Open-BIO

Opening bio-based markets via standards, labelling and procurement

Work package 9

Social Acceptance

Deliverable N° 9.2

Acceptance factors for bio-based products and related information systems

Public

Version: Final

September 2015

prepared by:

LEI-DLO, TU-Berlin

Marieke Meeusen, Jan Peuckert, Rainer Quitzow

Email: marieke.meeusen@wur.nl

Project website: www.open-bio.eu

Disclaimer

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° KBBE/FP7EN/613677.

Table of content

List of figures

List of tables

Executive Summary

Introduction and Objective

To foster an innovation-friendly market environment for bio-based products, the European Commission's Bioeconomy Strategy proposes the development of standards and standardized sustainability assessment methodologies as well as the promotion of green public procurement of bio-based products. The Open-Bio project supports these policy initiatives by performing co-normative pre-standardization research and by developing an information system to support the public and private procurement of bio-based products. Among other things, this involves the creation of a database containing information on bio-based products to be used as a support tool for the identification and comparison of bio-based products in the context of public procurement activities. In addition, the Open-Bio project is developing a strategy for the integration of bio-based products in the European Eco-Label as a potential vehicle for promoting the market uptake of bio-based products by consumers, businesses as well as in public procurement.

To ensure the effectiveness of measures that support the demand of bio-based products work package 9 of the Open-Bio project on "Social Acceptance" targets the identification of key criteria for the market acceptance of bio-based products and related standards and information systems, including labelling options for bio-based products. This report represents the second deliverable of work package 9 and provides an overview of the relevant acceptance factors for the following three target groups: (1) consumers, (2) businesses and (3) public procurement officials. The report summarize the findings from qualitative focus group research and quantitative survey on consumer acceptance and the overall results of a two-stage Delphi survey targeting the business community and public procurement officials (based on separate survey questionnaires).

Consumer Acceptance of Bio-Based Products

This study adopts a two-stage approach with qualitative and quantitative research among consumers to increase the understanding of consumers' perception of bio-based products. A positive perception of bio-based products is a condition for a positive attitude and intention to buy bio-based products. In order to understand consumers' perception we have asked for familiarity, associations, emotions and awareness. The research also addressed specific issues related to labelling, product information and standardization, which were of importance for the other work packages of the Open-Bio project.

Results of surveys conducted among consumers show a high degree of unfamiliarity with bio-based concept and bio-based products among consumers. They have positive associations linked to the environment. However, there are also mixed and negative feelings due to the lack of knowledge and arising questions about the bio-based concept and products.

Discussing seven specific bio-based products showed that each product is perceived in its own way. For every product it is important that one's personal benefits are fulfilled first. The bio-based element is perceived as only a small additional positive aspect. However, therefore it is important to have a coherent product concept in which all production process phases are sustainable on the social, environmental and economic dimension.

Regarding the labelling of bio-based products, consumers seem to prefer bio-based products with a label. The EU Ecolabel is assessed as neutral to positive, with differences between countries. Italian consumers are much more aware of the EU Ecolabel than Danish and Dutch consumers are. Regarding the sender of the consumer information, consumers perceive consumer organisations as being the most reliable sources of information. For all countries, NGO's and independent certifying organisations were also highly trustworthy. Finally, we asked what information consumers would like to have. They highly ranked information about the recyclability and biodegradability.

Acceptance of Bio-Based Products in the Business-to-Business Market

This study adopts the Delphi method to generate a generalized view on market acceptance of bio-based products. In addition, the survey addressed specific issues related to labelling, product information and standardization, which will directly inform activities in other work packages of the Open-Bio project.

The results of the survey indicate that the positive image of bio-based products and their ability to ensure stronger independence from fossil-based resources are considered the most important drivers of market acceptance. High and volatile production costs are key market barriers, the more so as the prospects for receiving a green premium are perceived as rather low. Furthermore, an unsupportive regulatory environment and uncertainty about future regulation seem to hinder a stronger market uptake, whereas concerns about social and environmental impacts and the use of GMOs in feedstock production are not considered important market barriers.

Regarding the development of a European label for bio-based products, there seems to be strong support for the introduction of a label as a tool that helps developing and stimulating the B2B market of bio-based products. This label should address additional environmental criteria and feedstock-sustainability-related issues. A significant degree of uncertainty, however, remains regarding the specific details of label design and whether such a label should be integrated with the EU Ecolabel scheme, as survey responses are ambivalent in this point.

In addition, a key finding that emerges from the survey is that important drivers of the market for bio-based products differ distinctly across countries and product groups. Respondents find local supply chains and the independence from fossil resources to be particularly important as market drivers in France and end-of-life-considerations in Italy. In other words, the survey indicates that national trends retain a role in driving B2B markets for bio-based products. Moreover, the survey identifies particularities of sub-sectors of the bio-based

economy that need to be considered when designing policy instruments to promote bio-based products.

Acceptance of Bio-Based Products in Public Procurement

The study on acceptance in public procurement adopts the Delphi method to generate a generalized view on factors influencing the acceptance of bio-based products in public procurement, based on the informed opinion of experts. In this context, the survey places particular emphasis on how current green public procurement practices might stimulate the increased uptake of bio-based products in public procurement. In addition, it addresses questions regarding the role of information on and standardization of bio-based products.

First and foremost, the survey shows that many public procurement officials are unfamiliar with the concept of “bio-based products”, as a large share of respondents does not know what the term exactly means. Key findings of the procurement sector survey include that bio-based products are not yet considered a relevant category in green public procurement and that bio-based content on its own is typically not viewed as a relevant justification for inclusion in green public procurement schemes.

Although many organisations do practice green public procurement, only approximately one third of respondents confirms that it would be possible to use bio-based content as a specification in the context of procurement processes in their organizations. Hence, it is more likely that bio-based products enter green public procurement schemes if they can credibly offer a broader set of environmental benefits.

For the current practice of green public procurement, impacts directly related to the production, use and disposal of products receive more attention than impacts related to the use of raw materials, which represents a major challenge for promoting bio-based products on the basis of bio-based content alone. Energy efficiency turns out to be the most important environmental aspect in the current practice of green public procurement, whereas bio-based content or the use of renewable resources figures among the least important environmental aspects.

It is interesting to note, however, that two respondents suggested in the supplemental comment section that the avoidance of fossil resources represents an important aspect for consideration within green public procurement. This may suggest that raising awareness on the link between bio-based content and the avoidance of fossil-based materials might help increase the willingness to consider this aspect in green public procurement.

Finally, regarding possible measures to promote the public procurement of bio-based products, the results indicate the need for a clear political decision to promote bio-based products via green public procurement schemes. The lack of practical guidance and information on bio-based products creates uncertainty regarding the use of specifications on bio-based content in public procurement. The acceptance of bio-based products in green public procurement would benefit from the provision of detailed product information that

compares the performance of bio-based and fossil-based reference products based on accepted environmental criteria. Moreover, eco-labelling schemes are important points of references for green public procurement, suggesting that the incorporation of bio-based content as criteria in relevant labelling schemes could also promote their uptake in green public procurement.

General conclusions

The following general conclusions can be drawn from the research on market acceptance for bio-based products among consumers, business experts and public procurement officials:

- **Public image – opportunity and risk for bio-based products.**
  The market acceptability of bio-based products is high. However, potential buyers are not aware of bio-based products and often do not understand the exact meaning of the concept. Environmental concerns are important market drivers, but unrealistic expectations about the performance of bio-based products may lead to market repercussions. The positive public image thus creates both an opportunity and a potential risk for the long-term market acceptance of bio-based products.

- **The higher price is a main barrier for market acceptance.**
  All stakeholder groups expect the expenditures for bio-based products to be relatively high. Higher cost of production and the volatility of feedstock prices are among the main barriers for a broader market acceptance of bio-based products.

- **Bio-based products have to contribute to multiple environmental criteria.**
  If marketed as green products, bio-based products need to ensure a comprehensive set of environmental and sustainability criteria. Bio-based content alone is not (yet) established as a valid environmental attribute sufficient to justify a premium price, among neither consumers nor public procurement agents.

- **The market is driven by environmental regulation rather than a green premium opportunity.**
  Increased future market opportunities for bio-based products rather depend on environmental regulation to stimulate a circular economy and the deliberate decision to promote bio-based products via public procurement than on the emergence of a green premium market based solely on end consumer demand.

- **Well-designed labels can be helpful instruments.**
  Among all target groups, labels have been assessed as helpful to stimulate the market. Ideally, the label should communicate the whole range of relevant issues. Environmental and sustainability label criteria thus need to be defined for the specific product category.

Acknowledgements

We would like to thank Vicky DeMesMaecker (GfK) and the moderators that have been asked by GfK to lead the discussions with the participants of the focus groups and the participants who discussed about bio-based products. We also appreciated the cooperation with Andrew Clarke (GfK) executing the quantitative survey among consumers. We look back on a pleasant and constructive cooperation with them.

We also would like to thank the companies that have send samples/ products for the focus groups: Daniel Kruse (Hempro International) for the hemp-based T-shirt, Francesco Degli Innocenti (Novamont) for their bio-based shopping bag, Michael Atzmüller (Werzalit) for a sample of WPC-decking, and company Rolsma for the printed label of their natural paints.

Moreover, we would like to thank Francesco Degli Innocenti (Novamont), Johnny Pallot (Roquette), Mario Ricci (Consorzio Italiano Compostatori), Henk Vooijs (Novamont/CEN) for providing feedback on the business questionnaire and Jenny van den Boogaard at PIANOo (Dutch Public Procurement Expertise Centre) for organising a small pilot testing of the procurement survey.

In addition, we would like to thank all external partners who participated in the dissemination of the online survey and, last but not least, all the survey respondents that dedicated their time to answering our questionnaires.

Finally, we are grateful for the comments and the constructive help in the execution of the work from our partners in work package 9: Martin Behrens (Fachagentur Nachwachsende Rohstoffe, FNR), John Vos (BTG Biomass Technology Group), Lara Dammer and Asta Eder (nova-Institute).

1. Introduction

1.1. Background

The development of a bio-based economy represents an important pillar of the European Union's strategy for promoting smart and green growth in Europe. It has the potential to be an important driver of innovation and economic development, while reducing fossil fuel dependence and supporting more sustainable production (European Commission, 2010b). Realizing this potential depends not only on promoting knowledge and skill development and increasing R&D investments in the field. It also requires measures to support the demand for innovative bio-based products and materials (European Commission, 2007). As suggested in the Aho Report on "Creating an Innovative Europe", enabling the market demand for innovative products is one of the key challenges for boosting the productivity and competiveness of Europe's economy (European Commission, 2006). Simultaneously, it represents the basis for stimulating the far-reaching process of innovation and societal transformation required for building a more sustainable, resource-efficient economy.

1.1.1. Objectives of the Open-Bio project

To foster such an innovation-friendly market environment for bio-based products, the European Commission's Bioeconomy Strategy proposes the development of standards and standardized sustainability assessment methodologies as well as the promotion of green public procurement of bio-based products. The Open-Bio project supports these policy initiatives by performing co-normative research and by developing an information system to support the public and private procurement of bio-based products. Among other things, this involves the creation of a database containing information on bio-based products to be used as a support tool for the identification and comparison of bio-based products in the context of procurement activities. In addition, the Open-Bio project is developing a strategy for the creation of a European label for bio-based products. Such a label represents a potential vehicle for promoting the market uptake of bio-based products by consumers, businesses as well as in public procurement. Future work in the Open-Bio project will investigate the possibility of introducing requirements on bio-based content in the criteria catalogue of existing product categories or the definition of new product categories for the EU Ecolabel.

1.1.2. Objective of work package 9 on Social Acceptance

To ensure the effectiveness of measures that support the demand of bio-based products, work package 9 of the Open-Bio project on "Social Acceptance" is tasked with the identification of key criteria for the acceptance of bio-based products and related standards and information systems, including labelling options for bio-based products. The work package focuses on acceptance among four target groups: (1) consumers, (2) businesses, (3) public procurement officials and (4) NGOs.

Research on the acceptance of bio-based products in the business-to-business market and in public procurement is led by TUB, while LEI-DLO leads the research on consumers and NGOs. This report (Deliverable 9.2) summarizes the main findings from tasks 9.2, 9.3 and 9.4 conducted between November 2013 and September 2015 presenting a final set of relevant acceptance factors for the three different stakeholder groups: consumers, businesses and public procurement officials.

The work has been conducted in close cooperation with the other partners of work package 9 (Fachagentur Nachwachsende Rohstoffe, nova-institute and BTG Biomass Technology Group) who provided feedback on the research design and methodology as well as the analysis of the results. In addition, the preliminary results were presented and discussed with the Open-Bio consortium on project meetings, at the 6th of May 2014 in Milano, at 17th of November in Wageningen and the 27th of May 2015 in Ghent, and with several external stakeholders on thematic workshops, at the 7th of April 2014 in Cologne, the 5th of September 2014 in Brussels, the 30th of October 2014 in Berlin, 20th of May in Delft and the 26th of May 2015 in Brussels.

1.2. Structure of the report

This report represents the second deliverable of work package 9 and provides an overview of the acceptance factors for the following three target groups: (1) consumers, (2) businesses and (3) public procurement officials. It presents the key findings from qualitative and quantitative research on consumer acceptance (task 9.2) and from two-stage Delphi surveys targeting the business community (task 9.3) and public procurement officials (task 9.4). The results pertaining to information systems and labelling provide input to related work in the Open-Bio project in work packages 7 (“Labelling”) and 8 (“Product Information List”). A more detailed presentation of the empirical findings for each target group can be found in the corresponding annexes to the report.

The report is structured as follows. Chapter 3 (and Annex I) presents the key findings from the consumer research. Chapter 4 (and Annex II) discusses the results from the survey on acceptance within the business-to-business market, and Chapter 5 (and Annex III) focuses on the results from the survey on the acceptance of bio-based products by public procurement officials. Each section briefly presents the conceptual framework and methodology followed by a discussion of key findings. The final chapter provides a synthesis of the findings, drawing general conclusions from the market acceptance research.

1.3. The conceptual approach and methodology

1.3.1. Social acceptance: the case of market acceptance

The social acceptance of new technologies represents the basis for their widespread adoption. This is particularly true for environmentally-friendly technologies, which frequently require additional policy support to achieve competitiveness via-à-vis existing technologies (Ashford & Hall, 2011; Jänicke & Lindemann, 2010; Wüstenhagen, Wolsink, & Bürer, 2007). Moreover, early market development for environmentally-friendly technologies often depends on purchases by consumer groups, which place an important value on the environmental attribute of the product (Noppers, Keizer, Bolderdijk, & Steg, 2014). As the mandatory introduction of ethanol fuel mixtures in Germany has recently shown, doubts concerning the performance or environmental benefits of a new product may severely hamper its adoption by consumers.

Studies on the role of social acceptance of environmentally-friendly technologies have largely focused on the case of renewable energy technologies, including the case of biofuels (Chin, Choong, Alwi, & Mohammeda, 2014; Emmann, Arens, & Theuvsen, 2013; Huijts, Molina, & Stegb, 2011; Savvanidou, Efthimios, & Tsagarakis, 2010; West, Bailey, & Winter, 2010; Wüstenhagen et al., 2007; Zoellner, Schweizer-Ries, & Wemheuer, 2008). Among these studies, Wüstenhagen et al. (2007) offer the most comprehensive concept of social acceptance, distinguishing between three basic dimensions: community acceptance, socio-political acceptance and market acceptance (see Figure 1). The remaining studies develop narrower concepts, which fall into one of the three dimensions.

Figure 1: Three dimensions of social acceptance

Source: Wüstenhagen et al, (2007)

Community acceptance is similar to what Huijts et al. (2011) label citizen acceptance and refers to the behavioural responses within communities, which are affected by the placement of a technological object close to their home. While this is highly relevant for the acceptance of site-specific plants such as industrial scale bio-refineries, this is less relevant for the broad field of bio-based products and the potential for their adoption, as addressed in this report.

Socio-political acceptance is a much broader form of social acceptance and refers to the response to new technologies or areas of technological innovation by the public, by political parties and other key societal stakeholders, which help shape both policy and public opinion in the related field (Huijts et al., 2011; Wüstenhagen et al., 2007). While highly relevant to the development of an innovation-friendly market for bio-based products, this is the focus of a separate report prepared within the Open-Bio project, which discusses the positioning of key non-governmental organizations on the bio-based economy.

Finally, the dimension of *market acceptance* relates to the willingness of market actors to adopt, purchase and financially support a new technology. Market actors refer to actors with a direct influence on market development. This generally includes consumers or firms, which may act as adopters and buyers of a particular product, as well as investors (Wüstenhagen et al., 2007). In addition, government agencies and other public bodies represent an important source of potential demand for environmentally-friendly and innovative technologies (Edler & Georghiou, 2007; OECD, 2011).

The following report focuses on the market acceptance of bio-based products in Europe, considering consumers, firms and public procurement officials. Because of the expected differences across these three target groups, three separate studies have been conducted, each utilizing a conceptual approach and method tailored to the respective target groups. The specific approach is outlined in the following chapters.

1.3.2. The role of standards, labels and information systems for market acceptance

As mentioned above, the Open-Bio project is conducting work related to standardization, labelling and information systems for bio-based products. Standardization and labelling represent important vehicles for codifying and diffusing information on technology, and they have been found to play an important role for the market uptake of innovations (OECD, 2011). In the field of environmentally-friendly products in particular, they may play an important role in supporting market acceptance by ensuring, verifying and visualizing key sustainability aspects. By offering harmonized approaches to the measurement of key product attributes and to the classification and reporting of related information, they enable the development of economies of scale and the lowering of transaction costs. Moreover, European-level standardization is considered an important vehicle for promoting the European single-market and the related benefits for the competitiveness of European industry (European Commission, 2010a).

In order for standards and labels to have these desired effects, it is essential that they are accepted by a critical mass of relevant market actors. Complementing and building on the analysis of relevant factors for the market acceptance of bio-based products, this report explores a number of more specific issues related to the design of standards, labels and information systems and the related requirements among the three target groups. For each target group, it presents findings on stated informational requirements, related requirements for the standardization of measurement and reporting methods as well as issues related to the design of a European label for bio-based products. Regarding the latter, the report explores whether and how a future label for bio-based products might address additional sustainability criteria and whether such a label might operate within the existing EU Ecolabel scheme.

2. Consumer Acceptance of Bio-Based Products

2.1. Overview

This chapter presents the main findings derived from a survey among consumers. The main objective of this two-stage consumer research is to increase the understanding of consumers' perception of bio-based products. Consumers' perception is one key factor that determines the acceptance of bio-based products. More detailed findings can be found in (1) Deliverable D9.1 in which the results of the first stage, qualitative research can be found and in (2) Annex I in which the results of the quantitative research can be found.

2.2. Conceptual approach and methodology

2.2.1. Conceptual approach

In the following the term consumer acceptance refers to the willingness of consumers to buy bio-based products. Therefore this study started with literature search on three streams of research to understand consumer buying behaviour: (1) Research on consumer acceptance of products in general, (2) research on consumer acceptance of green products, and (3) research on consumer acceptance of applications of new technologies. The theories uses in these different streams of research have in common that they all state attitudes of consumers form intentions to buy or use a product. One has to have a positive attitude towards a product before buying it, according to the Theory of Planned Behavior (Azjen, 2011). The attitude towards a product is based on (among others) the perception of a product. A positive perception of a product is a condition for a positive attitude and intention to buy the product. Because there is not much known about consumer perception and attitude of bio-based products, the present study aims to increase our understanding of consumers' perception of bio-based products. The concept of consumer perceptions includes among others familiarity, associations and emotions. Also awareness is a relevant factor. First of all one has to be aware of the product and one has to know something about a product. This is necessary to develop associations and emotions about the product.

2.2.2. Qualitative Research and Quantitative Research

We have chosen a two-stage approach. First, the exploratory, qualitative study was conducted. Focus group discussions were held. Focus groups can be defined as 'a research technique that collects data through group interaction on a topic determined by the researcher (Morgan, 1997). Focus groups are originally a specific tool for qualitative data collection, based on dynamics of the group to broaden and deepen insights. They are helpful to generate hypotheses that can be validated in further quantitative approaches (Stewart &

Shamdasani, 1990). Deliverable 9.1 provides the results of this qualitative study. Building on this, a quantitative survey was conducted. This survey provides insight into people's experiences, opinions, wishes, and concerns regarding bio-based products. The survey enables us to identify the most relevant issues in consumer acceptance of bio-based products.

2.2.3. Survey development

The guide for the focus groups (qualitative research) and the questions formulated in the questionnaire of the quantitative research have been developed in an iterative process. First, a review of the literature on consumer research on bio-based products and related subjects (green products, innovative products) was executed. In multiple feedback rounds with project partners in the Open-Bio project the final guide was designed. After finalizing the qualitative study the quantitative phase started. This second stage research was based on the main findings of the qualitative research and took up follow-on questions.

Existing perception models divide perceptions into multiple levels and dimensions. For example, in food choice there are 4 groups of determinants influencing consumer perceptions, i.e. individual characteristics, social environmental characteristics, food product characteristics, and contextual variables (Sijtsema, Linnemann, Gaasbeek van, Dagevos & Jongen, 2002). To obtain a comprehensive picture of consumer perception, this study explored consumer perceptions at different levels of specificity. We included

(1) a broad and general level in which we explore whether individuals understand the term, and what kind of associations, feelings and motives are associated with this term,

(2) a product-specific level in which we guide consumers to apply the term to specific products to explore perceptions, associations and feelings on a product-specific level. As such we can explore whether bio-based applies to all specific products or not.

(3) the label-specific level in which we guide consumers to think of the requirements they believe are important for a label on specific products.

For the product-specific label we selected 7 specific bio-based products which can be considered as a tangible end-product or product packaging in a business-to-consumer context. That is, a product that the consumer could buy and use (e.g., clothes). Furthermore, the 7 bio-based products had to differ regarding (1) the product category, (2) the environmental performance of the bio-based product, (3) the physical proximity of the product, (4) the personal relevance of, or identification with, the product. Based on these criteria the following products have been selected: t-shirt, foot cream, shopping bag, Coca-Cola bottle, door trimming dashboard, WPC decking and natural paint.

2.2.4. Survey execution

Market research organisation GfK was sub-contracted (1) to select the participants in the qualitative and quantitative research and (2) to provide moderators guiding the discussions in the focus groups. The focus groups were organized in the period from May-June 2014, while the data for the survey was collected in December 2014. We asked GfK to select the participants following our requirements (see 2.2.5).

In each Member State three focus groups have been organized at which six participants were discussing together under the leadership of the (GfK) moderator. Then Atlas version 7 was used to analyse the transcripts. Transcripts were coded by three independent coders and the interpretation of the results was performed by three independent researchers.

Regarding the quantitative research, respondents completed a self-administered online questionnaire that included, among others, (1) questions regarding their associations with and perceptions of bio-based products, (2) questions regarding the factors that determine acceptance of bio-based products and (3) questions focussing on the personal and socio-demographic characteristics of the respondents.

2.2.5. Respondent profiles

General

In the qualitative and quantitative consumer research the following countries were selected: Germany, The Netherlands, Italy, Slovenia, Denmark, and Czech Republic. The six countries were selected to represent a wide range of European countries. The countries were selected in two steps. In the first step, to achieve a geographical balance over Europe, countries were selected from different European regions: (i) Western Europe, (ii) Eastern/ Central Europe, (iii) Scandinavia and (iv) Southern Europe / Mediterranean. In the second step, member states were screened for their frontrunner status in the field of environmentally-friendly products (purchase of environmentally-friendly products, purchase of energy efficient appliances, awareness of environmental impacts of products, awareness of sustainability labels) and in the field of biotechnology (support for biotechnology and genetically-modified food).

Qualitative research

The focus group discussions were held among consumers living in those Member States. However, Slovenia was excluded from the analyses, because the moderator decided to use a different term for these focus groups. Therefore, the results of 89 consumers living in five Member States are the basis of this study: Denmark, Italy, The Netherlands, Germany and Czech Republic. In each country three focus group discussions were organised and six respondents participated per focus group. Two of the six participants per focus group were so-called lead users. Lead users were participants who scored high on dispositional innovativeness (Steenkamp & Gielens, 2003) ***or*** personal norms (Gärling et al., 2003). The other four participants are representative for their country for age, gender, and education.

Additionally, all participants were not illiterate and didn't work in sectors which could lead to more or specific knowledge or expertise about bio-based.

Quantitative research

The cross-national online consumer survey was run in the six member states that we have selected: Denmark (*N*=1012), Germany (*N*=1136), Italy (*N*=1060), The Netherlands (*N*=1016), Czech republic (*N*=1008), and Slovenia (*N*=1011).

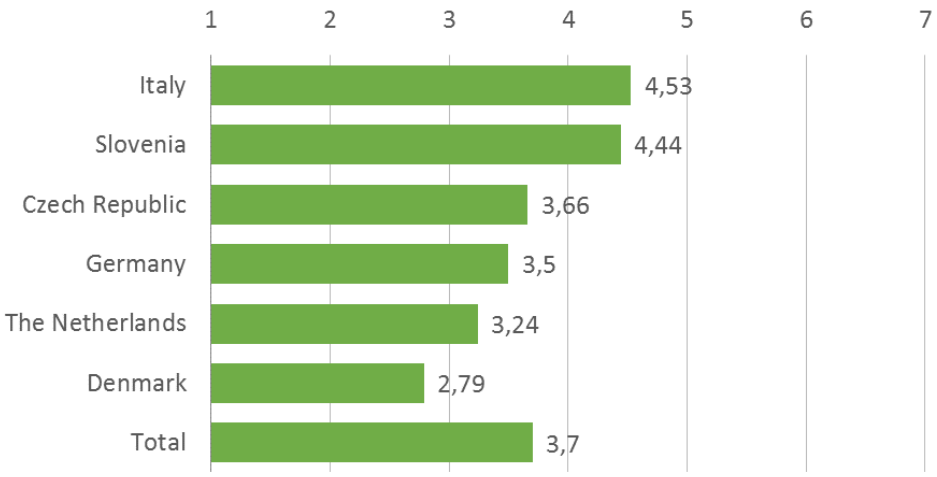
In all countries, we instructed GfK that our study samples should be representative of the specific country in terms of age, gender, education, and income distributions. In total 6241 respondents completed the questionnaire. Thirteen respondents were removed because they showed zero standard deviation, indicating that they did not answer the survey seriously (all questions were answered the same). This brings the used sample to 6228 respondentsThe sample consisted of 49.2% males. In general most of the respondents fall within the age group of 50 to 64 years old. All demographic characteristics of the respondents (e.g., income level, children, social status) are divided across answering categories showing broad samples.

2.3. Acceptance of bio-based products

2.3.1. Awareness of bio-based products

Awareness refers to the ability of a buyer to recognize or recall a bio-based product. We measured the awareness by using the brand awareness scale of Yoo et al. (2000). Figure 2 shows that there are significant differences between countries. Respondents from Italy and Slovenia are most aware of bio-based products, whereas respondents from Denmark are least aware. This result corresponds with the pattern that was found with regard to familiarity with bio-based products: Italy and Slovenia also appeared to be the countries with the highest percentages of respondents who know what bio-based products are.

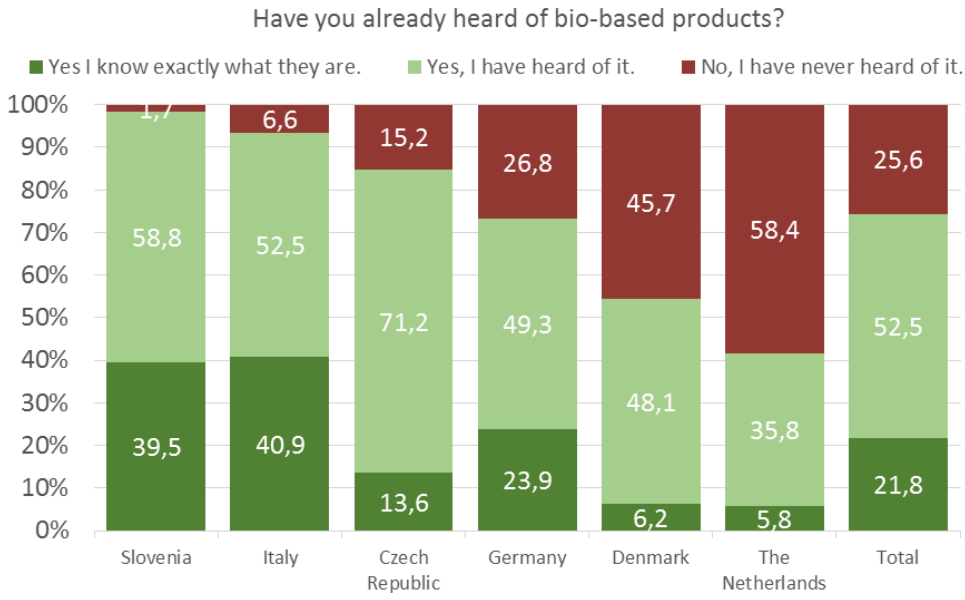
Figure 2: Awareness of bio-based products (1=low, 7=high awareness)



2.3.2. Familiarity with bio-based products

Figure 3 shows how familiar the respondents are with bio-based products. In general, 52.5% of the respondents stated that they had heard of bio-based products, but only 21.8% reported knowing exactly what bio-based products are. Note that these results might have a positive bias because individuals have a tendency to overestimate their familiarity with a specific product in aided questions. In Denmark and the Netherlands, the percentage of respondents who stated that they knew exactly what bio-based products were is relatively small (±6%). Italy and Slovenia show the largest percentages of respondents who reported knowing exactly what bio-based products are (±40%).

Figure 3: Familiarity with bio-based products



Familiarity with bio-based products is also reflected in the questions raised during the group discussions, see Table 1. These questions ranged from the extent to which bio-based products are organic and environmentally friendly to the composition, production and waste generated by bio-based products. There was a wide range of questions, and many referred to the environmental aspects of bio-based products.

Table 1: Questions raised among consumers about the bio-based concept

Topics mentioned as unknown	Questions raised
Bio	Is bio-based organic?
Composition/Ingredients	To what extent has bio-based product bio ingredients (including organic, natural, biological)? What are the other ingredients/compounds?
Environmentally friendly	Is a bio-based product environmentally friendly? Is it friendlier than biological, natural or organic?

Product/Production life cycle	Is a product bio-based or does it concern the production process/technique of production?
Biodegradable	Is a bio-based product biodegradable?
Energy	Can you make energy/fuel with bio-based products?
Waste	Do bio-based products reduce waste?

2.3.3. Associations with the term "bio-based"

Respondents were asked to report three types of associations: (1) positive associations, (2) negative associations and (3) associations with specific products.

Positive associations

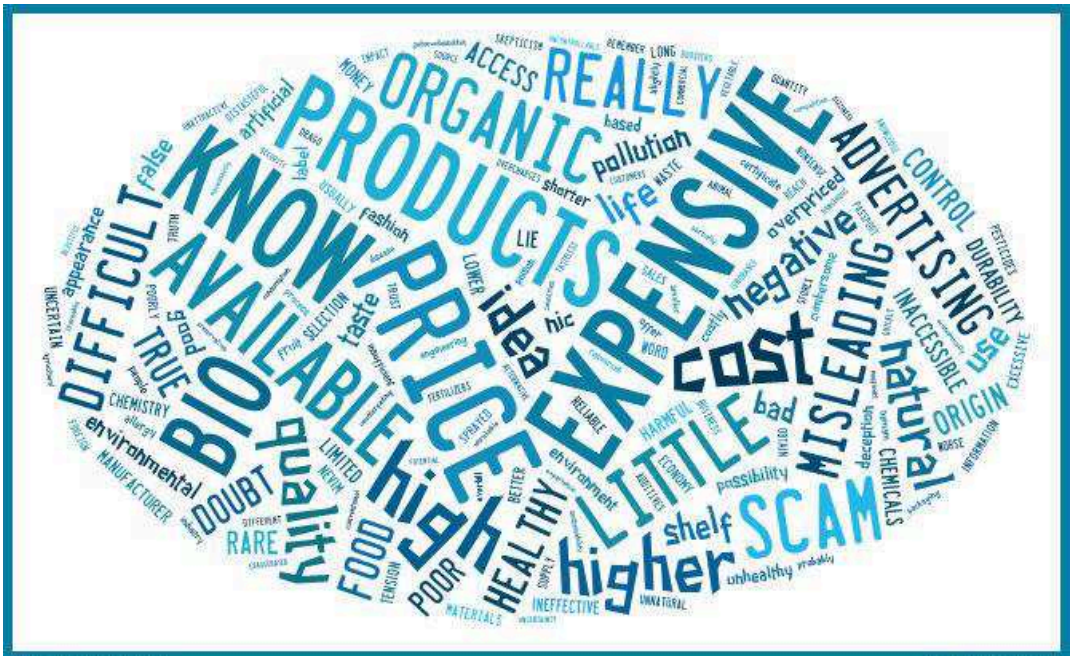
Figure 4 shows that bio-based is positively associated with the environment. Examples of associations are 'environmentally', 'biological', 'ecological', 'natural' and 'sustainability'. Furthermore, bio-based products are also positively associated with health ('healthy' and 'health').

Figure 4: Word cloud showing positive associations with bio-based products

Negative associations

Figure 5 shows negative associations with bio-based products. This figure shows that bio-based products are negatively associated with higher costs. For example 'price', 'expensive' and 'cost'. Additionally, bio-based products are negatively associated with marketing tricks. For example: 'misleading, 'scam', and 'advertising' are mentioned. There are also some negative associations with organic, bio, and low availability.

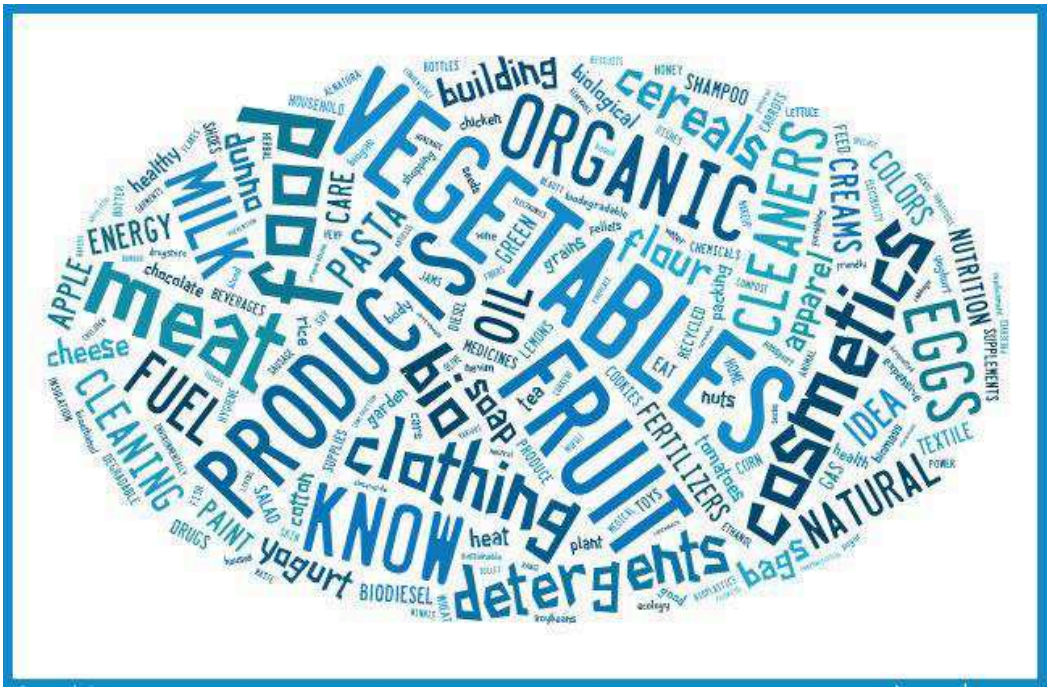
Figure 5: Word cloud showing negative associations with bio-based products



Specific type of products

Figure 6 shows which specific type of products people think of when they are confronted with the term ‘bio-based products’. The results show strong associations with food products, such as ‘vegetables’, ‘fruit’, ‘milk’ and ‘meat’. Additionally, ‘clothing’, ‘cosmetics’, ‘detergents’, and ‘cleaners’ are mentioned relatively often. Finally, respondents also mention ‘organic’, indicating that they link bio-based products with organic products.

Figure 6: Word cloud showing associations with specific products



Aided associations with bio-based products

We checked whether there are differences in associations between countries (Table 2). We summed up several items and asked respondents what items they associate with bio-based products. The results show that all aided associations differ significantly across countries. We can see that Germany, the Netherlands, and Denmark often have the same associations (e.g., traded in a fair way, price, animal welfare, innovative, and sustainable). Italy, Slovenia, and Czech Republic sometimes follow different patterns (e.g., technological, innovative, naturalness, sustainable) and sometimes the same (e.g., animal welfare, recyclable). Generally, all countries positively associate bio-based products the most with the environment, recyclable and naturalness. Though for Italy, Czech and Slovenia health and safety are relatively more positively associated with bio-based products than Denmark and the Netherlands.

Table 2: Aided associations with bio-based products from negative to positive for each country

	DK (*N*=1011)	DE (*N*=1132)	IT (*N*=1055)	NL (*N*=1012)	CZ (*N*=1008)	SI (*N*=1010)
Environment	5.84	5.77	6.25	5.82	6.03	5.93
Recyclable	5.79	5.39	6.10	5.78	6.03	5.91
Naturalness	5.66	5.78	6.21	5.80	5.62	5.74
Sustainable	5.64	5.64	6.01	5.69	5.24	4.67
Health	5.54	5.74	6.20	5.64	5.93	6.15
Animal welfare	5.51	5.51	5.94	5.57	5.78	5.73
Innovative	5.37	5.19	5.83	5.34	5.45	5.06
Energy use	5.35	5.00	5.47	5.26	5.43	5.05
Traded in a fair way	5.30	5.24	5.64	5.44	4.40	4.39
Technological	5.26	4.55	5.38	5.00	5.14	4.62
High tech	5.16	4.35	5.38	4.89	5.37	4.92
Safety	5.12	5.09	5.85	5.25	5.37	5.39
Appearance	4.51	4.89	5.15	4.53	4.90	4.82
Price	3.71	3.52	4.11	3.60	3.50	3.09

Summarized, the results show that bio-based products are most strongly associated with environmentally-friendly; the consumers referred to a broad range of aspects, such as recyclable, organic, and naturalness. These associations with the environment are most often recalled as positive. Health and safety are also relevant associations with bio-based

products, especially in Italy, Czech Republic, and Slovenia. Strikingly, animal welfare is also positively associated with bio-based products. Together with the fact that health is highly associated with bio-based products, these findings imply that consumers confuse the term bio-based with organic or natural/ sustainable or that they at least include all of these terms together. Technological and fair trade aspects are less often associated with bio-based products.

In addition, the results show that bio-based is often associated with food products, such as 'vegetables', 'fruit', 'milk' and 'meat'. Additionally, 'clothing', 'cosmetics', 'detergents', and 'cleaners' are mentioned relatively often. Finally, consumers also mention organic, indicating (again) that they link bio-based products with organic products. Additionally, the fact that many food products are mentioned as products that are associated with bio-based products implies that consumers may confuse the terms bio-based and organic. Thus, combined with the fact that consumers associate bio-based products with health and animal welfare, the results indicate that consumers may confuse different terms that look similar but in reality have different meanings.

2.3.4. Feelings about bio-based products

Unfamiliarity is associated with mixed feelings, distrust, and negative feelings; see Table 3. The results imply that a lack of clarity on the meaning of the term bio-based results in negative feelings. Some respondents are less extreme in their negative reaction, which results in mixed feelings. These participants believe that it is positive that more sustainable products and techniques have been developed, although due to the lack of clarity, they distrust the motives and actual consequences of these products and techniques. Taken together, although many of the participants link bio-based to environmental aspects, this link shows a wide variety of considerations that result in a wide range of feelings.

Table 3: Feelings and normative ideas about bio-based products

Feelings and normative ideas	Participants' criteria
Mixed feelings	Innovative, Organic, Bio, Biological, Environmental, Healthy, Marketing, Distrust
Negative feelings	Buzzword, Unknown, Waste
Positive feelings	Bio, Environmentally friendly, Natural, Healthy, Agricultural development, Energy, Future, Ideal, Innovative, Shopping criteria, Sustainable
Normative ideas	Environmentally friendly, Future, Ideal

2.3.5. Perception and buying intention of bio-based products

Discussing seven specific bio-based products showed that each product is perceived in its own way. The products that consumers had direct contact with, such as Coca-Cola, natural paint, foot cream and T-shirts, for example, show a higher involvement among participants. However, there are some clear, overarching findings to discuss. The consumers showed low involvement with the use of bio-based production methods. In general, bio-based aspects are not a decisive characteristic for buying or trying a product. They can be regarded as an additional positive sign, but other criteria (e.g., convenience, looks and price) are more important and must be fulfilled for participants to choose the specific products. Consumers strive to maximize their personal benefits, such as convenience, price, and status. These benefits might differ across products and across individuals. In each case, the consumers believed that one's personal benefits should be fulfilled first, and bio-based production methods are perceived as only a small additional positive aspect.

As was already clear from the participants' general perceptions of the term "bio-based", bio-based products were mainly linked to environmental aspects and to a lesser extent to technical and health-related (mostly via natural) aspects. The participants thus seem to link bio-based products to a range of natural and pro-environmental aspects. In comparison with the general associations with the term there were fewer associations with technical aspects, and more associations with health-related aspects. Because technical aspects are not related to a personal benefit and are therefore likely less relevant at a product-specific level, this finding indicates that on the product-specific level, personal benefits are more relevant for the bio-based perception. Additionally, the environmental friendliness and healthiness of bio-based products relate to personal benefits, such as good feelings or personal motives and having a sustainable and healthy lifestyle.

Participants' associations of bio-based products with the environment show a similar diverse range compared with the general associations with the bio-based concept. Some respondents expressed very positive feelings about seeing products with a better environmental performance. These participants stated that small improvements are also important. Others expressed negative feelings, for example when seeing the small share of bio-based in the product which was discussed. They were not convinced by the environmental benefits, and they noted that marginal steps have no meaning. Again, there were also participants who were in between and showed mixed feelings. They mentioned both positive associations about companies trying to be more environmentally friendly and negative associations because they do not know what the term actually means or what the actual consequences are, or because they believe that more should be done to produce environmentally friendly products.

There were differences between the products in how environmentally friendly they were perceived. The results imply that certain participants are more positive towards bio-based products that represented themselves as 100% bio-based or natural materials versus products that were only partly bio-based. The partly bio-based products were more often associated with negative terms such as environmentally unfriendly or even toxic, distrust, and marketing tricks by large companies. The participants seem to differentiate between

internal versus external (green washing) motivations of companies to process bio-based products. Small percentages of bio-based products are sometimes perceived as an external motivation, such that a bio-based production method is only used as a way to increase profits. Thus, the percentage of bio-based production can also be too small.

The results indicate the importance of a coherent product concept. The participants do not like inconsistencies in the product image or insecurities about quality. Products are questioned and receive negative associations and distrust when bio-based production does not match the total picture. This finding indicates that one might question whether all products or elements of products are suitable to be marketed as bio-based products. Consumers should at least know that the producers did whatever they could to make a product as natural as possible. This includes all aspects of the production process because consumers seem to use all of the available information on a product to evaluate it. For example, there were negative associations expressed regarding content, packaging, production method, country of production (e.g., some participants associated China with human rights violations) and transport. Note that this finding is based on the participants' assumption that bio-based production methods are aimed at finding pro-environmental or natural solutions, whereas the link between bio-based products as innovative products that are necessary to adapt to a changing world was made less clear by the participants. In sum, the participants link bio-based products to naturalness, which has advantages in terms of positive associations with environmental friendliness, but it also has disadvantages because the participants have high expectations regarding the environmental friendliness of the total production process.

Additionally, with regard to specific products, the participants expressed a lack of clarity with the term bio-based. There were many questions asked by the participants about what bio-based means and how it was specifically applied to a product. In some cases, this lack of clarity resulted in distrust and negative associations. In addition, many of the participants asked for more information, which concerned questions about the characteristics of bio-based products, the production of bio-based products, the materials used, and their environmental friendliness.

Finally, although this study mainly focused on consumer perceptions of bio-based products, the willingness to try a product was also discussed to obtain an indication of the consumers' intentions. Note that this willingness only refers to self-reported intentions, which is not the same as actual buying behaviour. Actual buying behaviour can be affected by many other aspects, such as habits, emotions, unconscious associations, and time constraints. However, the findings regarding self-reported intentions do indicate how the consumers believe they would like to act. The results show that the participants wanted to buy or try specific products to contribute to the environment, to the future, or to their own well-being or health. In addition to these long-term goals, the participants also noted immediate benefits, such as price, convenience, or aesthetics. However, the barriers for buying the products involved some of the same arguments, such as price, aesthetics, and convenience. Additionally, low involvement and distrust were mentioned as barriers for the intention to try or buy a specific bio-based product.

2.4. Labelling, product information and standardization

2.4.1. Labelling

To test the added value of labelling, we presented a question to the respondents in which they had to choose for different options of bio-based paint, with or without labels. The results revealed that the option with biodegradable logo is most often selected for a range of different product benefits (e.g., expensiveness, quality, attractiveness). The bio-based paint with the European Ecolabel logo is the second preferred option for all product benefits. The paint options with the labels showed also the highest buying preference among consumers (across all countries). Strikingly, bio-based paint without labels did not score better than non bio-based paint. This finding suggests that bio-based paint does not have any added value relative to non bio-based paint when there are no labels on the product. The impression – based on this case – is that companies using bio-based materials in their products should include a label on their products in order to differentiate their offerings in the market.

Examination of the role of different personality traits showed that especially feeling a higher moral obligation to protect the environment (i.e, personal norm) plays a role in choosing bio-based products with labels. Interestingly, subjective knowledge seems to have an adverse effect: respondents with a higher subjective knowledge are more likely to select bio-based paint without a label as compared to the paint with the biodegradable logo. Again, these findings indicate that targeting different consumer segments with specific marketing strategies for bio-based products may pay off.

With regard to the European Ecolabel logo, we specifically asked respondents how familiar they are with the label and how they would evaluate this label. The EU Ecolabel is evaluated neutral to positive among consumers. However, we saw differences among countries. Italian respondents are more positive towards the label and they more often indicate that the Ecolabel is a well-known label. This may be due to the fact that the number of products with the Ecolabel in Italy clearly outnumbers the other European countries. For example, in countries like Germany and Denmark strong national labels are used. Notice that the Ecolabel logo was changed in 2010 (into the current flower logo), which also may have affected people's knowledge and familiarity

Although there were small differences across countries, the trustworthiness of information sources shows a comparable ranking across countries. Information from consumer organisations was perceived to be most reliable across countries. For all countries, NGO’s (especially in Denmark, Germany, and Italy) and independent certifying organisations (especially in the Netherlands, Czech Republic, and Slovenia) were also highly trustworthy. In contrast, television programs, newspapers, government and manufacturers were less trustworthy.

2.4.2. Product information and standardization

To test what information consumers wish and require respondents were asked to select a maximum of three items from a list of 14 possible communication contents. Per country the highest percentage is highlighted in green and the second highest percentage is highlighted in yellow, see Table 4. Overall the results show that the most preferable information concerns health impact for Italy, Czech Republic, and Slovenia. Recyclability and biodegradability received high percentages for all countries. These findings correspond with the associations that people have with bio-based products. This table shows that health, environment and recyclable are most positively associate with bio-based products. Furthermore, Table 4 shows that compostability seems to be relatively important in Denmark. Social impact and product functionalities are examples of information which are relatively unimportant for all countries.

Table 4: Percentages of respondents that indicated to favour the information (green= highest %; yellow=second highest %)

	DK (*N*=193)	DE (*N*=224)	IT (*N*=212)	NL (*N*=189)	CZ (*N*=200)	SI (*N*=200)	Total (*N*=1227)
The percentage of bio-based	16.1	26.8	17.0	17.2	19.0	14.0	18.5
CO2 footprint of the product	23.8	16.1	31.1	14.6	7.0	6.5	16.6
Environmental impact of product's life-cycle	24.4	22.3	28.3	25.8	3.5	21.0	20.9
Environmental impact of the raw material	18.7	26.3	27.8	29.8	6.5	24.5	22.4
Health impact (benefits)	32.1	32.1	37.7	26.8	60.0	76.0	43.9
Safety impact (benefits)	15.5	9.4	13.7	12.6	24.5	24.0	16.5
Product functionalities	6.7	9.4	12.7	5.1	25.5	17.0	12.7
Compostability	36.8	21.0	11.3	15.7	13.5	15.5	18.8
Energy saving	20.7	19.2	25.5	21.2	25.5	24.0	22.7
Recyclability	40.9	36.2	33.5	46.5	55.0	31.0	40.3
Biodegradability	26.4	30.4	33.5	37.9	30.0	36.0	32.4
Social impact of production	5.7	8.9	11.3	7.1	5.5	7.5	7.7
Other, please specify: ...	1.6	0.9	0.0	2.0	0.5	0.0	0.8
No communication at all	3.6	10.3	1.9	8.1	5.0	0.5	5.0

Although there were small differences across countries, the trustworthiness of information sources shows a comparable ranking across countries. Information from consumer organisations was perceived to be most reliable across countries. For all countries, NGOs (especially in Denmark, Germany and Italy) and independent certifying organisations (especially in the Netherlands, Czech Republic and Slovenia) were also highly trustworthy. In contrast, television programs, newspapers, government and manufacturers were less trustworthy. These results suggest that cooperation with NGOs, consumer organisations or independent certifying organisations as information sources about bio-based, are most fruitful. Furthermore, Denmark, Germany, and the Netherlands have more trust in government as compared to manufacturers or suppliers of bio-based products, whereas Italy, Czech Republic and Slovenia have more trust in manufacturers of bio-based products than in the government. In Czech Republic and Slovenia the government is even perceived as less trustworthy information source. These country differences should be taken into account when companies launch bio-based products in different countries. In each country a careful selection of trustful information sources should be made.

2.5. Conclusions

Results of surveys conducted among consumers show a high degree of unfamiliarity with bio-based concept and bio-based products among consumers. They have positive associations linked to the environment such as “naturalness” and “environmentally friendly” but also “health-related”. However, there are also mixed and negative feelings due to the lack of knowledge and arising questions about bio-based concept and products.

Discussing seven specific bio-based products showed that each product is perceived in its own way. For every product it is important that one’s personal benefits are fulfilled first. The bio-based element is perceived as only a small additional positive aspect.

When bio-based products are marketed as green it is important to have a coherent product concept in which all production process phases are sustainable on the social, environmental and economic dimension.

A high demand for coherent product-specific information about the bio-based ingredients and their properties was also indicated. These findings are in line with a consumer focus group conducted in Austria to bio-based composites including also some of the same product groups such as decking and automobile interior parts (Haider et. al, 2012). The study indicated that the marketing communication of bio-based products should focus on specific product benefits as such and not on the environmental benefits.

Regarding the labelling of bio-based products, consumers seem to prefer bio-based products with a label. The EU Ecolabel is assessed as neutral to positive, with differences between countries. Italian consumers are much more aware of the EU Ecolabel than Danish and Dutch consumers. Regarding the sender of the consumer information, consumers perceive consumer organisations as being the most reliable sources of information. For all countries, NGO’s and independent certifying organisations were also highly trustworthy.

Finally, we asked what information consumers would like to have. Recyclability and biodegradability received high percentages for all countries. These items are important.

3. Acceptance of Bio-Based Products in the Business-to-Business Market

3.1. Overview

This chapter presents the main findings derived from a survey among business experts in the bio-based economy. The main objective of this two-stage Delphi survey is the identification of key factors influencing the acceptance of bio-based products in the business-to-business market. An additional objective of the survey was to deepen the understanding of the existing heterogeneities in the market of bio-based products. Moreover, it addresses a number of key issues on the role of standardization and information systems, including labelling schemes, for the market acceptance of bio-based products. More detailed findings can be found in the corresponding annex to this synthesis report (Annex II), as well as in the respective annex to Open-Bio Report D9.1.

3.2. Conceptual approach and methodology

3.2.1. Conceptual approach

In the following, the term acceptance refers to the willingness of firms to adopt and purchase bio-based products. It goes beyond weaker forms of acceptance - sometimes referred to as “acceptability” (Huijts et al., 2011) - defined as supportive attitudes towards a new technology or innovation. Following this definition, the aim of the study is to identify critical factors influencing the acceptance of bio-based products in the business-to-business market. More specifically, this means identifying the factors driving the adoption and purchase of bio-based products by firms. Building on these general insights, more specific questions are explored regarding labelling, product information and standardization and regarding market particularities of countries and sectors in the field of bio-based products.

3.2.2. The Delphi method

This part of the study adopts the Delphi method. This method represents an approach for aggregating and consolidating opinions from experts on a particular subject. The method involves two or more survey rounds, so that results from the initial survey can be validated and further refined. In later survey rounds, experts get the opportunity to revise their earlier assessments in light of the replies of other experts. In this way, the method aims to synthesize the collective expertise of the respondents, thus increasing the accuracy of the resulting assessment (for more information on the Delphi method see Häder (2009) and Linstone & Turoff (2002)).

The issue of firm heterogeneity makes the identification of the most decisive factors influencing decisions to adopt and purchase bio-based products in the business sector a challenging task. This is further compounded by the significant degree of heterogeneity among bio-based products themselves. Rather than representing a discrete product type with a specified field of application, bio-based products represent a broad spectrum of final and intermediate goods.

Despite different forms of heterogeneity among agents in the business sector, developing a comprehensive perspective on the acceptance of bio-based products is essential for providing relevant inputs to ongoing sector-wide policy and standardization processes. The Delphi method was chosen to generate a *generalized* view on the market acceptance of bio-based products. Rather than collecting data on the actual buying behaviour among heterogeneous firms in the sector, it solicits the informed opinion of experts on the acceptance of bio-based products in the B2B market in *general*. In a second step, the study explores potential differences across different categories of bio-based products.

3.2.3. Survey development

The first round questionnaire was developed in an iterative process, involving a review of the literature on policy and market developments in the field of bio-based products, a series of key informant interviews with representatives from businesses associations and potential buyers of bio-based products, and multiple feedback rounds with project partners in the Open-Bio project as well as representatives from relevant working groups on bio-based products in the European Committee for Standardization (CEN). Moreover, questions on standardization and information systems were designed in close cooperation with relevant partners in the Open-Bio project.

The second round questionnaire was based on the main findings of the first round and incorporated questions aimed at validating particular findings as well as further refining results (in particular regarding differences across product categories). Again, project partners had the opportunity to comment on the questionnaire draft to ensure that the survey results would provide relevant inputs to the related work programme of the Open-Bio project.

3.2.4. Survey execution

The first round of the survey was administered as a pen and paper survey and as an online survey. The pen and paper survey was available in English only and was distributed at the “International Conference on Bio-based Materials” held from April 8 – 10, 2014 in Cologne, and at the “Industrial GreenTec” exhibition in Hannover from April 7 – 11, 2014. It generated a total of 84 completed questionnaires.

The online distribution of the survey took place via a diverse set of European and national multiplier organizations in the field of bio-based products, including industry associations, research institutes and network organizations. The questionnaire could be freely accessed online from the 23rd of April until the 6th of June 2014 and was available in English, French,

German, Italian and Spanish. In total, the online survey registered over 600 accesses and was completed and submitted by 240 respondents.

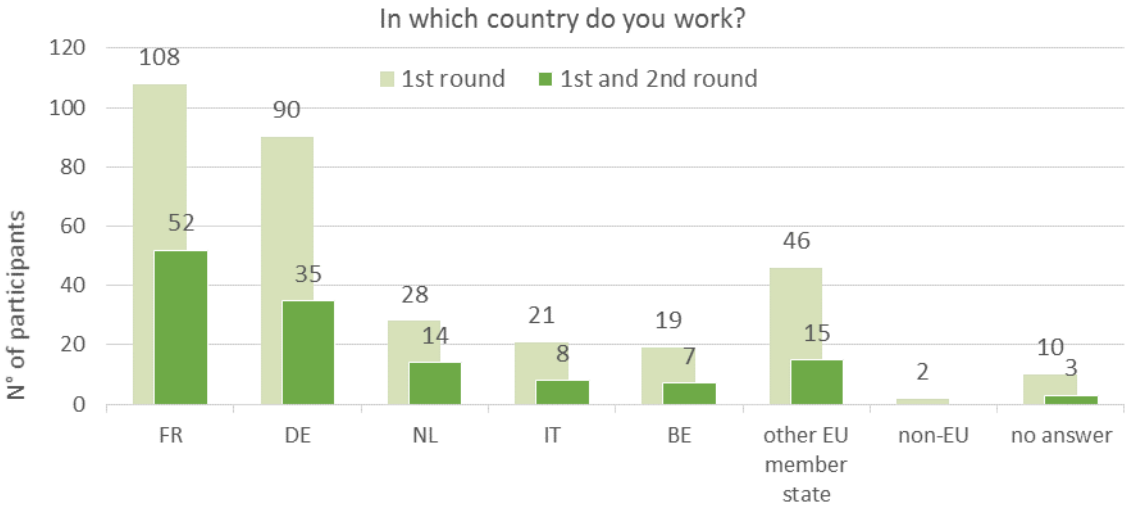
The second round of the Delphi study was designed as closed group survey that exclusively addressed those experts that had already participated in the first survey round and declared their willingness to be contacted for a second round. The 232 first round participants that had provided their contacts for this purpose were invited by email to take part in the second survey round. This approach helped to ensure that survey participants were strongly motivated to share their opinions, possessed the necessary background information and a profound sector expertise to improve the outcome of the first round further.

The second survey questionnaire was available online in English, French, German and Italian. It was accessible from the 4th of February to the 16th of March 2015. Each contacted expert received a personalized key to access the questionnaire. This key helped to match the information provided in the first round to the responses given in the second round. To increase the response rate, those invited experts that had not responded until the 23rd of February 2015 were individually contacted by telephone and asked to participate in the survey. Overall, 134 business experts completed the second round survey, which corresponds to a relatively high response rate of 57.8% and a total share of 41.4% of the first round participants.

3.2.5. Respondent profiles

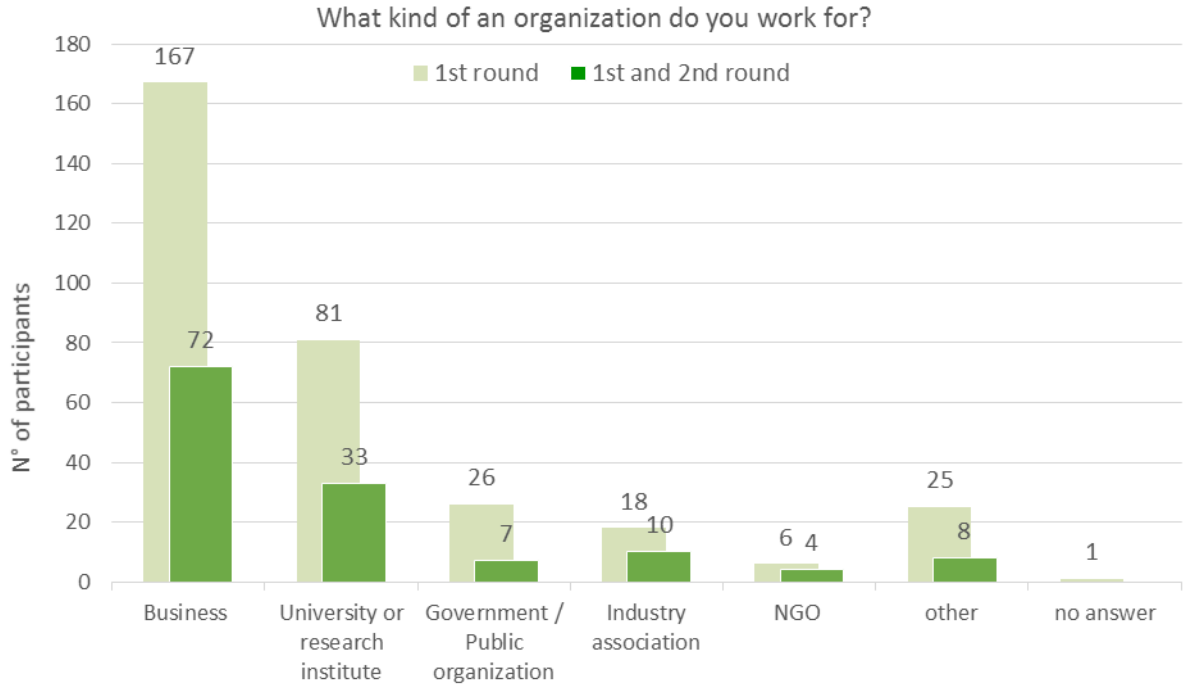
The survey includes responses from 17 EU member states. The largest number of responses comes from France, Germany, the Netherlands, Italy and Belgium (see Figure 7).

Figure 7: Place of work



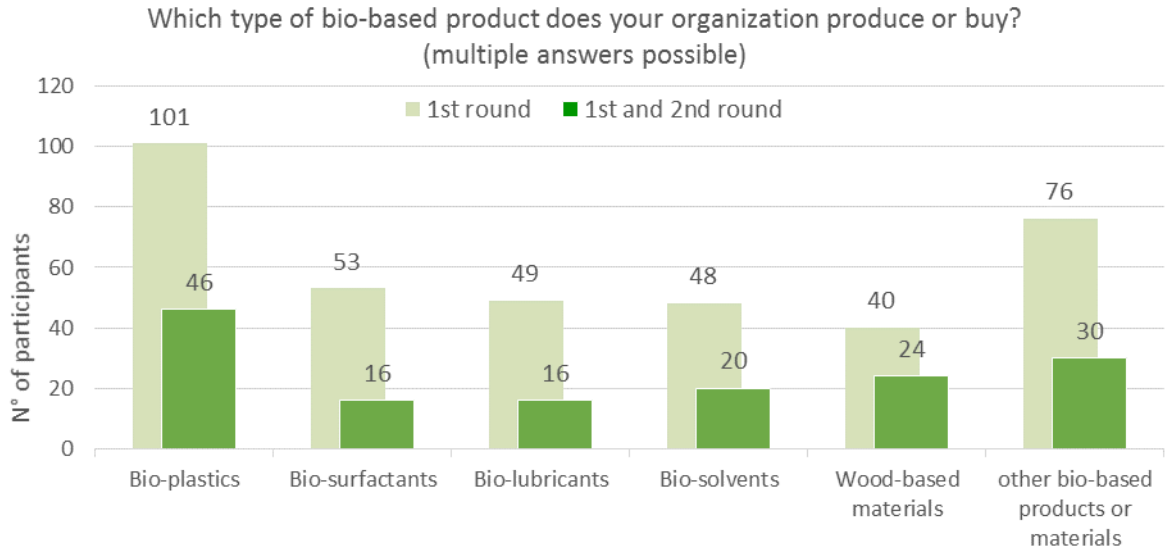
The survey captures predominantly the opinion of business experts. More than half of the respondents are business representatives, approximately one fourth comes from universities or research institutions and another quarter from other organizations (see Figure 8).

Figure 8: Type of organization



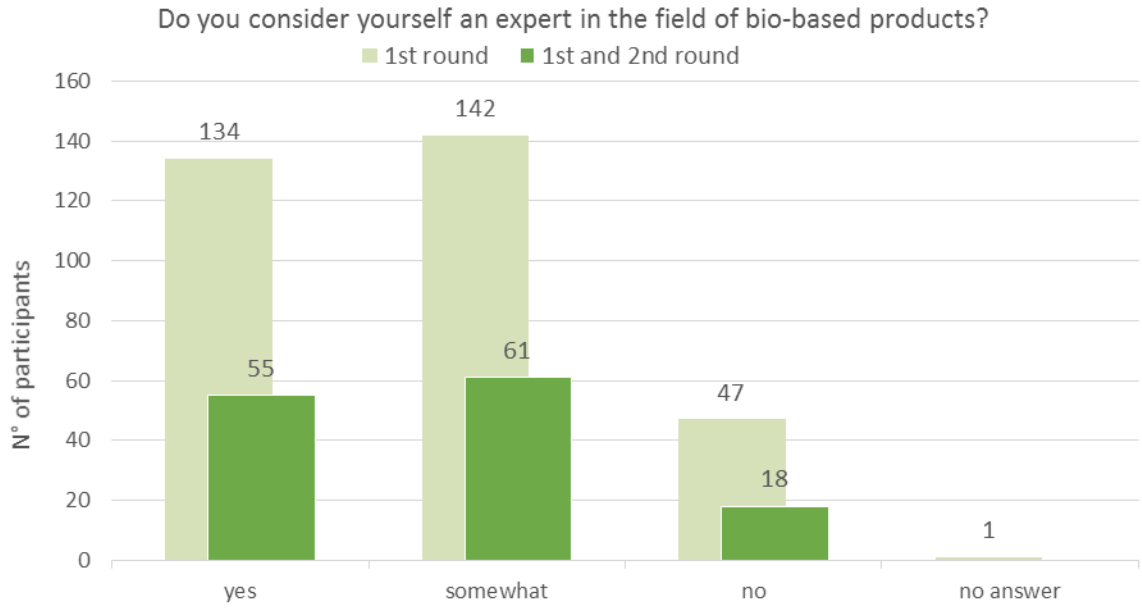
The respondents work with various types of bio-based products (bio-plastics, wood-based materials, bio-surfactants, bio-solvents and bio-lubricants) are well-represented. The largest number of respondents indicates their involvement in the field of bio-plastics, which accounts for approximately twice the number of respondents compared to each of the other product groups (see Figure 9).

Figure 9: Type of bio-based product



Finally, respondents confirmed a high level of sector-based expertise. Approximately 85 percent of respondents indicated to have at least some expertise in the field of bio-based products, of which almost half consider themselves as experts (see Figure 10).

Figure 10: Familiarity with the term "bio-based products"



Overall, participants in the second round appear to be a representative subsample of the business experts that participated in the first survey with regard to all relevant characteristics. The distribution of respondent profiles gives no reason for concern about a bias towards a specific subgroup of experts.

3.3. Acceptance of Bio-Based Products

3.3.1. Market drivers and barriers

In both survey rounds, the core question on the acceptance of bio-based products in the business-to-business market had two components: Respondents were asked to assess both drivers and barriers of the future development of the B2B market for bio-based products. They were presented with two corresponding lists of items derived from key informant interviews and the relevant literature on the market for bio-based products.

In the first survey round, respondents were asked to rate the importance of each item as a driver or barrier, respectively. Respondents of the second survey were confronted with the resulting rankings (based on the average of first round responses) and asked whether they agreed or not that these rankings correctly reflected the relative importance of the items as drivers or barriers of the future market development. In case of disagreement, they were given the opportunity to create an alternative ranking.

Table 5: Market drivers and market barriers (from the most to the least important items)

Rank	Market drivers	Market barriers
1	positive public image	higher cost of production
2	independence from fossil sources	uncertainty about future regulation
3	savings in CO2 emissions	volatility of feedstock prices
4	compliance with environmental regulation	unsupportive regulatory environment
5	reduced human toxicity	low performance or uncertainty regarding performance
6	utilization of waste products	uncertainty about available feedstock quantity and quality
7	new or added functionality	lack of public awareness about bio-based products
8	recyclability	incompatibility with existing supply arrangements or high replacement costs
9	potential to source feedstock locally	higher life-cycle costs to buyers (from purchase to disposal)
10	local employment creation	difficulty in obtaining finance
11	improved performance	difficulty in communicating environmental benefits
12	potential to attract new customers	limited local feedstock availability
13	reduction of environmental pollutants (other than CO2)	uncertainty regarding environmental benefits
14	energy savings during production	environmental impacts of feedstock production
15	lower production cost	incompatibility with existing recycling schemes
16	biodegradability / compostability	concerns regarding GMOs in feedstock production
17	life-cycle cost savings for buyers (from purchase to disposal)	increased eco-toxicity and negative effects on the eco-system
18	willingness to pay green premium	social impacts of feedstock production

A large majority of second round respondents (71% for the market drivers issue and 80% for the market barriers issue, respectively) agreed with the rankings that resulted from the first survey round. Even considering the opinions of the disagreeing experts, the total weighted average position of each item remained unchanged. Furthermore, second round participants were requested to incorporate additional items in the ranking, which had been suggested by respondents in the first round. Table 5 reports the final results of the Delphi survey with regard to the relative importance of drivers and barriers for the future development of the B2B market for bio-based products.

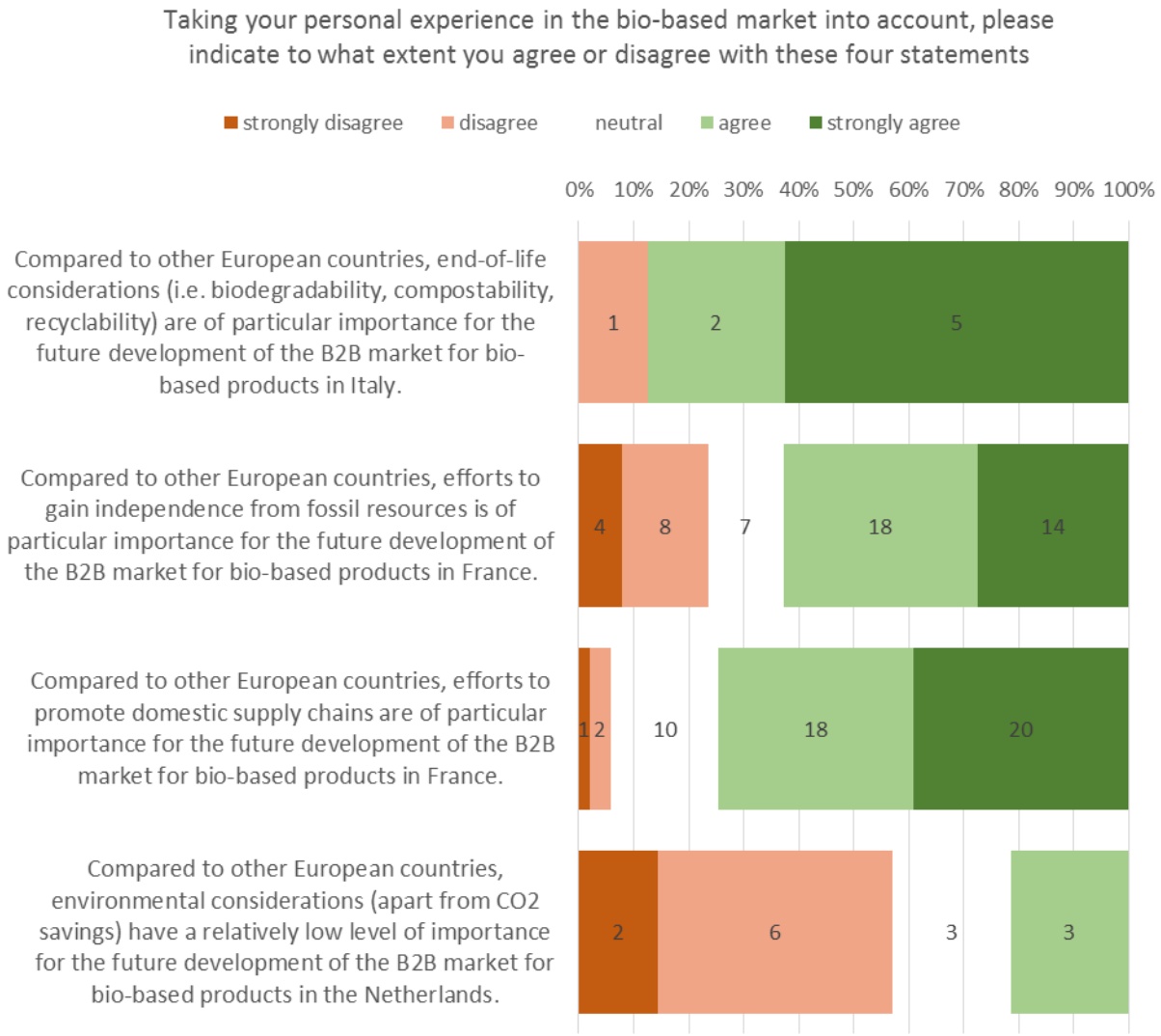
The results indicate that the positive image of bio-based products and their ability to ensure stronger independence from fossil-based resources represent the most important drivers of market acceptance by businesses. High production costs and relatively volatile feedstock prices are considered as important market barriers. This corresponds well with the finding that a price premium for better environmental performance is not considered particularly relevant for the B2B market. Furthermore, an unsupportive regulatory environment and uncertainty about future regulation hinder a stronger market uptake, whereas concerns about social and environmental impacts and the use of GMOs in feedstock production are not considered important market barriers.

3.3.2. Differences across countries

The answers to the first survey round were analysed to identify variations across different respondent groups (i.e. by place of work, by type of product, etc.). Most of the subgroups, however, did not exhibit significant differences, suggesting that respondents indeed offered a generalized view on bio-based products when answering the survey questions (rather than referring to their own specific product or activity). Nevertheless, the analysis of responses regarding market drivers revealed a number of statistically significant differences across countries. To investigate the existence of national particularities in the B2B market further, respondents of the second survey round were asked to validate a number of statements interpreting the observed response patterns based on their personal experiences.

Although not all suggested interpretations find approval, we conclude that country-specific particularities play a considerable role in the European B2B market for bio-based products. The majority of respondents endorses three of the four stated national market particularities. The assessments of only the corresponding local experts (see Figure 11) reinforces the general picture, according to which the French market is driven by an exceptional emphasis on promoting local supply chains and the ambition to gain independence from fossil resources, while the Italian market for bio-based products is particularly driven by end-of-life considerations. These country differences should be taken into consideration in ongoing policy and standardization processes at the European level.

Figure 11: Country differences regarding driving factors (only local experts)



3.3.3. Differences across product sectors

At various occasions, when presented the results of the first survey round, stakeholders expressed the belief that the answers to the questionnaire very much depended on the type of bio-based products concerned. Therefore, a main objective of the second Delphi round was to examine the existing differences among bio-based products. To deepen the understanding of acceptance factors in the B2B market, the second survey included questions that explicitly asked for particularities of certain market segments.

For the sub-sectors for which they had sufficient expertise, respondents were asked to indicate significant differences with regard to the importance of market drivers and barriers compared to the overall B2B market for bio-based products in general. Table 6 presents the acceptance factors for which a majority of respondents indicated a particular importance for the specific sub-sector.

Table 6: Particularly important market drivers and barriers by product sectors

Note: Cells are flagged when more than 50 percent of respondents chose "significantly more important" (+) or "significantly less important" (-).	Plastics	Solvents	Lubricants	Surfactants	Chemicals	Wood-based
Market Drivers						
positive public image						+
independence from fossil sources		+				
reduced human toxicity		+				
utilization of waste products						+
recyclability	+					+
potential to source feedstock locally						+
reduction of environmental pollutants (other than CO2)		+				
biodegradability / compostability	+	+	+	+		
Market Barriers						
higher cost of production	+					
volatility of feedstock prices					+	
incompatibility with existing recycling schemes	+					

Sub-sector particularities of the bio-based economy need to be considered when designing policy instruments to promote bio-based products. For instance, new bio-based products, such as polymers and chemicals, seem to face significantly more barriers than well-known bio-based products, such as wood-based materials. For certain sectors of bio-based products (plastics, solvents, lubricants and surfactants), the fact of being biodegradable / compostable is of particular importance for the uptake of the future B2B market.

3.4. Labelling, product information and standardization

3.4.1. Labelling

In support of Open-Bio work programme, the survey incorporated a set of questions regarding a possible European label for bio-based products. To ensure their relevance, these questions were developed in close cooperation with nova-institute, the Open-Bio project partner leading the work package on labelling (WP7).

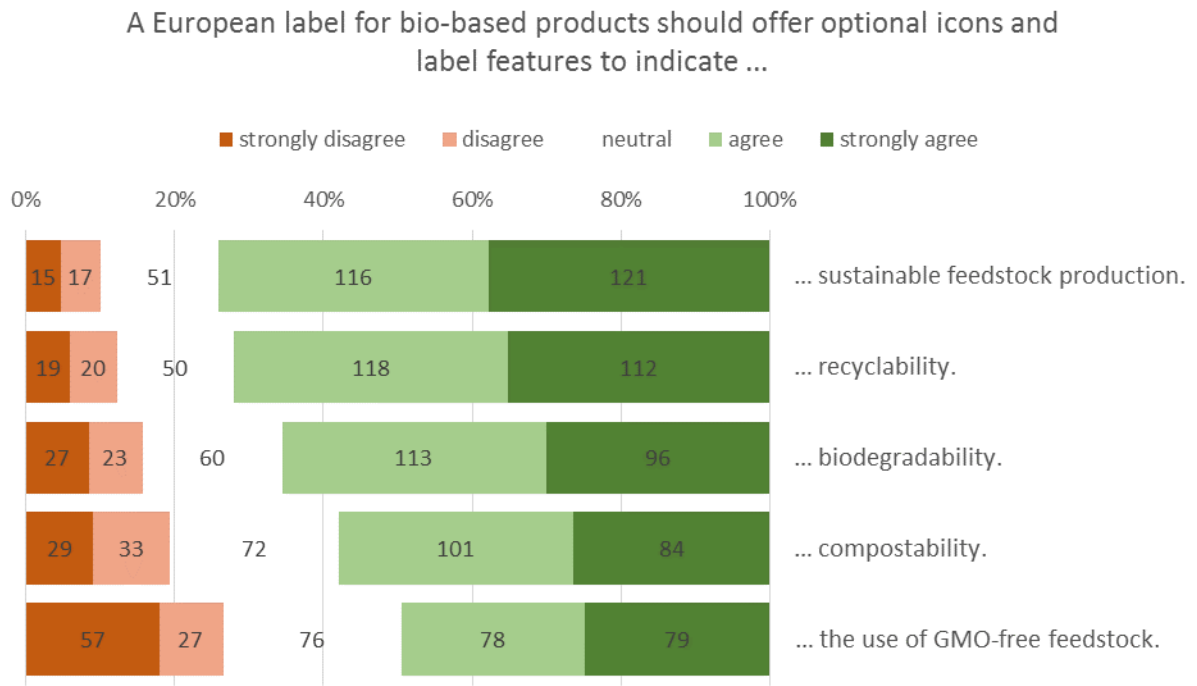
In a first set of questions, respondents were asked to indicate their agreement with general design options for a possible European label for bio-based products (Figure 12).

Figure 12: Design options for a European label for bio-based products

A large majority agreed that the creation of a European bio-based label would promote the market for bio-based products, indicating a high level of support for such a label among industry stakeholders. Moreover, a clear majority supports mandatory environmental and sustainability criteria for bio-based feedstock. This clearly indicates a preference of business experts for a multi-criteria label rather than a single-issue label focused on bio-based content. This is confirmed by the low level of support for making additional label criteria optional. Finally, slightly less than half of the respondents agree that a European label for bio-based products should be integrated within the EU Ecolabel. A large number of neutral answers indicates a comparatively high degree of uncertainty, suggesting that there is still a substantial need for discussion on this particular issue within the community.

In a second set of questions, respondents were asked to indicate whether they agreed with including optional icons or label features to indicate various aspects, which might be considered important by potential buyers of bio-based products. Figure 13 shows the results of this question, ranked in descending according to the average of all responses. Although social and environmental impacts of feedstock production are not considered important market barriers (see section 3.3.1), there is a high level of support for an optional icon indicating sustainable feedstock production, followed by three end-of-life-related items (recyclability, biodegradability and compostability). This may indicate that compliance with corresponding criteria is not viewed as a significant challenge, while representing a way to build confidence among buyers. On the other hand, the lower support for a GMO-related label feature, and the fact that concerns regarding GMOs in feedstock production are not seen as a major barrier of the future market development (see section 3.3.1), indicate that the expected benefits from this may not outweigh the expected costs of compliance.

Figure 13: Optional icons or label features



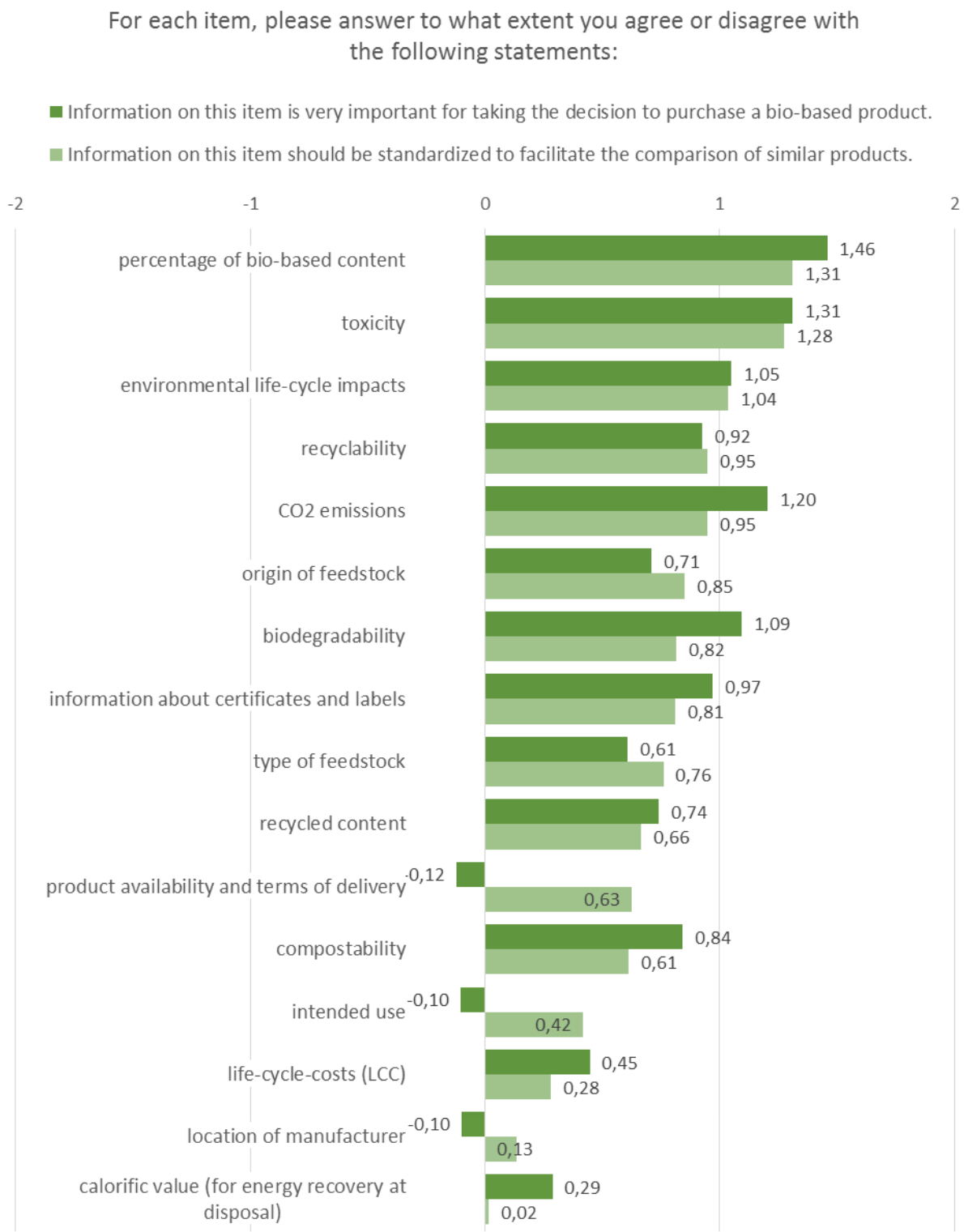
3.4.2. Product information and standardization

As mentioned above, the Open-Bio working programme includes the development of a database with information on bio-based products. In support of these activities as well as a number of co-normative activities within the Open-Bio project, a set of questions on related issues was developed in close cooperation with FNR, Open-Bio partner and leader of the work package on product information (WP8), and was based in part on a product information sheet under development in the CEN working group on bio-based products.

For a list of selected items, respondents were asked to indicate whether this information was important for taking a decision to purchase a bio-based product and whether this information should be standardised to facilitate the comparison of similar products. Figure 14 presents the results for both questions (ranked in descending order based on the average importance of the information).

In general, information requirements and needs for standardization are highly correlated. The responses to this survey question have been the main input to the development of the so-called scheme guideline that was to be defined under task 8.3 of the Open-Bio project. More details on this work can be found in Open-Bio Report D8.3.

Figure 14: Information requirement and need for standardization (businesses)



3.5. Conclusions

High production costs and volatile feedstock prices are considered to be among the most important barriers in the B2B market for bio-based products. The acceptance of bio-based products in the B2B market thus critically depends on the offering of extra values in addition to the technical performance also provided by comparable fossil-based products. In fact, it has previously been shown that the realization of price premiums is a precondition for many a bio-based value chain. The analysis of 35 cases of bio-based products by Carus et al. (2014) demonstrates that premium prices do exist for certain products and higher prices are paid in the value chains of different bio-based chemicals, polymers, and plastics.

The survey, however, shows that price premiums for bio-based products in the B2B market are expected to be based on strategic considerations rather than environmental reasons, as respondents do not consider the willingness of consumers to pay a price premium for a better environmental performance to be an important market driver. The survey results rather indicate that the positive image of bio-based products and their ability to ensure stronger independence from fossil-based resources are expected to become the most important drivers of market acceptance.

The reliance on bio-based products thus may bring important strategic benefits for businesses, such as the positioning as an innovative and technologically advanced company, the diversification of supply chains, and the safeguarding against oil price increases. Other strategic considerations, indicated by the perceived importance of savings in carbon emissions and compliance with environmental regulation as drivers of the future market, relate to the company's ability to benefit from potential subsidies and public incentives and to gain early-mover-advantages in anticipation of future regulations and carbon taxes.

According to the survey respondents, currently an unsupportive regulatory environment and uncertainty about future regulation hinder a stronger market uptake of bio-based products. Again, this indicates the importance of strategic business decisions in the B2B market for bio-based products. In contrast, concerns about social and environmental impacts and the use of GMOs in feedstock production are not considered important market barriers.

A key finding is that drivers of the market for bio-based products and hence the importance of information on related items differ distinctly across countries. In the second Delphi round, the existence of national market particularities was confirmed by the endorsement of corresponding statements based on observed response patterns in the first survey. Concretely, local business experts predominantly confirm that the promotion of local supply chains and the independence from fossil sources plays a particularly important role in driving the B2B market in France, whereas in Italy end-of-life considerations are particularly important. Overall, these findings indicate that national trends play a role in driving markets for bio-based products. These country-level differences should be taken in to consideration in ongoing policy and standardization processes at the European-level.

Although a robust ranking of acceptance factors for bio-based products in general could be developed and validated through the Delphi survey, the importance of drivers and barriers varies significantly according to the actual type of product and related market sector. For instance, new bio-based products, such as plastics and chemicals, seem to face significantly more barriers than well-known bio-based products, such as wood-based materials. Biodegradability / compostability plays a particular role as a market driver for a number of bio-based product categories (plastics, solvents, lubricants and surfactants). A detailed account of the identified differences can be found in Annex II to this report.

The identified sub-sector particularities of the bio-based economy need to be considered when designing policy instruments to promote bio-based products. For the stimulation of the B2B market, a disintegrated strategy based on appropriate product categories may be more effective than measures targeted at the whole sector of bio-based products in general.

Regarding the development of a European label for bio-based products, there seems to be strong support from the industry for the introduction of a label as a tool to stimulate the market of bio-based products. This label should address additional environmental criteria and feedstock-sustainability-related issues. A significant degree of uncertainty, however, remains regarding the specific details of the label design, and whether such a label should be integrated with the EU Ecolabel scheme. The Open-Bio project will further investigate potential strategies for implementing the latter option.

Regarding the required product information, a list of the most important items has been identified that will be used for informing the design of the interaction tool to be developed within the Open-Bio project. Furthermore, the results demonstrate that there is a strong link between the importance of the information and the perceived need for standardization.

4. Acceptance of Bio-Based Products in Public Procurement

4.1. Overview

This chapter presents the main findings derived from a two-stage Delphi survey among experts in the field of public procurement and in particular green public procurement. The main objective of this survey is the identification of factors influencing the acceptance of bio-based products by public procurement officials. In particular, it considers the potential of green and innovation-oriented procurement in this context. In addition, it addresses a number of key issues on the role of standardization and information systems, including labelling, for the acceptance of bio-based products in this context. More detailed results can be found in the corresponding annex to this synthesis report (Annex III), as well as in the respective annex to Open-Bio Report D9.1.

4.2. Conceptual approach and methodology

4.2.1. Conceptual approach

For the context of public procurement, the term acceptance refers to the willingness of public procurement officers to adopt and purchase bio-based products. Following this definition, the aim of the study is to identify critical factors influencing the acceptance of bio-based products in public procurement. Given the strict rules and guidelines governing traditional public procurement procedures, the uptake of bio-based products in public procurement is closely linked to the question whether the targeted purchase of bio-based products can be justified based on existing practices and guidelines. In particular, green public procurement and innovation-oriented public procurement may offer entry-points for this purpose. The survey places particular emphasis on current green public procurement practices, the more widespread practice among the two. It explores the role of key environmental and cost-related aspects within this context and to what extent they may represent vehicles for supporting the increased purchase of bio-based products in public procurement. In addition, more specific questions regarding product information and standardization required by public procurement officials are explored.

4.2.2. The Delphi method

Like the study on acceptance in the business-to-business market, the study on acceptance in public procurement adopts the Delphi method (see section 3.2.2 for more details) and aims to generate a generalized view on factors influencing the acceptance of bio-based products in public procurement, based on the informed opinion of experts on public procurement and

green public procurement. This is complemented with a small number of questions on current practices in the organizations of the respondents.

4.2.3. Survey development

The first round questionnaire was developed in an iterative process, involving a review of the literature on policy and market developments in the field of bio-based products and on current practices in the field of green public procurement and innovation-oriented public procurement. In addition, the survey was reviewed by project partners in multiple feedback rounds. The questions on standardization and information systems were designed in close cooperation with partners in the Open-Bio project to ensure that the results would provide relevant inputs to the related work package on product information (WP8). Finally, a preliminary version of the survey was tested by a group of procurement officials.

The second round questionnaire was based on the main findings of the first round and took up a number of follow-up questions, which emerged as a result. Again, project partners had the opportunity to comment on the questionnaire draft to ensure that the survey results would provide relevant inputs to the related work programme of the Open-Bio project.

4.2.4. Survey execution

The first round of the two-stage Delphi survey was administered as an online survey, available in English, Czech, Danish, Dutch, French, German, Italian and Slovenian. The distribution of the survey took place via a diverse set of European and national multiplier organizations in the field of public procurement and green public procurement. The survey was freely accessible online between the 4th of June 2014 and the 15th of August. In total, it was completed and submitted by 171 respondents. 107 respondents left their contact details for being contacted for the second survey round.

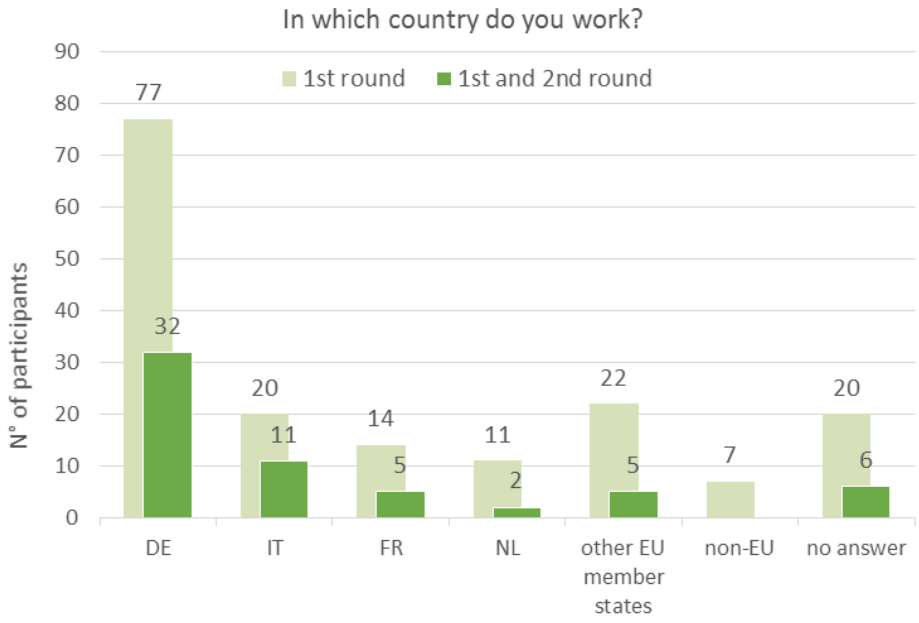
The second survey round was designed as a closed group survey that exclusively addressed those first round participants that also wanted to participate in the second survey. Experts who had provided their contact details for this purpose were invited per email to take part in the second survey round. This approach helped to ensure that participants were motivated to share their opinions, possessed the necessary background information and a profound sector expertise to improve the outcome of the first round further.

The second online questionnaire was available in English, French, German and Italian. It was accessible from the 4th of February to the 16th of March 2015. Each invited expert received a personalized key to access the questionnaire, which permitted to match the responses of the second survey to the information the person had provided in the first survey. To increase the response rate, experts who had not answered by the 23rd of February 2015 were individually contacted by telephone and asked to participate in the survey. Overall, 61 respondents completed the second round survey, which corresponds to a very high response rate of 57.0% and a total share of 35.7% of the first round participants.

4.2.5. Respondent profiles

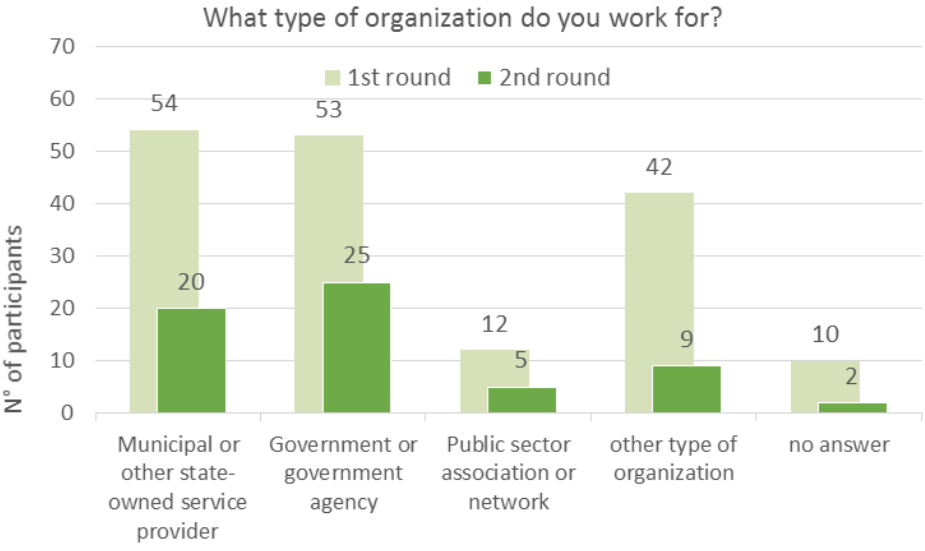
The survey was completed by respondents from more than 12 different EU member states and a number of non-EU member states, defined according to their place of work. The largest number of respondents indicated Germany as their place of work followed by Italy, France and the Netherlands (see Figure 15).

Figure 15: Geographic distribution



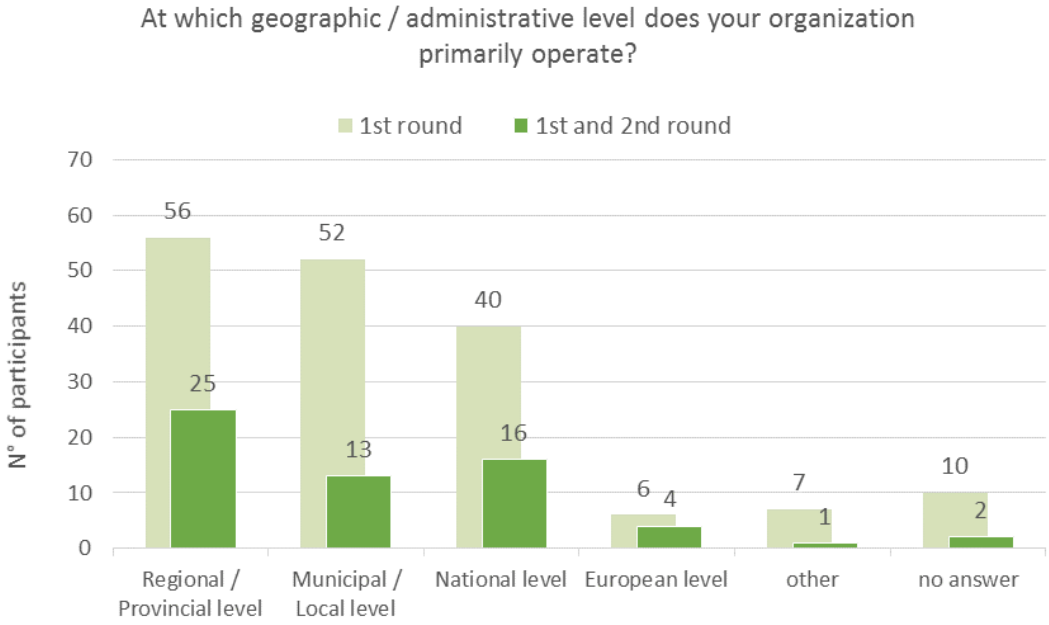
Over two thirds of respondents work either directly for the government, a government agency or for a municipal or other state-owned service provider. A small share of respondents works for public sector associations or networks. Compared to the first survey round many experts from other types of organizations dropped out of the sample (see Figure 16).

Figure 16: Type of organization



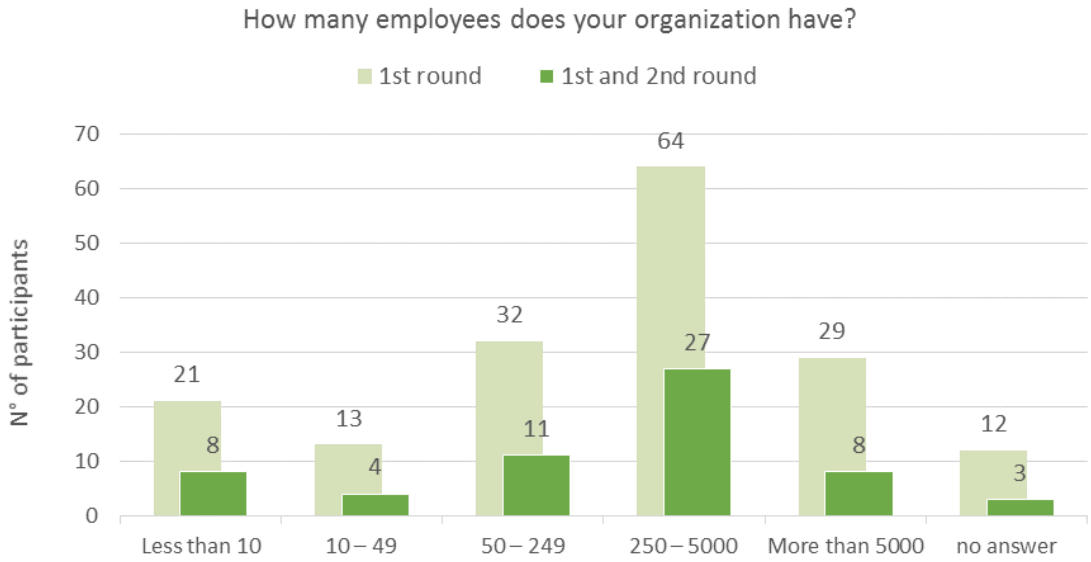
About two thirds of respondents work for organizations, which operate at the municipal / local level or the regional / provincial level. Approximately a quarter operate at the national level, and only a small share works at the European-level (see Figure 17).

Figure 17: Administrative level



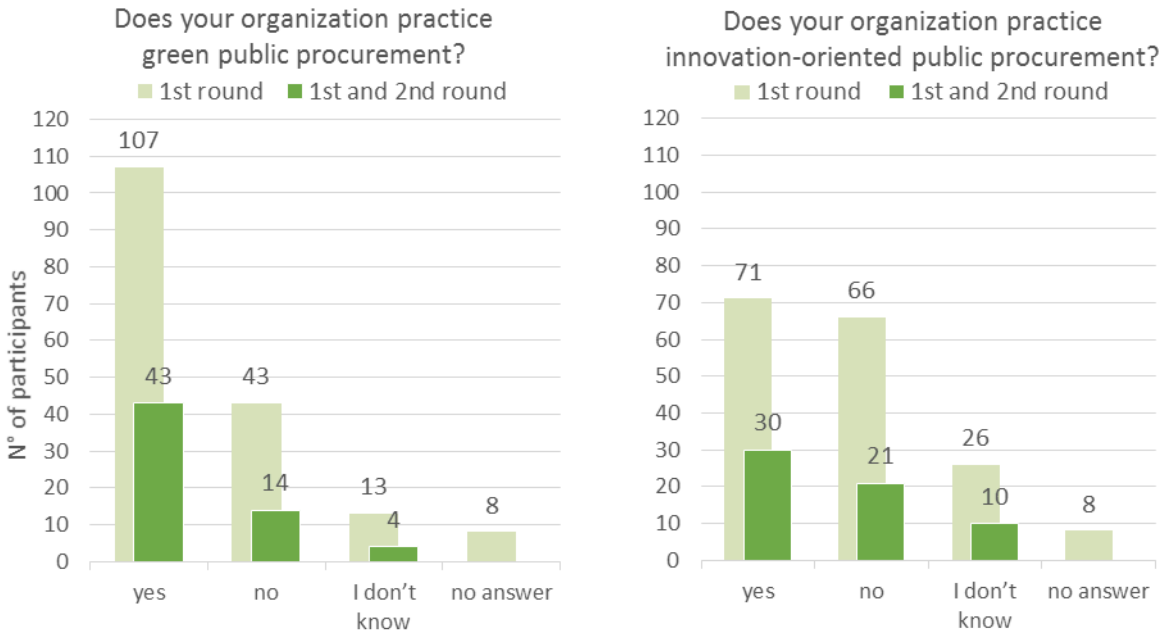
The distribution of organization size categories is very similar between the first and the second survey round (see Figure 18). More than half of the organizations have over 250 employees. Approximately one fifth of the organizations have less than 50 employees.

Figure 18: Size of organization



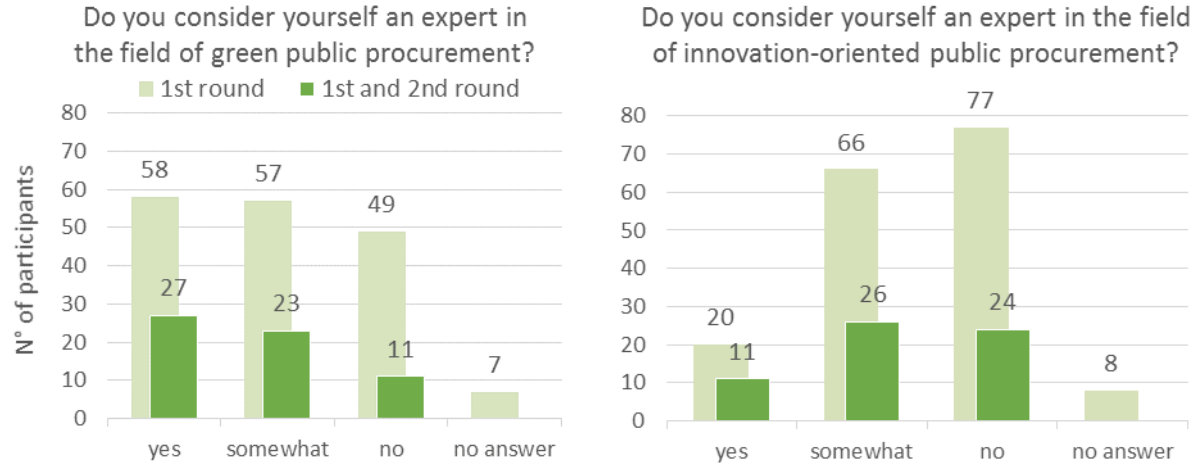
In general, the share of organizations that engage in practices of green public procurement is higher than the share of organizations involved in innovation-oriented procurement practices. Although in the second survey round the numbers of organizations practicing either of these two procurement schemes increases over-proportionally compared to the first round, the larger importance of green public procurement remains unaffected (see Figure 19).

Figure 19: Procurement practices



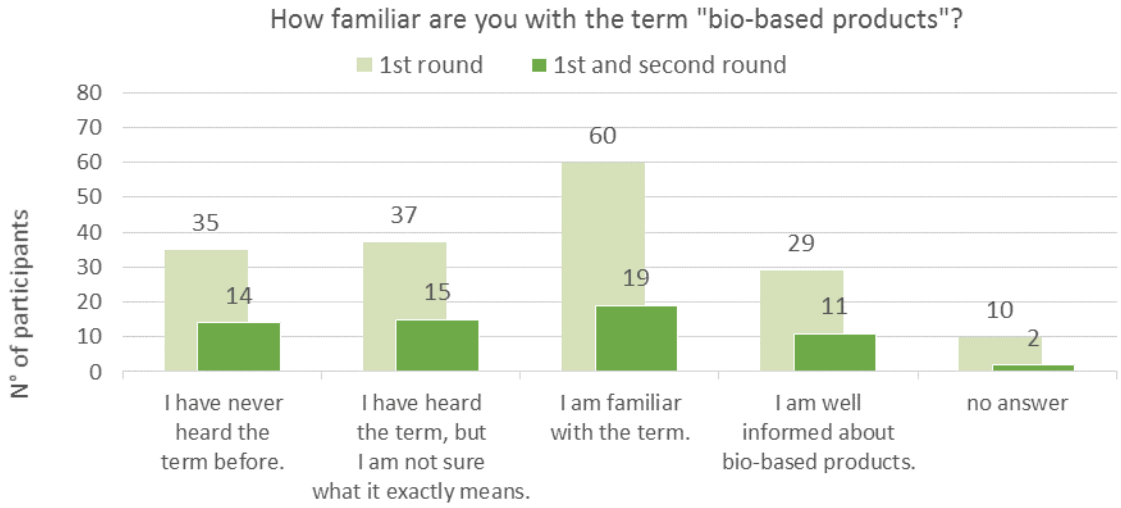
Respondents were also asked to indicate their level of expertise in the field of green and innovation-oriented public procurement (see Figure 20) as well as their familiarity with the term "bio-based products" (see Figure 21). Respondents with expertise in the relevant public procurement schemes were slightly more likely to participate in the second round than those with no expertise in the respective fields. The distribution of expertise with regard to bio-based products among the respondents remained virtually the same.

Figure 20: Expertise in relevant public procurement schemes



Half of the respondents are familiar with the term or even well informed about bio-based products. However, considering the high number of respondents involved in green and innovation-oriented public procurement, the share of respondents that are unfamiliar with bio-based products is remarkably high.

Figure 21: Expertise in the field of bio-based products



Overall, participants in the second round appear to be a representative subsample of the procurement experts that participated in the first survey with regard to all relevant characteristics. The distribution of respondent profiles gives no reason for concern about a bias towards a specific subgroup of experts, except for a (desirable) higher level of expertise in the relevant public procurement schemes.

4.3. Acceptance of Bio-Based Products

4.3.1. Environmental aspects considered in green public procurement

Respondents of the first survey round were asked to assess the importance of various aspects in the current practice of green public procurement. For each item, respondents indicated their level of agreement with the statement that it was an important aspect in the current practice of green public procurement. A ranking of the importance of environmental aspects was developed based on the average response (Table 7).

In the second round, survey respondents were asked to indicate whether they agreed that this ranking correctly reflected the relative importance of these items. If respondents disagreed with the first round ranking, they had the chance to create an alternative ranking. A vast majority of respondents (89%) indicates that they agreed with the ranking. Even when considering the disagreeing experts, the total weighted average position of each item remains the same. The second round thus clearly corroborates the results of the first survey round.

Table 7: Environmental aspects (from the most to the least important items)

Rank	Environmental aspects in the current practice of green public procurement
1	Energy efficiency
2	Savings in CO2 emissions
3	Recyclability
4	Reduction of environmental pollutants (other than CO2)
5	Reduced human toxicity / increased health tolerance
6	Use of recycled material or waste products
7	Sustainability of raw material production / extraction
8	Biodegradability / Compostability
9	Bio-based content / Use of renewable raw materials
10	Use of GMO-free raw materials

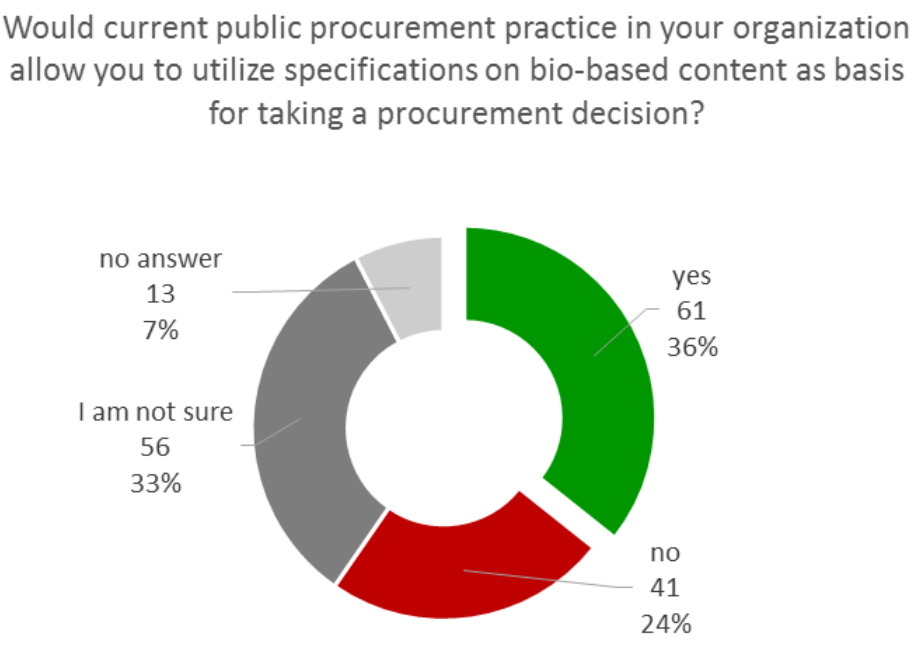
With regard to the uptake of bio-based products in public procurement, the results of the second survey round reinforce the impression that bio-based content as such is not an important environmental aspect typically considered in the current practice of green public procurement. Therefore, to increase the uptake of bio-based products in green public procurement, they need to demonstrate superior performance on other environmental criteria, such as energy efficiency, emission savings and ensure compatibility with existing recycling schemes.

As these results clearly indicate, the uptake of bio-based products in green public procurement is unlikely to occur based on the criterion of bio-based content alone. Given the higher importance of other environmental concerns, it is rather likely that the acceptance of bio-based products will be dependent on an above-average performance along multiple environmental criteria.

4.3.2. Bio-based content as a criterion in current public procurement practices

In the first survey round, respondents were asked whether specifications on bio-based content could be utilized as a basis for taking public procurement decisions in their own organization. Slightly over 40 percent were either unsure or failed to answer the question, indicating a high degree of uncertainty. Slightly less than one quarter indicated that procurement practices would not allow such a practice, while approximately one third indicated that this would be possible (see Figure 22).

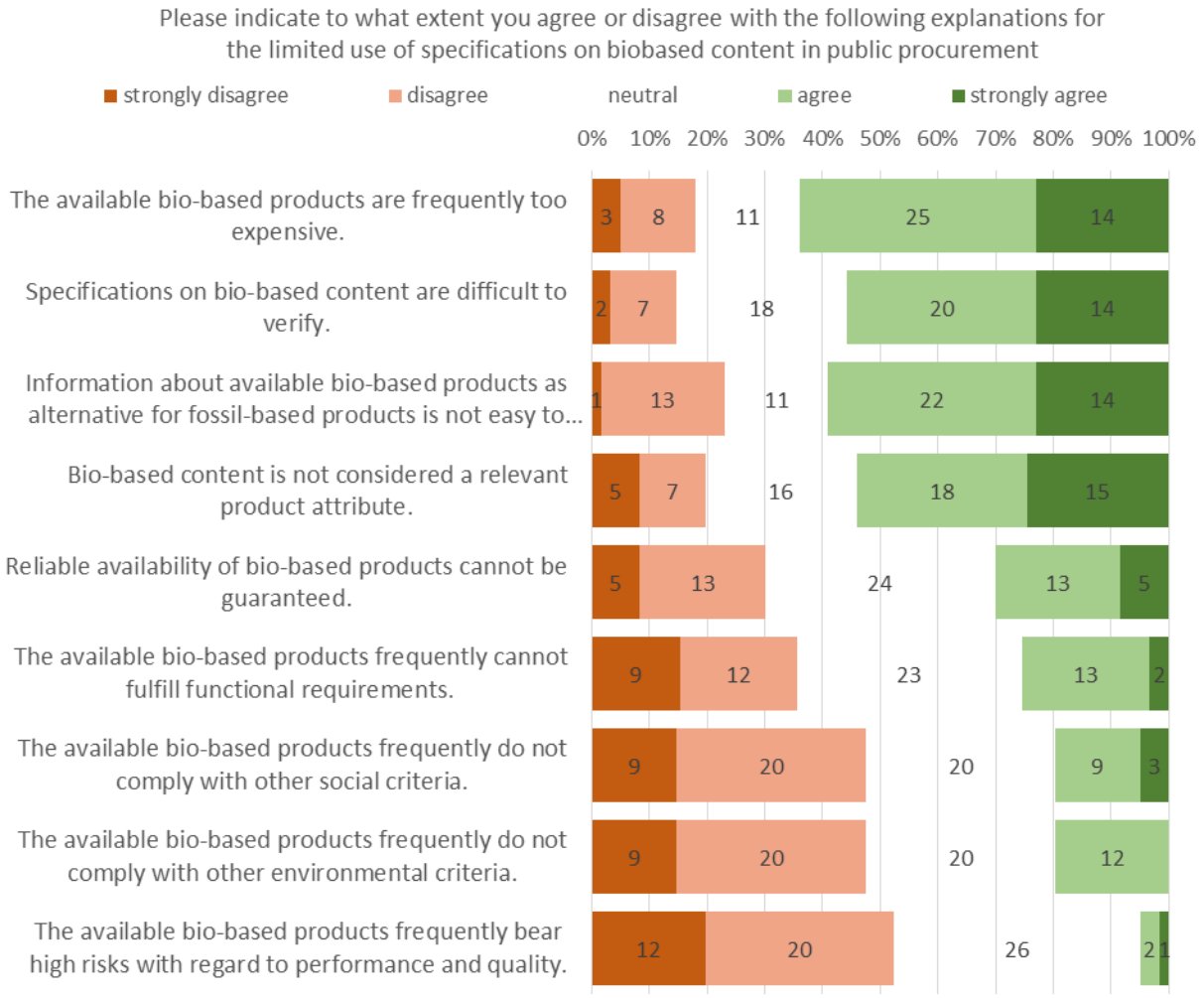
Figure 22: Use of specifications on bio-based content



These results clearly indicate that bio-based content does not yet represent an important criterion in the current practice of public procurement. Nevertheless, a significant share of those who gave an affirmative response indicates that this could be justified on the basis of green public procurement principles or principles for innovation-oriented public procurement. This indicates the potential scope to do so in the future.

To investigate the barriers for the acceptance of bio-based products in public procurement in greater detail, respondents of the second survey round were asked to indicate their level of agreement with a number of potential explanations for the limited use of specifications on bio-based content. Figure 23 shows that high prices, problems of verifying related claims, lack of information and the low relevance of bio-based content as product attribute are seen as the main reasons for the limited use of specifications on bio-based content.

Figure 23: Explanations for the limited use of specifications on bio-based content



4.3.3. Effective measures for promoting bio-based products in public procurement

Another set of questions addressed possible measures for enhancing the uptake of bio-based products in public procurement. In the first round, respondents were asked to choose up to four measures (from a list of thirteen options), which they considered to be the most effective for promoting the uptake of bio-based products in public procurement. As a result, a ranking of measures was created based on the number of times each item was chosen by first round respondents.

Respondents of the second survey were asked to validate the first round findings by indicating whether they agree or not that this ranking correctly reflected the relative effectiveness of measures for promoting the uptake of bio-based products in green public procurement. In case of disagreement, they were asked to create an alternative ranking. More than 85 percent of the second round respondents agreed with the ranking that resulted from the first survey round. Including the disagreeing experts, the total weighted average ranking of all second survey participants equals the first round ranking and thus clearly corroborates the previous results.

Table 8: Measures for promoting bio-based products (from the most to the least effective)

Rank	Measures for promoting bio-based products in public procurement
1	A political decision to promote bio-based products via public procurement
2	Practical guidance for incorporating specifications on bio-based content in public procurement (e.g. text blocks for tender requirements)
3	A checklist to facilitate a systematic comparison of bio-based products and conventional products
4	A database of bio-based products containing key product information
5	The integration of bio-based content as a criterion in green public procurement guidelines.
6	Information on environmental life-cycle impacts of bio-based products
7	The integration of criteria on bio-based content in existing eco-labelling schemes, such as the EU Ecolabel or other existing eco-labelling schemes.
8	Trainings on bio-based products
9	Informational material on bio-based products
10	Endorsement of bio-based products by networks on green public procurement
11	The creation of a new labelling scheme for bio-based products.
12	An institutionalized dialogue with producers of bio-based products
13	Additional staff to assess new bio-based products

According to the final ranking, a political decision to promote bio-based products via public procurement is identified as the most effective measure, indicating the need for a stronger political signal in favour of integrating bio-based products in green public procurement schemes.

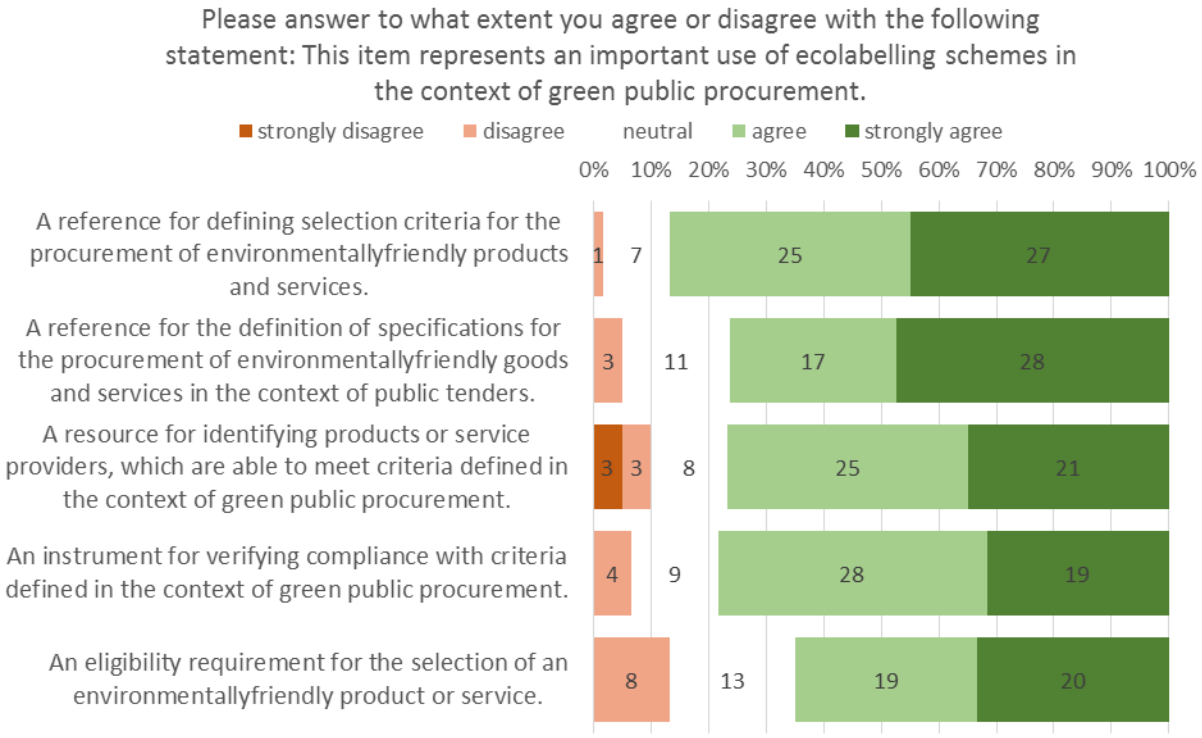
In addition, practical guidance and tools to facilitate the procurement of bio-based products, including a database with comparable information on bio-based products, were considered as effective measures. With regard to labelling options, the integration of criteria on bio-based content in existing eco-labelling schemes is considered to be more effective than the creation of a new labelling scheme for bio-based products. This supports the strategy pursued in work package on labelling (WP7), which focuses on developing strategies for the integration of bio-based products in the European Eco-Label as a potential vehicle for promoting the market uptake of bio-based products.

4.4. Labelling, information and standardization

4.4.1. Labelling

To investigate further the potential of labelling measures, in the second round respondents were asked for their perspective on the use of eco-labels in the context of green public procurement. They were given a list of possible applications, for all of which a vast majority of respondents agreed that it represented an important use of eco-labelling schemes in the context of green public procurement (see Figure 24). This underlines the multifaceted usefulness of labelling measures as instruments that facilitate the public procurement of environmentally-friendly products: Eco-labels may serve as a reference for the definition of selection criteria, tender specifications or eligibility requirements, for identifying appropriate providers or verifying compliance with criteria defined in the context of green public procurement.

Figure 24: Eco-labels in the context of green public procurement



4.4.2. Product information and standardization

Analogous to the survey on acceptance of bio-based products in the business-to-business market, respondents were asked to assess the importance of information on a number of items for the decision to purchase a bio-based product as well as the need for standardizing this information.

Figure 25: Importance of information and need for standardization (public procurement)

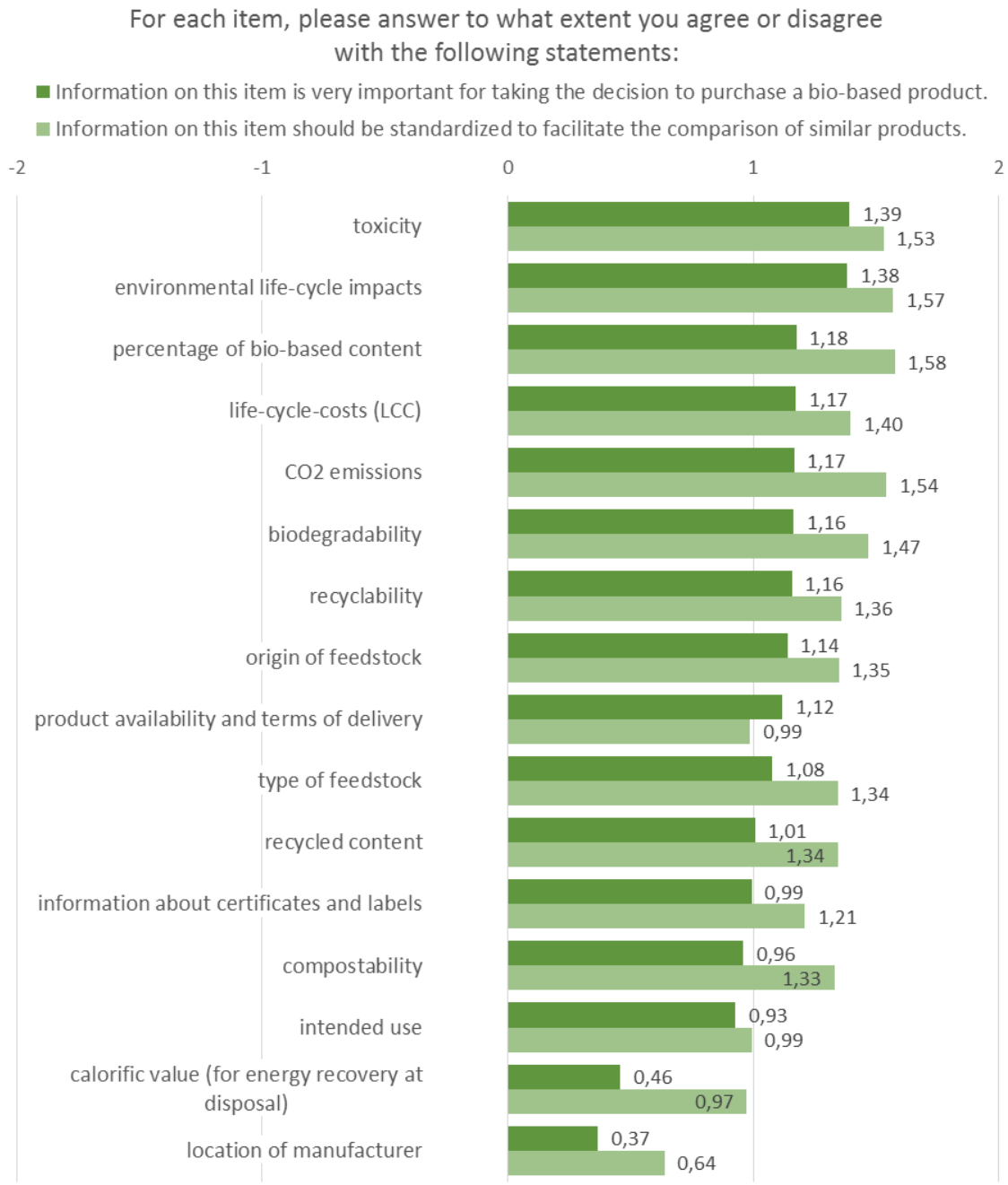


Figure 25 presents the responses of public procurement experts for the various items, ranked in descending order according to the average of all responses. As in the survey on the business-to-business market, the perceived importance of the items shows a positive correlation with the perceived need for standardization to facilitate comparison with similar products. Moreover, for all items respondents more strongly agree with the need for standardization of information than with their importance for purchasing bio-based products. Average responses among procurement experts were slightly higher than among business experts. The responses to this question have been the main input to the development of the so-called scheme guideline that was to be defined under task 8.3 of the Open-Bio project.

4.5. Conclusions

Green and innovation-oriented public procurement schemes represent potential entry points for the promotion of bio-based products when demonstrably contributing to relevant environmental benefits (like energy efficiency, saving CO_2 emissions and recyclability) in the case of the former scheme, or when representing new technological solutions and potential lead market opportunities in the case of the latter. In general, the share of organizations that engage in practices of green public procurement is higher than the share of organizations involved in innovation-oriented procurement practices. Given the relatively low level of implementation of innovation-oriented public procurement, this policy instrument should be strengthened in order to promote innovative bio-based products.

Given the importance of environmental concerns in the field of energy use, CO_2 emissions and end-of-life options, it is rather likely that the acceptance of bio-based products in green public procurement schemes will depend on an above-average performance along multiple environmental criteria. The high level of importance attributed to energy efficiency and emission savings as environmental aspects suggests that bio-based products, which can prove climate-friendliness, would have a significantly higher acceptance in green public procurement. Similarly, bio-based products, which perform poorly with respect to end-of-life options, are not likely to benefit from green public procurement schemes.

Overall, the survey shows that bio-based content is not an important environmental aspect typically considered in the current practice of green public procurement. A large share of respondents does not even know what the term “bio-based products” exactly means. Actually, about two thirds of all respondents are either not sure whether it would be possible or even not allowed to use bio-based content as a specification in the context of procurement processes.

Higher product prices, problems of verifying related claims and the lack of information about bio-based products are seen as the main hampering factors. Furthermore, a majority affirms that bio-based content lacks recognition as a relevant product attribute. Accordingly, a political decision to promote bio-based products via public procurement is seen as the most effective promotional measure.

Furthermore, practical guidance and tools that facilitate the procurement figure among the most effective measures to support the uptake of bio-based products. Furthermore, the study identifies important applications of labelling schemes in green public procurement and important informational requirements for the purchase of bio-based products, which will help the subsequent work programme of the Open-Bio project.

5. Overall Conclusions

The following section will summarize the findings of the research on market acceptance for bio-based products and intermediates, which relates to the willingness of market actors to adopt, purchase and financially support new products wholly or partly derived from biomass. It aims to formulate a number of synthesized conclusions drawing on the results from all three target groups: consumers, businesses and public procurement officials.

5.1. Acceptance factors

5.1.1. Public image – opportunity and potential risk for bio-based products

A first key finding is that in principle the market acceptability of bio-based products is high. Business experts expect the positive public image of bio-based product to become a main driver of the future market uptake. Consumers have positive environmental associations with bio-based products. The consumer perception as green products clearly represents an opportunity for the marketing of bio-based products. Furthermore, green public procurement schemes offer potential opportunities to tap into public demand for environment-friendly products. Accordingly, business experts consider a number of environmental concerns as important drivers of the market for bio-based products.

However, the awareness of bio-based products among potential buyers is still low. In fact, business experts consider the lack of public awareness an important market barrier. A large share of public procurement officials is not familiar with the term and not sure whether allowed to use specification on bio-based content in the context of green public procurement. Many consumers are unfamiliar with the term “bio-based”, and the lack of understanding rather evokes distrust and alertness with regard to alleged attempts of producers to insinuate product performances that may not be fully substantiated.

Overly optimistic consumer expectations about the environmental performance of bio-based products pose a serious risk of market repercussion. Furthermore, as bio-based products are often wrongly associated with health, safety, and other rather remote issues, consumers may end up feeling misled when it turns out that bio-based products do not comply with their unrealistic expectations. The positive public image of bio-based products thus creates both an opportunity and a considerable risk for the long-term market acceptance.

5.1.2. Higher price is a main barrier in market acceptance among all target groups

All stakeholder groups expect the expenditures for bio-based products to be relatively high. Price and expensiveness are among the most prominent negative associations of consumers with bio-based products, which in turn cause the high demands for additional benefits. According to the business experts, higher cost of production and the volatility of feedstock

prices are among the main barriers for a broader market acceptance of bio-based products. Public procurement experts predominantly agree that higher prices represent an important reason for the limited use of specifications on bio-based content in public procurement so far. They call for a clear political decision to promote bio-based products for effectively increasing demand from the public sector.

5.1.3. Market driven by environmental regulation rather than a green premium opportunity

A second key finding is that an increased future demand for bio-based products rather depends on the implementation of public incentives, such as the deliberate decision to promote bio-based products via public procurement and environmental regulation to stimulate a circular economy, than it is expected to result from the emergence of a significant green premium consumer market. Consumer research shows that individual buyers are primarily interested in personal benefits of bio-based products, such as convenience, looks, functionality. Accordingly, business experts do not expect the consumers' willingness to pay a green premium to become an important driver of the market. Accordingly, most of the premium prices found in the market are paid for bio-based intermediates and polymers (Carus et.al, 2014). Among the most important drivers identified by the business experts ranges the compliance with environmental regulation, which hints at the key role of public intervention in shaping the future market of bio-based products.

5.1.4. Bio-based products marketed as green products have to contribute to multiple environmental criteria

If marketed as green products, bio-based products need to ensure a comprehensive set of environmental and sustainability criteria. Bio-based content alone is not accepted as sufficient environmental product attribute, neither by consumers nor by public procurement agents. Moreover, as indicated by the procurement survey, some potential buyers do not even consider it to be relevant.

One reason for this ignorance is the lack of awareness and understanding: Many consumers and public procurement officials are not familiar with the term "bio-based product" and are not able to assess their contribution to a green economy. Consequently, it is too early to communicate the term "bio-based" to consumers as a meaningful environmental claim. In addition, only about one third of the public procurement experts are confident to be allowed to use specifications on bio-based content as a basis for taking a procurement decision.

Another important reason is the existence of trade-offs with regard to other environmental concerns. Environmentally concerned stakeholders fear that other (more important) environmental or sustainability requirements may be disregarded when the purchase decision is based on bio-based content alone, despite the contribution to the establishment of a circular economy. The acceptance of bio-based products as green alternatives to fossil-based products depends on their overall sustainability performance.

Given the importance of other environmental concerns in the current practice of green public procurement, the acceptance of bio-based products in the public sector will depend on an above-average performance along multiple environmental criteria. The high level of importance attributed to energy efficiency and emission savings as environmental aspects suggests that bio-based products, which can prove climate-friendliness, would have a significantly higher acceptance in green public procurement. Similarly, bio-based products, which perform poorly with respect to end-of-life options, such as recyclability and biodegradability, are not likely to benefit from green public procurement schemes.

The consumer research showed that many consumers seem to appreciate holistic approaches, including the consideration of social aspects and dealing with all stages of the product life cycle – from cradle to grave, in the communication of product benefits. In order to capitalize on the positive public image as a key driver of the market acceptance of bio-based products and in order to receive green premium prices, the industry needs to embrace the high expectations of consumers regarding sustainability performance and complement marketing strategies with communication about additional sustainability criteria. The terms used in market communication to describe bio-based raw materials or products should be considered carefully in the each particular context, especially in end consumer markets.

Green Public Procurement and Procurement of Innovation schemes represent potential entry points for bio-based products. However, the lack of information and the absence of corresponding administrative guidelines creates an uncertainty among public procurement officials with regard to the use of specifications on bio-based content. Nevertheless, business experts see a number of environmental advantages as more important for the future market uptake of bio-based products: the independence from fossil sources, savings in CO_2 emissions, reduced human toxicity and the utilization of waste. Hence, environmental benefits are supposed to become relevant factors of market acceptance.

5.2. Labelling, information and standardization

5.2.1. Labels are a helpful instrument

All three target groups assess labels to be helpful in the stimulating the market of bio-based products. Because of the multidimensionality of environmental performance, the purchase of green products is a complex task. Ecolabels can facilitate purchasing decisions by reducing the amount of information that needs to be processed by the potential buyers. Accordingly, public procurement experts clearly confirm the usefulness of ecolabels in the context of green public procurement.

In public procurement, bio-based content (still) lacks the recognition as a relevant product attribute. Although a political decision to promote bio-based products via public procurement is considered effective in stimulating public demand, green public procurement schemes will have to ensure a variety of environmental and sustainability requirements. Procurement

experts consider eco-labelling useful for the definition of selection criteria, identification of products and producers, and the verification of environmental claims.

5.2.2. Bio-based content has to be complemented by additional criteria

In order to fulfil the function of complexity reduction, ecolabels need to comprise various dimensions of sustainability. The business experts clearly support activities to introduce a European label for bio-based products. However, requirement regarding bio-based content have to be complemented by additional criteria with regard to environmental performance and the sustainability of feedstock production. Minimum requirements need to ensure that bio-based products do not go against other (environmental) concerns.

A main challenge in creating a label for bio-based products will be to decide which other criteria should be included. The research on acceptance factors has produced various rankings for the different target groups that indicate their most relevant environmental concerns. Summarizing the results of all three target groups that have been studied, it seems that energy use, CO_2 emissions and end-of-life options are the most important issues, although further criteria research in this project shows that each criteria needs to be considered separately for each bio-based product group. The integration of bio-based requirements with criteria concerning these issues may enhance the acceptance of any label for bio-based products and thus its effectiveness in promoting the market.

5.2.3. Differentiation to product categories is necessary

In addition to the target group concerned, the relevance of environmental criteria also differs across product categories. Consumers respond differently to bio-based claims, depending on the function of the particular bio-based product. Business experts have pointed out that the importance of specific market drivers and barriers differs among sub-sectors of bio-based products. This may suggest that a consumer label for bio-based products would be more effective if developed and implemented for individual product groups as it is done in the frame of the EU Ecolabel and all other major multi-issue ecolabels, in which each product group has their own criteria set to be fulfilled.

The integration of criteria on bio-based content in existing eco-labelling schemes could also help to legitimize bio-based products for green public procurement. As a result, integrating bio-based content criteria for certain product categories within the already established EU Ecolabel may be an option to be considered for further evaluation and will be assessed within the Open-Bio project in WP 7 Labelling.

5.3. Recommendations

5.3.1. More favourable and stable regulatory environment

The future development of the market for bio-based products needs a stable and long-term political support. Considering the dependence on regulation-induced demand, an important issue raised by business experts is the lack of a supportive and stable regulatory framework. Uncertainty about future regulation and unsupportive regulatory environment are indicated as important market barriers for bio-based products. This general uncertainty is also reflected by the survey among procurement expert who call for a clear political decision to promote bio-based products via public procurement as the most effective promotional policy measure.

5.3.2. Communicate and demonstrate environmental benefits

Another strategy for promoting the market for bio-based products is to raise the awareness among consumers and public agents and to develop the positive public image further by demonstrating the related environmental advantages and stressing the contribution to a circular economy. To this aim, conducting thorough product life cycle analysis and providing access to the results will facilitate systematic comparisons of bio-based products with competing fossil-based products.

The integration of bio-based content requirements in existing eco-labelling schemes would also help to legitimize bio-based products in the context of green public procurement. When defining the environmental and sustainability criteria for awarding eco-labels it is however important to ensure that bio-based products are not held to higher standards (for instance, with regard to the origin of raw materials) than fossil-based products.

5.3.3. Highlight new functionalities or improved product attributes

An alternative marketing strategy is to position bio-based products as innovative rather than environmental products. Companies may be able to get a premium price by highlighting improved product attributes and new functionalities rather than environmental advantages. Similarly, innovation-oriented public procurement schemes provide a powerful instrument for supporting the market uptake of bio-based products. Currently, innovation-oriented public procurement is not as widely practiced, however, as green public procurement. The objective of establishing a lead market for bio-based innovations could provide an argument for the political decision to promote bio-based products by public procurement. Such a decision is considered the most effective policy instrument for increasing the public demand for bio-based products and would relieve public procurement officials from the complex task of verifying environmental claims in the context of green public procurement.

5.3.4. Cross-country differences should not be ignored

When designing European strategies to promote bio-based products, market particularities have to be taken into account. The results from the surveys among business and procurement experts as well as consumer research indicate that important differences exist between markets for bio-based products across Member States. Consumer awareness and perception of bio-based products differ significantly across countries.

It is puzzling that in some countries were more consumers claim to know exactly what the (English) term “bio-based” means, wrong associations are more prevalent. For instance, consumers in Italy, the Czech Republic and Slovenia associate bio-based products more often with health and safety issues than consumers in Denmark and the Netherlands. In order to strengthen the position of bio-based products, it is recommended to take consumers’ perceptions and unfamiliarity seriously into account in developing communication strategies for bio-based products. The approach should be context specific and as concrete and comprehensive as possible.

The business survey provides further insight into cross-country differences. The response patterns of business experts show statistically significant differences across countries with regard to the importance of market drivers for bio-based products. In particular, questions of biodegradability and compostability are of special importance within the Italian context. French business experts place a particular emphasis on feedstock-related issues and the potential to stimulate local economic development through bio-based products.

These results suggest that informational needs may differ across European Member States. Ongoing policy and standardization processes at the European-level will have to take these country-specific trends into consideration. For instance, it may be necessary to address country-specific issues in the development of labels and informational tools at European level. In addition to building a single European market for bio-based products, European initiatives should aim to reinforce, combine and diffuse important national trends. In an effort to support Europe-wide diffusion of innovations, European informational instruments and standards may address dimensions of particular importance in individual national markets.

References

Ashford, N., & Hall, R. (2011). The Importance of Regulation-Induced Innovation for Sustainable Development. *Sustainability* 3, 270–292.

Azjen, I. (1991). The theory of planned behavior: Organizational behavior and human decision processes 50(2), 179-211.

Azjen, I. (2011). The theory of planned behaviour: reactions and reflections. *Psychology & Health* 26(9), 1113-1127.

Carus, M, Beckmann, J., Eder, A. (2014) GreenPremium Prices Along the Value Chain of Biobased Products. *Industrial Biotechnology*, 10, 83-88.

Chin, H.-C., Choong, W.-W., Alwi, S. R. W., & Mohammeda, A. H. (2014). Issues of social acceptance on biofuel development. *Journal of Cleaner Production*, *71*(May), 30–39.

Edler, J., & Georghiou, L. (2007). Public procurement and innovation — Resurrecting the demand side. *Research Policy*, *36*(7), 949–963.

Emmann, H., Arens, C., & Theuvsen, L. (2013). Individual acceptance of the biogas innovation: A structural equation model. *Energy Policy*, *62*(November), 372–378.

European Commission. (2006). *Creating an Innovative Europe: Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit and chaired by Mr. Esko Aho*. Brussels: European Communities.

European Commission. (2007). *Accelerating the Development of the Market for Bio-based Products in Europe*. Brussels: Report of the Taskforce on Bio-Based Products Composed in preparation of the Communication “A Lead Market Initiative for Europe” (COM(2007) 860 final).

European Commission. (2010a). *An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*. Brussels: Communication from the Commission to the European Parliament, the Council, the European Social and Economic Council and the Committee of the Regions (COM(2010) 614).

European Commission. (2010b). *Europe 2020: A strategy for smart, sustainable and inclusive growth, COM(2010) 2020 final*.

Gärling, T., Fujii, S., Gärling, A., & Jakobsson, C. (2003). Moderating effects of social value orientation on determinants of proenvironmental behavior intention. *Journal of environmental psychology*, 23(1), 1-9.

Haider, A., Eder, A. Sobczak, L., Grestenberger, G. (2012) Market opportunities for bio-based composites, Biobased materials - 9th WPC, Natural Fibre and other innovative Composites Congress and Exhibition, June 19 - 20, 2012, Fellbach, Germany.

Häder, M. (2009). Delphi-Befragungen: ein Arbeitsbuch. Wiesbaden: VS Verlag für Sozialwissenschaften.

Huijts, N. M. A., Molina, E. J. E., & Stegb, L. (2011). Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. Renewable and Sustainable Energy Reviews, 16(1), 525–531.

Jänicke, M., & Lindemann, S. (2010). Governing environmental innovations. *Environmental Politics*, *19*(1), 127–141.

Linstone, H. A., & Turoff, M. (2002). *The Delphi Method: Techniques and Applications*. Newark, NJ: New Jersey Institute of Technology.

Morgan, D. L. (1997). Focus Groups as Qualitative Research. 2nd Edition. Qualitative Research Methods series, Vol. 16. Sage, London.

Noppers, E. H., Keizer, K., Bolderdijk, J. W., & Steg, L. (2014). The adoption of sustainable innovations: Driven by symbolic and environmental motives. *Global Environmental Change*, *25*(March), 52–62.

OECD. (2011). *Fostering Innovation for Green Growth*. Paris: OECD Green Growth Studies, OECD Publishing.

Savvanidou, E., Efthimios, Z., & Tsagarakis, K. P. (2010). Public acceptance of biofuels. *Energy Policy*, *38*(7), 3482–3488.

Sijtsema, S., Linnemann, A., Gaasbeek van, T., Dagevos, H., & Jongen, W. (2002). Variables influencing food perception reviewed for consumer-oriented product development. *Critical Reviews in Food Science and Nutrition*, 42 (6) 565-581

Steenkamp, Jan-Benedict EM and Gielens, Katrijn, Consumer and Market Drivers of the Trial Probability of New Consumer Packaged Goods (February 2003). Available at SSRN: http://ssrn.com/abstract=380180 or http://dx.doi.org/10.2139/ssrn.380180

Stewart D.W. & Shamdasani P.N. (1990) Focus groups: theory and practice. Sage, London

West, J., Bailey, I., & Winter, M. (2010). Renewable energy policy and public perceptions of renewable energy: A cultural theory approach. *Energy Policy*, *38*(10), 5739–5748.

Wüstenhagen, R., Wolsink, M., & Bürer, M. J. (2007). Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policyicy*, *35*(5), 2683–2691.

Yoo, B., Donthu, N., & Lee, S. (2000). An examination of selected marketing mix elements and brand equity. *Journal of the academy of marketing science*, 28(2), 195-211.

Zoellner, J., Schweizer-Ries, P., & Wemheuer, C. (2008). Public acceptance of renewable energies: Results from case studies in Germany. *Energy Policy*, *36*(11), 4136–4141.

For further details, please refer to the following documents:

Annex I: Consumer Acceptance of Bio-Based Products

Annex II: Acceptance of Bio-Based Products in the Business-to-Business Market

Annex III: Acceptance of Bio-Based Products by Public Procurement Officials