore recommended that this biomass should not go directly into biofuels, but only after extraction. Extractables are, for example, relevant for fine chemicals or the pharmaceutical industry, i.e. for small to medium-sized markets for biomass but with high revenue per unit of biomass.

II.11 Sustainability Criteria for Renewable and Fossil Feedstocks in Different Applications According to Different Legal Frameworks

	CEN TC 411 draft on sustainability criteria for bio-based products (2014)	Sustainability criteria for biofuels and bioliquids according to RED DIRECTIVE 2009/28/EC		Proposal for a Directive of the European Parliament and of the Council on sustainability criteria for solid and gaseous biomass used in electricity and/or heating and cooling and biomethane injected into the natural gas network (draft version from 2013) on voluntary basis of the Member States		Sustainability criteria for fossil-based energy & products
Environmental criteria						
Greenhouse gas emissions	yes	yes	greenhouse gas emission saving shall be at least 35 %	yes	greenhouse gas emission saving shall be at least 35 %	no
Air quality	yes	no		no		no
Quality and quantity of Water	yes	no		no		no
Soil quality, productivity, erosion	yes	yes	minimum requirements for good agricultural and environmental condition (cross-compliance)	yes	minimum requirements for good agricultural and environmental condition (cross-compliance)	no
Biodiversity	yes	yes	shall not be made from raw material obtained from land with high biodiversity value (natural forests and other wooded land, nature protection/ conservation areas, highly biodiverse grassland)	yes	shall not be made from raw material obtained from land with high biodiversity value (natural forests and other wooded land, nature protection/ conservation areas, highly biodiverse grassland)	no
Protection areas: Wetlands, continuously forested areas, other forest areas	yes	yes	shall not be made from raw material obtained from land with high carbon stock (wetlands, continuously forested areas, other forest areas)	yes	shall not be made from raw material obtained from land with high carbon stock (wetlands, continuously forested areas, other forest areas)	no
Protection area: Peatland	no	yes	shall not be made from raw material obtained from land that was peatland in January 2008	yes	shall not be made from raw material obtained from land that was peatland in a specific date	no
Protection target: Primary forest biomass	no	no		yes	primary forest biomass shall be obtained from sustainably managed forests in line with international principles and criteria, according to which biomass harvesting is carried out at sustainable yield, biodiversity resources are preserved, and carbon stocks are maintained or increased over the medium and long term	no
Energy & material efficiency	yes	no		yes	member states shall differentiate in favour of installations that achieve high energy conversion efficiencies	no
Use of renewable & non-renewable resources	yes	no		no		not applicable
Waste management	yes	no		no		no
Social criteria						
Labour rights	yes	no		no		no
Working conditions	yes	no		no		no
Living conditions	yes	no		no		no
Land use rights	yes	no		no		no
Water use rights	yes	no		no		no
Local development	yes	no		no		no
Economic criteria						
Fair business practices	yes	no		no		no
TOTAL	**16 criteria**	**5 criteria**		**7 criteria**		**0 criteria**

Table II.7: Sustainability Criteria for Renewable and Fossil Feedstocks in Different Applications According to Different Legal Frameworks (nova 2014)

II.12 Small Scale Profitability: Bio-based Plastics' Development Independent of the Future of Biofuels

In the discussion of the level playing field between materials and energy, it is often mentioned that bio-based materials profit from the support of bioenergy and biofuels, since they utilize the same technologies. In fact, the economics and dynamics of the chemical industry in material applications differ quite strongly from the fuel industry in terms of scales and processes. Three authors have recently illuminated these differences and have stressed why the industrial material use of biomass does not necessarily require big volumes or the development of biofuels as precursor. They challenge common preconceptions of the structure of a bioeconomy:

> „A widely held perception is that the biobased plastics industry is inextricably linked to and dependent on the emergence of a robust biorefining industry focused mainly on providing fuel. This perception is quite understandable, given that this is how the petrochemical industry developed. […]
>
> There is reason to believe that the biobased plastics industry could develop regardless of what happens with biofuels. In fact, biobased plastics companies could innovate and thrive precisely because of that independence. The biobased plastics industry is emerging in a world of mature and sometimes obsolete manufacturing facilities, which present opportunities to leverage and repurpose infrastructure which the petrochemical industry, nascent in the early twentieth century, did not enjoy. The net result is that the model set by the petrochemical industry, which was dependent on a strong petroleum-based fuels infrastructure, does not necessarily hold for the biobased plastics industry. The biobased plastics industry is also emerging in a world filled with well-established applications for plastics, so the market uncertainties are much reduced relative to what the nascent petrochemical industry faced.
>
> The biobased plastics industry, even if it were wildly successful in displacing all conventional plastics, is dwarfed by the biofuels industry. [...] An independent biobased plastics industry could be better positioned to advance to second and third generation biomass feedstocks than the biofuels industry precisely because of the enormous differences in scale. Because biofuels are a relatively low value commodity, they need scale to be cost competitive. The smaller production volume of biobased plastics and their potentially higher value may make some options viable, which are not feasible for large production volume biofuels.
>
> Since smaller production volumes may be economically viable, the logistics may be more manageable. The geographic reach to obtain sufficient biomass feedstock or the need to concentrate agricultural production to simplify logistics is substantially reduced. Alternatively, one could consider smaller scale distributed processing, bringing the chemical intermediate production facility to the feedstock rather than vice versa.
>
> In addition to potentially simplified logistics, the potential exists for repurposing obsolete facilities for processing biomass into monomers and intermediates as mentioned above. Many of these facilities available for repurposing could be ideally sized for a biobased plastics intermediate operation. Note that a fermentation facility (i.e., where microbes convert the feedstock to chemical intermediates or polymers) scales up mainly by adding fermentation vessels rather than through using a bigger vessel. Yes, there may be economies of scale upstream and downstream of the fermenters, but the core of the process is inherently modular and suited to smaller volume operation.“ (SPI 2013)

The next quote also stresses the economic distinctiveness of the industrial material use compared to energy and highlights the advantages this could mean for national economies, in this case focusing on the Dutch economy:

> The conclusion I is that the chemical industry is the only sector that allows a higher cost price for its raw materials because these can be compensated by lower capital costs.
>
> A second important conclusion II has been made in the recent study, that because of the lower capital costs per ton of product, also the scale of operation is less an important factor in the competition between companies of the future. It is anticipated that factories of 10 000 tonnes of product per year can become as competitive as the large petrochemical factories that have annual capacities of 200 000 and even 500 000 tonnes. The dominant competitive factor will become how to obtain the right raw material/conversion process combination. Especially in times that the biomass raw materials are not available yet as commodities, the sourcing is an additional risk factor when financing has to be done. Also for the introduction of totally new products, small factories will be a competitive factor since this gives time to develop the market. [...]
>
> The third conclusion III is that the chemical industry 50% based on biomass will create a lot of new jobs. Employability can grow with 40,000 jobs to supply the Dutch chemical industry with 50% of biomass raw materials (now being ca. 80,000 fte). This is revolutionary in a way because in agriculture but also in the process industry we have seen only reduction of labour because of the ever-growing productivity reached by automation, taking over of human and animal labour by machines. [...]
>
> The conclusion IV is that when the chemical industry can afford to pay higher prices for components with suitable molecular structures that lower the need for capital, the other biomass components that result from a biorefinery, can become available at a much lower price, enabling the electricity and transportation fuel sectors to obtain their raw materials at competitive prices.
>
> Therefore, conclusion V, the chemical sector is key and could pave the way towards our biobased economy.“ (Sanders 2014)

Also from the U.S. perspective the picture looks quite similar:

> [...] in the face of declining support for biofuels among policy makers [...] Developers of biochemicals, biomaterials, bioactive ingredients, and processing aids have a bright future. While these opportunities are orders of magnitude smaller than fuels, they offer producers good margins and pricing power. Moreover, they have the additional benefit of not relying on policy incentives to create demand.
>
> Now the time is come for a more strategic, robust, and collective engagement. … we lack a muscular voice to drive a coherent narrative that rises above the biofuels fracas. The sector is in need of an effective advocate to bring forward information and address the bigger picture. (Huttner 2013)

II.13 The 2014 U.S. Farm Bill and Bio-based Materials

The 2014 Farm Bill, signed on 8 February 2014 by President Barack Obama, provides new opportunities for bio-based materials.

First of all, the BioPreferred® program on bio-based products by the Department of Agriculture (USDA) has been extended and provided with new funding, thus guaranteeing a continuation of the successful labelling and public procurement scheme. However, USDA now has the task of designating categories of bio-based intermediate ingredients and feedstocks or assembled and finished products within one year for the preferred procurement (Buckhalt & Goodman 2014). Mandatory funding for this program has been set at 3 million Dollars per year with discretionary funding of additional 2 million Dollars per year (Biodiesel Magazine 2014).

USDA will also conduct an economic impact study within one year, investigating the economic effects of a switch to a bio-based industry, both in terms of value added and employment (Buckhalt & Goodman 2014).

Furthermore, an important step has been taken in the eligibility of renewable chemicals now both in the Biorefinery Assistance Program and the Biomass Research and Development Program. **This is a crucial development towards a level playing field of material and energy use.** 22.5 million Dollars will be available over two years for the manufacturing of renewable chemicals under the Biorefinery Assistance Program (Buckhalt & Goodman 2014).

Good news also for the wood and fibre industries: Forest products that apply an innovative approach to any of the steps of the production process regardless of the date of entry in the market place are now also eligible for support by the new Farm Bill. Of course, the term "innovative approach" is wide open for a multitude of interpretations, so USDA will be working over the next months on defining product categories eligible for support.

Finally, also the restrictions on growing and researching industrial hemp have been eased, "paving the way for several states to begin pilot growing programs for this variety of the cannabis plant, which can be refined into oil, wax, rope, cloth, pulp and other products" (NY Times 2014). This will most probably give a push to the emerging fibre and biocomposite industry in North America.

10 Literature

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