

Standards and Regulations for the Bio-based Industry STAR4BBI



Work Package 2

D2.2

Elimination of hurdles in standards and regulation

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Table of contents

Summary	4
1 Introduction	6
1.1 Introduction	6
1.2 The companies and other stakeholders	6
1.3 General approach	7
2 Potential Solution Routes for Hurdle: End-of-Life (EOL)	9
2.1 Introduction	9
2.2 Agreement on most preferable EOL option for a given bio-based product	9
2.2.1 Background analysis	9
2.2.2 Drivers of different stakeholders	10
2.2.3 Direction for potential solutions	10
2.3 Conflicting interest of bio-based product manufacturers and waste processors	10
2.3.1 Background analysis	10
2.3.2 Drivers and behaviour of different stakeholders	11
2.3.3 Direction for potential solutions	12
2.4 Local alignment of accepted EOL route for bio-based compostable products	12
2.4.1 Background analysis	12
2.4.2 Drivers of different stakeholders	13
2.4.3 Direction for potential solutions	13
2.5 Summary and conclusions	13
3 Potential Solution Routes for Hurdle: Certification & standards	15
3.1 Introduction	15
3.2 Standards are not in line with everyday practice (e.g. EN 13432)	15
3.2.1 Background analysis	15
3.2.2 Drivers of different stakeholders	15
3.2.3 Direction for potential solutions	16
3.3 Multiple certificates in the market	17
3.3.1 Background analysis	17
3.3.2 Drivers of different stakeholders	17
3.3.3 Direction for potential solutions	18
3.4 Double Testing	18
3.4.1 Background analysis	18
3.4.2 Drivers of different stakeholders	18
3.4.3 Direction for potential solutions	19
3.5 Non-functional specifications	19
3.5.1 Background analysis	19
3.5.2 Drivers of different stakeholders	20
3.5.3 Direction for potential solutions	20
3.6 Biodegradation of lignin	21
3.6.1 Background analysis	21
3.6.2 Drivers of different stakeholders	21
3.6.3 Direction for potential solutions	21
3.7 Standards for insulation material need rephrasing	21
3.7.1 Background analysis	21
3.7.2 Drivers of different stakeholders	22
3.7.3 Direction for potential solutions	22
3.8 Summary and conclusions	22
4 Potential Solution Routes for Hurdle: Biofuel policy	24
4.1 Introduction	24
4.2 The biofuel policy puts pressure on availability and price of biomass for bio-based products, results in non-level playing field between bio-based products and biofuels	24
4.2.1 Background analysis	24
4.2.2 Drivers of different stakeholders	25

4.2.3	Direction for potential solutions	26
4.3	Double counting in certain feedstocks listed by Renewable Energy Directive (RED) lead to price increase of feedstock due to their allocation for biofuel.....	29
4.3.1	Background analysis.....	29
4.3.2	Drivers of different stakeholders	30
4.3.3	Direction for potential solutions	31
4.4	Food vs. fuel discussion creates negative image	31
4.4.1	Background analysis.....	31
4.4.2	Drivers of different stakeholders	32
4.4.3	Direction for potential solutions	34
4.5	Summary and conclusions	34
5	Potential Solution Routes for Hurdle: Long term policy	36
5.1	Introduction	36
5.2	Non-level playing field between bio-based and fossil based products.....	36
5.2.1	Background analysis.....	36
5.2.2	Drivers of different stakeholders	36
5.2.3	Direction for potential solutions	37
5.3	Need for CO ₂ tax and fossil carbon tax	38
5.3.1	Background analysis.....	38
5.3.2	Drivers of different stakeholders	39
5.3.3	Direction for potential solutions	39
5.4	Implementation and organisation of Extended producer responsibility faces challenges	40
5.4.1	Background analysis.....	40
5.4.2	Drivers of different stakeholders	41
5.4.3	Direction for potential solutions	41
5.5	Lack of sustainability schemes and sustainability rating of bio-based products	42
5.5.1	Background analysis.....	42
5.5.2	Drivers of different stakeholders	42
5.5.3	Direction for potential solutions	43
5.6	Summary and conclusions	44
6	List of abbreviations	46
Appendix A	General solution routes to tackle hurdles faced by bio-based products.....	47
Contact	51

Summary

This report describes possible solution directions to overcome market entry barriers due to regulation and standardisation that companies that are active in the bio-based economy experience. The market entry barriers were investigated and described in the deliverable D2.1. Five main hurdles were described in D2.1:

- A number of issues around End-of-Life of bio-based products
- Certification and standards
- Biofuel policy, and the fact that supporting policy for bio-based products is missing
- Missing long term policy that helps to promote bio-based products
- Communication and image.

In order to define possible solution routes to the hurdles, for each hurdle the relevant stakeholders and their drivers towards the hurdle were investigated. Based on this investigation directions for solutions were defined and discussed with various stakeholders. Furthermore a workshop was held where the solutions were presented and discussed with a broad group of stakeholders.

Solution directions defined for the first four identified hurdles are:

- End-of-Life issues: There is no general agreement on which EOL option is most preferable for a several bio-based products. This relates to present regulations, recycling targets, and industrial operation practices and business models of waste processors. All parties involved would benefit from clear LCA data for EOL options for (groups of) products. This would allow governments, municipalities, consumers and waste processors to decide which product best goes where. Clear icons indicating the preferable EOL, EU wide can help to minimise products going into the “wrong” bin. And in particular cases it may be useful to indicate what is not the desired EOL route, e.g. for products which look like a particular material but in fact are not. Furthermore research on recycling of bio-based plastics and composting of biodegradable plastics is proposed with both the bio-based plastics suppliers and the waste processors being stakeholders in the project.
- Certification and standards: Several possible solutions are proposed to overcome the hurdle related to certification and standards. In principle, it is important to involve as many stakeholders as possible in the standardization process, in order to achieve a widely supported middle ground that corresponds as well as possible with everyday practice. Besides this, to give new materials the possibility to enter the market, standards should focus on the functioning of materials instead of the material itself. In the field of certificates, solutions lie in mutual compatibility, alignment and transparency in tests. However, aligning all involved parties can be (politically) challenging due to competition (between schemes). Moreover, amending standards is time consuming, but in the end these proposed solutions could open the door more easily to new bio-based materials.
- Biofuel policy: The RED puts pressure on availability and price of biomass for bio-based products. Different options are considered as potential solutions. One option is to reform the RED in order to integrate bio-based chemicals and materials. Another option is without changing the RED to create a link of bio-based materials to the RED through a “bio-ticket” system. The third option considered is a new directive special for bio-based materials. Furthermore a harmonized classification system of wastes and residues across EU is necessary, which needs to be implemented under the EU Waste Framework Directive (WFD). Where the use of feedstocks by the bio-based products industry is possible, such

uses must be incentivized. The same classification system that will be needed to be developed by the WFD will need to be adopted by the Biofuel policy for defining the feedstocks of “advanced biofuels”.

- Missing long term policy: In order to level the playing field between fossil-based and bio-based products two possible solutions are proposed. In the first place, the producer should be responsible for paying for the negative externalities of the production processes (e.g. possible damage to the environment) and not the whole society. Furthermore, sustainable certifications, currently often asked only for bio-based products, should be requested for all products. The lack of clear, robust methodologies and criteria for assessing the sustainability of both bio-based and fossil-based products represents a major gap that is hampering the future development of the bio-based industry. Development of the same sustainability criteria for all types of feedstock (bio-based and fossil based) and all sectors (materials and fuels/energy) across the whole life-cycle (material production, use and EOL) is proposed as a potential solution. And harmonization of LCA procedures is described to be important for this.

During the investigation process it was found that the fifth hurdle, communication and image, was an integral part of the other four hurdles, it was therefore not investigated and presented separately, but integral with the other hurdles.

The solution directions described in this report are focused specifically on the hurdles that were collected in D2.1 by interviewing a number of companies. During the investigation also more general aspects to stimulate the introduction of bio-based products came up. An overview of these is presented in appendix A.

The analysis laid down in this report has served as the basis for a deeper investigation and proposals to overcome specific market barriers, which are presented in D4.4, and proposals for supporting policy, presented in D3.3.

1 Introduction

1.1 Introduction

This report describes possible solution routes to the market entry barriers due to regulation and standardisation that were investigated in a previous report (deliverable 2.1¹). For deliverable 2.1 companies in eight value chains operating in the bio-based economy were extensively interviewed. Based on the analysis of the hurdles that the companies experience and an investigation of the drivers of the various stakeholders involved, possible solution routes are presented in this report.

From the presented solution routes the most promising will be investigated further and will be worked out in more detail in the deliverables 3.3 and 4.4.

1.2 The companies and other stakeholders

The companies that served as the basis for the market entry barriers investigated were selected on the basis of a good spread of their respective positions in the value chain and over different feedstock (see Figure 1). All companies do actually market products based on biomass feedstock and thus have experience in market entry barriers that may arise.

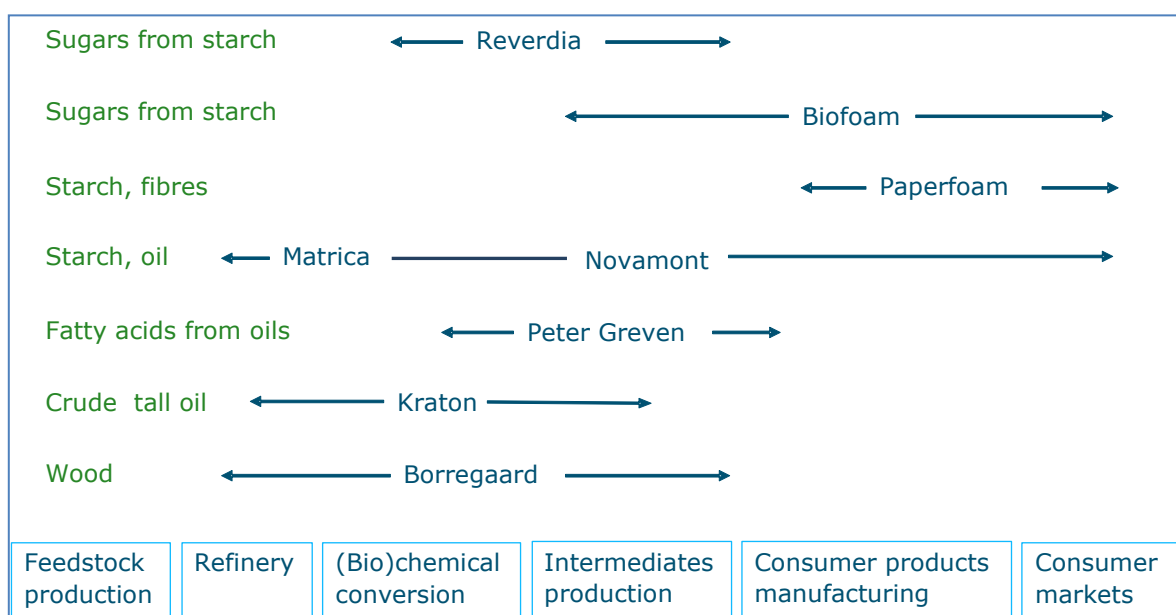


Figure 1: Position of interviewees of deliverable 2.1 in the production chain.

Next to the companies deliverable 2.1 also lists stakeholders that are relevant for each of the hurdles presented. These stakeholders cover a wide range of organisations from waste processors active in recycling or composting, to policy makers on municipal, national and EU level. The drivers and behaviour of these stakeholders are seen as very relevant for the existence of the hurdles, and one of the keys towards solutions, therefore they were taken as the starting point for the construction of the solution directions.

¹ <http://www.biobasedeconomy.eu/app/uploads/sites/2/2018/09/Please-click-here-to-access-deliverable-2.1.pdf>

1.3 General approach

After describing the market entry barriers of bio-based products (deliverable 2.1) it was decided to keep the key themes of that study as the main study objectives for addressing potential solutions as well:

- End-of-life
- Certification and standards
- Biofuel policy
- Long term policy
- Communication and image

The first idea for developing solution routes for the hurdles identified was as follows (and schematically represented in Figure 2):

- identify the origin/reasons behind each of the nearly 60 hurdles
- bundle origin/reasons to see if potential overarching solutions would become visible
- discuss key potential solutions with governments to check options and feasibility
- discuss potential solutions with industry and other stakeholders to check feasibility
- define potential solution routes

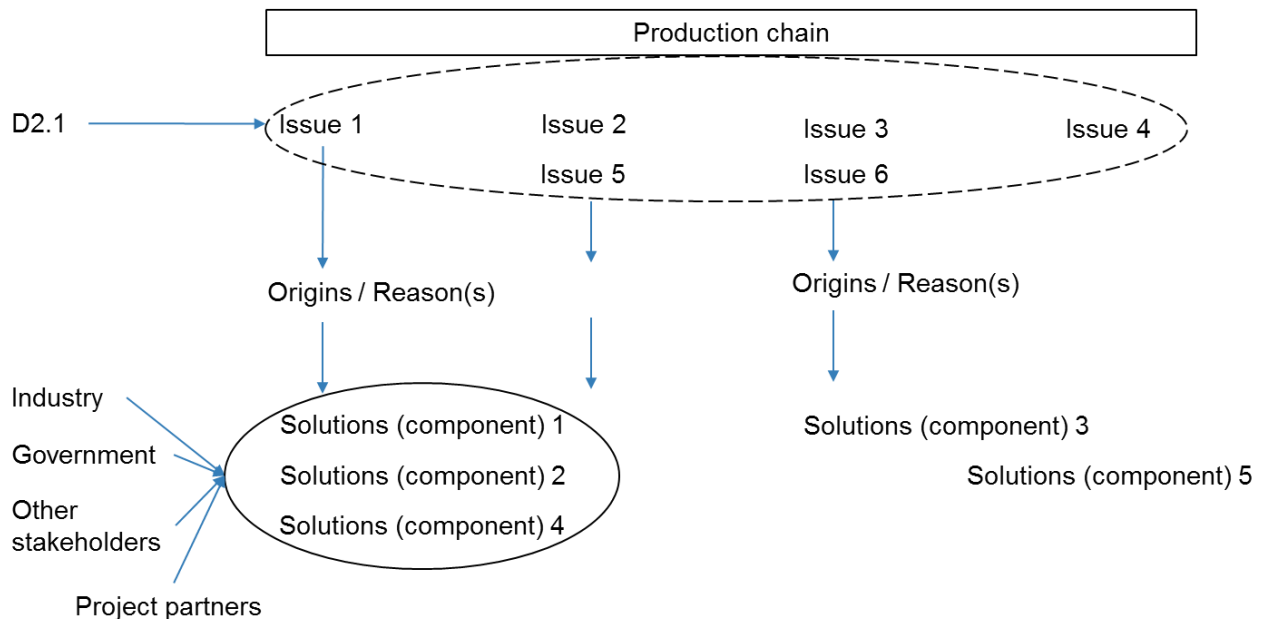


Figure 2: Schematic representation of initial approach to develop solution routes for hurdles identified in deliverable 2.1.

It turned out that this exercise resulted in overarching goals, too 'far away' to provide insight in next steps to take. Therefore, another approach was adopted:

- Starting with the same nearly 60 hurdles identified in deliverable 2.1
- Identify stakeholders (already partly addressed in deliverable 2.1)
- Identify drivers and behaviour of stakeholders

- Identify potential solutions
- If a potential solution is out of reach, which steps are required to come to a solution?

As it was observed that some hurdles show a kind of overlap, and as it was expected that addressing each of nearly 60 hurdles would withdraw attention from the hurdles which have highest chances for really being tackled, it was decided to prioritise the hurdles. Scoring was done by a total of 10 expert employees of the 4 partners in the project. An overall score was given by using the following criteria:

- Impact in Europe
- Feasibility 'technically'
- Feasibility time wise
- Urgency

Based on this score we clustered and chose the hurdles as described in this report.

As the issue of 'communication and image' appeared to play an important and interrelated role in the potential solutions of many hurdles during the prioritising exercise (which was confirmed during the course of the work), it was decided that this aspect was not separately addressed, but rather included in the elaboration of the other hurdles.

Next step is an even more thorough analysis of the 'most promising' solution routes (and next steps) in deliverables 3.3 and 4.4, in which discussions with governments, industry and other stakeholders are foreseen.

2 Potential Solution Routes for Hurdle: End-of-Life (EOL)

2.1 Introduction

For a number of bio-based applications the EOL options are one of the important aspects that can help with or stand in the way of market introduction. This is especially apparent for applications in packaging, since these are products with a relatively short service life. These hurdles take different forms:

- *There is no general agreement on which EOL option is most preferable for a given bio-based product.* There is no shared vision on which EOL option is the most preferable for different bio-based products.
- *There is conflicting interest of bio-based product manufacturers and waste processors.* Recycling companies and industrial composters are sceptical towards bio-based products.
- *There is no alignment of accepted EOL route for bio-based compostable products, between different municipalities and between national governments and municipalities.*² In various countries collecting household waste is a responsibility of the local governments. Different municipalities have different rules as to what is accepted in which bin. Also the ambitions of the national government differ from the rules of municipalities.

These issues will be discussed separately in the following subsections.

2.2 Agreement on most preferable EOL option for a given bio-based product

2.2.1 Background analysis

There is no general agreement on which EOL option is most preferable for a given bio-based product. Bio-based products are a diverse group, that can be divided in a number of main categories:

- Paper, cardboard and other products based on paper fibres
- Biodegradable bio-based plastics and bio-based resins (non-textile)
- Non-biodegradable bio-based plastics and bio-based resins (non-textile)
- Combinations of fibres and bio-based plastics and resins (a.o. panels and boards)
- Bio-based textiles

But even within such a category, products are very diverse. For instance panels and boards may be blanc, coated with a plastic layer, painted and/or filled with nails and screws. Plastics are very diverse as well (also see section 2.3), leave alone textiles which often consist of 2 or more intimately mixed materials. Recycling of materials sounds like an attractive EOL route, however, it often requires separation of the components of a product composed of different materials. The preferred EOL also depends on the question how to weigh the different environmental impacts of the various EOL processes among each other (f.i. how to compare the impact of depletion of fossil fuels, land use, eutrophication and smog).

² <https://www.vlaanderen.be/nl/natuur-en-milieu/afval/afvalinzameling> , visited 30 November 2017.

2.2.2 Drivers of different stakeholders

Governments and municipalities may wish to achieve the highest possible recycling %. Sending plastics to a recycler may be counted like that, however, sending plastic to a waste processor does not automatically mean that the plastic will be recycled indeed.³

Producers often feel natural responsibility for their products until use by the customer. This means they optimise their processes and material selection for product performance until use. As far as EOL disposal is of concern, producers often put that responsibility down in some other company or organisation.

Waste processors (recycling, digestion, composting) wish to recycle products, and get paid for accepting waste. Another part of their income originates from selling recycled materials (plastics regranulate, biogas, compost). Some waste products contribute more to this income than others, so waste processors will resist to waste products that do add to their costs and do not contribute to additional income.

Consumers often select products based on fashion, what appeals to them, and on price. They do not have the knowledge and tools to make choices in line with optimal EOL disposal. For example consumers appreciate board materials to build rooms, but appearance usually requires some kind of paint or coating, while one option might affect recyclability more than another option. Or consumers like fashion, but have little clue of materials used and their effect on recyclability.

2.2.3 Direction for potential solutions

All parties involved benefit from clear LCA data for EOL options for (groups of) products. That allows governments, municipalities, consumers and waste processors to decide which product best goes where. This relates to section 5.5.

Direction solution: Establish clear LCA data for EOL options for products, EU wide.

2.3 Conflicting interest of bio-based product manufacturers and waste processors

2.3.1 Background analysis

Producers of bio-based products would like their products after use to be accepted in disposal routes which have a positive connotation at the public. However, although these EOL routes are in principle possible, such disposal may cause issues for waste processors at present (D2.1¹). For instance, producers of compostable plastics would like their products meeting the EN 13432 standard to be accepted in the green bin. However, composting of biodegradable plastic has little advantage for waste processors, biodegradable plastics decompose to CO₂ and H₂O only and leave no compost. But maybe more important, acceptance of (certified) compostable plastics brings the risk of ordinary non-biodegradable plastics ending up in the green bin. This appears to require additional separation efforts in the facilities and there is a risk that non-biodegradable plastics end up in the compost, lowering its quality.

Another example is mechanical recycling of bio-based plastics. Like most plastics, except for black plastics which cannot be detected by Near Infrared (NIR), and laminate plastics, bio-based plastics can be technically recycled. Considering the world wide plastic soup discussion, the public appreciates the terms 'bio-based' and 'recyclable'. However, plastic waste processors only make money with the largest fractions, consequently virtually all being fossil plastics: HDPE, PP and PET,

³ M. van den Oever, et al. Bio-based and biodegradable plastics – Facts and Figures. WFBR 2017, available at <https://edepot.wur.nl/408350>

because further separation of the plastics adds more costs than the income from the respective recyclates.¹² As in the Netherlands basically all plastic is collected together, introduction of bio-based plastics, except for so called drop ins like Bio-PE and Bio-PET, means that converters need to handle a more diverse waste stream ending up with lower volumes of the economically interesting materials. The effect is that both composters and plastic recyclers tend to oppose to compostable and bio-based plastics in general, while merely focussing on the presently operating waste processing system.

A third example is a biofibre-starch based product. The producer wishes its product to be accepted in the waste paper stream because this enables the recycling of the fibres, which has a positive image. However, as the product only contains relatively small amounts of fibre, paper recyclers have to deal with high content of non-fibre constituents.

2.3.2 Drivers and behaviour of different stakeholders

Bio-based materials and products are relatively new to the market. Producers of such products wish to show advantages of their products to gain interest of consumers in order to maximise sales and profit. An easy and effective way to 'show' advantages is claiming general features which have a positive connotation for customers already. In particular when the consumer can imagine that the claimed features may be true, such as: bio-based, compostable, recyclable, recyclable in waste paper stream.

Organic waste processing companies aim to maximise their profit. The companies get paid for converting organic waste and they sell the resulting compost. Their costs are based on the composting facilities and operations. Income from accepting organic waste is more or less constant. Compostable plastic bags which facilitate collection of organic waste result in an increased volume and consequently more income. Therefore there is less opposition to accepting compostable plastics bags in the green bin, as long as they are used to collect organic waste. During the composting process, compostable plastics either degrade in full and do not contribute to compost, or they only degrade in part and end up in the compost, lowering its perceived quality (plastic particles visible), or need to be removed from the compost which adds costs. Consequently the income/cost ratio for just compostable plastics is lower compared to standard organic waste. Moreover, as compostable plastic resembles non-compostable plastic very much, waste processors fear introduction of such non-compostable plastics when accepting just compostable plastics. As a consequence, waste processors tend to oppose acceptance of just compostable plastics in the green bin, and even to put compostable (and bio-based) plastics in a bad light in general.

Mechanical recycling of plastics involves the recovery of plastic from waste through mechanical processes like separation to produce recyclates that can be converted into new.¹² The recyclers of plastics aim for maximum profit. The companies get paid for converting the mixed plastic waste stream into sorted plastic material which they sell to plastics converting industry. Their cost are based on the separation, grinding, washing, drying and re-granulation processing. Income from accepting mixed plastic waste is more or less constant. Further income is coming from supplying the sorted plastic material fractions, currently being (mostly) fossil based HDPE, PP and PET. Further separation of the plastics adds more costs than the additional income from the respective recyclates. So introduction of so called drop ins like Bio-PE and Bio-PET pose no change in operations. However, introduction of other bio-based plastics causes them to end up in the mixed fraction. As the recyclers fear reduction of the mixed fraction quality, they oppose to acceptance of bio-based plastics in the Plastic Hero system.

For feedstock price reasons, paper recyclers sometimes are happy to accept products which contain significant amount of non-paper components. Examples are e.g. drinking cartons which contain up to 25% of PE and aluminium, and 'only' 75% of high value fibre, and paper coffee cups which contain

about 85% of fibre and 15% of plastics. Because of the high content of non-paper fibre components, however, recycling requires dedicated processing equipment and all of these products need to be fed to a paper recycling process as a separate stream. Consequently, paper recyclers are not happy with such products in the conventional mixed waste paper stream. Therefore in the Netherlands, f.i. drinking cartons are either collected separately, or together with plastic and metals, and then separated prior to recycling. Also, economic recycling requires a minimum amount of paper fibre.

2.3.3 Direction for potential solutions

Little research has been performed on the effect of bio-based plastics on recycling and recycle quality. In order to obtain a clear and unambiguous picture of the effects, research on recycling of bio-based plastics and composting of biodegradable plastics needs to be performed with both the bio-based plastics suppliers and the waste processors being stakeholders in the project. Parameters could be plastic grade, plastic content, collection system and processing parameters, and their effect on operational throughput, material output quality environmental impact and cost/gain.

Solution direction: Stimulate research on the effect of bioplastics in recycling systems.

Additionally, development of plastic separation techniques may be supported.

Solution direction: Stimulate developments of plastic separation techniques.

Some applications may benefit from plastics which are more easily compostable than 'industrial compostable' certified plastics. E.g. France requires that bags are home compostable, which makes it more likely that they degrade in composting facilities, even if conditions are temporarily suboptimal for whatever reason.

The best EOL route for a product must be very clear to the consumer. This could be communicated using icons to help consumers with their decision. The icon should be clear and large enough that they can be easily found and read/understood. Nowadays, icons are often very small, not readable nor clear to elderly people, and easily overlooked by young people.

Solution direction: Introduce clear icons indicating the preferable EOL, EU wide. And in particular cases it may be useful to indicate what is not the desired EOL route, e.g. for products which look like a particular material but in fact are not.

Constraint is that waste collection systems are diverse throughout Europe, and even between municipalities.

Consumers play a key role in separation and collection of products at EOL, however, they are unreliable to some extent. Next to ambiguity, this may relate to costs. A guidance-monitoring-modified guidance cycle may be implemented.

2.4 Local alignment of accepted EOL route for bio-based compostable products

2.4.1 Background analysis

There is no alignment of accepted EOL route for bio-based compostable (plastic) products, between different municipalities and between national governments and municipalities. In the Netherlands, for example, more than one organisation provides advice on how to dispose of compostable products. Although the situation has changed a bit since 1 year ago (D2.1), still Milieu Centraal⁴ and the Dutch Ministry of Infrastructure & Water Management⁵ advise compostable plastic packaging

⁴ <https://www.afvalscheidingswijzer.nl/?u=verpakkingen+van+composteerbaar+plastic> , visited 18 January 2019.

⁵ <https://lap3.nl/sectorplannen/sectorplannen/gft/> , visited 18 January 2019.

to be disposed in the grey bin, except for bags used to collect organic kitchen waste. KIDV (Dutch Knowledge Institute for Sustainable Packaging) on the other hand, doesn't mention compostable packaging anymore.⁶ It should be noted that such advising organisations may be subject to lobbying. Since in the Netherlands municipalities are responsible for waste processing, it is not unlikely that different municipalities come up with different approaches to handle their waste. Some follow the advice of Milieu Centraal / Ministry (Utrecht⁷, Renkum⁸), others do not (clearly) communicate any advice on disposal of compostable packaging (Wageningen⁹, Arnhem¹⁰).

In Germany the situation is similar, yet slightly more strict (D2.1). The Ministry of Environment states that only compostable bags for collecting biowaste should go into the biowaste bin. However, some municipalities don't even accept compostable bags for collection of organic waste, whereas others do not accept plastics without differentiating between biodegradable and non-biodegradable.

2.4.2 Drivers of different stakeholders

The Dutch Ministry has a clear policy on which compostable plastics may go into the green bin, however municipalities are responsible and (apparently) may choose their own policy. And because municipalities may have different level of interest in sustainable solutions, so may be their policy to handle their waste. Their policy thus may be partly based on their vision on waste, as well as on the (financially optimal) agreement with the waste processor. The situation in Germany is basically identical.

2.4.3 Direction for potential solutions

Municipalities are responsible for waste collection and processing. Consequently, they may choose different options.

Solution direction: Establish uniform guidelines for EOL routes for compostable products, at least country wide, but preferably EU wide.

Constraint is that just in the Netherlands, composters run different processes.

The municipality of Renkum advises to collect organic kitchen waste in 'bio-bags', differentiating these from 'plastic bags'. Such 'nomenclature' may be an approach to avoid / reduce the introduction of non-compostable plastic in organic waste streams.

Solution direction: Establish regulated nomenclature which appeal to consumers in a natural way.

2.5 Summary and conclusions

There is no general agreement on which EOL option is most preferable for several bio-based products. This relates to present regulations, recycling targets, and industrial operation practices

⁶ <https://www.kidv.nl/6428/weggooiwijzer.pdf> , visited 18 January 2019.

⁷ <https://www.utrecht.nl/wonen-en-leven/afval/groente-fruit-en-tuinafval-heeft-waarde/#c337416> , visited 18 January 2019.

⁸ <https://www.renkum.nl/Inwoners/Afval/Afvalsoorten> , visited 18 January 2019.

⁹ <https://www.acv-groep.nl/wageningen/afvalinzameling/afvalscheidingstips> , visited 18 January 2019.

¹⁰ https://www.arnhem.nl/Inwoners/wonen_en_milieu/afval/afval_abc/groente_fruit_en_tuinafval , visited 18 January 2019.

and business models of waste processors. All parties involved would benefit from clear LCA data for EOL options for (groups of) products. This would allow governments, municipalities, consumers and waste processors to decide which product best goes where. Clear icons indicating the preferable EOL, EU wide, can help to minimise products going into the “wrong” bin. And in particular cases it may be useful to indicate what is not the desired EOL route, e.g. for products which look like a particular material but in fact are not.

In addition, to overcome the resistance of various stakeholder against bio-based products, and in order to obtain a clear and unambiguous picture of their effects, research on recycling of bio-based plastics and composting of biodegradable plastics needs to be performed with both the bio-based plastics suppliers and the waste processors being stakeholders in the project.

3 Potential Solution Routes for Hurdle: Certification & standards

3.1 Introduction

Standards ensure that materials, products, processes and services are fit for their purpose. Standards provide people and organizations with a basis for mutual understanding, and are used as tools to facilitate communication, measurement, commerce and manufacturing. Hurdles around standards arise when these standards cause confusion instead of clarity. This could be because standards are no longer up-to-date or when there are too many overlapping standards/certificates in the market.

These issues will be discussed separately in the following subsections.

3.2 Standards are not in line with everyday practice (e.g. EN 13432)

3.2.1 Background analysis

Standardization bodies seek to have all parties concerned at the table during the development of standards. When stakeholders are not represented during the development of the standard, the outcome may be less than optimal for stakeholders that use the standards. The development of standards takes up to several years. During this time, it is also possible that processes have evolved which make the standard already outdated once it is published. This is the case with the EN 13432 “Packaging: requirements for packaging recoverable through composting and biodegradation” Compostability is a characteristic of a product, packaging or associated component that allows it to biodegrade under specific conditions (e.g. a certain temperature, timeframe, etc). This standard defines how quickly and to what extent a biodegradable plastic must degrade under industrial composting conditions. The EN 13432 is a harmonised European standard linked to the European Directive on Packaging and Packaging Waste (94/62/EC). The standard prescribes (among other requirements) for disintegration: after twelve weeks, at least 90% of the product should be able to pass through a 2 x 2 mm mesh.

The general opinion is that when the characteristics of biodegradable plastics are in line with the EN 13432 standard, they can be composted by industrial composters without complications. Biodegradable plastics usually do not have problems to comply with these requirements in the standards. Composters on the other hand run composting installations in less time than the described 12 weeks. The Dutch Waste Management Association (VA) states that composting time is around 2-3 weeks. During a workshop the VA confirmed that at some composting installations the composting time is even shorter: between 5 and 18 days. As a result, biodegradable plastics cannot fully decompose in the short composting cycles and composters will sieve out the (bio)plastics beforehand. The average composting time is 6 weeks according to interviewed biodegradable plastic producers. The composters state that they must comply with the Fertilizers Act which states that there cannot be any plastics (biodegradable or non-biodegradable) in the compost. Therefore, most biodegradable plastics currently end up in the incineration facilities.

3.2.2 Drivers of different stakeholders

There are a number of stakeholders involved with different interests and drivers as described below.

Biodegradable product producers:

Biodegradable product producers want to have their products certified according to the EN 13432 that states that their products can be composted at the EOL. This certificate is of value to end consumers that feel that the value of a biodegradable product is higher because it will be composted instead of incinerated. The biodegradable product producers want their products to be actually composted at the EOL.

Composters:

Composters want to run their composting facilities as efficiently as possible. Due to new technologies they can run their composting cycles in a shorter time. Composters are bound by regulation (fertilizer act) to eliminate any plastics in their compost. Besides this, compostable plastics do not add any value to the compost as they usually do not contain any nutrients. The composters do not have any added value of having the compostable plastics in their composting cycles.

Policy makers/government:

Governments want to have a good practise around compostable plastics. Waste management is high on the agenda within governments and good practises are supported.

3.2.3 Direction for potential solutions

There are several potential solutions to solve this problem.

- Composters run an extra cycle for materials that have not yet composted in the cycle (e.g. compostable plastics, banana peel). However, it is extra work for composters to run more cycles.
- Biodegradable products producers change their products to comply with the composting cycles of the composters. This means that the compostable plastics will have to be composted in less time than the agreed terms in the standard (12 weeks). According to several biodegradable product producers they are able to produce biodegradable products that compost within 6 weeks. However the cycles that composters are currently running are too short for biodegradable products to compost. They also claim that several “normal” bio products (e.g. a banana peel) can also not compost within these short cycles. They claim that the composter run additional cycles for these products. They also claim that composters are reluctant to do the same for biodegradable products.
- The fourth potential solution is to find a middle ground that is acceptable for all parties concerned. For this solution the composters and the biodegradable products producers come to an agreement of the cycles times. This could also mean that some biodegradable products will not be accepted as they possibly cannot compost within the proposed time. This could result in different classes within compostability (e.g. gold, silver and bronze). This would mean however further complication of certification schemes. The segregation between certain products could cause unclarity among biodegradable product producers, composters, consumers, certifying bodies and other parties concerned. Amendment of standards thereby takes much effort and is time consuming.

3.3 Multiple certificates in the market

3.3.1 Background analysis

Over the last years many certificates have been developed by NGOs, authorities or certification bodies to help consumers, manufacturers, distributors, traders to choose the right products for their purpose. Within the bio-based economy multiple certificates demonstrating the sustainability of biomass, the bio-based content and certificates for the EOL have been developed. A challenge arises when specific certificates are asked for by users in specific regions (or sectors). As a result, doing business in different regions requires multiple certificates.

An example that was given and researched is on sustainable forest management. FSC and PEFC together account for some 98% of the world's certified forests and chain of custody certificates. An example is where a company needs to import FSC certified wood as requested by customers and the country itself has PEFC certified. Another case around multiple certificates was raised in relation to the organised workshop.¹¹ A bio-based packaging producer involved in our project has the following certificates: EN 13432 "Compostable" for 8 different products, EN 13432 "Industrial Compostable" for 2 products, EN 16785 "Bio-based content certification scheme, AS 5810: 2010 "Home and garden compostable", Vinçotte "OK compost Home" for 3 products, Vinçotte "OK biobased" class "****" for 2 products, ASTM D 6866 "Bio-based > 85 %" or 2 products. The total costs for these certificates are over €80,000 per year. There are two reasons why there is a need for multiple certificates. The first reason is that in some cases these certificates overlap but are requested by users in certain regions. The second reason is that certificates are often complementary, and they demonstrate the different characteristics of bio-based products. Bio-based product producers often express their frustration of the number of certificates needed.

3.3.2 Drivers of different stakeholders

There are number of stakeholders involved with different interests and drivers as described below.

Raw-materials producers:

Material producer want to prove the sustainable origin of their materials. Sustainable materials are requested by the value chain and end-users. Certification of the materials is a relatively straight forward way to prove the sustainability.

Bio-based product producers:

Bio-based products producers request specific sustainable materials with a specific certificate to produce their products. The request either depends on their own preferences or on the preferences of end-users/consumers.

Scheme owners:

Scheme owners developed their schemes according to specific sustainability or functionality criteria. Their interest is to have the market use their scheme to prove the sustainability or function of the materials.

Governments:

Governments strive to have a healthy market with enough competition and thus stimulate the development of multiple certificates.

¹¹ The STAR4BBI workshop was organised in Brussels in October 2018 to discuss identified hurdles around standardization with different stakeholders.

End-users/consumers:

Consumers want to know that the products they purchase are made with sustainable materials. In some cases they have a preference for a specific certificate.

3.3.3 Direction for potential solutions

There are several potential solutions for this challenge.

- Inter-changeable certificates is a possible solution. This would mean that certificates from one specific scheme can be used instead of a similar scheme. This would mean that PEFC certified wood would also be accepted as an alternative for FSC certified wood. However when there are fewer competing schemes in the market, the interests of all stakeholders are less protected as competition between the two global schemes would encourage continuous improvement, ensure cost effectiveness, deliver efficiency and provide a legitimate choice.
- An umbrella certificate for all related certificates was identified as a potential solution to solve (part of) this problem. It is however difficult to reduce the number of similar certificates due to the fact that users are used to specific certificates. It is in most cases unwanted to reduce the number of certificates that demonstrate the different characteristics of bio-based products as these all add value to the end product.
- Alignment of tests for similar certificates to reduce the costs of certification. With this option certification schemes have to be transparent about the standard and tests that they perform to receive the certificates. In this way relatively similar certificates can be obtained at less costs. It is however commercially not always in the best interest to share valuable testing knowledge with competitors.

3.4 Double Testing

3.4.1 Background analysis

Standards help to ensure safety, reliability and environmental care. As a result, users perceive standardized products and services as more reliable – this in turn raises user confidence, increases sales and the take-up of new technologies. When products cross borders (or oceans), testing is needed to be performed to guarantee national or regional safety requirements. Private parties in different countries may also request certain safety requirements compliance. Usually, these compliance tests are based on the same standards as in the “home” country. In practise this often comes down to performing the same or similar tests on products twice. The costs of these tests are in most cases for the producer. “Double” testing is costly as well as time consuming. The costs of testing are relatively high for smaller companies that enter a new market like the bio-based market.

3.4.2 Drivers of different stakeholders

There are a number of stakeholders involved with different interests and drivers as described below.

Bio-based product producers:

Bio-based product producers want to bring their (new) products to the market as soon as possible and at the lowest possible costs. They want and have to comply with the safety regulations for products.

Test houses:

Test houses want to perform tests that assure that products comply with certain standards. The more test they perform the more income they generate.

Policy makers/Governments:

Policy makers want to ensure that products that are sold on the market comply with the safety regulations set. These safety regulations are set for all products, not just bio-based products.

Consumers:

Consumers want to know that their products are safe and comply with the law.

3.4.3 Direction for potential solutions

Double testing adds costs to producers that want to enter a new market. Possible solutions to reduce these costs are:

- Increased transparency around the tests that are performed. When test houses are more open about the test they perform and the standards that are used to perform these test, this information could be taken by the customer to the next testing house that will (in most cases) perform similar tests. For test houses it is commercially not always in the best interest to share valuable testing knowledge with competitors. However, it would partly avoid double testing and thus avoid costs.
- An option is to develop a guidance document on requirements versus test methods. This would give an overview of the test methods that can be used to test certain characteristics of a product. This document could also state the limitations of certain test methods (test methods developed for specific purposes e.g. packaging, PLA) or the scope of the test method. This could however not be specific enough as it might be unclear to what extent the test methods are actually comparable.
- An overview of the equivalency of test methods could help to reduce the double testing. Different methods that claim the same property should be evaluated and compared. This overview will evaluate whether the claim of different methods to measure the same property is actually correct. This is however a process that can go on and on. Within different test methods there are many things that can be compared.
- International harmonization of standards is another solution. In this way tests in the US are the same as test in Europe and China. However, it is a time consuming process to initiate international harmonization of standards as all countries/regions have their own standards and regulations. Aligning all these parties is politically challenging.

3.5 Non-functional specifications

3.5.1 Background analysis

For many years product standards have been developed that specify requirements to be fulfilled by a product or a group of products, to determine its fitness for purpose. Most of these standards have been developed when fossil-based products were still the “mainstream” products. These standards are developed to evaluate the characteristics of materials to demonstrate this fitness whereas it would be more appropriate to evaluate the functionality of materials or products against the requirements of the application. For bio-based products to demonstrate their fitness for

purpose they must comply with tests based upon these standards. An example is the climate test. During transport, vibrations, shocks, knocks, pressure loads, changes in temperature or changes in air humidity can have a great influence on products and/or packaging. Packaging products producers (usually) are required to have their products successfully pass a climate test to secure that the material can deal with these possible issues during shipment. Climate testing involves exposing a package or a product to different controlled levels of temperature and humidity inside a calibrated test chamber. This simulates a range of climatic changes that may occur during distribution. The test can expose flaws in packaging such as seals and glue joints becoming impaired and packaging getting damaged, impairing its ability to protect the product. The conditions for these climate tests are however not based upon actual transportation situations and the high relative humidity (RH), generally part of the tests, is not representative for real life situations.

The atmospheric test is perceived to be too strict as the conditions in real life are never as extreme as in the climate tests. The tests are historically based upon plastic being resistant to 100% RH, so only faults in the package (design) would then lead to water leakage and thus test failures. Due to their hydrophilic nature, bio-based materials respond differently to changes in the RH (and to a lesser extent temperature). For this reason, bio-based materials (can) fail the climate test, whereas the test actually is set to determine failures in the product and not in the materials used. At the time the standards were developed, alternative materials entering the market were not considered.

3.5.2 Drivers of different stakeholders

There are a number of stakeholders involved with different interests and drivers as described below.

Bio-based product producers:

Bio-based product producers have to comply to standards to pass tests or obtain certain certificates. They therefore want to have their materials recognised by the “old” standards.

Certifying bodies/scheme owners:

Certifying bodies want to have the assurance that new materials/products are as competent as the traditional ones in relation to performance. They are looking for a track record or confirmation of quality of these products.

Standardization bodies:

Standardization bodies have set standards for decades. They want their standards to be used by the current market as well.

3.5.3 Direction for potential solutions

The potential solution to solve this challenge is to update current tests and standards where the focus is on the functioning of the material instead of the product. The focus should not be on the material itself. Where standards have been developed with the specification of certain materials in time amendments should be made to more real-life specifications that could open the door more easily to new materials. In this way the lack of a track record is less of an issue. Amending standards is however time consuming.

3.6 Biodegradation of lignin

3.6.1 Background analysis

When bio-based materials are biodegradable, their constituents can be returned to nature by means of organic recycling based on biological processes, enabling biogenic circular routes where the biodegraded material becomes nutrients for new plants and trees which can then become new bio-based products and thus closing the loop. There are several standards to demonstrate the biodegradability of products. These standards prescribe for degradation to CO₂, water, methane, biomass and minerals within a certain time (typically 90% within 6 months). This requirement cannot be met by products containing lignin. Lignin is a recalcitrant biopolymer, meaning that it resists degradation. When a plant is degraded in soil, the polysaccharides are degraded to CO₂ and water fast, while the last 30% of the plant, the lignin, is converted to soil organic matter (humins, humic acid). The latter is essential for soil to be productive. Lignin will, in the end, degrade to CO₂ but this takes longer than the prescribed 6 months in the standard tests. The EU demands that all polymers or coatings used in controlled release fertilizers must be biodegradable. The problem arises when biodegradability is assessed with one of the above standards. As a result lignin will not be allowed as a controlled release polymer in fertilizers (not degraded to CO₂ and water, only to humic acid). This is contradictory as lignin is possibly the soundest polymer to use; the soils need the lignin.

3.6.2 Drivers of different stakeholders

There are number of stakeholders involved with different interests and drivers as described below.

Bio-based materials companies:

bio-based material companies want to sell their lignin to fertilizer producers as a biodegradable coating material.

Policy makers/Governments:

The policy makers want to reduce hazardous goods in the environment. They therefore only want biodegradable polymers or coating in fertilizers.

3.6.3 Direction for potential solutions

- A potential solution is to evaluate whether the EU can make an exception for specific products where the constraint should not apply. In this case the soil needs the lignin. It is however challenging to make exception to laws.
- Another solution is to amend the EN 13432 to exclude lignin from the biodegradability requirements.
- Develop a separate standard for lignin (wood-based) containing products.

3.7 Standards for insulation material need rephrasing

3.7.1 Background analysis

EN 13171 and EAD 040005-00-12.01 specify a wide range of testing methods for wood fibre and annual biofibre based insulation materials, a.o. the procedure to determine the so called declared thermal conductivity, λ_D , of materials. These standards address the effect of moisture content on λ_D in an indirect way. The λ_D of an insulation material (the lower the better) is derived from λ at

10°C and 'dry' conditions, $\lambda_{10,dry}$. Subsequently, this $\lambda_{10,dry}$ value is multiplied by conversion factors based on λ of insulation material determined at 10°C, however, having moisture contents which are at equilibrium with 50% RH at 23°C. The conversion factors are calculated using equations comprising alternately logarithms and exponents.

Next to being rather non-transparent for non-experts, these methods don't account for the effect of temperature on thermal conductivity. And it may be assumed that the thermal conductivity of an insulation material is most relevant at low temperature (freezing conditions) and at high temperature (reaching 50°C and above beneath the roof during summer).¹² The effect is that, in particular, SMEs (most biofibre insulation material producers are SMEs) have difficulty in understanding and communicating the performance of their products. At the same time, the methods do not include measuring the performance at the extreme conditions at which the insulation materials are actually meant to deliver their performance, e.g. at high temperature to represent summer and at freezing temperature to represent winter.

Finally, it is strange that about 10 slightly different methods apply to determine thermal conductivity of comparable products (e.g. mineral wool, EPS, XPS, PUR, cellular glass, expanded perlite, expanded cork, wood wool, wood fibre) for one type of application. This not only further complicates direct comparison of the different products, it also forces producers of bio-fibre based insulation products to define 'their own' standard, but at the same time to adopt the heart of the existing standards in order to make test results somewhat comparable.

3.7.2 Drivers of different stakeholders

Large producers of conventional insulation materials have set up standards to determine product quality performance in a standardised way. The fact that slightly different standards apply for products aiming at one type of application suggests that in parallel the stakeholders wanted to protect their business from newcomers. Setting up standards is on a voluntary basis, so parties cannot be forced.

SMEs wish and need to provide certified performance of their products as well, and need to conform to existing standards.

3.7.3 Direction for potential solutions

One standard method for all thermal insulation materials. Constraint is that sufficient parties would need to agree.

Measuring and specifying thermal conductivity values directly at -10°C and 50°C and 50% RH, without correction, logarithms and exponents.

3.8 Summary and conclusions

In principle, standards and certificates increase transparency and boost consumer confidence in (bio-based) products and services. However, they can also raise barriers, for example when they are not in line with everyday practice. The example of the compostability standard shows that even when compostable plastics meet the standard's maximum duration for disintegration, practice maintains shorter cycles, resulting in bioplastics still ending up in the incinerator. Non-functional specifications in standards can also have a restrictive effect. At the time when many standards were developed, alternative materials entering the market were not considered. Due to the current focus within tests and standards to demonstrate fitness based on the evaluation of the characteristics of

¹² OpenBio Deliverable 4.5 (Restricted report, p.103-104)

materials instead of the requirements of the application, many new materials are unnecessarily rejected, or even excluded. In addition, the presence of multiple certificates that differ little from one another, can lead to confusion and unnecessary costs, for example due to "double testing".

To overcome these hurdles, several possible solutions are proposed. In principle, it is important to involve as many stakeholders as possible in the standardization process, in order to achieve a widely supported middle ground that corresponds as well as possible with everyday practice. Besides this to give new materials the possibility to enter the market standards should focus on the functioning of materials instead of the material itself. In the field of certificates, solutions lie in mutual compatibility, alignment and transparency in tests. However, aligning all involved parties can be (politically) challenging due to competition (between schemes). Moreover, amending standards is time consuming, but in the end these proposed solutions could open the door more easily to new bio-based materials.

4 Potential Solution Routes for Hurdle: Biofuel policy

4.1 Introduction

As both the biomaterials sector and the biofuels rely on the same raw materials, appropriate policies are required to create fair conditions for both sectors – a situation which is often called a “level playing field”. The RED gives incentives for biomass use in biofuel and bioenergy sectors. However, no supportive legislative mechanism exists for the use of biomass in the materials sector.

Furthermore, RED grants for certain feedstocks double counting which exacerbate hurdles for some bio-based material industries who based their activities on the same feedstock.

Another result of biofuel policy is that the use of biomass in the bio-economies other than food has received a negative image by the public. Bio-based products are required to prove they are environmentally friendly, whereas fossil based do not. This leads to extra costs.

4.2 The biofuel policy puts pressure on availability and price of biomass for bio-based products, results in non-level playing field between bio-based products and biofuels

4.2.1 Background analysis

The EU’s Renewable Energy Directive (RED) of 2009 sets a mandatory target of 20% final energy consumption from renewable sources by 2020.¹³ Furthermore, EU countries are required to have at least 10% of their transport fuels come from renewable sources by 2020. This has resulted in increasing biomass demand from the energy and fuels sector.

On 13 November 2018, the European Parliament approved the new targets for renewables, energy efficiency and second-generation biofuels. This recast of the RED provides an outline of the Union’s renewable energy framework for the timeframe up to 2030. This directive is also known as the RED II.¹⁴ The important bio-based relevant points from this directive are listed below:

- The directive sets the overall target of a renewables share in the EU’s energy consumption at 32% by 2030 and includes the sectors electricity, heating and cooling as well as transport.
- In the transportation sector the share of the renewable fuels should reach at least 14%.
- Minimum share of advanced biofuels, using non-food biomass feedstocks should reach 1% by 2025 and 3.5% by 2030.
- Contribution of energy from food and feed crops may grow by maximum 1% by 2030 compared to the contribution of those fuels in 2020 in each Member State; capped at a maximum of 7%.
- This creates unfavourable conditions for several branches of bio-based industries with key issues listed below:
 - Increasing demand for biomass to meet bioenergy and biofuel targets puts pressure on biomass availability for bio-based products.

¹³ Renewable Energy Directive, Directive 2009/28/EC <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0028>

¹⁴ RED II, COM/2016/0382 <http://data.consilium.europa.eu/doc/document/ST-10308-2018-INIT/en/pdf>

- Incentives by the RED create subsidising mechanisms for bioenergy and biofuels, which results in increased revenues for biofuel producers. They are then able to pay a better price for the biomass leading to increased prices of biomass. The non-incentivized bio-based material industry faces problems to pay the higher price. This results in distorted competition for feedstock between energy and material use – a situation often called as a non-level playing field.
- The double counting mechanism for certain feedstocks (Annex IX of the RED) leads to increased allocation of the biomass feedstocks included in the list to biofuel production while the same feedstock has been used for bio-based chemical production. This creates a market distortion. (to be elaborated further in section 4.3)

4.2.2 Drivers of different stakeholders

There are a number of stakeholders involved with different interests and drivers as described below.

Policy makers:

By setting regulatory frameworks, policy makers have the responsibility to develop regulations that will define the actions for reaching climate change mitigation targets. The challenge of policy makers is to propose policies that combine solutions for reaching the climate change mitigation targets while enabling economy and businesses to thrive. At the same time, proposed policies should be acceptable for the public and the NGOs. They support renewable energy to reduce dependence on fossil fuels and provide energy security.

Investors:

High biomass prices and supply insecurity of biomass deter investors from putting money into bio-based chemistry and materials – even though these create higher value at greater resource efficiency. Policies for bio-based materials (e.g. quotas, mandates, tax incentives) would stimulate investment. Currently the investors are not incentivised to invest in bio-based materials production compared to the situation with bioenergy and biofuels where such policy targets are set.

Bio-based chemical and material producers:

No policy support exists for bio-based materials. Therefore, it has not been picking up any speed and the developments are stagnating. Bio-based chemical and material producers have problem of supply of biomass since policies favour the acquisition of biomass for bioenergy and biofuels production. Furthermore, high subsidies lead to high feedstock prices making it for bio-based material producers harder to be profitable. Therefore, they are looking for a level playing field and receiving the same policy support.

Bioenergy and biofuel producers:

Due to strong regulatory support and incentives from national regulations, bioenergy and biofuel sectors have seen high development. The European renewable ethanol producers' associations reacted on capping crop based biofuels in the RED II with the following remark: "Of course, this is not a perfect solution. Allowing Member States to undermine the transport target by lowering the crop cap or relying on artificial multipliers gives the illusion of progress and puts Europe's commitment to decarbonising transport into question. Capping crop-based biofuels at 2020 levels also unfairly penalizes sustainable biofuels like European renewable ethanol, which, if given the chance, could drive EU decarbonisation even further – but it is a major improvement over the initial proposal from the Commission".

Farmers:

Farmers' interest is to sell their biomass for the highest price available on the market. Hence, the first market of choice for them is to bring their product to the food market. For the remaining biomass that does not correspond to standards of the food market, they try to sell to biofuel producers, chemical industry and bio-based products producers with obvious goal of receiving the highest price possible. With the subsidies created by the RED for biofuel producers, farmers prefer to sell to biofuel producers rather than to bio-based product producers. In Europe, there are agricultural cooperatives owned and controlled by farmers where they join together to get better outcomes than they would get individually. Especially in Northern Europe, they are increasingly involved in political action to influence agricultural policy.

NGOs:

Main interest of NGOs is to raise their environmental concerns to shed light on political and industrial processes having an impact on environmental conservation. In this context NGOs criticise use of biomass for applications other than food and feed.

4.2.3 Direction for potential solutions

Policies have a high impact on the development of the bio-based economy in the right direction. Supportive policy incentives and subsidies are required to achieve commercial progress and to be able to compete with fossil based products in both bioenergy and biomaterial sectors.

A new political framework is therefore needed to balance the support for energy and material use of biomass and should be linked with the GHG reduction, circular economy, resource efficiency and employment. Bio-based materials offer benefits in environment (e.g. GHG emissions savings, circular economy), social (e.g. new jobs, also in the rural environment) and economic terms (e.g. value-added). **Table 1** provides an overview of the comparison of energy and material use of biomass.

Table 1 Comparison of energy and material use of biomass across different criteria¹⁵

Criteria	Energy use of biomass	Material use of biomass
GHG reduction	Significant reduction compared to fossil-based energy	GHG mitigation at least equal but most often higher than energy use of biomass
Circular economy	No additional use or possibility to recycle	Possibility of multiple material use by recycling. At the end of life use for energy.
Employment, Value-added	Short value chains	Due to longer and more complex value chains can support 10 times as much employment and provide 9 fold value-added compared with energy use of biomass
Resource efficiency	For biofuel need to convert to hydrocarbons, lower mass yield	Most often higher land and resource efficiency compared with energy use of biomass

¹⁵ Adapted from nova-Institut, 2010, The development of instruments to support the material use of renewable raw materials in Germany

Criteria	Energy use of biomass	Material use of biomass
Renewable alternatives	Many options (solar and wind energy, hydropower and geothermal energy)	Only alternative to renewable carbon from biomass is direct use of CO ₂ which is at very early stage of development
Added functionality	-	Bio-based products can offer added functionality compared with their fossil-based counterparts (biodegradability, reduced toxicity)

The new political framework should provide a balanced support possibly taking into consideration all these criteria rather than focusing on one aspect. The best framework would be the one that allows to achieve the highest resource efficiency, highest value-added, highest employment and greatest climate protection/climate change mitigation.

There are several ways to change the current framework in this direction which are discussed below:

In order to balance the policies between energy and material use of biomass different options are considered. One option is to reform the RED in order to integrate bio-based chemical and materials. Another option is without changing the RED create a link of bio-based materials to RED through a “bio-ticket” system. The third option considered here is a new directive special for bio-based materials.

a. Reform of the Renewable Energy Directive

In 2014 nova-Institute published a proposal to reform the RED to integrate bio-based chemicals and materials in the incentive scheme.¹⁶ The idea is to account for material use of a chemical building block by converting them into bioethanol equivalent based on their calorific value or GHG emission reduction. It supports preserving and expanding the existing structures in place for bioenergy and biofuels to transform and accommodate bio-based chemicals and materials. It does not intend to establish a new quota for the chemical industry but to make bio-based chemicals and materials also accountable for the renewables quota of each Member State. This provides an additional way to fulfil the existing quota which currently member states are having trouble with. For the implementation of material use of biomass into the existing RED, no alteration to the legislative basis is required as it is covered by the environmental jurisdiction of Articles 191 & 192 of the Treaty on the Functioning of the European Union.¹⁶ It can therefore be easy from legal point of view however complicated in term of developing a correlating calculation system. Furthermore, in order to avoid future market distortions both bioenergy/biofuel and bio-based material sector associations should be involved in the discussions to formulate the reform. The proposed reform could be built into the national legislation of the member states. How it will be implemented in practice would be country specific where some countries would prefer using bio-based chemicals and materials to fulfil the quotas immediately. While other countries would not currently have the necessary level of development continue with bioenergy and biofuels but would be more inclined to support establishing commercial plants for bio-based materials .

¹⁶ nova paper #4 on bio-based economy 2014-09, Proposals for a Reform of the Renewable Energy Directive to a Renewable Energy and Materials Directive

b. Bio-based Materials linked to Renewable Energy Directive

An idea is to count for bio-based chemicals and materials towards the renewable energy quota. This is currently practiced in the Netherlands where bio-kerosene producers get awarded so-called “bio-tickets” on the volume they sell which they can subsequently sell to road transport fuel producers.¹⁷ In turn these producers can use the bio-tickets to fulfil their quota instead of using biofuels. In a similar way a regulation can be developed that producers of bio-based chemicals and materials receive a bio-ticket which they can sell to energy producers. For the implementation, the system used currently in the Netherlands for bio-kerosene can be used as an example. The regulation has been developed and implemented and approved by the European Commission. Using this as example will save a lot of effort and possibly reduce friction for expanding it for chemicals and materials. It could be suitable to start this effort also in the Netherlands with approval and contribution from the European Commission in order to have it implemented in other EU countries soon after.

c. Bio-Based Materials Directive

A Bio-based Material Directive with specific targets and quotas for bio-based products would accelerate the transition from fossil-based materials to bio-based alternatives which have been considerably slow so far. Efforts to draft a Directive may be exploited in the short term via a Commission Recommendation or Communication. It can include:

- Minimum bio-based share i.e. 10% for drop-in plastics
- GHG reduction goal for specific economic sectors such as plastics industry
- Durable products made bio-based – long term carbon storage for climate protection
- Mandatory use of specific bio-based products with environmental/health benefits

Several examples are:

- i. Mandatory use of (bio-based and) biodegradable materials in applications where they cannot be collected from the environment
 - Plastics used in horticultural applications such as mulching films, clips
 - Lubricants and hydraulic fluids such as use in boats, ships, chainsaws, harvesting equipment
 - Detergents, body care products
 - Body bags
 - Fishing nets
 - Wipes
- ii. Mandatory use of compostable plastics for food applications (to divert organic waste from incineration to organic recycling)
 - Cups, dishes, utensils for catering services
 - Fruit, meat wraps and stickers
 - Tea bags
 - Coffee capsules
- iii. Ban hormone impacting plasticizers for health protection – use of bio-based plasticizers for food, cosmetics and pharmaceuticals instead

¹⁷ Ecofys (2013). Biofuels for aviation. May 2013. www.ecofys.com/files/files/ecofys-2013-biofuels-for-aviation.pdf

The current RED framework does not take resource efficiency and circular economy into account. The new directive should make biomass coming from recycling or secondary streams more attractive to use than fresh biomass. The fresh biomass should ideally be first used to produce high-value bio-based products, then go through one or possibly more times recycling to additional applications with possibly lower value and end with the energy use at the EOL. This allows efficient use of bio-based resources and reduce the demand for additional biomass. Several fossil-based counterparts (at least one fossil material and energy) can be substituted using the same biomass source. In a report on the Commission's Bioeconomy Strategy, the European Parliament stated that a legal instrument is needed to "pave the way for a more efficient and sustainable use" that would lead to "a hierarchical, smart and efficient use of biomass, to value-added applications".¹⁸

Although this was discussed in several policy documents, there is no concrete support for its implementation yet. As this plays an important role in Circular Economy, the European Commission needs to bring this into the agenda in order to achieve the declared goals in the communication from the Commission "Towards a circular economy" (COM (2014) 398).¹⁹ The bio-based material sector and relevant associations (such as European Bioplastics) should highlight the importance of bio-based products in this context and actively participate in political debates to convey the message.

4.3 Double counting in certain feedstocks listed by Renewable Energy Directive (RED) lead to price increase of feedstock due to their allocation for biofuel

4.3.1 Background analysis

The RED classifies a list of feedstocks (given in the Annex IX A) which are considered to be "advanced biofuels feedstocks" and for which special incentives are given to increase the rate of advanced biofuels production. When these feedstocks are used for the production of biofuels, their contribution can be considered to be twice their energy content ("double counting"). Furthermore, these feedstocks are exempt from any sustainability requirements, making them much easier to handle for biofuels producers. These mechanisms for fuels from certain feedstocks exacerbate hurdles for some bio-based material industries who based their activities on the same feedstock. There is a number of valuable bio-based residues from various production lines that are being used as a feedstock for the chemical industry which are listed in Annex IX A. Including these feedstocks in the listing in Annex IX leads to their increased allocation to biofuel production, hence to a limited access to these by bio-based products producers.

Examples of such co-products which were mentioned in the interviews are crude tall oil (CTO) and tallow.

- CTO is a co-product produced during the wood pulping process. CTO is used by bio-based industries for the production of a variety of high value-added products.
- Tallow is an animal fat produced during meat processing. Tallow, with a number of other animal fats, is an essential feedstock for the European oleochemistry. From tallow, fatty acids and glycerol are produced, which are then used as raw materials by other chemical industries.

Additionally, in the list of feedstocks listed under RED II Annex IX A, wastes and residues from forestry and forest-based industries (i.e. bark, branches, pre-commercial thinnings, leaves, needles, tree tops, saw dust, cutter shavings, black liquor, brown liquor, fibre sludge, lignin and tall oil) and

¹⁸ European Parliament 2013, Report on innovating for sustainable growth: a bioeconomy for Europe (2012/2295(INI)). Committee on the Environment, Public Health and Food Safety.

¹⁹ European Commission 2014, Communication from the Commission "Towards a circular economy: A zero waste programme for Europe", COM (2014) 398.

wastes from industrial processes are included as well. However, RED II does not give a clear definition or classification to wastes and residues, as a result there is 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 which by their evaluation were more suitable for RED II purposes. Sweden for example has included tall oil as a waste which caused problems for pine chemicals company Arizona Chemical (now Kraton). Other countries did not include tall oil as a waste feedstock in their national implementations, following the definition of the Waste Framework Directive. 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 residue can very well be labelled as a waste in another.

4.3.2 Drivers of different stakeholders

EU policy makers

RED has been set with the goal of decreasing overall GHG emissions from different sectors of the economy. Transportation is a major GHG emitting sector relying mainly on (fossil) petroleum. Therefore, politicians have set rules to increase the mix of biofuels used for the transportation sector, to achieve reduction of GHG emissions in this sector. However, due to food vs fuel discussions (see paragraph 4.4), special attention was given by EU policy makers to increase the rate of biofuels coming from secondary sources, in RED II terms: The advanced biofuels. While inclusion of feedstocks in the list of Annex IX A expands the opportunities for biofuels producers to access biomass (with an additional advantage of double counting) and increase the volume of advanced biofuels in the EU, it puts pressure on bio-based product producers to access some of the feedstocks given in the list, which they have been using for a long time.

National Governments

The role of national governments is to implement EU legislation by setting rules and giving clear definitions and classifications, e.g. of waste streams and residues. These classifications create a legally binding framework for waste, residues and co-products that can be counted double or single if used for biofuel production. The interest of governments while making these classifications is to create conditions for fulfilling their quota of biofuels production set by the EU, while also applying the rationale of cascading use and circular economy, which is also a requirement set by EU legislation. This leads to differed decisions and frameworks developed by various member states and creates hurdles for import and export of certain feedstock that in one state might be considered as waste while in the other are classified as residue, thus the double or single counting of that feedstock will also differ dependent on the state.

Biofuels production companies

Double counting gives increased chances for biofuel producers to access biomass and, due to incentives they receive, to pay a better price for the biomass they acquire. Their interest is clear: To increase their production rate of advanced biofuels, since this gives them a higher payback provided by the incentives of EU and national policies.

Bio-based product producing companies

Companies producing bio-based products are interested in having a level playing field on which to compete for valuable bio-based feedstocks. The mechanisms in place for incentivising advanced biofuels lead to market distortions for certain feedstocks. The interest of bio-based industry is to secure their biomass feedstocks, which have come under pressure due to double counting for their use in biofuel production. They want to create fair conditions for the availability and price of the biomass, which in turn is dependent on policy makers and national governments. Companies such as Kraton have been advocating for a longer time in Brussels to create awareness of the unfair conditions, even obtaining a legal assessment by EU bodies stating that CTO is a residue and not a waste. However, these efforts have not been successful so far.

4.3.3 Direction for potential solutions

By following the cascading use principle, a potential solution needs to include mechanisms that will encourage the use of biomass feedstock in materials and products before their application in bioenergy. To harmonize the market distortion created by double counting, the following solutions are suggested with noting the constraints of the current situation:

- To create a level-playing field for bio-based industries for accessing the feedstocks that are double counted when used for biofuels, another update of the RED II would be necessary. In such an update, the feedstocks that are being used by the bio-based industries should be taken out of the ANNEX IX list and their use for material applications should be encouraged following the rationale of cascading use. One of such mechanisms would be creating a double (or multi) counting mechanism of feedstocks for their uses in materials, before their application in bioenergy. For a revision of an EU Directive to take place, one of the member states has to request a revision, which then should be decided by all other member states whether to confirm or reject. However, it needs to be mentioned that a revision has been agreed upon by all stakeholders only recently (end of 2018). Yet, to overcome this constraint, the bio-based industries need to engage in more in-depth conversation with national governments to present the unfavourable conditions created by double counting, which eventually can lead to the member states requesting a revision. It should be noted, that entering such discussions and providing information and data about their current status means additional work and costs for the bio-based industries.
- A harmonised classification system of residues and wastes needs to be developed at EU level to avoid the issue of different counting of the same feedstocks across different member states. In cases where co-products, residues and wastes can be used for the production of materials, preference should be given for their applications in materials and products by following the cascading use principle. This is mostly an issue for harmonisation of the EU Waste Framework Directive (WFD) and the EU Biofuel policy. The WFD and related explanations already provide comprehensive guidance on the classification. EU Biofuel policy, however, does not adhere to these principles and leads to the mentioned distortions. These issues have been addressed by the Better Regulation agenda, for example. However, the initiative has not led to improved conditions and more harmonisation yet, at least not in the policy areas in focus of this analysis.

4.4 Food vs. fuel discussion creates negative image

4.4.1 Background analysis

There has been an active public debate in the last years whether “food crops” should be used for other applications than food and feed, namely for energy or materials. The public debate mostly focuses on the obvious direct competition for food crops between different uses: food, feed, industrial materials and energy.

This discussion has started after the biofuel producing companies increased their production of biofuels from food crops to satisfy the quota of fuels coming from renewable sources set by the biofuel policy while at the same time the world faced a severe hunger problem in 2008, also known as food crisis. Therefore, the discussion is known as the food vs. fuel debate. However, there is sound research which concluded that peak prices for corn related to a multitude of reasons – mostly

caused by an extreme peak in speculation with commodity prices²⁰. The complexity of the causes is not mirrored in any way by the public debate.

Also, companies producing bio-based chemicals and materials are influenced by the discussion and receive a negative image by using first generation feedstock for their products.

It should be noted that bio-based chemicals and materials are produced at much lower volumes than biofuels, so the biomass allocated for bio-based products is less than for biofuels. This means that biomass needed for bio-based products does not pose a large competition for agricultural land that could be used for food and feed.

These particularities make the situation of bio-based industry different from biofuels, however due to misinterpretation of information a false image about bio-based products in the public has been developed. As a result, the companies operating in bio-based industries report that they have to prove the environmental friendliness of their products, which isn't the case for fossil-based products. Often companies in B2B communication have to fill in questionnaires about social (e.g. working conditions, child work, etc.) and environmental friendliness of their products. These efforts are associated with extra costs, leading to additional barriers of bio-based products in the market. Many bio-based product producers order an LCA study for their product carried out often by a third party. The results are then used in B2B and B2C communication. However, again, carrying out an LCA is associated with extra costs.

4.4.2 Drivers of different stakeholders

NGOs

NGOs are interested in raising their environmental concerns to shed light on political and industrial processes having an impact on environmental conservation. In this context, NGOs have largely participated and contributed to the debate of food vs fuel. They criticize biomass use for biofuels with arguing that using first-generation feedstocks occupy land that could be used to produce food crops. However, the results of an analysis carried out in the EU funded project RoadToBio, where eleven NGOs were interviewed to express their position on bio-based products, revealed that only few of these eleven NGOs had an official position concerning bio-based products. One of the interviewees had mentioned that the lack of legislation focusing on bio-based products leads to NGOs not focusing much on the bio-based products. They think working with topics where a clear legislation is in place leads to a higher impact of their activities.²¹ Additionally, during these interviews NGOs mentioned that bio-based products create the opportunity to switch away from fossil to renewable resources. However, they also argued that the reduction of GHG emissions by switching to bio-based products will largely depend on the product and the resources used for their production.

Their main argument was that the solutions should not be focused on replacing fossil-based products with bio-based ones, but the focus should be rather put on banning certain products in general, such as single use plastics. Furthermore, they mentioned that the switching to products coming from renewable sources can promote the "throw-away" culture, instead of promoting the "reduction-first" strategy.²¹

²⁰ Food Commodities Speculation and Food Price Crises

http://www.srfood.org/images/stories/pdf/otherdocuments/20102309_briefing_note_02_en_ok.pdf

²¹ RoadToBio. Public perception of bio-based product – qualitative analysis of stakeholders' concerns.

https://www.roadtobio.eu/uploads/publications/deliverables/RoadToBio_D23_Public_perception_of_bio-based_products_stakeholder_concerns.pdf

It remains unclear what would happen with regard to NGO activities if bio-based products shifted more into the focus of a sustainability strategy of the EU. In case of more legislation being implemented, more NGOs would focus on bio-based products. They could be both a hindrance or a promoting factor, depending on awareness levels and information, but also depending on how bio-based product policy would be implemented. A transparent and sustainable policy procedure would be key to ensure the beneficial involvement of NGOs.

Consumers

In the food vs fuel discussion, only very simplified information reaches the consumer, namely that land is occupied to produce food crops, which are used for biofuels. This creates a negative image combined with the thought that we are living in a world where hunger and food safety are still relevant and crucial issues to be tackled with by the agenda of the international cooperation. However, recent research by the EU funded Bioforever project in which consumers from three different countries (Germany, Poland and Italy) were questioned in in-depth interviews about their preferences of first vs. second generation feedstocks for products showed that consumers' concerns are not as strong as one could think²². It is entirely possible that the companies' concerns which result in painstaking sustainability requirements in the B2B chain are not fueled by consumers' concerns but only by the NGOs.

EU policy makers

Policy makers and the EU Commission are interested in creating policies that will reach the set targets of EU to reduce GHG emissions. This process is however influenced by various factors, such as the social acceptance of the solutions proposed, NGOs critics and feasibility of proposed actions in the given framework of resource availability, technical feasibility, etc.

By setting a maximum of first-generation biofuels share to 7 % in RED II, the EU has approved of the concerns of NGOs and other public stakeholders related to the environmental disadvantages of first-generation feedstocks. However, scientific facts and LCA data show that while second generation biofuels perform better at GHG savings, this effect is relativized when offset against the abatement costs. By this, it is meant that reducing GHG emissions through second generation biofuels is expensive – and may prevent more efficient climate actions that could be implemented elsewhere²³.

This debate pertains similarly to bio-based products. Since the EU Commission disapproves of the use of first-generation feedstocks and gives more incentives for the use of second-generation feedstocks, it contributes to the problem of creating a negative image for industries using first-generation feedstocks.

Bio-based materials companies

The interest of bio-based product producers is to reduce or avoid the extra efforts and costs associated with LCA studies they carry out, the questionnaires they fill in or the requests they have to answer to prove the sustainability of their products. They are interested in creating a better informed and educated society, where bio-based products and their advantages or disadvantages (coming both from first- or second-generation feedstocks) will be easily recognisable for their customers and business partners. However, they rely on politicians, NGOs and the scientific community for creating clear communication tools to reach a better-informed consumer status.

²² Press Release: In-depth psychological market research finds surprising insights into consumers' mindset towards bio-based products. <http://news.bio-based.eu/media/2019/01/19-01-08-PR-consumer-research-and-cooperation-nova-september.pdf>

²³ L. Dammer, et. al. Sustainable First and Second Generation Bioethanol for Europe: A sustainability assessment of first and second generation bioethanol in the context of the European Commission's REDII proposal. nova-Institute October 2017

4.4.3 Direction for potential solutions

The stakeholders listed above are to some extent involved in the public image of bio-based products and hence the solutions proposed are related to the actions that these stakeholders should collectively reach.

- While making decisions, governments need to base their decisions on the scientific facts about the environmental performance of feedstocks coming from first and secondary sources. Namely, the fact that even if feedstocks from secondary sources have higher GHG savings, this effect is relativized when offset against the abatement costs, meaning that reducing GHG emissions by increasing the volume of biofuels coming from the second-generation feedstocks is expensive and not effective. A higher GHG saving effect could be achieved by using these financial resources by other means.
- The EU Commission, national governments and NGOs need to clearly communicate about the biomass volume required for production of bio-based products vs. biofuels. This will help demonstrate that bio-based products are not a high competitor for land that could be used for food or feed production and will support bio-based producing companies improving their image in the food vs. fuel debate.
- A policy focusing on bio-based products needs to be put in force, which needs to be developed based on the scientific information available about the environmental advantages and disadvantages of bio-based products. This will help to set a clear framework of responsibilities that bio-based industry needs to comply with and will help the companies to avoid the additional work they carry out to prove the environmental and social impacts of their products.
- Clearer communication about these facts should be given by NGOs, governments and industries. To achieve this goal all mentioned stakeholders should cooperate to create harmonized communication strategies.
- Educational and awareness raising activities carried out by the governments, NGOs, scientific community and the media are necessary for achieving a status where the consumers are better informed and educated about bio-based products.

4.5 Summary and conclusions

The RED puts pressure on availability and price of biomass for bio-based products. This creates a strong incentive for the use of biomass for biofuels and bioenergy resulting in a non-level playing field and market distortions for use of biomass in materials. No such supportive legislative mechanism exists for the use of biomass for materials and therefore the developments are stagnating. A new policy framework is therefore needed to balance the support. Different options are considered as potential solutions. One option is to reform the RED in order to integrate bio-based chemicals and materials. Another option is without changing the RED to create a link of bio-based materials to the RED through a “bio-ticket” system. The third option considered is a new directive special for bio-based materials.

Additionally, double counting creates incentives for the use of certain feedstocks by biofuels. However, a number of materials that are double counted for their use in biofuels have been used by other industries as a feedstock for the production of chemicals and materials. This creates a non-level playing field in the competition for these feedstocks between biofuel and bio-based product producers. To tackle this issue, it is important to take out the feedstocks, that are being used by the bio-based products industries, from the list of Annex IX A of RED II. The use of these feedstocks for bio-based products industries must be further encouraged.

Another hurdle associated with RED is that it does not specify a definition or classification for wastes and residues, which leads to the MS setting a classification system for various industrial streams at the national level. Therefore, the same feedstock is in one MS state counted double for its use in biofuels (if it is classified as a waste) and in another MS, it is classified as a residue and is single-counted.

A harmonized classification system of wastes and residues across EU is necessary, which needs to be implemented under the EU Waste Framework Directive (WFD). Where the use of feedstocks by the bio-based products industry is possible, such uses must be incentivized. The same classification system that will be needed to be developed by the WFD will need to be adopted by the Biofuel policy for defining the feedstocks of “advanced biofuels”.

Furthermore, the “food vs fuel” debate has created a negative image for bio-based product producers, even if the biomass allocated for the latter is considerably lower in comparison to biomass use by biofuels. Clear communication is necessary by the EU Commission, the national governments and NGOs concerning the real environmental effects of bio-based products even when using food-crops. Governments and decision makers need to communicate science-based information concerning the environmental performance of different feedstocks, including those from first and secondary sources. On the way to a clear communication a policy focusing on bio-based products will help to set clear responsibilities for the bio-based product producers, to protect them from non-factual criticism by the public and the cooperating industries. Finally, educational activities need to be carried out by the MS, scientific community, the media, etc., to raise awareness about advantages and eventual issues associated with bio-based products.

5 Potential Solution Routes for Hurdle: Long term policy

5.1 Introduction

Costs for externalities of fossil based products (e.g. damage to environment) are paid by society, and not by the producer/buyer of the product. On the other hand, the GHG savings of bio-based products in comparison to the fossil-based products do not bring financial benefits for the producer. Diverse policy instruments have the potential to promote bio-based products such as the introduction of a carbon tax and the use of extended producer responsibility (EPR) schemes for packaging waste, with reduced fees for bio-based materials. The implementation of an EPR involves several challenges. Furthermore, the lack of clear sustainability criteria for bio-based and fossil based products represents a major gap that is hampering the future development of the industry.

5.2 Non-level playing field between bio-based and fossil based products

5.2.1 Background analysis

In order to support the level playing field between fossil-based products and bio-based products, the externalities from producing all products should be borne in mind. However, currently, the externalities from producing fossil-based products (e.g. damage to the environment) are paid by the society as a whole and not by the producer/buyer of the product.

Also, regulators and environmental NGOs put a lot of emphases on sustainability and in order to be promoted, bio-based products should show evidence of their sustainability by for example certifications. This is relevant, however, as traditional fossil based products do not have to show a sustainability score (and compete on price basis), required sustainability certifications for bio-based products also contribute to a lack of level playing field, especially due to the costs related to sustainability certifications.

5.2.2 Drivers of different stakeholders

European Commission:

The European Commission aims to support the level playing field between fossil-based products and bio-based products. On the one hand, the EC's Lead Market Initiative (LMI) identified bio-based products market as a lead market. The LMI aimed to support the up-take of bio-based products in order to lower barriers to bring these products into the market. In addition, Europe's Bioeconomy Strategy addresses the production of renewable biological resources and their conversion into bio-based products. This strategy was led by the DG Research and Innovation, although the Strategy was supported by several Commission departments: e.g. DG Agriculture and Rural Development, DG Environment, DG Maritime Affairs, and DG Industry and Entrepreneurship.

Other European initiatives also aim to support the level playing field between fossil-based products and bio-based products.

- Under the Europe 2020 strategy there is a LMI which supports the shift towards a resource-efficient low-carbon economy to achieve sustainable growth.
- The EU Strategy on Plastics in the Circular Economy, adopted in 2018, lays the foundations for production of plastics and plastic products design which fully respect reuse, repair and recycling needs, thus promoting production and development of more sustainable materials. The strategy recognizes the opportunity of the use of alternative feedstocks

(including bio-based) as long as genuine environmental benefits compared to the non-renewable alternatives are ensured, and therefore contributes to the development of a sustainable bio-economy in Europe.

Besides, there is a Commission Expert Group for Bio-based Products which monitors and supports the development of the policy framework, and the implementation of the priority recommendations proposed by the LMI Ad-hoc Advisory Group for Bio-based Products; proposes demand-side industrial policy actions conducive to the market uptake of bio-based products and processes (standardisation, public procurement, awareness raising, labelling, etc.); and maps of bio-based products and relevant bioeconomy related activities and exchanging of good practices at regional, national, international, and EU-level aimed at increasing the competitiveness of European industry.

Policy makers:

Policy makers, both at EU and national level, are driven by the achievement of sustainable development goals (including CO₂ reductions). Since these environmental benefits are not yet evidence based, policy makers ask that producers of bio-based products show certification of the environmental benefit. It is not clear why policy makers do not strive openly for regulations to address externalities of fossil based products like environmental damage.

NGOs (e.e environmental NGOs):

Particular NGOs put pressure on producers of bio-based products to quantify the environmental trade-offs. On the other hand, non-renewable products producers do not receive the same demands.

Fossil based products producers:

Fossil based product producers have been in business for many decades. Their driver is to continue with fossil based product manufacturing and marketing as long as legislation and market allow.

Bio-based products producers:

Bio-based plastics industry want to bring their products to the market. To meet requirements from policy and NGOs, they arrange certificates on sustainability, at quite some costs though.

BBI Consortium (Industry association):

The BBI Consortium sees the production of bio-based products as an important way to strive for sustainable growth and boosting European industries competitiveness. Therefore, the drivers for the European Commission are the creation of additional new jobs and the economic growth for Europe.

5.2.3 Direction for potential solutions

The following potential solutions can be proposed in order to reduce the lack of level playing between fossil-based and bio-based products.

- Costs for externalities (e.g. damage to environment) should be borne by the respective party. Such costs for externalities may be quantified by a team of policy makers, environmental experts, life cycle cost experts and industry. The polluter pays principle. (This also links to carbon tax, addressed in section 5.3).
- Bio-based products are required to demonstrate their sustainability and this should be extended to all products independent from the origin of the raw material.

5.3 Need for CO₂ tax and fossil carbon tax

5.3.1 Background analysis

5.3.1.1 Background analysis for CO₂ tax:

The GHG savings of bio-based products in comparison to the fossil-based products are not expressed in financial benefits for the industry. The “cap and trade” mechanism of the European Emission Trading System (ETS) only pertains to emissions stemming from energy in industrial installations. Renewable energy and biofuels are counted with zero emissions, so if you use them in your production, you need to buy less CO₂ allowances, providing the industry with an incentive to switch to renewable energies, including biofuels. In contrast, no such mechanism is in place for using bio-based resources in your materials instead of fossil ones. Emissions stemming from material usage (e.g. at the end of life when a product is incinerated and the fossil CO₂ emits into the atmosphere) are not accounted for in any climate policy measure as of now, providing no incentives to switch to bio-based feedstocks in your production process.

A general CO₂ tax has been largely discussed in the past decades. Such a tax would reinforce the “polluter pays” principle and create strong incentives for the uptake of bio-based products. The costs of fossil-based products would considerably increase by internalising the externalities such as costs associated with ecosystem, environmental and health impacts resulting from emissions during petroleum extraction, pollution during production processes, oil spills etc. This would create a considerably positive position for bio-based products in the market.

The CO₂ tax has not been integrated in the EU yet, since this would pose a risk that, if only the EU were to introduce such a tax, a huge loss of industrial activities would take place. The global integration of CO₂ tax would allow achieving considerable positive outcomes in terms of saving GHG and moving towards a bioeconomy.

The World Bank reports that in the past 27 years 15 countries have adopted a CO₂ tax, while each of these countries have differed strategy to implementing such carbon tax. Five of these countries are EU countries: Finland, France, Ireland, Sweden and the UK²⁴.

It should be noted that as a learning from the European Emissions Trading System (EU ETS), any future CO₂ tax would also need to be set at a price that would have a real impact. For a long time, CO₂ allowances in the ETS were much too cheap (around 7 €/ton of CO₂ until March 2018). Over the last year, prices have increased considerably, lying around 20 €/ton of CO₂ right now (March 2019)²⁵. However, it is not completely clear yet if this development will hold. A CO₂ tax would need to be stable to create significant impact.

5.3.1.2 Background analysis on fossil carbon tax:

Compared to implementing a CO₂ tax that targets emissions, it would be relatively easy to implement a carbon tax targeted at the input use of fossil carbon in products. The latter is much easier to measure and monitor, especially for imports. The fossil carbon contained in the product can be easily measured and the tax will be implemented on the amount of fossil carbon of the product. The problem of global implementation could be solved elegantly this way. When products are imported, simple sample tests would be sufficient to determine the fossil carbon content of a products and the according import duty would be applied. On the other hand, for the export of the products produced in the EU, a refund of the tax will be given to the companies from the national

²⁴ World Bank Group. Putting a Price on Carbon with a Tax:

https://www.worldbank.org/content/dam/Worldbank/document/SDN/background-note_carbon-tax.pdf

²⁵ <https://www.finanzen.net/rohstoffe/co2-emissionsrechte>

taxing institutions. This mechanism will ensure that the prices of products produced in EU or elsewhere will be balanced and will not cause disadvantages for European companies, nor in the internal market and neither in world trade.

This means that such a carbon resource tax could be implemented on a regional level. In contrast, the main argument against a CO₂ tax is that it needs to be implemented globally in order not to lead to severe competitive disadvantages of the European industry.

This form of a carbon tax has not been discussed. Usually, when the term “carbon tax” is mentioned, it refers to a CO₂ tax. Nevertheless, a tax on input fossil carbon would provide a potential solution for the often-cited problem of global implementation of a CO₂ tax.

5.3.2 Drivers of different stakeholders

EU and national level policy makers

While the implementation of a CO₂ tax would be very effective in achieving climate change targets, the economic challenges related to applying the tax one-sided is deterring the EU and member states to follow up with the tax. Global recognition for the urgency of a CO₂ tax is necessary to push forward this effective instrument.

On the contrary, applying a tax on the fossil carbon of the products has not been discussed by the member states and policy makers so far, although it can be a beneficial tool for reduction of GHG emissions. Drivers for policy makers to implement this mechanism would be the introduction of an effective tool which would lead to a market-based, abrupt reduction of GHG emissions, without leading to negative economic impacts for the industry.

Bio-based product producers and biofuel producers

Both a CO₂ tax and a fossil carbon tax would be very effective instruments that would assist the uptake of bio-based products and biofuels to a great extent. The companies producing biofuels and bio-based products are highly interested in the implementation of such a CO₂ or fossil carbon taxing mechanisms that will result in fossil-based product producers paying for their GHG emissions. Both mechanisms introduced above would result in higher price for fossil-based products and would make bio-based products more competitive in the market. However, it should be noted that if such a tax is implemented, the competition for biomass between bio-based product producers and biofuel producers will increase. Therefore, policies and regulations at EU level should be developed and implemented to create fair conditions for access to biomass, a.o. by considering the cascading use principle. In general, food will come prior to applying the cascading use principle.

Fossil-based product producers

Fossil-based material and product manufacturers will want to protect their business interests, so they will probably oppose to regulation like an input carbon or CO₂ tax which puts their present business under pressure.

5.3.3 Direction for potential solutions

5.3.3.1 Direction for potential solutions for CO₂ tax:

A possible solution for the implementation of a CO₂ tax is only feasible when a global recognition for the urgency of such a tax is achieved. The alternative of an input carbon tax could be implemented EU-wide instead as explained above. To push ahead either version of this strong instrument, EU member states need to be the pioneers and carry out the following actions of integrating such a CO₂ tax into the global economy:

- The EU member states and the Commission need to set the integration of global CO₂ tax as one of the major goals in their agenda of international cooperation.
- A clear strategy should be developed by the EU how the CO₂ tax should be adopted by member states and attempt to forecast the economic impacts it will have on different regions.

Another potential solution would be to extend the Emission Trading System to the material use in such a way that fossil based materials are subject to CO₂ allowances (like fossil energy), thus providing the industry with an incentive to switch from fossil-based to bio-based materials. With a higher price for CO₂ or input carbon, automatically that material use will be stimulated which reduces most input carbon or CO₂ emissions.

5.3.3.2 Direction for potential solution for fossil carbon tax:

Contrary to CO₂ tax, carbon tax on fossil carbon can be applied within EU, or within each country, without creating disadvantageous conditions for industries within EU or the countries where such a tax would be implemented.

Such a carbon tax should be discussed within the EU countries and a proposal for the implementation of such a tax should be developed. The relevant stakeholders should be interviewed and requested to provide their suggestions and narratives on the positive and negative effects of such a tax. A final evaluation of the possible outcomes of such a tax should be carried out and a version prepared based on the provided information and suggestions of the stakeholders should be put into force.

5.4 Implementation and organisation of Extended producer responsibility faces challenges

5.4.1 Background analysis

The extended producer responsibility (EPR) is an environmental policy approach whereby producers take over from society/government the financial and/or organizational responsibility for collecting or taking back used goods, as well as EOL processing.²⁶

Some existing packaging EPR schemes in Europe do apply lower fees for 'bio-plastics': e.g. Austria and Latvia and soon Germany (Watkins et al, 2017), or for biodegradable or compostable plastics (e.g. Netherlands). The removal fee system, however, often is basically not effective as the price advantage for 'bio-plastics' is too small to overcome the price difference.

In addition, the IEEP report, states that the implementation of an EPR implies the following challenges, in particular for compostable products (since many non-degradable plastics can be recycled with fossil-based plastics): lack of clarity on material properties, intended after-use pathways and to the potential cross-contamination with recycling streams.²⁷

²⁶ Watkins, E. et al. (2017) EPR in the EU Plastics Strategy and the Circular Economy: A focus on plastic packaging. Institute for European Environmental policy. Available at: <https://ieep.eu/uploads/articles/attachments/9665f5ea-4f6d-43d4-8193-454e1ce8ddfe/EPR%20and%20plastics%20report%20IEEP%2019%20Dec%202017%20final%20rev.pdf?v=63680919827>

²⁷ COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS (2018) A European Strategy for Plastics in a Circular Economy. Available at: <https://ec.europa.eu/transparency/regdoc/rep/1/2018/EN/COM-2018-28-F1-EN-MAIN-PART-1.PDF>

5.4.2 Drivers of different stakeholders

EU:

The transition to fully reuse, repair and recycled plastics is a key priority of the EU Action Plan for a circular economy, adopted by the EC in December 2015. Together with the EU Action Plan for a circular economy, the new EU strategy for plastics aims at ensuring that by 2030, all plastic packaging at the EU market will be reusable or easily recyclable. In this context, the Commission will try to improve the impact of new rules on EPR (A European Strategy for Plastic in a circular economy²⁷) and reward the most sustainable design choices through economic incentives.

In addition, a key element of the Circular Economy Action Plan is to update the current waste management rules, including new targets for recycling, packaging and landfilling. In this sense, the plan seeks to reach a recyclability of at least the 55% of the municipal waste by 2025; and by 2035 a recyclability of at least the 65% of packaging materials is targeted. Also, specific separation targets for specific packaging materials are included: e.g. paper and cardboard, plastics, glass, metal and wood. The proposals will also strengthen waste prevention and EPR, as well as, streamline definitions, reporting obligations and calculation methods for targets.

National governments:

Many EU countries have implemented EPR for plastic packaging. Several of these countries have a diversified packaging fee for 'bioplastics' and fossil based plastics; In some countries the fee for 'bioplastics' is lower than for fossil based plastics, in some countries the fee is higher. Most probably all countries aim for an optimally sustainable system, but apparently base themselves on different data.

Industry and industrial associations:

Manufacturers have to pay when bringing good in the market, to account for the EOL processing. On the other hand, manufacturers want to avoid that their products end up in the roadside, so they see the benefit of proper EOL solutions.

Bio-based packaging producers:

They wish to serve the market, however their product costs are higher compared to fossil counterparts (e.g. due to smaller production scale, less mature technology, etc). In several EU countries a lower fee applies for 'bioplastics'

Waste collectors and processors:

Waste collectors wish to continue business by processing products at EOL. Further extension and implementation of EPR may affect their operation, e.g. if higher recycling percentages are required. Further implementation of EPR may require additional investments in technologies, which will increase cost for the waste processors. Revenues collected from the removal fees should be sufficient for waste collectors and re-processors to run their processes in accordance with regulation.

5.4.3 Direction for potential solutions

The following actions could be taken in order to improve the effect of EPR schemes:

- An integration of EPR into environmental and circular economy regulations.
- Extending application of EPR to other products.
- Harmonisation of existing EPR schemes.
- Currently, data is lacking to assess the impacts of existing EPR schemes and these are not adequately monitored and controlled. Existing schemes could be enhanced by developing clearer definitions at EU level, allocating responsibilities between stakeholders, ensuring a cost

average, facilitating fair competition and ensuring transparency on schemes performances and costs.

- Modulation of fees depending on the level of recyclability, amount of recycled contents, bio-based materials, biodegradability and/or compostability.

5.5 Lack of sustainability schemes and sustainability rating of bio-based products

5.5.1 Background analysis

The lack of clear, robust methodologies and criteria for assessing sustainability of bio-based and fossil based products represents a major gap that is hampering the future development of the industry. Life cycle analysis (LCA) studies are conducted following different methodologies and using different type of data sources. This results in different outcomes for LCA studies performed by different evaluators on basically the same set of products.

As a result of the lack of a clear and harmonized sustainability assessment system, governments (e.g. Netherlands) are internally divided regarding the positive environmental aspects of bio-based products (CO₂ mitigation, avoidance of non-renewable resources) and negative aspects related to agriculture and land use change. Governments require clear and harmonized methodology and criteria to be able to assess the environmental performance of all products.

5.5.2 Drivers of different stakeholders

Government:

The Ministry of Economic Affairs will have a view on a sustainable future, however, it is influenced by industry and generally focusses primarily on short term economic interests. The Ministry of Environmental Affairs focusses on environment, and will be influenced by NGOs, including one-topic NGOs. Lack of harmonized data etc. gives each of the parties room to stick to their primary interest instead of stimulate them to search for the overall long term best solutions.

European Commission:

European Commission is working on a standardized way of assessing environmental performance and would like the member states to use this method.

Bio-based product manufacturers:

Bio-based products have to prove that they are environmentally friendly whereas fossil based do not. This results in extra effort and cost leading to additional barriers for these products in the market. Therefore, bio-based product manufacturers want sustainability assessment to be required for all type of products including fossil-based. They would like the governments to set clear rules and policy on this.

Standardization developing organizations:

CEN Technical Committee 411 for bio-based products has been developing European standards for bio-based products and would like these standard to be brought to use by developing certification schemes.

Certification bodies:

There are multiple certification schemes available based on different methodologies. Each certification body would like that their scheme is used to assess the sustainability of products.

End-users/consumers:

Consumers want to buy environmentally friendly products but they don't completely trust producer's claims about the environmental performance of their products. They are willing to pay more if they trust that the product is more environmentally friendly.

5.5.3 Direction for potential solutions

5.5.3.1 Same sustainability criteria

This are the criteria for all type of feedstocks (bio-based and fossil based) and all sectors (materials and fuels/energy) across whole life-cycle.

Certification of all products for all sectors is required to show the sustainability of their production. Currently biofuels and bioenergy need to fulfil a limited number of sustainability criteria (GHG emissions, biodiversity, soil quality, carbon stock change) in order to be eligible for the incentives of the RED. This is a first step but it only addresses a portion of the concerns.

It is required to cover more aspects than covered by RED for proof of sustainability. Therefore, there is a requirement of a comprehensive set of sustainability criteria that should be obligatory for the use of any feedstock, both biomass and fossil, in all applications. To have a level playing field between material and energy use, material use should also be linked with incentives and the same set of criteria should apply to both. The sustainability criteria should include environmental, social and economic aspects. For the environment, besides GHG emissions it should include; air quality, water use and quality, soil quality, biodiversity, indirect land use change and carbon stock change.

The CEN Technical Committee 411 for bio-based products has been developing European standards for bio-based products covering horizontal aspects. EN 16751:2016 Bio-based products-Sustainability criteria sets horizontal sustainability criteria applicable to the bio-based part of all bio-based products, excluding food, feed and energy, covering all three pillars of sustainability; environmental, social and economic aspects. This European standard with a comprehensive set of sustainability criteria should be applied to all bio-based products. Similarly, a comprehensive set of sustainability criteria should be developed for fossil-based products. Most of the environmental criteria for bio-based products apply to fossil-based products as well (such as GHG emissions, air quality, water use and quality, soil quality, biodiversity). There should be also determination of environmental burdens caused by the extraction of crude oil and natural gas. Social criteria (such as labour rights, local development, human rights) also apply for fossil-based products.

The sustainable impacts should cover the whole life-cycle of the product: feedstock production, conversion, end-use. Currently, most schemes focus on the feedstock production so the sustainability of the biomass used. However it is also important to account for the sustainability of the operation, the processing of feedstock and manufacturing of the product. Furthermore, the EOL of the product needs to be considered i.e. whether it is possible to recycle, is it biodegradable etc.

5.5.3.2 Harmonization of LCA procedures

Life cycle analysis can be used to assess criteria regarding environmental performance of bio-based products throughout their life cycle. It includes several environmental impact categories: Climate change, Ozone depletion, Human toxicity, Ionizing radiation, Photochemical ozone formation, Acidification, Eutrophication, Ecotoxicity, Land use, Resource depletion, Water use. Although, this is comprehensive it does not cover all environmental concerns. In recent years a significant discussion has been made regarding indirect land use change and biodiversity impacts of bio-based products. Significant research has been done to quantify indirect land use change impact, however there is still no consensus on how to consistently and systematically address it in LCA. Inclusion of biodiversity impacts in LCA is also still largely lacking.

There is an increasing demand for LCA in recent years and there is a requirement of clear methodology/procedure to enable reproducibility, comparability and consistency of LCA studies. To have common standards for bio-based products CEN/TC 411 developed EN 16760:2015 Bio-based products – Life Cycle Assessment that provides specific life cycle assessment requirements for bio-based products. It is based on international standards ISO 14040 and ISO 14044.²⁸ The European Commission's Product Environmental Footprint Initiative provides a standardised framework for the assessment of the environmental footprint of products in the European Union. Product Environmental Footprint Category Rules provide further specification at the level of a specific product category.²⁹ The approach has been already tested for several product categories such as plastics including bio-based plastics. It needs to be still developed for some other product categories. Aim of PEF is to ensure that the same assumptions and calculations are made to support comparability of environmental performance claims across products delivering the same function. It also provides principles for communicating the environmental performance. With a standardized LCA method it will be easier to carry out an LCA and the quality and the credibility of the results go up. Already this harmonized LCA method is highly developed and European Commission recommends the use of this method.³⁰ But in order to be effective this should be brought in policies in consultation with relevant stakeholders. In this way its implementation in the new LCA studies can be achieved.

This can also act as a basis for clear rating and labelling of products based on their environmental performance. It can be done in a similar way with the EU Energy Label (based on EU Directive 2010/30/EU) applied for white goods, light bulbs, etc. to show their energy efficiency with a grade from A to G present on the label. Currently consumers are interested in buying environmentally friendly products but don't necessarily trust the claims of producers. This standardized way of assessment and labelling will also enable such products to receive price premium as consumers are willing to pay more if they are confident of their better environmental performance.

It is important that future technology improvement is taken into account when considering the environmental impacts of bio-based products. As fossil-based technology is mature, and bio-based production is in its infancy, there is vast scope for improvements in the environmental performance of bio-based products that should not be disregarded. To have a fair comparison of bio-based and fossil-based products this should be kept in consideration.

5.6 Summary and conclusions

In order to level the playing field between fossil-based and bio-based products two possible solutions are proposed. In the first place, the producer should be responsible for paying for the negative externalities of the production processes (e.g. possible damage to the environment) and not the whole society. Furthermore, sustainable certifications, currently often asked only for bio-based products, should be requested for all products.

With regard to the first suggestion, also known as Extended Producer Responsibility (EPR), several solutions are provided, such as the integration of an EPR strategy into environmental and circular economy regulations and the extension of the application of EPR to all products. In addition, an improvement of existing EPR schemes is required, through the harmonization of definitions at the EU level, the adequate monitoring and the assurance of the transparency on schemes

²⁸ ISO 14040:2006 Environmental management — Life cycle assessment — Principles and framework, ISO 14044:2006 Environmental management — Life cycle assessment — Requirements and guidelines

²⁹ European Commission, PEFCR Guidance document, - Guidance for the development of Product Environmental Footprint Category Rules (PEFCRs), version 6.3, May 2018.

³⁰ Commission Recommendation on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations, 2013/179/EU (April 2013)

performances and costs, among others. The cost would vary depending on factors such as the amount of recycled contents, bio-based materials, biodegradability and/or compostability.

Under EPR is also laying the responsibilities of paying for the emissions that are associated with the production of products. While fossil fuels are falling under the “cap and trade” mechanism of the EU ETS system and pay a price for the emissions generated, the fossil resources used in products are not priced or taxed, hence the externalities related to the emissions from the fossil carbon in products is not priced in any way. CO₂ tax is already being implemented by a number of EU countries, however it is very complex to implement this for products. A fossil carbon tax would allow easier implementation of carbon pricing, by measuring and taxing the fossil carbon in fuels and products. This way, also for imported products the fossil carbon can be measured and taxed.

The lack of clear, robust methodologies and criteria for assessing the sustainability of both bio-based and fossil-based products represents a major gap that is hampering the future development of the bio-based industry. Development of the same sustainability criteria for all types of feedstock (bio-based and fossil based) and all sectors (materials and fuels/energy) across the whole life-cycle (material production, use and EOL) is proposed as a potential solution. And harmonization of LCA procedures is described to be important for this.

6 List of abbreviations

ASTM	American Standard for Testing and Materials
B2B	Business-to-business
B2C	Business-to-consumer
BBI JU	Biobased Industries Joint Undertaking
Bio-PE	Polyethylene containing bio-based materials
Bio-PET	Polyethylene terephthalate containing bio-based materials
C	Carbon
CAP	Common Agricultural Policy
CEN/TC	European Committee for Standardization / Technical Committee
CO ₂	Carbon dioxide
CTO	Crude tall oil
DG	Directorate General
EAD	European Assessment Document
EC	European Commission
EN	European standard
EOL	End-of-life
EPR	Extended producer responsibility
EPS	Expanded polystyrene
ETS	Emissions Trading System
EU	European Union
FSC	Forest Stewardship Council
GHG	Greenhouse gas
H ₂ O	Water
HDPE	High-density polyethylene
ISO	International Organization for Standardization
JRC	Joint Research Centre
KIDV	Dutch Knowledge Institute for Sustainable Packaging
LCA	Life cycle assessment
LMI	Lead Market Initiative
MS	Member State(s)
NEN	Dutch Standard (Nederlandse Norm)
NGO	Non-governmental organisation
NIR	Near infrared analysis
PE	Polyethylene
PEF	Polyethylene furanoate
PEFC	Programme for Endorsement of Forest Certification Schemes
PET	Polyethylene terephthalate
PLA	Polylactic acid
PMD	Plastic, metal, drinking cartons
PP	Polypropylene
PS	Polystyrene
PUR	Polyurethane
R&D	Research and development
RED	Renewable Energy Directive
RH	Relative humidity
SME	Small to medium enterprise
VA	Dutch Waste Management Association
WFD	Waste Framework Directive
XPS	Expanded polystyrene

Appendix A General solution routes to tackle hurdles faced by bio-based products

There are several ways to change the current policy framework in order to provide a level-playing field for bio-based products and boost their market uptake. These can be grouped into three main categories as; availability of biomass, technology push and market pull. The different options and how to bring them to implementation are discussed below:

1. Feedstock availability

Legislation and policies should promote the availability of sustainable biomass. What could be done in this respect is discussed below:

a. Map availability and flows of different biomass sources on a regional basis

A comprehensive view of available biomass is necessary. National authorities should therefore conduct a thorough analysis of biomass availability and flows on a regional basis. JRC biomass study is important in this respect to provide data, model and analysis on supply, demand and sustainability of all sources of biomass. There are more European projects to bring insights into the available biomass. Such data and assessments will support the implementation of policy measures to expand the opportunity of using biomass in bio-based products. The existing studies should be continued and expanded to provide detailed overview of each biomass type over whole Europe.

b. Research on closing the yield gap – increased production of crops without requirement of additional land

Regarding concerns of use of food crops for applications other than food and feed, yield gap studies show that there can be much more production on current land.³¹ The Global Yield Gap and Water Productivity Atlas provides robust estimates of untapped crop production potential on existing farmland. Such studies can be used to identify regions with greatest potential for investment in agricultural development and supplied additional biomass can be used for food/feed and other applications.

c. Common Agricultural Policy (CAP)

DG AGRI should support the mobilization of available additional biomass from forests and agriculture as there are currently available and underutilized sources. This should be linked with the agricultural policy (CAP). CAP should become an interface between agriculture and the bio-based economy, including biobased chemicals and materials. This will provide a new opportunity for the farmers. In the new CAP specific financial incentives for farmers can be given to improve the logistical capabilities to collect biomass by-products and residues from agriculture and forestry. Furthermore, investment in regional infrastructures and logistical capabilities is important to allow all type of biomass to be utilized.

2. Technology push for bio-based products

Technology push is needed to provide financial support for R&D, pilot and demonstration plants and flagship investments in order to bring sustainable and innovative bio-based products to market.

a. Support for R&D to develop renewable alternative for fossil-based products

Continuation of programmes such as H2020 to support the development of bio-based products further. There should be more focus on market related factors to ease the further

³¹ Global Yield Gap Atlas <http://www.yieldgap.org/>

development and commercialization of the bio-based products in the following stage. This can be done by inclusion of early stage techno-economic and environmental assessment of developed routes and products. This will provide direction for further research and insight into their potential. R&D investment is required to lower the operating and capital costs to be able to bring the innovation on bio-based products to the market. Also as processes are further optimized more resource efficiency and GHG reduction could be attained.

b. Funding for pilot, demo plants and flagship investments to bring bio-based products to market

i. Continuation of BBI JU funding innovation

The Bio-based Industries Joint Undertaking (BBI-JU) has been very important to enable scale-up of the technological developments and growth of the bio-economy. It is essential that this is continued until bio-based production is able to compete with the well-established fossil-based production, which has had years to have their supply chains optimized and additionally the plants have been amortised. This requires increased public funding and private funding by the bio-based industry.

ii. Harmonize different funding mechanisms – European Bioeconomy Strategic Investment Fund

There is a need to harmonise funding mechanisms to develop the bioeconomy. Currently, although there are several funding mechanisms available, they are fragmented with different procedures spread across different institutions and organisations. This makes accessing finance lengthy and complex. One idea is to create a dedicated task force involving different DGs to provide coherence and facilitate access to finance for the bio-based economy. A new funding instrument can be used, proposed as European Bioeconomy Strategic Investment Fund (EBESIF) by the Commission Expert Group on Bio-based Products.³² This could help pool resources from different financing mechanisms such as those available through the European Investment Bank and private funds. All funds that are being used to support and implement bioenergy and biofuels should be opened to bio-based products.

3. Market pull for bio-based products

At the moment there is an artificially created strong market pull for bioenergy and biofuels. Market pull is also needed for bio-based products to even the scales and stimulate markets for bio-based products. Public procurement will contribute significantly to establish market for bio-based products. Mandates and bans are strong instruments to increase market penetration of bio-based products in a long-lasting way. Also tax incentives and trading/credits related to CO₂ emissions are strong market pull instruments, especially to create a level playing field with fossil-based products, and will be discussed in section 5.3.

a. Public procurement

Public procurement can act as a market pull to stimulate the growth of bio-based product markets. Considering that bio-based products find use in many applications, there can potentially be significant public spending on bio-based products. To facilitate this, explicit guidance on the procurement of bio-based products is required in public administrations. There is a risk that procurement officers would be reluctant in taking risks and reverting to products that were used in the past. Additional staff capacity should therefore be allocated to exploring new and innovative bio-based products and their potential by doing market search, attending events and trade fairs, etc. However, still it can be challenging to find

³² Commission Expert Group on Bio-based Products Final Report, November 2017

bio-based products and producers that are relevant for their procurement needs. In this respect campaigns and information folder/database will be useful.

- i. Campaigns – e.g. bio-based products fair to develop knowledge and support material for procurers
- ii. Information folder/Database – list of bio-based products, their manufacturers/suppliers, areas of application, sustainability profile, cost profile, performance

The tender specifications should be prepared in order to address the sustainability benefits of bio-based products. It should also be assured that there are hard sustainability criteria that need to be met so that price does not overrule the decision. The challenge here is that procurers struggle to define appropriate criteria to identify sustainable products and also to verify if the tenderers meet these criteria.

European project InnProBio³³ contributed to improving the knowledge and skills of those involved in designing procurement procedures and increasing awareness of the potential benefits of bio-based products and services to lower the barriers to purchasing bio-based products. InnProBio prepared educational material to support public procurement practitioners. The material was collected in an online toolbox available under: <https://www.biobasedconsultancy.com/>. The toolbox also includes a database of products and suppliers of bio-based products. The database provides information about the bio-based content of certain products, sustainability, functionality and EOL aspects such as biodegradability. This database is a starting point and it should be expanded by producers of bio-based products. It will be essential in widening the public procurement product portfolio beyond conventional fossil-based products.

In the Netherlands, the Dutch Environmental Database (Nationale Milieudatabase³⁴) was established where producers of construction products supply environmental profiles of their products. The environmental data that is declared is verified by LCA experts according to the specific procedures. A uniform calculation of the environmental performance is achieved by following a specific assessment method provided. This is a good initiative by Stichting Bouwkwaliiteit (The Foundation for Construction Quality) that should be expanded to other sectors.

On 12 April 2016, the Public Procurement Working Group of the European Commission's Expert Group for Bio-based Products published 15 recommendations for an increased uptake of bio-based products in public procurement programs.³⁵ The group stresses on the requirement of a long term permanent coordination. This should be done by a central team involving professionals in public procurement that will support the coordination among the commission-initiated grants and tendered projects. This team should be dedicated to planning and implementation of a diverse package of measures for reaching ambitious targets for uptake of bio-based public procurement practices. Recommended actions include:

- i. Give preference to bio-based – A recommendation or a requirement to give preference to bio-based can be put down in national action plan adopted by the government

³³ InnProBio, <http://innprobio.innovation-procurement.org/home/>

³⁴ Nationale Milieudatabase, <https://www.milieudatabase.nl/index.php?q=over-nmd>

³⁵ Commission Expert Group for Bio-based Products, Working Group Public Procurement of Bio-based Products Recommendations, April 2016, <https://www.kidv.nl/7009/working-group-public-procurement-of-bio-based-products-recommendations.pdf?ch=DEF>

- ii. Public Procurement Directive – Extending to EU wide implementation by directive providing support for bio-based public procurement
- iii. Implementation of strong Green Public Procurement programmes for bio-based products

To strengthen regional and national efforts, national programs dealing with bio-based, green or circular procurement need to be strengthened, such as available at the Dutch PIANOo³⁶ and the German Agency for Renewable Resources³⁷.

b. Mandates and bans

Mandates and bans should be linked with sustainability policies and sustainable development goals and bio-based products should be offered as a solution to environmental and societal challenges faced today. Legislation based on these reasons will create a positive image for the bioeconomy and encourage investment.

c. Trading and Credits

Biofuel industry as a part of the Emission Trading System gain financial benefits due to the avoided CO2 emissions. This could be extended to cover the material use. With a higher CO2 price the material use will be automatically stimulated where it reduce CO2 more.

d. Tax incentives

Different type of tax-incentives for bio-based are possible including

- i. Taxation of non-renewable carbon as input for the chemical industry, tax based on the fossil-based carbon content
- ii. Reduced tax for bio-based products, environmentally advantageous products.
- iii. CO2 tax – including all sectors (energy and material) - see section 5.3

³⁶ PIANOo, <https://www.pianoo.nl/nl/themas/maatschappelijk-verantwoord-inkopen-mvi-duurzaam-inkopen>

³⁷ Public Procurement at Fachagentur Nachwachsende Rohstoffe e.V. <https://beschaffung.fnr.de/>

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