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Annexes 4 -11 of the Impact Assessment

Accompanying the document

Proposal for a
COUNCIL REGULATION

on the Bio-Based Industries Joint Undertaking

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"Bio-based industries, towards a public-private partnership under Horizon 2020?"

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for revision by Commission Services

Contents

1. INTRODUCTION

Implementing Horizon 2020 in relation to bio-based industries

Bio-based industries, at the heart of the bio-economy

Europe is committed to excel in smart, inclusive and sustainable growth. In this context, the Europe 2020 strategy highlights the building of a ***bioeconomy*** by 2020 as one of the deliverables under its flagship initiative "Innovation Union". The Commission has recently presented the communication "Innovating for sustainable growth: A *bioeconomy* for Europe" (COM (2012) 60 final).

The on-line public consultation conducted in connection with the preparation of the bioeconomy communication found that a large majority (>85%) of respondents saw significant advantages in developing a European strategy on a sustainable bio-based economy as follows:

- Supporting bio-based markets and the creation of economic growth and highly-skilled jobs (88.3%)
- Fostering the move towards a zero waste society (90.4 %)
- Securing a sufficient supply of food and biomass (88.3 %)
- Integrated, sustainable agricultural, aquatic and ecosystem services (89.9 %)
- Strengthening the research and innovation base (85.7 %)

The above-mentioned communication also sets out a comprehensive bioeconomy action plan. The plan includes the establishment of a *public-private partnership* on research and innovation for ***bio-based industries*** as a means to promote the development of integrated and diversified biorefineries, including their biomass supply chains. Consequently, the aim of a public-private partnership has been proposed in Horizon 2020, the future EU framework program for research and innovation.

Europe needs to champion the use of sustainable bio-based resources as a major source of raw material for conversion into innovative industrial products and fuels/energy. This must be achieved without creating shortages in food and feed supply and in full respect of the environment. Several studies (e.g. by the European Environment Agency[1]) demonstrate the potential to mobilise, in a sustainable manner, large volumes of non-food biomass in the EU as feedstock to support the growth of the bio-based industries. Europe's *bio-based industries* need to be technologically prepared and equipped to successfully address this challenge, along with all other participants in the value chain (e.g. farmers, foresters, waste managers).

An important goal is to expand the range and the volume of innovative products manufactured by the *bio-based industries* (including e.g. bio-based plastics, chemical building blocks, high-value ingredients for pharmaceuticals or cosmetics, advanced biofuels) from renewable biological resources (e.g. specialty crops, residues from agriculture, forestry, fisheries and the utilisation of biowaste). This will require the development of new types of biorefineries and the associated value chains as well as innovation within established bio-based industries with a long tradition of processing renewable biological resources (e.g. the pulp and paper industry, the starch and the food

[1] Estimating the environmentally compatible bioenergy potential from agriculture EEA Technical Report No 12/2007 How much bioenergy can Europe produce without harming the environment?
EEA Report No 7/2006

industry). The pulp and paper and the starch industries have the potential to play a significant role in the innovation cycle leading to the successful development of an effective integrated biorefinery infrastructure in Europe. Furthermore, the chemical industry can play an important role by expanding its use of bio-based resources. The biotechnology industry will deliver key components for innovative new processes.

The development of *bio-based industries*, if successful, can bring a lot of rewards that concern many stakeholders: consumers who get access to new sustainable products based on renewable biological resources, bio-based industries that take technological and sustainability leadership and thereby build long-term competitive advantages; enhanced economic growth and new jobs in rural, coastal and industrial areas; new revenue streams for EU27 agriculture and forestry.

Horizon 2020, aims to build technological and sustainability leadership as a lever for industrial competitiveness on a global scale. In addition to delivering excellence in research and technology development, the aim is to deliver real innovation and to promote its deployment on a large scale.

Under FP7, the EU's currently on-going seventh Framework Programme for Research, certain sectors pioneered the use of *public-private partnerships (PPP)*, as a novel means to manage and implement EU Research Programmes. In the context of a PPP, both private and public sector contribute resources to support research and innovation activities, based on multi-annual research agendas. Examples of PPPs operating under FP7 include: European Green Cars Initiative, Factories of the Future, Innovative Medicines Initiative, Clean Sky, Fuel Cells and Hydrogen. The continued use of public-private partnerships is explicitly provided for under Horizon 2020.

A large group of stakeholders from the bio-based industries has shown strong interest in the creation of a new PPP in the area of bio-based industries and has expressed a commitment to contribute to its activities. The Commission is considering supporting a PPP in the area of bio-based industries, addressing specific parts of Horizon 2020: "Sustainable and competitive bio-based industries" and "Alternative fuels and mobile energy sources".

On the basis of these considerations, the “Bio-based industries, towards a public-private partnership under Horizon 2020?” consultation was launched to collect the opinions of stakeholders active in the field and of public at large on the state of play of the European bio-based industries, focusing on the aspects related to research and innovation.

The consultation specifically aimed at seeking respondents’ views about the role of the public-private partnership in implementing research and innovation activities under Horizon 2020.

The research design of the public consultation is made up of six general dimensions (as shown in the concept map, fig. 1):

– *Respondents’ profile*: information about respondents according to their type of participation to the consultation (individuals or on behalf of an organization or institution), such as occupation, organization sector, professional field, residence, workplace;

– *Identification of the problems*: this section addresses the respondents’ perception about: the competitiveness of the European bio-based Economy; the strengths and weaknesses of the European bio-based industries; the innovation capacity of the bio-based industries;

– *European Added Value*: views about the Added value of European level intervention in facing the problems of the bio-based industries, in comparison with other levels (regional, national);

– *Objectives of EU level intervention*: what are the goals that should be addressed assuming EU level action on Research and Innovation in connection with bio-based industries;

– *Towards a PPP?*: considerations about the implementation of research and innovation activities in the bio-based industries area under Horizon 2020 through a PPP;

– *Impacts:* this section deals with the perceived potential impact of EU Research and innovation actions on bio-based industries if these actions are applied under a PPP framework;

The instrument used for the public consultation was a questionnaire (designed with assistance of the "Inter-service Steering Group (ISG) on Article 187 initiatives"). The on-line version of the questionnaire was prepared using the internet-based software package IPM (Interactive Policy Making), an Internet-based software package aiming at the creation, launch and analysis of replies of online questionnaires. The questionnaire was accompanied by the Specific Privacy Statement and a statement for the protection of personal data.

The questionnaire was articulated in six sections, resembling the research dimensions shown before. Each research dimension was measured using a single question or, more often, a set of items.

The public consultation was open for contributions between 21/09/2012 and 14/12/2012.

Awareness about the opening of this consultation was raised through a number of sources, including:

– the DGs involved in the Interservice Group;

– Programme Committee;

– FP7 Advisory group and National Contact Points;

– European Bioplastics Association;

– ERRMA (European Renewable Resources and Materials Associations);

– European Technology Platform for Sustainable Chemistry;

– Forest-based sector Technology Platform;

– Plants for the Future Technology Platform;

– EuropaBio;

– CEFIC (European Chemical Industry Council);

– CEPI (Confederation of European Paper Industries);

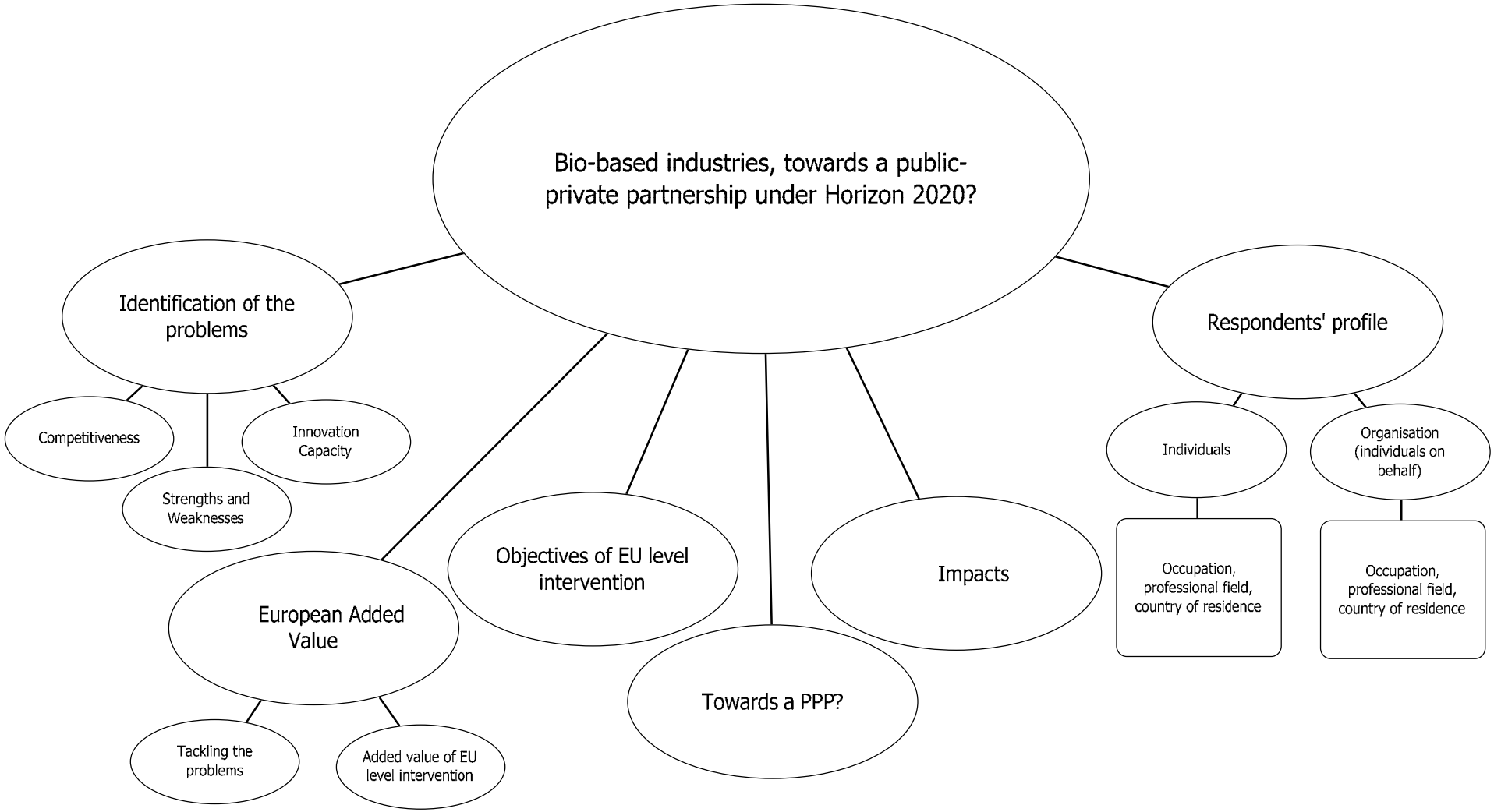
– FoodDrinkEurope;

– COPA COGECA (European Farmers and European Agricultural Cooperatives Association);

– ESA (European Seed Association).

All contributions collected through the on-line questionnaire were analyzed and used to generate the tables and the graphs found in this report.

fig. 1 - Concept map of public consultation



2. RESULTS

The online public consultation was open from 21/09/2012 to 14/12/2012.

During the consultation period 682 answers were collected. Data quality control and data cleaning procedures were applied to the dataset.

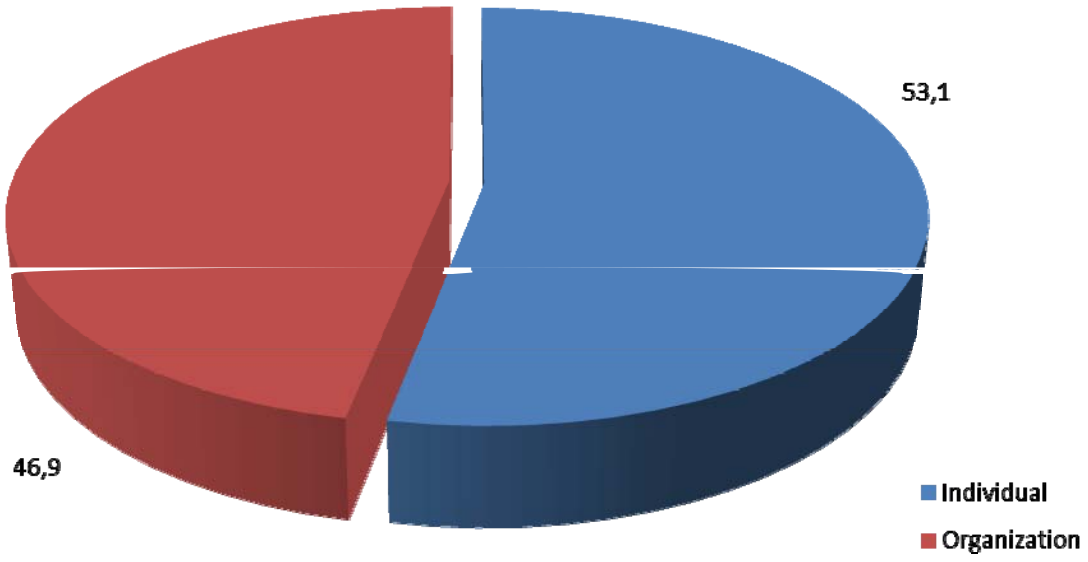
Nine (9) participants were removed because they answered two times to the public consultation (they were identified because they provided the same contact details); moreover, 35 people were removed from the final dataset because they did not agree to provide their name and contact details. During the analysis of the replies it was noted that 61 respondents from one single Member State were absolutely identical, apart from the contact details. These responses, representing 9.5% of the total, were further analysed to establish whether they overall influenced the outcome of the analysis and to what extent. It was concluded that the overall outcome of the consultation was not affected by the 61 respondents and for that reason it was decided to fully include them in this report.

The final sample is composed of 638 respondents.

2.1. Respondents' profile

This paragraph illustrates the profile of the participants to the public consultation. As shown in Fig. 2, the number of respondents who answered as "individuals" (53.1%) was slightly higher than that who answered "on behalf of an organization or an institution" (46.9%).

fig.2 - Are you answering as an individual or on behalf of an organization or an institution? (%; n=638)



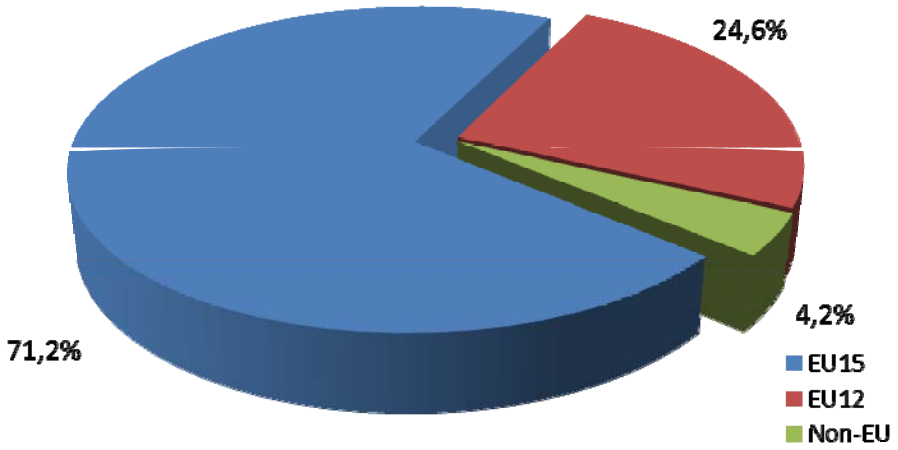
Poland was the most represented country in this consultation, followed by Netherlands, Germany, Spain, France, Belgium, Sweden, Finland, Italy and Austria. Generally speaking, almost all EU Member States are represented; there were also some respondents from associated and non EU-countries (Norway, Switzerland, Bosnia and Herzegovina, Serbia, United States, and so on).

tab. 1 - Geographical contributions (frequency; n=638)

	Frequency
Poland	143
Netherlands	94
Germany	82
Spain	58
France	54
Belgium	47
Sweden	30
Finland	24
Italy	22
Austria	21
Norway	9
United Kingdom	9
Czech Republic	6
Portugal	5
Romania	5
Denmark	4
Switzerland	4
Bosnia and Herzegovina	3
Ireland	3
Hungary	2
Serbia	2
United States	2
Brazil	1
China (People's Republic of)	1
Greece	1
Israel	1
Moldova (Republic of)	1
Peru	1
Singapore	1
Slovakia	1
Turkey	1
Total	638

The previous table is summed up in the next figure that shows the distribution of the respondents according to their origin: 71.2% of participants originated from the EU15 (Member States of the European Union prior to 1 May 2004), 24.6% originated from the EU12 (those MS joining the EU on/after 01 May 2004), 4.2% originated from countries outside the EU.

fig. 3 - Geographical contributions grouped according to EU aggregation (%; n=638)



2.1.1. Respondents answering as individuals

The number of respondents answering as "individuals" was 339 (53.1% of the total sample); the majority of them working as a researcher in a research organization or in academia (30.1%) or for a private company (other than an SME; 25.4%).

Also a significant number of farmer/forester (19.2%) and SME employees (13.0%) participated in the consultation.

tab. 2 - If you are responding as an individual (frequency; %; n=339):

	frequency	%
I work as a researcher in a research organization or in academia	102	30,1
I work for a private company (other than an SME)	86	25,4
I am a farmer / forester	65	19,2
I work for an SME	44	13,0
I am self-employed (but not as a farmer / forester)	11	3,2
I work for a public authority (national level)	11	3,2
I work for a public authority (local/regional level)	8	2,4
I work for a non-governmental organisation (other than a consumer organisation)	3	,9
I work for an international organisation (e.g. UN, OECD)	2	,5
Other	7	2,1
Total	339	100,0

As regards professional fields, respondents were allowed to give up to two choices, which explains why the number of responses exceeded the number of respondents (tab. 3).

tab. 3 - Main professional field of respondents' answering as individuals (*multiresponse*)

	frequency	% responses
Agriculture	115	26,6
Food and feed	60	13,9
Industrial biotechnology	60	13,9
Chemicals	42	9,7
Energy and bio-fuels	40	9,3
Forestry	27	6,3
Environment	25	5,8
Transport	8	1,9
Health	8	1,9
Socio-economics	5	1,2
Nanotechnology	4	,7
Fisheries and aquaculture	0	,0
Other	27	6,3
Other (non-pharmaceutical) biotechnologies	11	2,5
Total (n= 339; responses = 432)	432	100,0

The relative majority of respondents was engaged in the agricultural field (26.6%). Other professional fields mainly represented were: Food and feed (13.9%), Industrial biotechnology (13.9%), Chemicals (9.7%), Energy and bio-fuels (9.3%). No individual respondent from the Fisheries and Aquaculture field responded.

2.1.2. Respondents answering on behalf of an organization or an institution

Participants answering on behalf of organization or an institution mainly represented the private sector: 48.2% represented a small or medium-sized enterprise (SME, 22.4%), a multinational or a trans-European private company (18.1%) or a national private company (7.7%). Other respondents represented the academic sector (18.1%), public authorities/public administrations (10.0%) and industry associations or chambers of commerce (9.7%).

tab. 4 - If you are responding on behalf of organization or an institution (frequency; %; n=299):

	frequency	%
I represent a Small or Medium Enterprise (SME)	67	22,4
I represent a multinational or a trans-European private company	54	18,1
I represent an academic/research organisation or association of academic/research organisations	54	18,1
I represent a public authority/public administration	30	10,0
I represent an industry association or a chamber of commerce (national/regional/local)	29	9,7
I represent a national private company (excluding SME)	23	7,7
I represent an association of farmers or other primary producers (national/regional/local)	16	5,4
I represent a non-governmental organisation/associations of NGOs (excluding consumer association)	9	3,0
Other	17	5,6
Total	299	100,0

Participants replying on behalf of an organization mainly represented the Industrial biotechnology field (17.9%), and fields like Agriculture (14.4%), Food and feed (12.7%), Energy and bio-fuels (12.2%), and Chemicals (11.2%).

tab. 5 - Main professional field of respondents on behalf of an organization or an institution (*multiresponse*)

	frequency	% responses
Industrial biotechnology	75	17,9
Agriculture	60	14,4
Food and feed	53	12,7
Energy and bio-fuels	51	12,2
Chemicals	47	11,2
Forestry	28	6,7
Environment	23	5,5
Transport	6	1,4
Health	6	1,4
Fisheries and aquaculture	5	1,2
Socio-economics	4	1,0
Nanotechnology	3	,7
Other	47	11,2
Other (non-pharmaceutical) biotechnologies	10	2,5
Total (n= 299; responses = 418)	418	100,0

2.1.3. The whole sample

In order to synthetize the information about the type of organization the respondents worked for, a typology was created, combining the answers to the variables shown in table 2 and table 4.

The typology has four categories[2]: Private, Public, Academia and NGO (Non-governmental organization) (tab. 6).

The majority of respondents worked in a private organization (64.6%), whereas 24.6% belonged to the academic sector. Few respondents were categorized coming from the Public sector (8.8%) or a NGO organization (2.0%).

tab. 6 - Type of organization

	frequency	%
Private	412	64,6
Academia	157	24,6
Public	56	8,8
NGO	13	2,0
Total	638	100,0

Considering the entire sample, the most represented professional fields were Agriculture (20.6%), followed by Industrial biotechnology (15.9%), Food and feed (13.3%), Energy and bio-fuels (10.7%) and Chemicals (10.5%).

tab. 7 - Main professional field of respondents (whole sample; *multiresponse*)

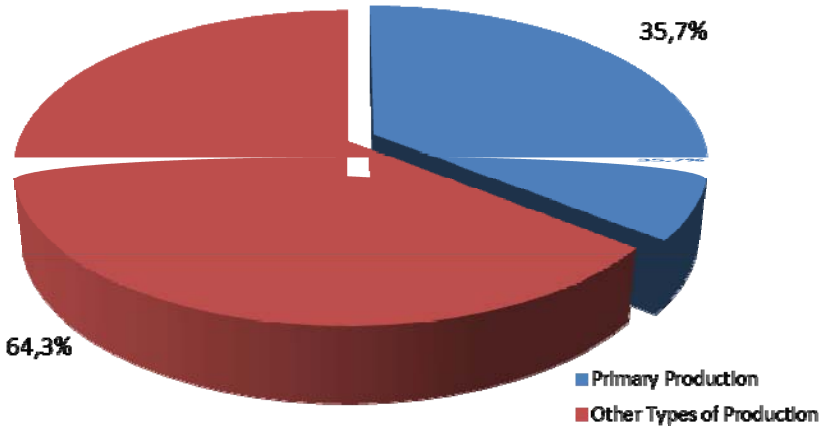
	frequency	% responses
Agriculture	175	20,6
Industrial biotechnology	135	15,9
Food and feed	113	13,3
Energy and bio-fuels	91	10,7
Chemicals	89	10,5
Forestry	55	6,5
Environment	48	5,6
Transport	14	1,6
Health	14	1,6
Socio-economics	9	1,1
Nanotechnology	7	,8
Fisheries and aquaculture	5	,6
Other	74	8,7
Other (non-pharmaceutical) biotechnologies	21	2,5

[2] Respondents who chose the residual category, i.e. “Other”, could specify their answers with a textual comment. The content analysis allowed to re-classify the open answers Into one of the four categories. The same criterion has been adopted for the re-categorization of the professional field.

	frequency	% responses
Agriculture	175	20,6
Industrial biotechnology	135	15,9
Food and feed	113	13,3
Energy and bio-fuels	91	10,7
Chemicals	89	10,5
Forestry	55	6,5
Environment	48	5,6
Transport	14	1,6
Health	14	1,6
Socio-economics	9	1,1
Nanotechnology	7	,8
Total (n= 638; responses = 850)	850	100,0

In the following graph, professional fields were re-categorized according to primary (35.7%) and other type of production (64.3%).

fig. 4 – Type of Production (n= 638; %)



3. IDENTIFICATION OF THE PROBLEMS

Section B of the questionnaire addresses the respondents' perception about the competitiveness of the European Bio-based Industries. Participants were asked to express their view about the state-of-the-art of the bio-based economy in Europe, focusing on the problems faced by European Bio-based Industries. This section of the questionnaire contained three sets of items, whose specific aim was to survey the opinions of the respondents about the potential strength and weakness of the bio-based industries in relation to the current state of affairs in research and innovation.

3.1. Overall views on the competitiveness of the European bio-based Industries

The first question of section B intended to analyze what participants think about the general level of competitiveness of the European bio-based Industries. This topic was surveyed with a set of seven statements, each one of them referring to the perceived competitiveness in various steps in the value chain (Primary production; Logistics and storage; Extraction and processing of renewable resources; Commercialization; Market development).

Respondents were asked to express their agreement with each item using a 5 point Likert scale, ranging from "strongly disagree" to "strongly agree".

According to the respondents' answers, the items were divided in three groups:

(1) Sectors in which European bio-based Industries were considered competitive in a global context (fig. 5):

- Logistics and Storage (strongly agree + agree = 65.0%) and
- Primary production (strongly agree + agree = 54.5%);

(2) Sectors in which uncertainty prevailed over European bio-based Industries competitiveness in a global context (tab. 8):

- Extraction and processing of renewable biological resources into value-added bio-based materials (neutral = 40.1%) and
- Extraction and processing of renewable biological resources into biofuels (neutral = 39.3%);

(3) Sectors in which European bio-based Industries were not considered competitive in a global context (fig. 5):

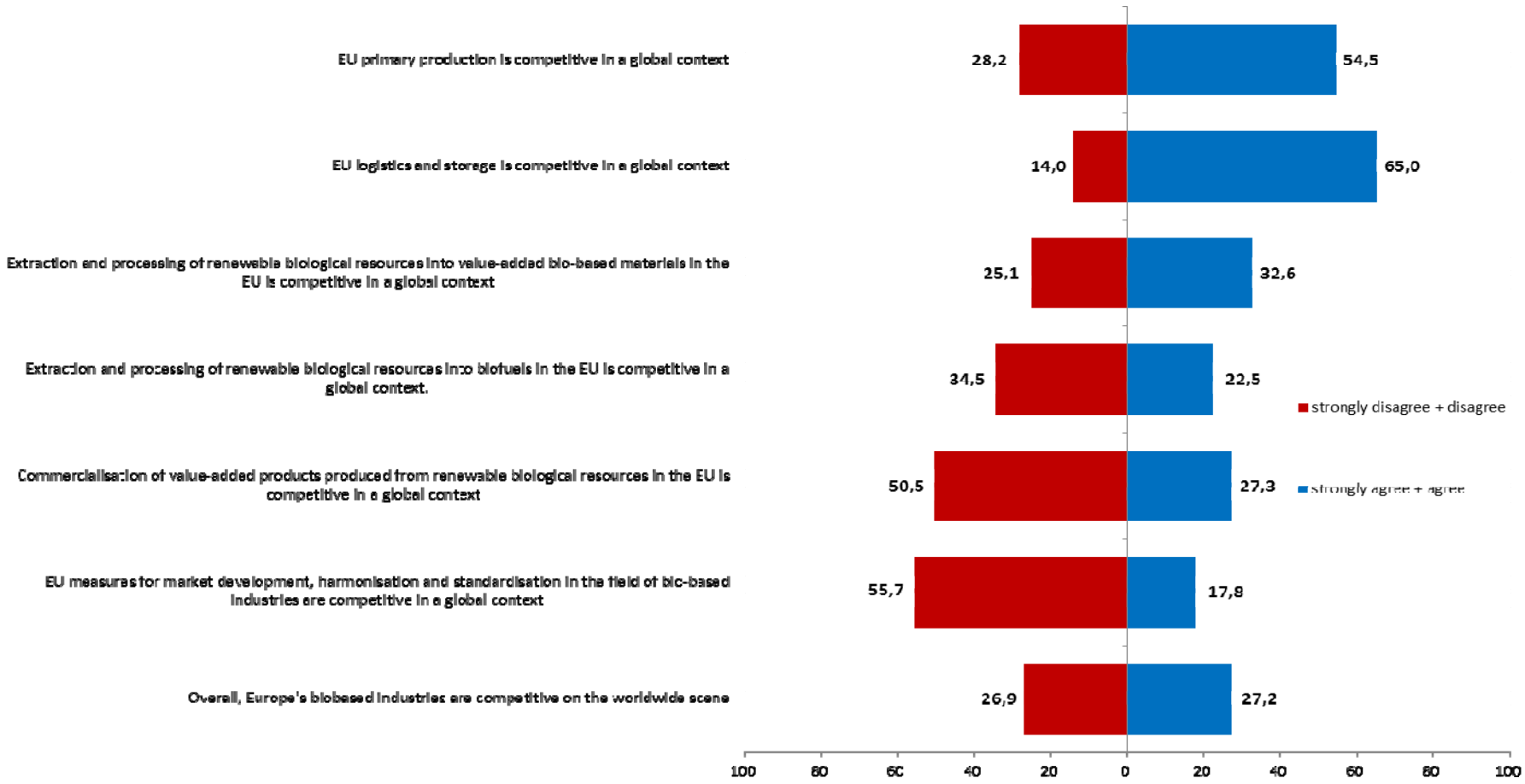
- EU measures for market development, harmonization and standardization in the field of bio-based Industries (strongly disagree + disagree = 55.7%) and
- Commercialization of value-added products produced from renewable biological resources (strongly disagree + disagree = 50.5%).

tab. 8 - What are your overall views on the competitiveness of the European bio-based Industries? (%)

Items	strongly disagree	disagree	neutral	agree	strongly agree	no opinion	total
EU primary production is competitive in a global context	5,2	23,0	14,6	47,0	7,5	2,7	100,0
EU logistics and storage is competitive in a global context	1,6	12,4	15,5	55,6	9,4	5,5	100,0
Extraction and processing of renewable biological resources into value-added bio-based materials in the EU is competitive in a global context	3,6	21,5	40,1	24,1	8,5	2,2	100,0
Extraction and processing of renewable biological resources into biofuels in the EU is competitive in a global context	5,8	28,7	39,3	17,2	5,3	3,7	100,0
Commercialization of value-added products produced from renewable biological resources in the EU is competitive in a global context	29,2	21,3	19,1	19,9	7,4	3,1	100,0
EU measures for market development, harmonization and standardization in the field of bio-based Industries are competitive in a global context	28,4	27,3	21,6	13,9	3,9	4,9	100,0
Overall, Europe's bio-based Industries are competitive on the worldwide scene	3,1	23,8	42,9	21,9	5,3	3,0	100,0

N. B. = "Strongly agree" plus "Agree" more than "Strongly disagree" plus "Disagree"; ="Strongly disagree" plus "Disagree" more than" Strongly agree" plus "Agree"; ="Neutral" more than 25%;

fig. 5 - What are your overall views on the competitiveness of the European bio-based Industries? (%; strongly disagree + disagree vs. strongly agree + agree)



As shown in the following graphics (fig. 6 to fig. 7), the overall competitiveness perception of EU Bio-based Industries appeared to vary by type of organization: respondents from academia and the public sector were more likely to have a better perception of the competitiveness of Bio-based Industries than those from the private sector.

fig. 6 - What are your overall views on the competitiveness of the European bio-based Industries? (%; strongly disagree + disagree vs. strongly agree + agree)

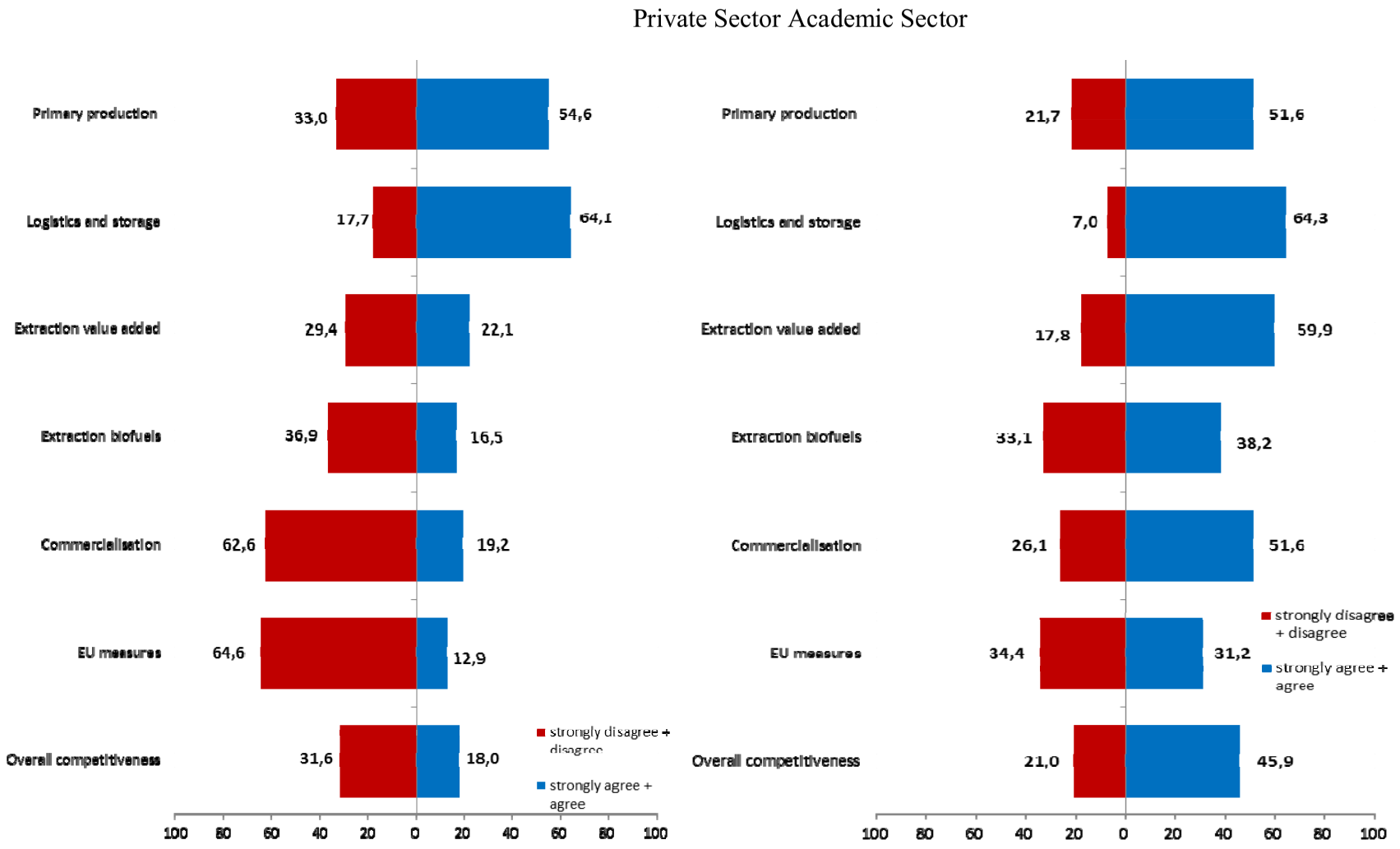
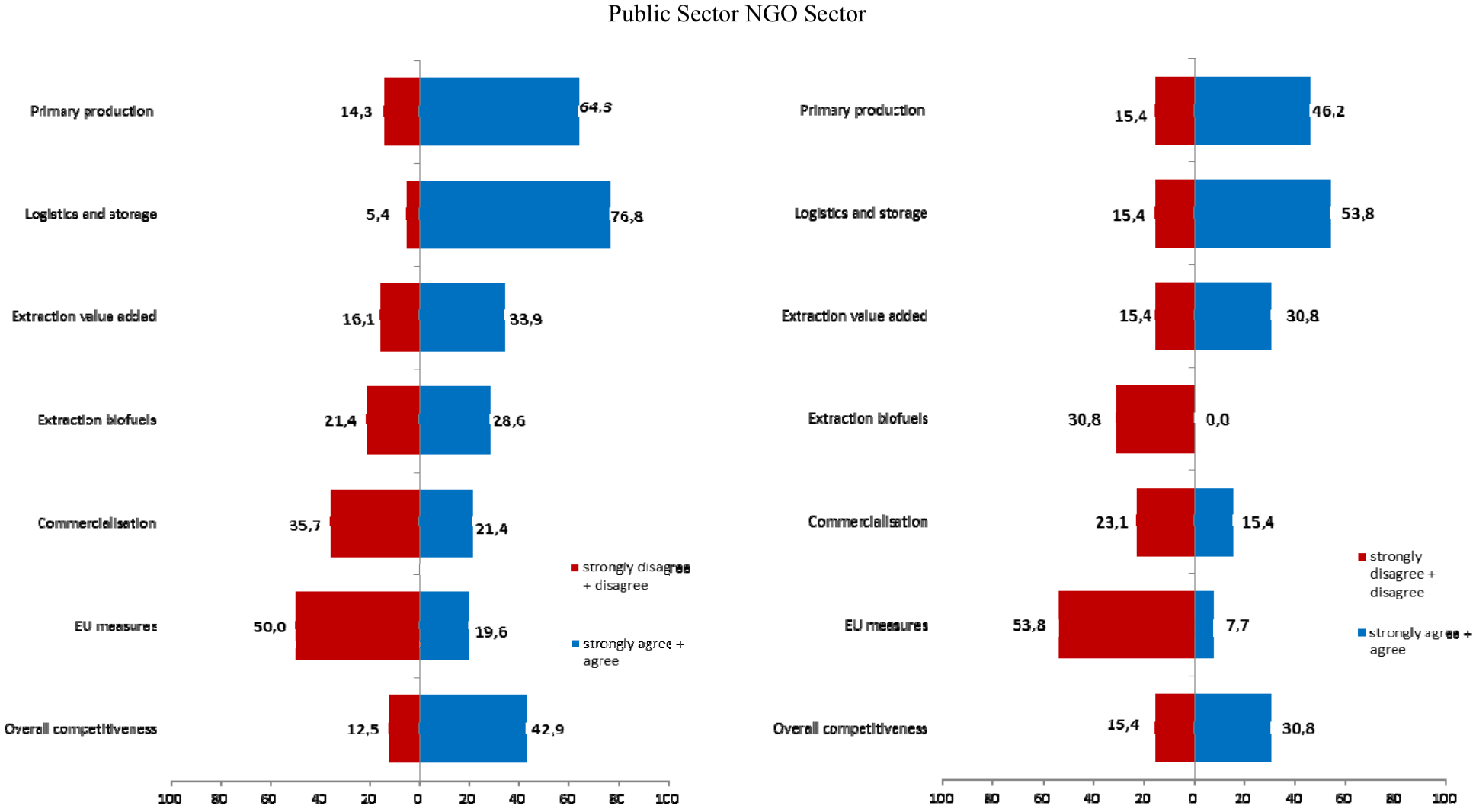


fig. 7 - What are your overall views on the competitiveness of the European bio-based Industries? (%; strongly disagree + disagree vs. strongly agree + agree)



3.2. The European bio-based Industries: strengths and weaknesses

The next part of the questionnaire dealt with the perceived strengths and weaknesses of the European bio-based Industries. Two sub-dimensions were surveyed: 1) the EU's current situation and 2) the current innovation capacity of the bio-based Industries.

Regarding the evaluation of the EU's current situation, respondents were asked to rate, on a 5 point scale from “very weak” to “very strong”, the EU's current situation for 10 items, having as benchmark what they believed was required for Europe to be successful in the development of competitive bio-based industries (Tab. 9).

According to the responses received, the following 3 items received the highest approval rates, based on summing up the results for "very strong" and "strong":

- Strength of basic research in areas of likely future relevance with 78.7%;
- Investment of the private sector in research and innovation related to bio-based industries with 50.3%;
- Filing of patent application with 42.6%.

Other items considered rather strong than weak by respondents were:

- Strength of applied research & technology development (41.8%);
- SME participation in Research and Innovation related to bio-based industries (40.7%);

Having analyzed the responses for “very weak” and “weak”, two items were identified as being by far the weakest points:

- Access of bio-based industries to a range of state-of-the-art demonstration plants with 70.8%;
- Involvement of primary producers (farmers, forestry or aquaculture) in innovation efforts related to the development of supply chains for biomass as feedstock for bio-based industries with 68.5%.

Other items considered more weak than strong by respondents were:

- Collaboration between stakeholders along value and supply chains in terms of conducting R&I pertinent to bio-based industries (60.7%);
- Investment of the public sector in Research and Innovation related to bio-based industries (59.3%);
- EU wide coordination of applied research & technology development (55.9%).

In the context of this online public consultation it was surprising to see that even the public sector itself seemed to indicate that the investment in R&I by the public sector was considered a weakness (Figure 9). Due to the sample size of 638 valid responses, this result could certainly not be regarded as fully representative for the public sector in the EU in general; nevertheless it was considered to show a consensus among all stakeholder groups, calling for better and more public support for R&I activities in the EU.

tab. 9 - The European bio-based Industries: strengths and weaknesses - the EU's current situation (%)

Items	very weak	weak	neutral	strong	very strong	no opinion	total
Strength of basic research in areas of likely future relevance	0,6	7,7	11,1	64,6	14,1	1,9	100,0
Strength of applied research & technology development	0,6	40,6	15,7	32,1	9,7	1,3	100,0
EU wide coordination of applied research & technology development	26,6	29,3	23,8	13,6	4,1	2,6	100,0
Involvement of primary producers (farmers, forestry or aquaculture) in innovation efforts related to the development of supply chains for biomass as feedstock for bio-based industries	8,2	60,3	17,1	9,9	2,4	2,1	100,0
Investment of the private sector in Research and Innovation related to bio-based industries	4,1	23	20,4	45,6	4,7	2,2	100,0
SME participation in Research and Innovation related to bio-based industries.	6,3	23,2	24,1	35,7	5	5,7	100,0
Investment of the public sector in Research and Innovation related to bio-based industries	5,2	54,1	20,7	14,7	3,6	1,7	100,0
Filing of patent applications (in line with the exploitation potential of research results obtained)	1,6	14,7	27,0	40,4	2,2	14,1	100,0
Collaboration between stakeholders along value and supply chains in terms of conducting R&I pertinent to bio-based industries	4,9	55,8	20,5	12,1	3,1	3,6	100,0
Access of bio-based industries to a range of state of the art demonstration plants	39	31,8	14,7	7,4	2,8	4,3	100,0

N. B. = "Very strong" plus "Strong" more than "Very weak" plus "Weak"; ="Very weak" plus "Weak" more than "Very strong" plus "Strong"; ="Neutral" more than 25%; =”no opinion" more than 10%

fig. 8 - The European bio-based Industries: strengths and weaknesses - the EU's current situation (%; very weak + weak vs. very strong + strong)

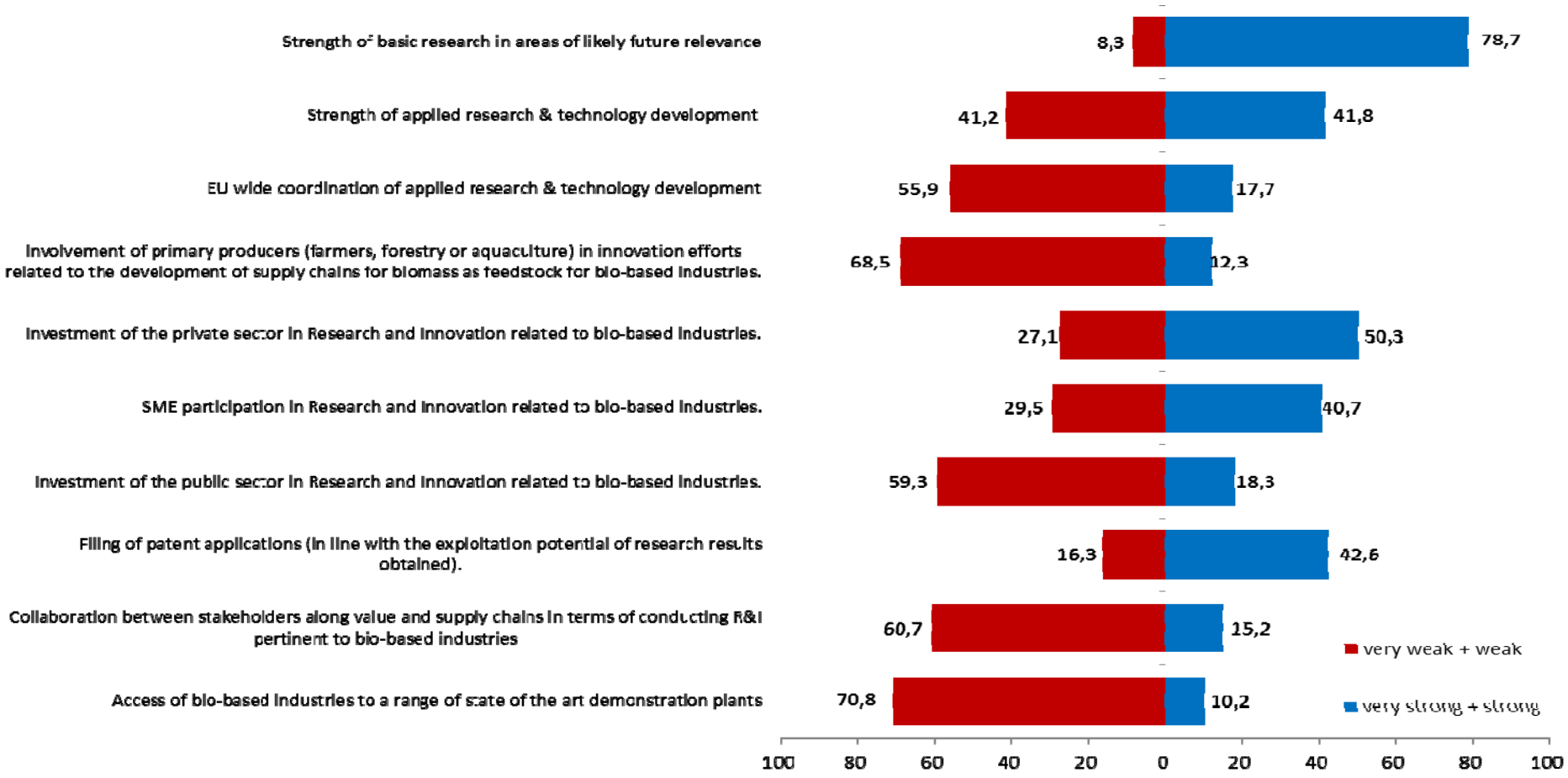


fig. 9 - The European bio-based Industries: strengths and weaknesses - the EU's current situation (%; very weak + weak vs. very strong + strong)

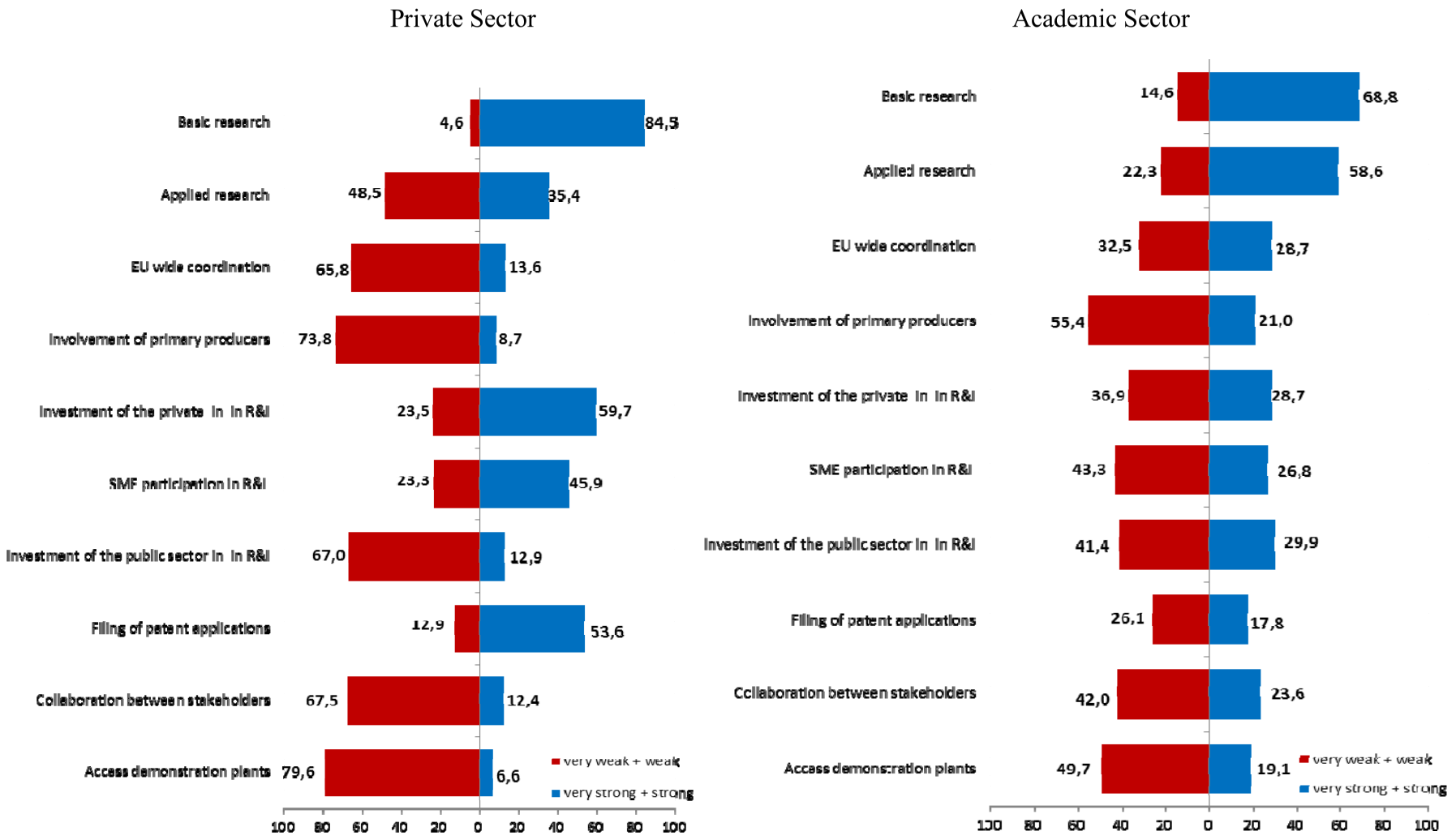
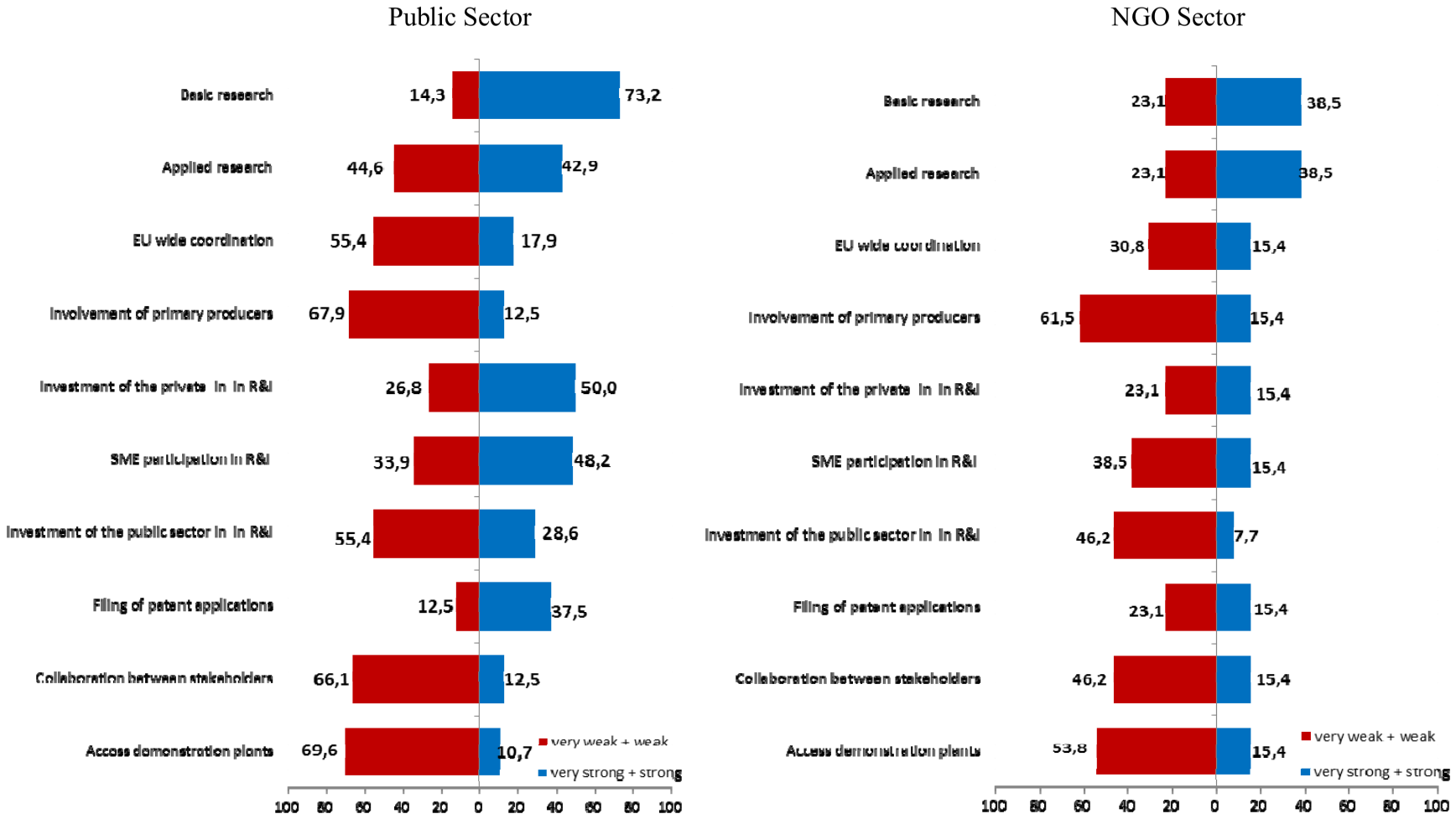


fig. 10 - The European bio-based industries: strengths and weaknesses - the EU's current situation (%; very weak + weak vs. very strong + strong)



Overall, the perception of individual stakeholder groups with regard to the items surveyed was found to be very similar and in line with the overall results for all stakeholder groups together. However, some interesting indications in terms of different views between stakeholder groups were identified as follows:

- The NGO and academic sector differed from the other 2 sectors in that they regarded the participation of SMEs in research and innovation activities as being rather weak, whereas the private and public sectors considered this being rather a strong point in the EU.
- The private and public sectors regarded the investment of the private sector in R&I as a strength, whereas the NGO/academic sectors seem to have considered this rather a weakness.
- And finally, the same pattern was identified for filing patent applications, which was regarded by the private and public sectors rather a strength, in contrast to the other 2 sectors, which were of opposing views.

The second item surveyed the opinion of stakeholders regarding the current innovation capacity of the bio-based industries in the EU. A set of 11 statements was presented in the questionnaire. These statements were considered having a direct or indirect impact on the industrial innovation capacity. Respondents were again asked to rate these statements on a 5 point scale from strongly disagree to strongly agree.

Participants were found to generally disagree with the majority of the statements, and therefore also indicating an overall limited innovation capacity of bio-based Industries in the EU. Taking the responses of all stakeholder groups into account, the most disapproved statements were as follows (see Table 10 and Figure 11):

- Consumers are well informed about benefits and risks associated with bio-based products with 82.2%;
- Bio-based Industries are sufficiently consolidated and integrated (critical mass) across Europe to support the growth of the biorefinery infrastructure with 69.9%;
- Appropriate industry standards, certification systems and labels are in place to create a favorable economic environment for the development of bio-based industries with 68.8%;
- Member state public support mechanisms stimulating large-scale deployment of innovation in the bio-based industries are strong with 68.0%.

However, 2 statements overall received fairly positive ratings from all participants, namely:

- There is good potential to source, in an environmentally sustainable way, other types of non-food feedstocks with 56.9%;
- There is a sufficient availability of traditional feedstock, mainly foodcrops such as maize, wheat, sugar beet or oilseeds in Europe, to support the rapid growth of bio-based industries while assuring food and feed supply with 51.1%.

Generally speaking, under the current circumstances respondents seemed not to have much confidence in the current innovation capacity of the bio-based industries in the EU. This issue was further analyzed in the following sections of this report.

tab. 10 - European bio-based Industries: strengths and weaknesses which may have a direct or indirect impact on the innovation capacity of bio-based industries (%)

Items	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree	No opinion	total
Bio-based Industries are sufficiently consolidated and integrated (critical mass) across Europe to support the growth of the biorefinery infrastructure	8,3	61,6	13,6	11,8	1,7	3,0	100,0
There is a sufficient availability of traditional feedstock, mainly foodcrops such as maize, wheat, sugar beet or oilseeds in Europe, to support the rapid growth of bio-based industries while assuring food and feed supply	8,6	21,3	13,5	21,0	30,1	5,5	100,0
There is good potential to source, in an environmentally sustainable way, other types of non-food feedstocks (e.g. residues from agriculture, forestry and biowaste, lignocellulosic crops) in Europe, supporting the future development of EU bio-based industry	2,0	6,3	33,2	36,8	20,1	1,6	100,0
Appropriate solutions to ensure an effective biomass supply chain are already in place (e.g. logistics, stable supply contracts)	11,6	31,8	39,5	13,2	1,4	2,5	100,0
Necessary cross-sectorial collaboration between stakeholders in bio-based value-chains enabling smart and sustainable ways of using biomass is in place	8,5	56,7	15,5	11,9	4,9	2,5	100,0
EU level public support mechanisms stimulating large-scale deployment of innovation in the bio-based industries are strong	37,8	29,8	18,5	9,1	1,9	3,0	100,0
Member state public support mechanisms stimulating large-scale deployment of innovation in the bio-based industries are strong	34,0	34,0	18,0	9,4	1,4	3,1	100,0
Appropriate industry standards, certification systems and labels are in place to create a favourable economic environment for the development of bio-based industries	8,9	59,9	13,8	10,3	2,4	4,7	100,0
Policy measures and initiatives promoting the use of bio-based products create a favourable environment for the development of local bio-based industries	9,1	52,7	15,2	13,0	6,9	3,1	100,0
There is a strong and effective integration of measures to protect the environment with measures aimed at the development of bio-based industries	7,7	53,0	17,1	14,7	2,8	4,7	100,0
Consumers are well informed about benefits and risks associated with bio-based products	48,7	33,5	9,4	5,6	,9	1,9	100,0

N. B. = "Strongly agree" plus "Agree" more than "Strongly disagree" plus "Disagree"; ="Strongly disagree" plus "Disagree" more than" Strongly agree" plus "Agree"; ="Neutral" more than 25%

fig. 11 - Actions required for Europe to be successful in enhancing the innovation capacity of the bio-based Industries

(%; strongly disagree + disagree vs. strongly agree + agree)

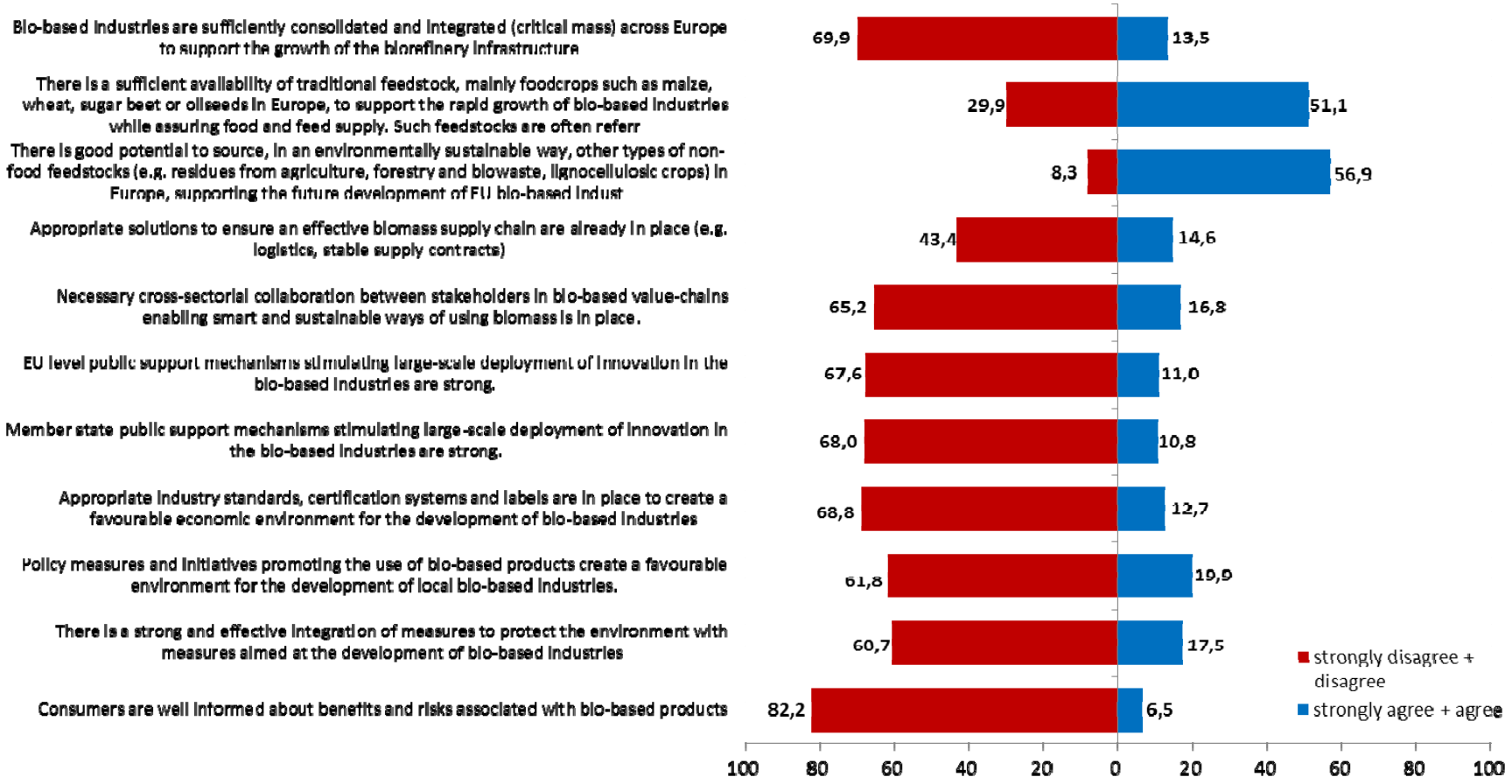


fig. 12 - Actions required for Europe to be successful in enhancing the innovation capacity of the bio-based Industries

(%; strongly disagree + disagree vs. strongly agree + agree)

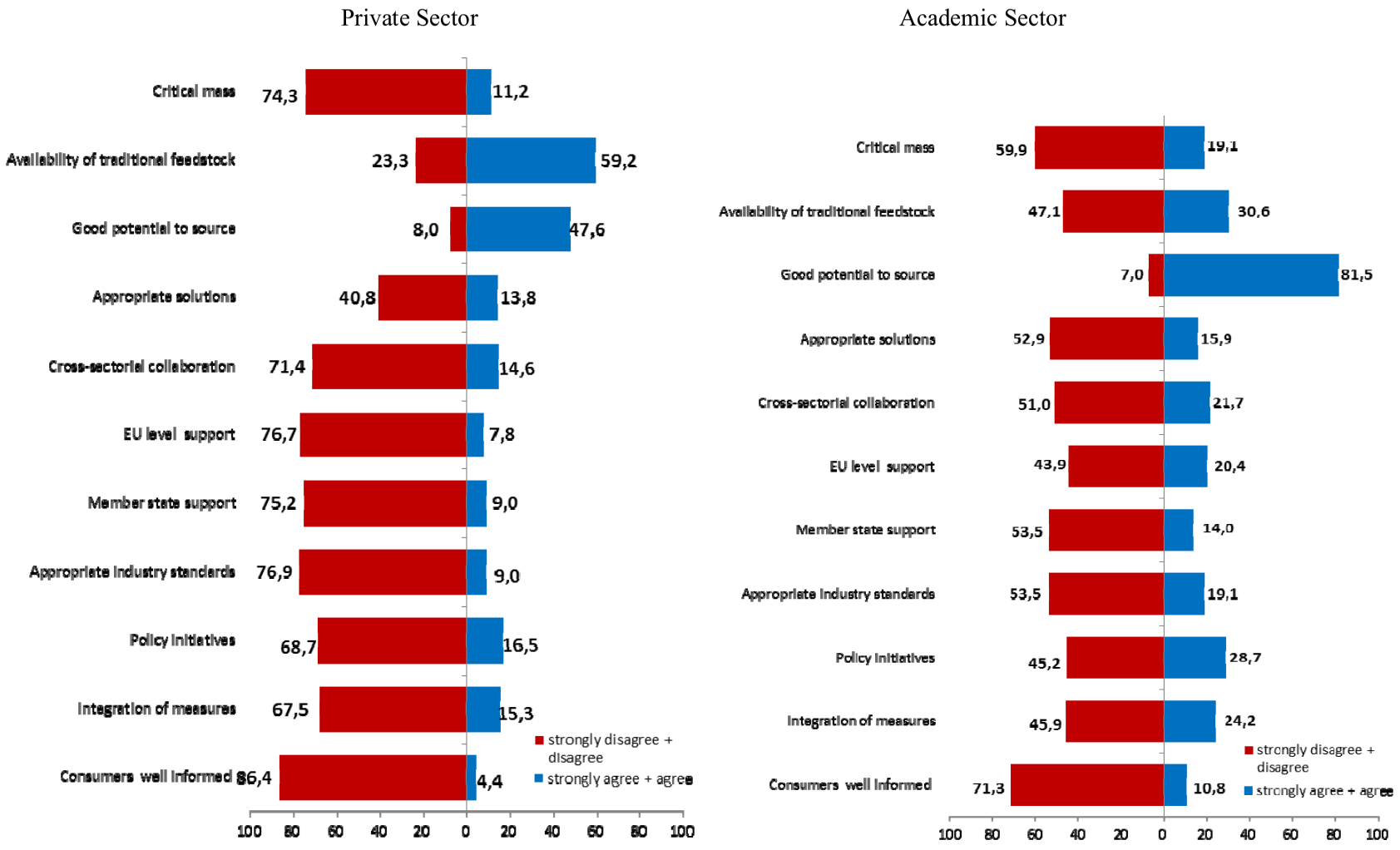
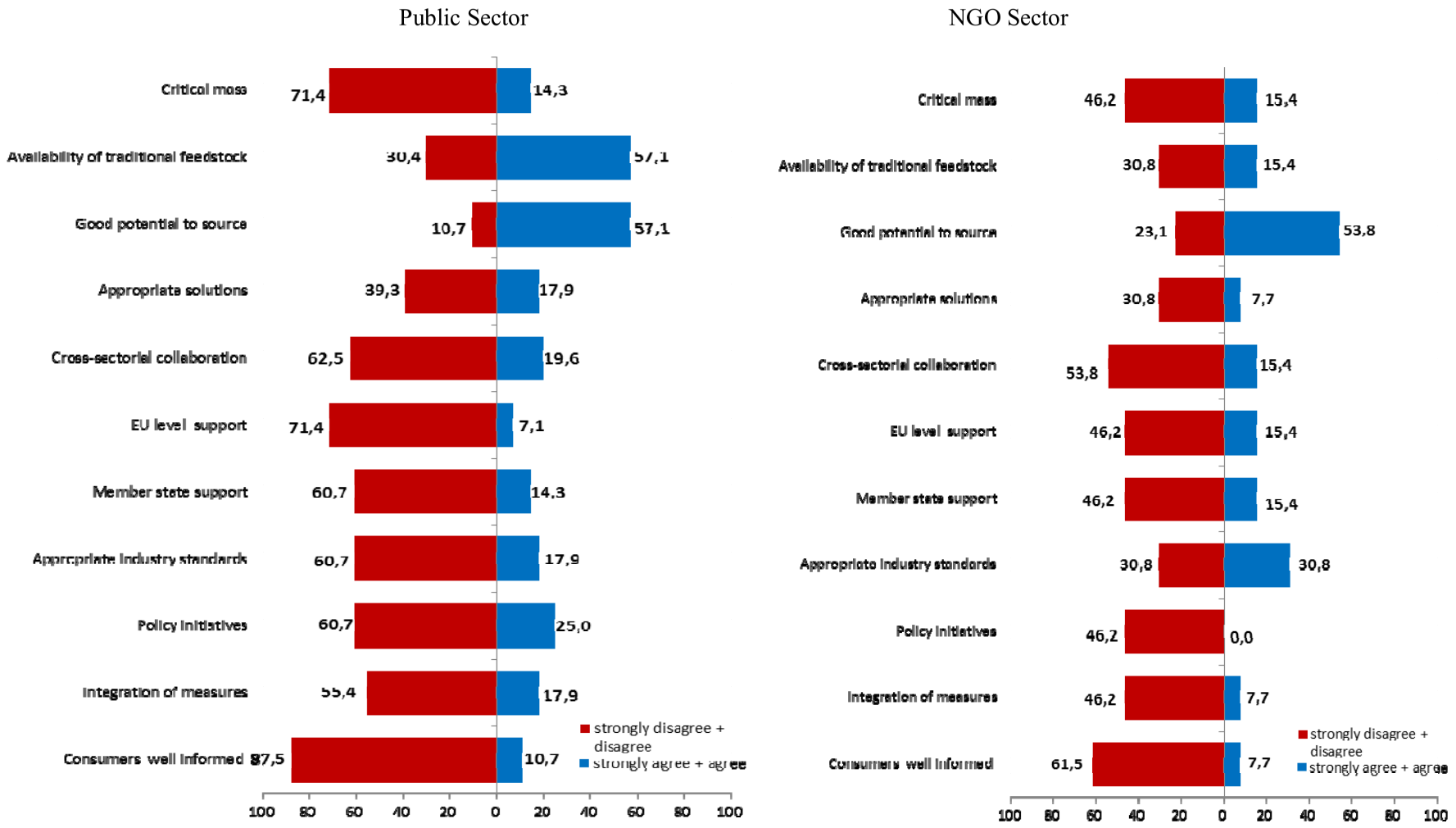


fig. 13 - Actions required for Europe to be successful in enhancing the innovation capacity of the bio-based Industries

(strongly disagree + disagree vs. strongly agree + agree)



Figures 12 and 13 display the opinion of the individual stakeholder groups regarding the 11 statements mentioned. Apart from 2 issues, no major differences between the groups were identified.

The statement “There is a sufficient availability of traditional feedstock, mainly food crops such as maize, wheat, sugar beet or oilseeds in Europe, to support the rapid growth of bio-based industries while assuring food and feed supply” was supported by the majority of respondents of the private and public sector groups, whereas the majority of the academic and NGO groups did not agree with this statement.

Another difference in views between stakeholder groups was found regarding the statement "Appropriate industry standards, certification systems and labels are in place to create a favorable economic environment for the development of bio-based industries". Here, the opinion within the NGO group was equally split between those who agreed and who disagreed (both 30.8%), while respondents of the other 3 groups largely disapproved this statement.

4. EUROPEAN ADDED VALUE

Section C of the questionnaire requested the view of stakeholders on the added value of EU level action on research and innovation for the bio-based industries. Respondents were asked to provide their opinions regarding: 1) the importance of EU level intervention in comparison with other types of interventions and 2) the added value of EU level intervention.

4.1. The importance of EU level intervention

Participants were asked to provide their opinion concerning the added value of European level intervention in comparison with no public intervention and intervention at regional and/or national level.

According to the replies displayed in table 11, respondents strongly believed that support for research and innovation actions at European level is essential; the statement “An intervention at EU level is needed to help industry address the problems” was supported by 94.3% of all participants. No major differences between stakeholder groups were noted in this regard, although the statement received slightly more support from private and academic stakeholders and slightly less from NGOs and public stakeholders.

In this context also to be noted that some participants from academia with 18.5%, NGO with 15.4% and private stakeholders with 10.2%, expressed support for intervention at regional or national level.

tab. 11 - Tackling the problems (%)

Items	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree	No opinion	total
Industry alone, without government support, is able to address the relevant problems	54,5	38,7	3,4	1,7	,8	,9	100,0
An intervention at the level of the regions or of Member States would be sufficient to help industry address the relevant problems	10,2	59,9	16,8	9,7	2,5	,9	100,0
An intervention at EU level is needed to help industry address the problems	,8	1,1	2,5	31,0	63,3	1,3	100,0

N. B. = "Strongly agree" plus "Agree" more than "Strongly disagree" plus "Disagree"; ="Strongly disagree" plus "Disagree" more than" Strongly agree" plus "Agree"; ="Neutral" more than 15%

fig. 14 - Tackling the problems (%; strongly disagree + disagree vs. strongly agree + agree)

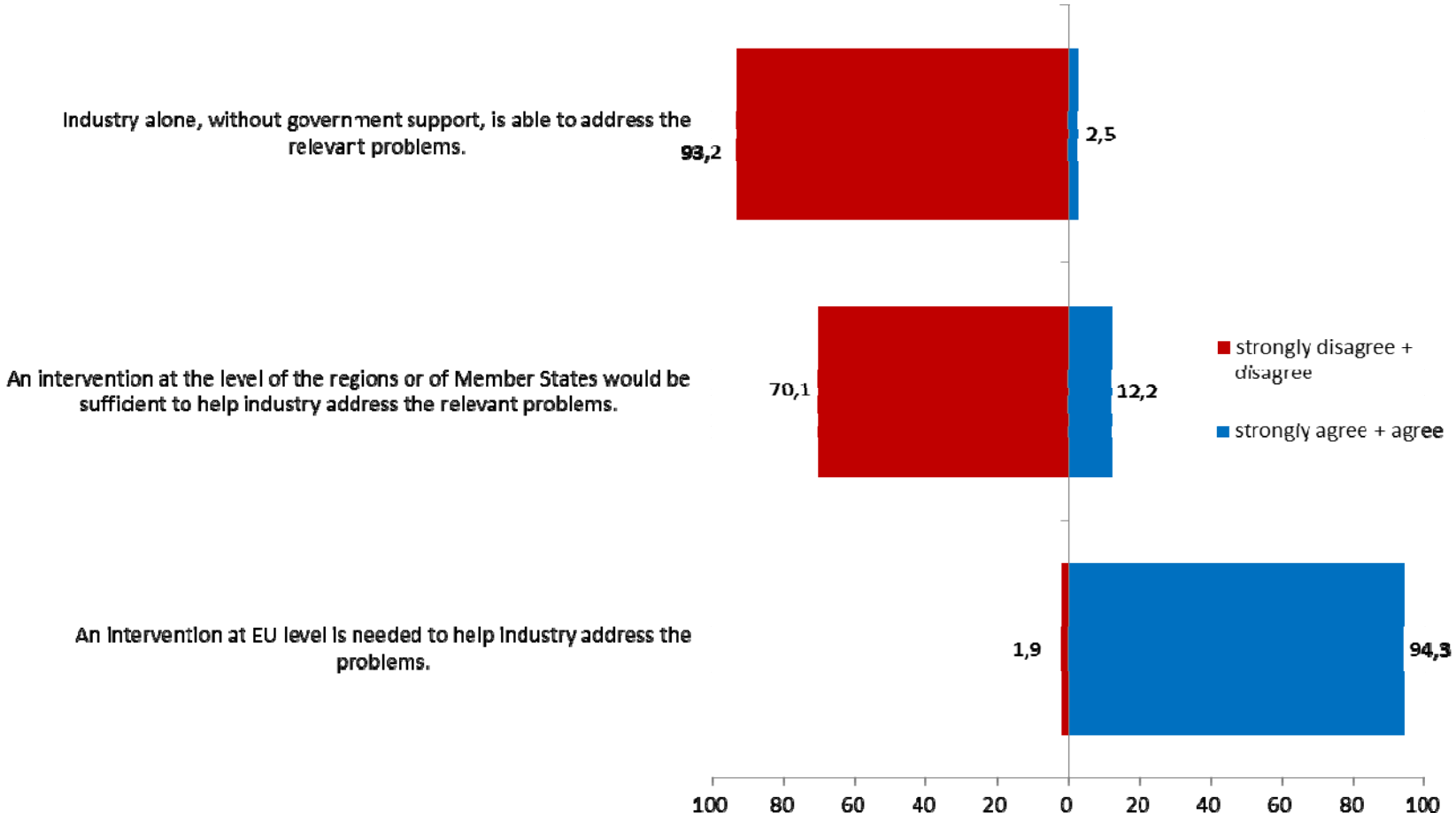


fig. 15 - Tackling the problems (%; strongly disagree + disagree vs. strongly agree + agree)

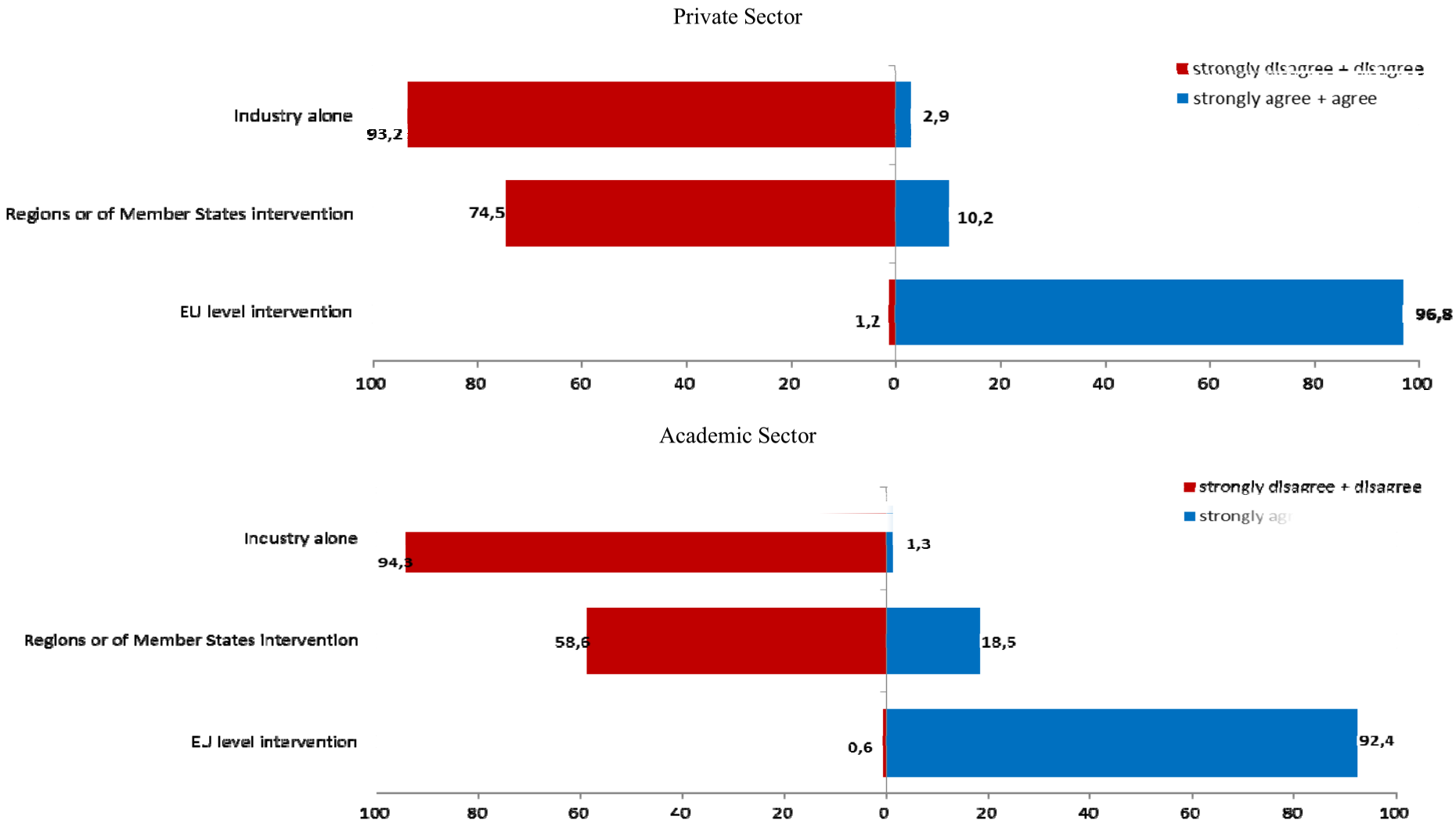
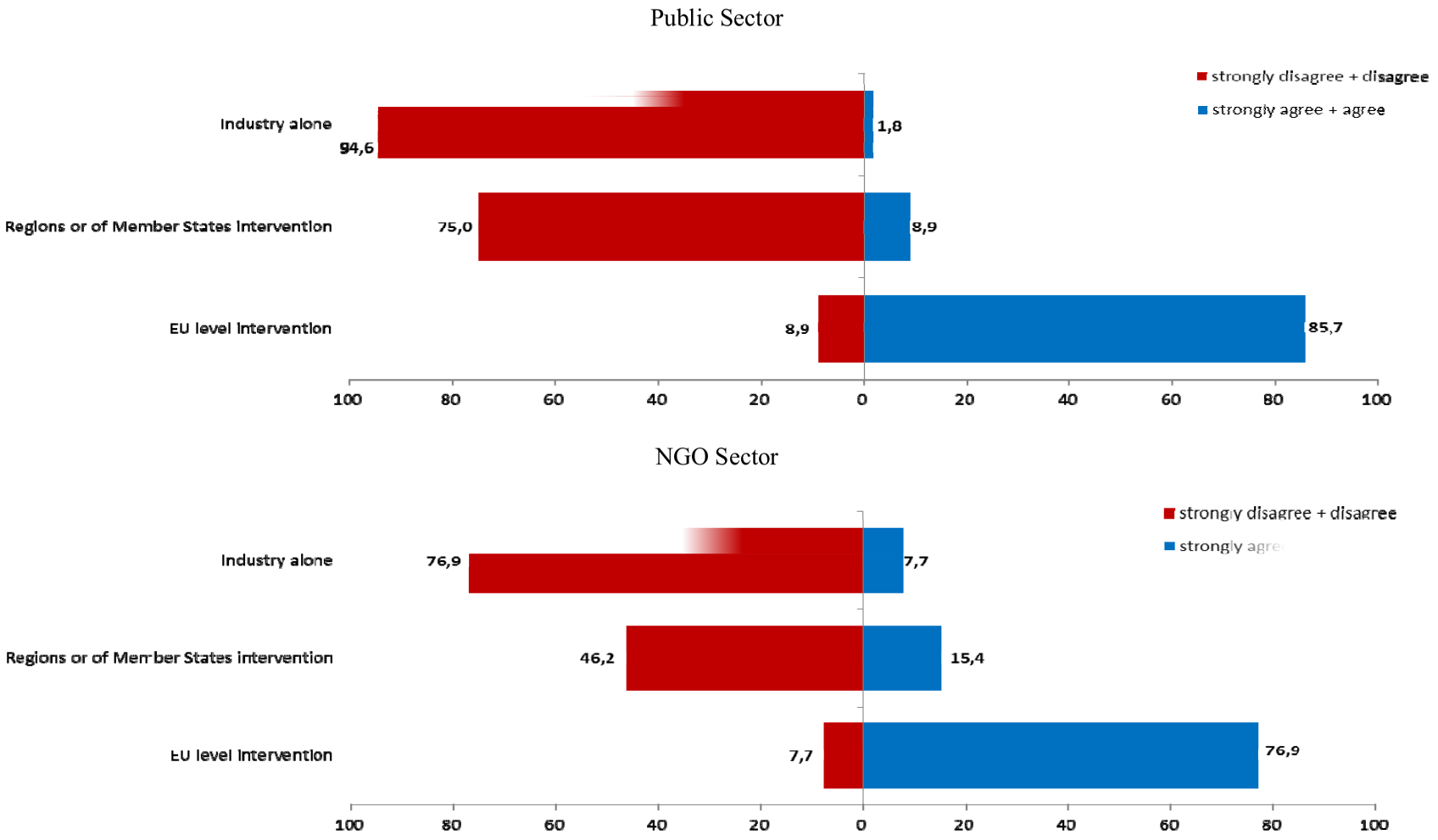


fig. 16 - Tackling the problems (%; strongly disagree + disagree vs. strongly agree + agree)



4.2. Added value of EU level intervention

The next section of the questionnaire aimed to gather stakeholder's views about the potential added value of public intervention at EU level with regard to bio-based industries. The section was composed of 8 statements, which respondents were asked to rate, using a series of 5 points ranging from “Strongly disagree” to “Strongly agree”.

Table 12 and figure 17 respectively provide an overview of the responses received and the results achieved in terms of ranking the 8 statements on the added value of a possible EU intervention. According to the results, all statements listed in the questionnaire were considered by the stakeholders to indeed provide added value, with strongest support for:

- achieving the required level of investment in research and innovation with 93.1%;
- ensuring EU wide cooperation between all relevant stakeholders along the value chains with 92.0%;
- providing improved policy coherence, e.g. in terms of environmental, agricultural and industrial policies with 91.4%;
- promoting non-traditional partnerships (transnational, cross-sectorial) between stakeholders that may otherwise lack opportunities or incentives to collaborate with 90.8%.

The least appreciated statement was identified as “greater mobilization of research efforts in universities and research institutes”, which was supported by the respondents with 61.5%, with 34.3% of them giving a "neutral" answer.

tab. 12 - EU intervention will provide added value in terms of: (%)

Items	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree	No opinion	total
… mobilizing the necessary critical mass required to reach key objectives in a timely way	,6	1,3	7,1	38,9	50,8	1,3	100,0
… ensuring EU wide cooperation between all relevant stakeholders along the value chains	,2	1,6	5,3	62,2	29,8	,9	100,0
… promoting non-traditional partnerships (transnational, cross-sectorial) between stakeholders that may otherwise lack opportunities or incentives to collaborate	,3	1,1	6,9	32,3	58,5	,9	100,0
… contribute to achieving the required level of investment in research and innovation	,5	,8	4,7	32,0	61,1	,9	100,0
… greater mobilisation of research efforts in universities and research institutes	,5	2,4	34,3	35,3	26,2	1,3	100,0
… coordination between national policies	,3	1,1	9,6	60,3	26,3	2,4	100,0
...reduce first mover risk associated with deployment of innovative technologies	,2	1,6	8,2	27,4	58,8	3,8	100,0
… providing improved policy coherence, e.g. in terms of environmental, agricultural and industrial policies	,3	,9	5,5	29,5	61,9	1,9	100,0

N. B. = "Strongly agree" more than " agree" = " Agree" more than " Strongly agree "; ="Neutral" more than 20%

fig. 17 - EU intervention will provide added value in terms of: (%; strongly agree + agree)

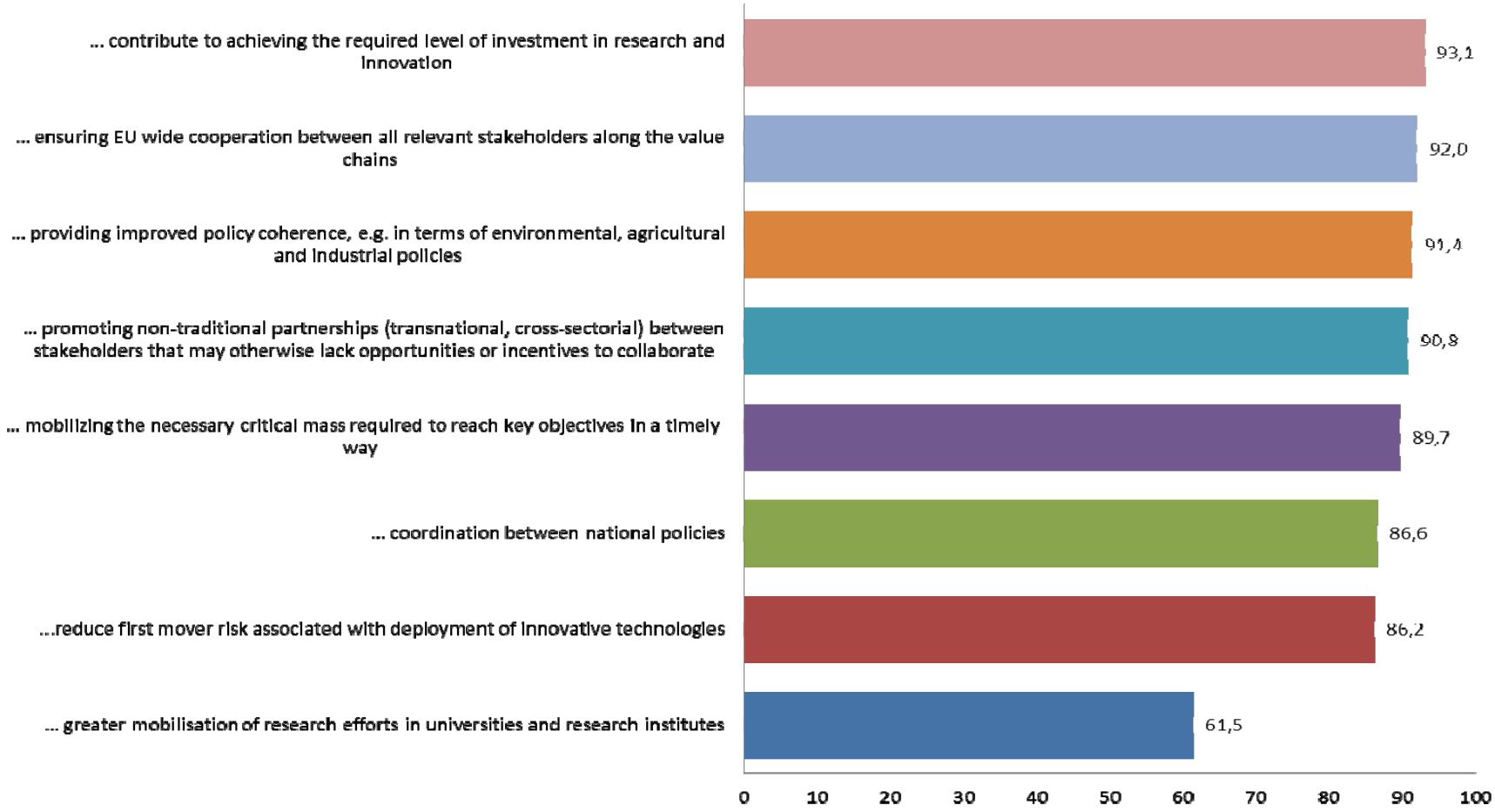
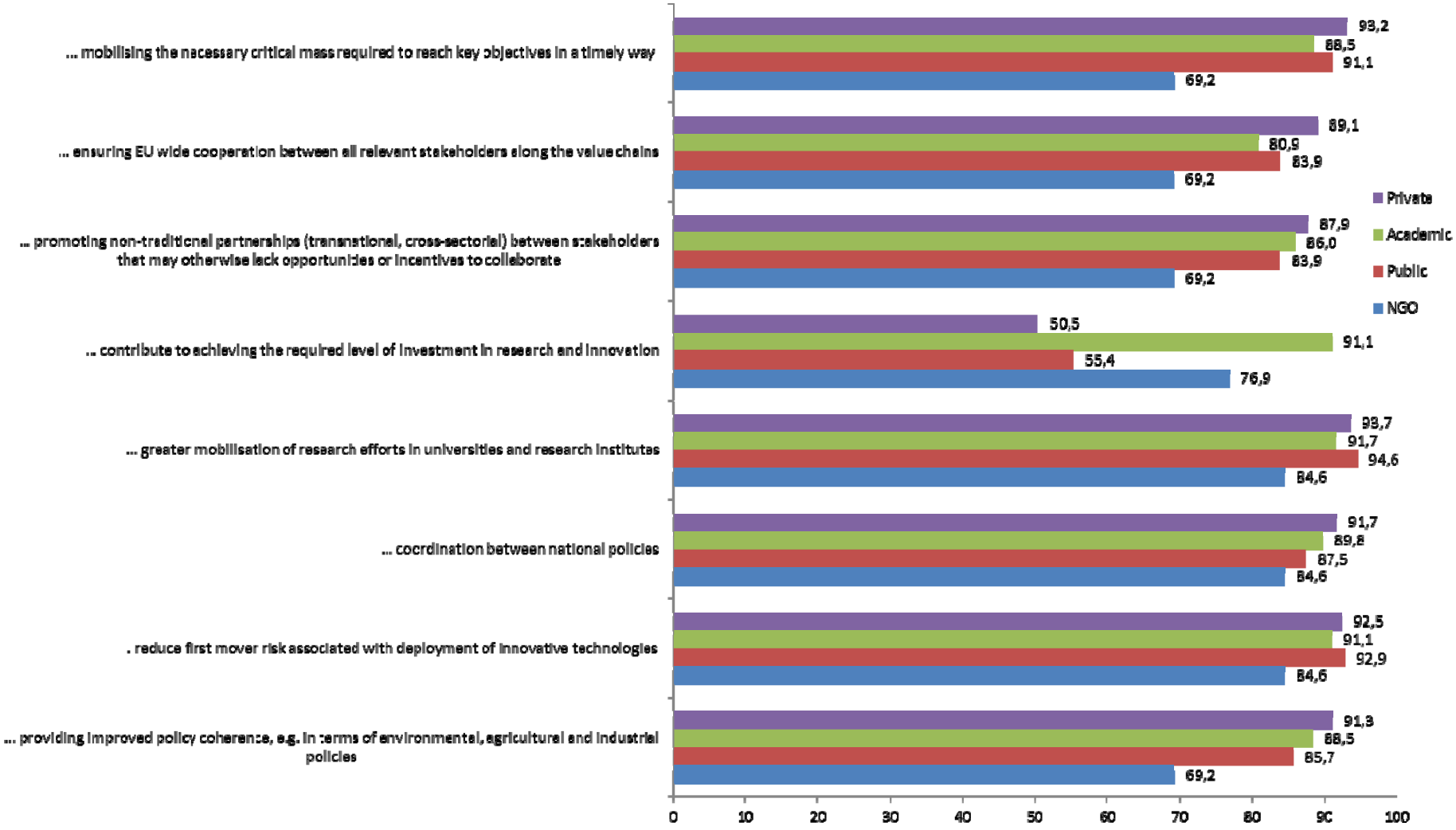


fig. 18 - EU intervention will provide added value in terms of: (%; strongly agree + agree)

differences by stakeholders



5. OBJECTIVES OF EU LEVEL INTERVENTION

Section D of the questionnaire sought stakeholder's views on a range of objectives of EU level intervention. Respondents were asked to rate in 5 steps from “Not important at all” to “Very important” the significance of these 15 objectives, the results of which are summarized in table 13.

According the replies received, the top 5 ranked EU level intervention objectives were as follows:

- facilitate more rapid deployment of promising technologies in pilot, demonstration and "first of its kind" industrial scale plants with 94.2%;
- generate knowledge required for competitiveness of EU industries in the medium and long term with 93.4%;
- promote effective collaboration on research and innovation between all stakeholders along the value chain for greening the industry with 93.3%;
- delivering innovative technologies for the use of biomass in smart and efficient no-waste processes with 92.0%;
- deliver innovative technologies aimed at building stable, competitive and sustainable biomass/biowaste supply chains (e.g. with regard to logistics and integration of supply networks) with 90.6%

The objective of "ensuring that greater emphasis is placed on seeking protection through intellectual property rights when promising results emerge" was the least supported statement by respondents, still receiving a relatively good mark of 64.9%.

With regard to differences between individual stakeholder groups, it was noted that in particular the objective of "reinforcing and effectively utilising the research and innovation potential present in Europe's universities and research centres" showed significantly higher support from academia compared to the public and private sectors. Given the discussions on the innovation "valley of death" in Europe, this could be interpreted as indeed there seems to be a gap between basic and applied research, which closer cooperation between academia and private sectors is expected to overcome.

With regard to differences between stakeholder groups, NGO seemed to consider the following 2 statements as of much lower importance than the other 3 groups:

- "ensure that greater emphasis is placed on seeking protection through intellectual property rights when promising results emerge" was considered by only 23.1% of NGOs as being an important objective of EU level intervention;
- "favour high industrial participation rates in funded projects" was considered important by 46.2% of NGO participants, still considerably lower compared to other stakeholders.

tab. 13 - Objectives of EU level intervention: EU level action on Research and Innovation in connection with bio-based industries should (%)

Items	Not at all important	Unimportant	Neutral	Important	Very important	No opinion	Total
… generate knowledge required for competitiveness of EU industries in the medium and long term	0,2	0,6	4,7	31,5	61,9	1,1	100,0
… boost EU leadership in technologies for conversion of lignocellulosic biomass and other non-food feedstock such as biowaste	0,0	0,5	7,4	26,2	64,3	1,6	100,0
… promote effective collaboration between stakeholders to conduct the research and innovation work required to ensure sufficient availability of biomass	0,0	0,6	7,8	33,7	56,7	1,2	100,0
… promote effective collaboration on research and innovation between all stakeholders along the value chain for greening the industry	0,0	1,3	4,9	33,4	59,9	0,5	100,0
… promote building projects with greater critical mass	0,3	2,5	12,9	29,5	53,3	1,5	100,0
… incentivise private sector stakeholders to increase their investment level in R&I	0,0	1,4	8,5	34,5	54,1	1,5	100,0
… help to build pan-European and cross-sectoral linkages with a view to achieving enhanced innovation success	0,0	1,3	29,9	37,3	29,6	1,9	100,0
… effectively promote the participation of SME's in funded projects	0,2	1,7	11,6	53,1	32,0	1,4	100,0
… favour high industrial participation rates in funded projects	0,2	1,4	13,2	31,8	52,4	1,0	100,0
… reinforce and effectively utilise the research and innovation potential present in Europe's universities and research centres	0,0	0,3	31,8	32,6	33,9	1,4	100,0
… ensure that greater emphasis is placed on seeking protection through intellectual property rights when promising results emerge	0,6	6,4	22,9	50,5	14,4	5,2	100,0
… facilitate more rapid deployment of promising technologies in pilot, demonstration and "first of its kind" industrial scale plants.	0,0	0,8	3,6	23,8	70,4	1,4	100,0
… deliver research and innovation outputs (e.g. related to standards or labels) that can stimulate the growth of the markets for bio-based products	0,2	1,6	8,8	30,1	57,5	1,8	100,0
… deliver innovative technologies for the use of biomass in smart and efficient no-waste processes	0,0	0,6	5,6	30,6	61,4	1,8	100,0
… deliver innovative technologies aimed at building stable, competitive and sustainable biomass/biowaste supply chains (e.g. with regard to logistics and integration of supply networks)	0,0	0,9	6,9	59,9	30,7	1,6	100,0

N. B. = "Very important" more than " Important"; = " Important" more than "Very important"; ="Neutral" more than 20%

fig. 19 - EU level action on Research and Innovation in connection with bio-based industries should (%; important + very important)

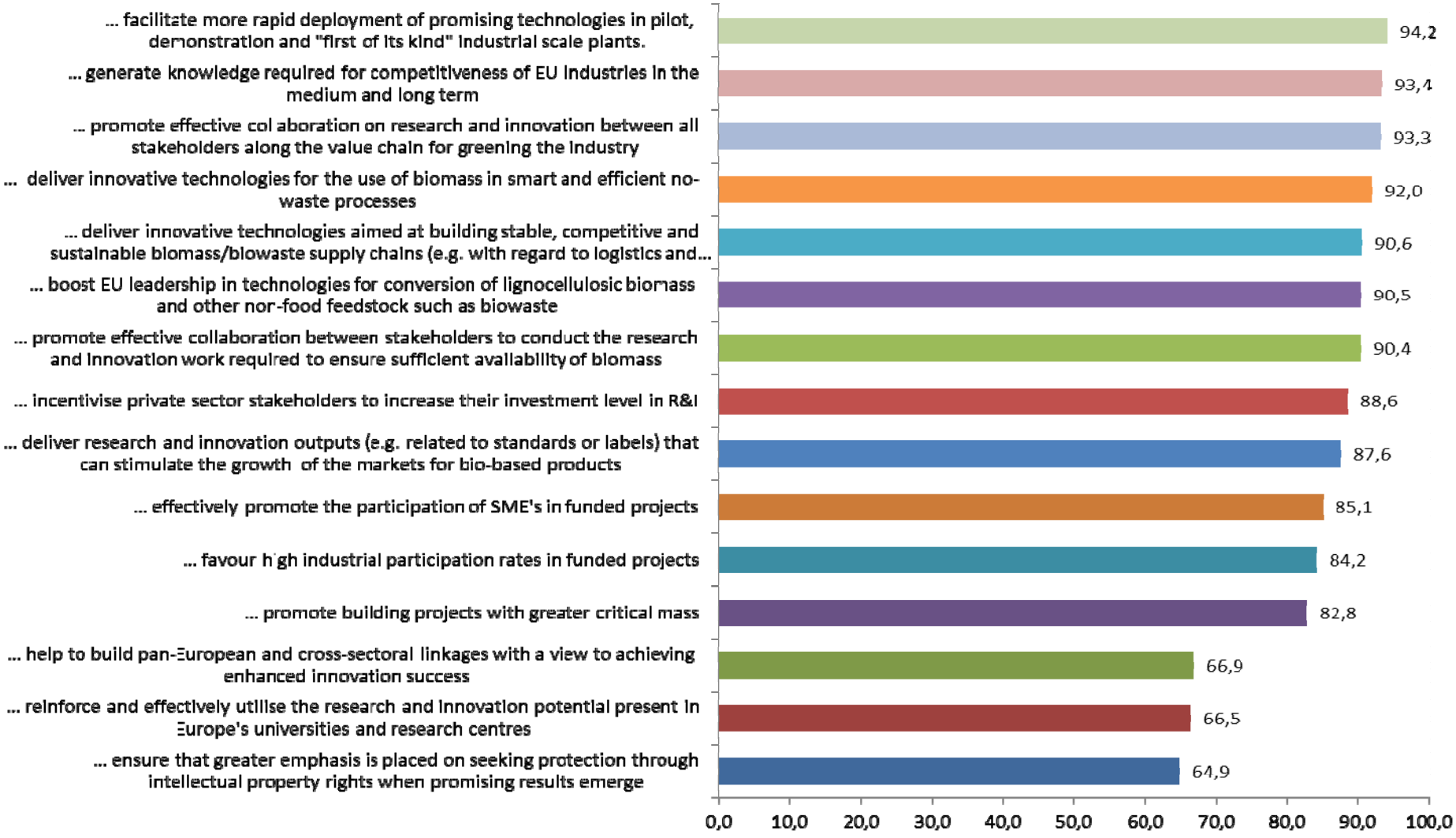
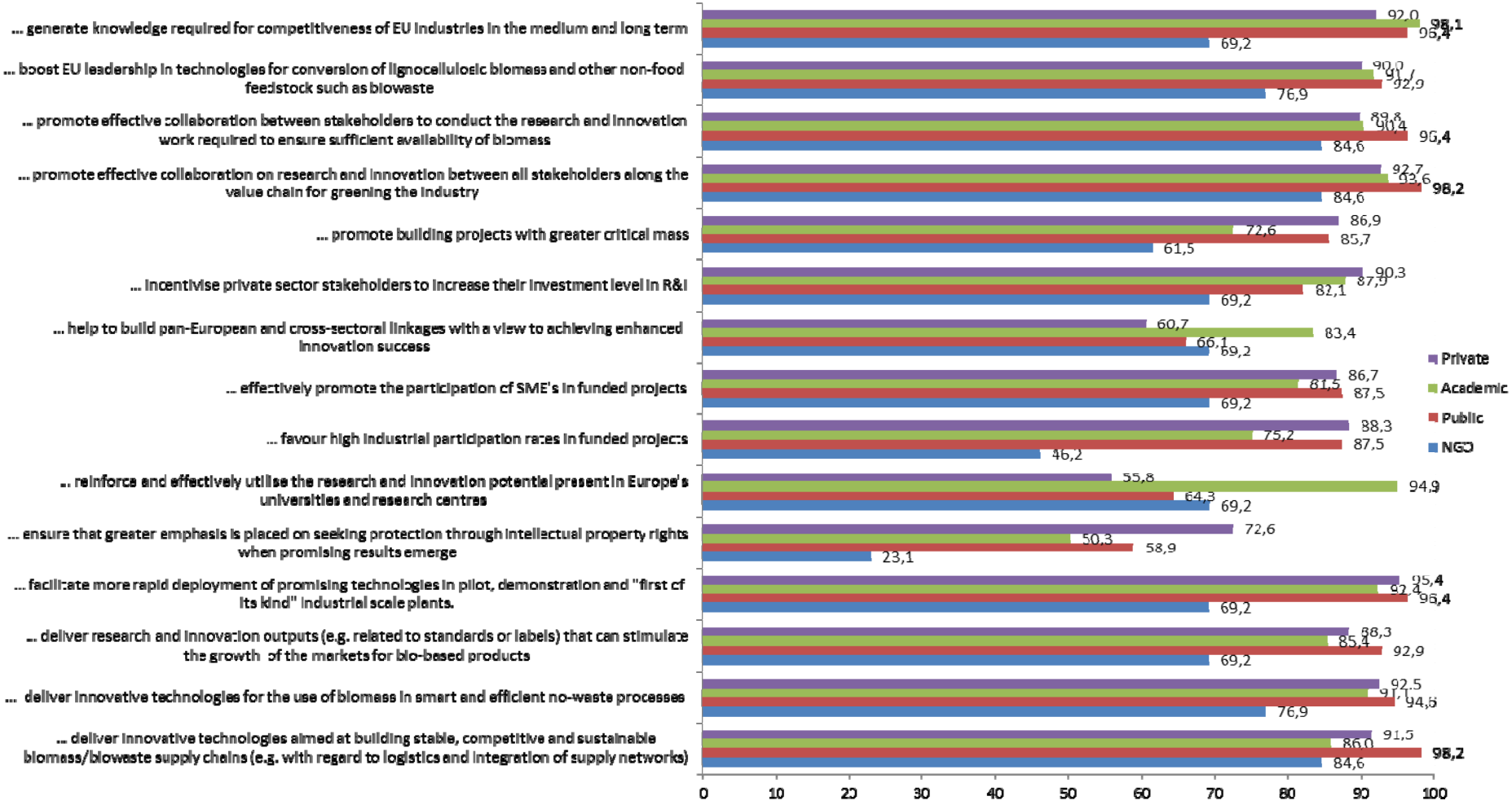


fig. 20 - EU level action on Research and Innovation in connection with bio-based industries should (%; important + very important)

differences by stakeholders

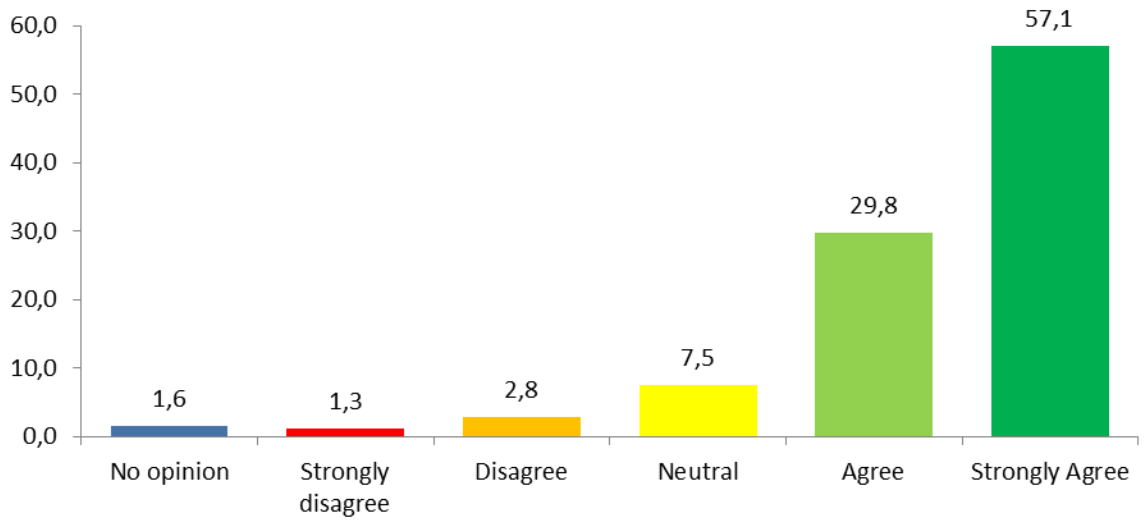


6. TOWARDS A PPP?

Section E of the questionnaire contained a single question seeking the view of stakeholders regarding the format of a future EU research programme on bio-based industries. It was explained in the questionnaire that compared to the standard management of collaborative research by the European Commission, setting up a PPP would allow for a much greater role of private sector stakeholders in establishing a jointly agreed long-term strategic research agenda with the European Commission. It was furthermore explained that compared to standard collaborative research, a PPP would allow to take on board a greater private sector financial contribution, thus generating additional "leverage" at European level and that different types of PPP structures could be considered.

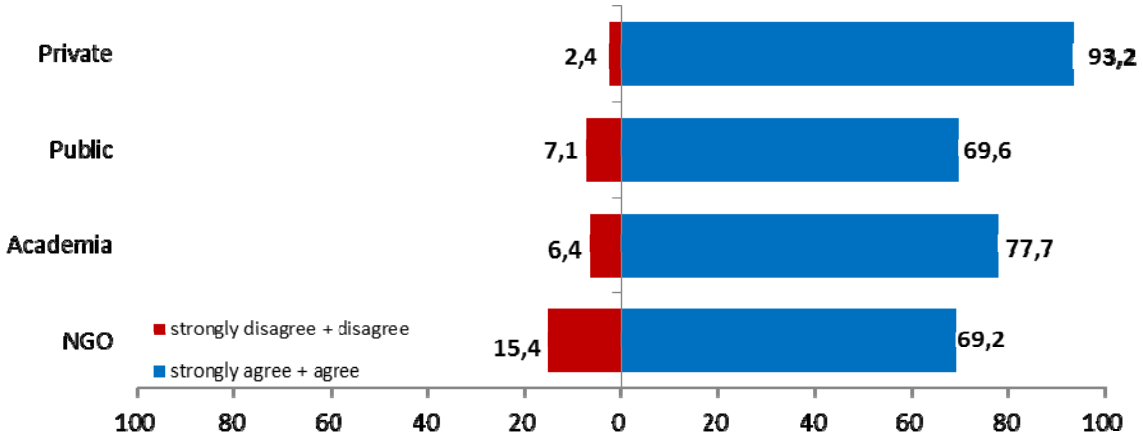
The vast majority of stakeholders, 86.9%, agreed or strongly agreed that a PPP was the most appropriate mechanism to implement the research and innovation programme for bio-based industries under Horizon 2020 (fig. 21).

fig. 21 - A public-private partnership is the most appropriate mechanism to implement the Research and Innovation Programme for bio-based Industries under Horizon 2020 (%)



The idea that a PPP could be the best solution to foster the implementation of a research and innovation programme was strongly supported by the private sector with 93,2%, followed by academia with 77.7%, the public sector with 69.6% and NGOs with 69.2% (fig. 22).

fig. 22 – Agreement towards PPP per Stakeholders (%)



7. IMPACTS

Section F explores the potential impact of EU research and innovation actions - applied in the context of a PPP - on bio-based industries. Specifically, respondents were asked to rate on a 5 point scale from "strongly disagree" to "strongly agree", their agreement with twelve medium or longer-term socio-economic impacts that one can expect to achieve as a result of an optimal development of the bio-based industries in Europe under the PPP frame.

Considering together "strongly agree" or "agree", all the items were scored with a mark higher than 80%. This significant result means that interviewees are very favorable to a European research and innovation strategy on the basis of a PPP and they believe that implementing this could produce many favorable outcomes in terms of socio-economic impact (tab. 14).

Participants mostly appreciated the following statements, when they were asked whether research and innovation work done in the context of a PPP:

- will enable a greater use of renewable biomaterials in a wide range of products (92.3%);
- will help to increase overall investments in research and innovation activities in the EU in the sectors concerned (91.4%);
- will help ensure that bio-based industries develop in line with EU objectives on sustainability (90.6%);
- will contribute to the competitiveness of bio-based industries in the EU at a global level (89.5%);
- will contribute to developing technologies that allow the conversion/upgrading of existing plants to use new types of biomass input and / or to manufacture new products (88.7%);
- will help in achieving EU ambitions with regard to bio-based products from biomass in a way that is environmentally sustainable and compatible with food/feed security (88.2%);
- will increase the chances of setting up "first of its kind" industrial scale biorefineries in the EU based on innovative processes (87.7%);
- will contribute to the creation of new jobs in rural and/or coastal areas (85.3%).

The least supported items were:

- will contribute to the creation of new and attractive income streams for farmers, foresters and aquaculture (81.5%) and,

- will help ensure development of bio-based industries in a way that is compatible with food security objectives (82.7%).

Results clearly indicate that the private sector is more confident towards the socio-economic effects of a PPP than the academic and the public sectors: the percentage of "strongly agree + agree" expressed by respondents from the private sector is by far the highest in all the items but one; "will enable a greater use of renewable biomaterials in a wide range of products" received slightly more support from the academic sector (94.3 vs 93.9%).

Tab. 14 - Achievement of Socio-economic Impacts: Research and innovation work done in the context of a PPP on bio-based industries … (%)

Items	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree	No opinion	Total
… will help ensure development of bio-based industries in a way that is compatible with food security objectives	0,6	2,5	11,4	29,3	53,4	2,8	100,0
… will help ensure that bio-based industries develop in line with EU objectives on sustainability	0,5	2,0	5,6	36,4	54,2	1,3	100,0
… will contribute to developing technologies that allow the conversion/upgrading of existing plants to use new types of biomass input and / or to manufacture new products	0,5	1,6	7,1	33,4	55,3	2,1	100,0
… will increase the chances of setting up "first of its kind" industrial scale biorefineries in the EU based on innovative processes	0,5	1,3	8,2	31,3	56,4	2,3	100,0
… will contribute to the competitiveness of bio-based industries in the EU at a global level	0,3	2,2	6,7	29,5	60,0	1,3	100,0
… will contribute to the development of more effective biomass supply chains in the EU	0,5	2,5	11,0	35,0	49,4	1,6	100,0
… will contribute to the creation of new and attractive income streams for farmers, foresters and aquaculture	0,2	2,7	13,0	29,8	51,7	2,6	100,0
… will contribute to the creation of new jobs in rural and/or coastal areas	0,3	3,0	8,6	28,1	57,2	2,8	100,0
… will contribute to achieving EU greenhouse gas emission reduction objectives	0,3	3,6	10,5	28,2	55,2	2,2	100,0
… will enable a greater use of renewable biomaterials in a wide range of products	0,2	0,8	5,0	26,8	65,5	1,7	100,0
… will help in achieving EU ambitions with regard to bio-based products from biomass in a way that is environmentally sustainable and compatible with food/feed security	0,6	1,7	6,7	29,9	58,3	2,8	100,0
… will help to increase overall investments in research and innovation activities in the EU in the sectors concerned	0,2	1,6	5,6	29,0	62,4	1,4	100,0

N. B. = *"Strongly agree" more than 50%;* = *"Neutral" more than 10%*

Fig. 23 - Achievement of Socio-economic Impacts: Research and innovation work done in the context of a PPP on bio-based industries (%; strongly agree + agree)

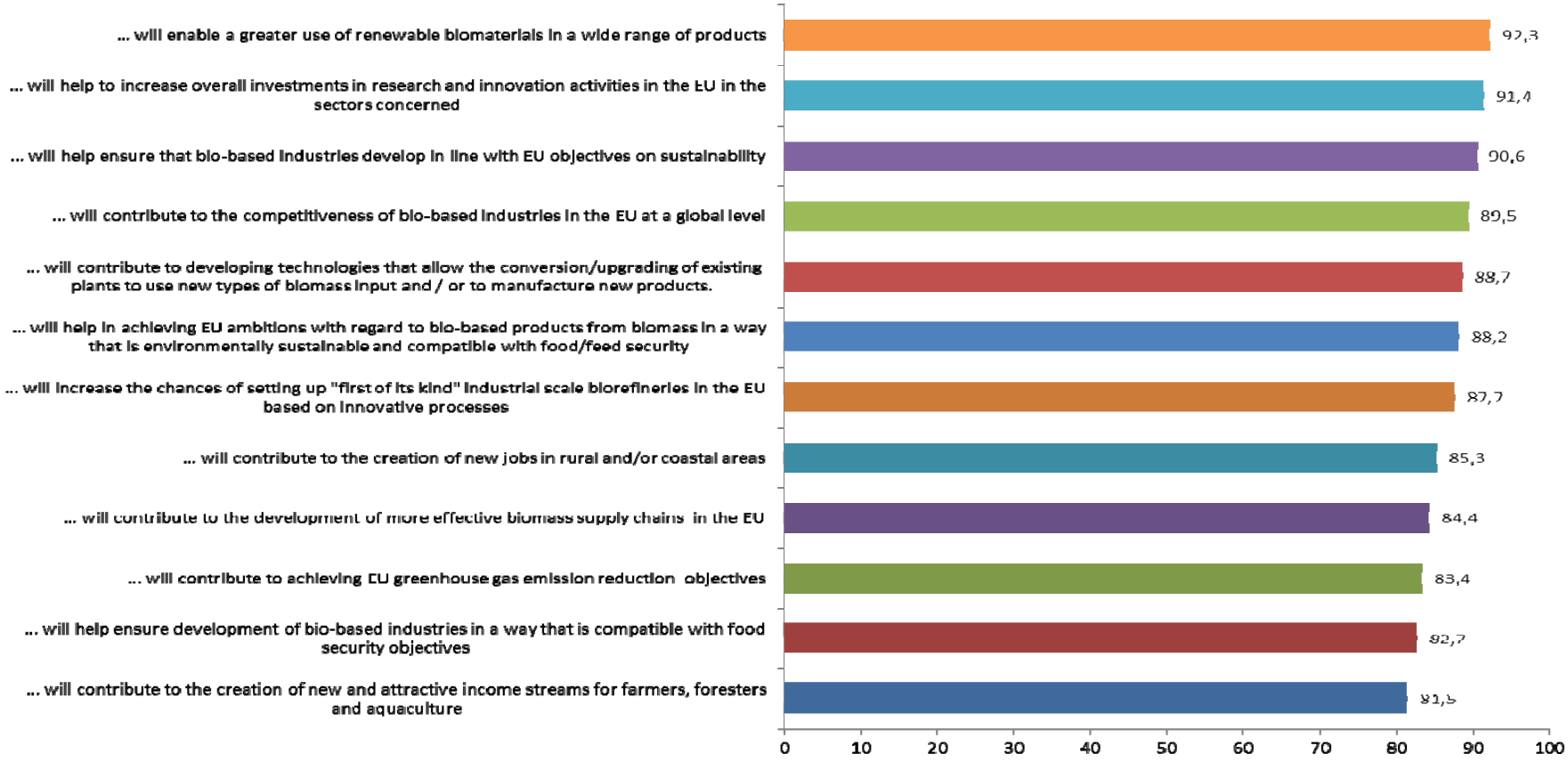
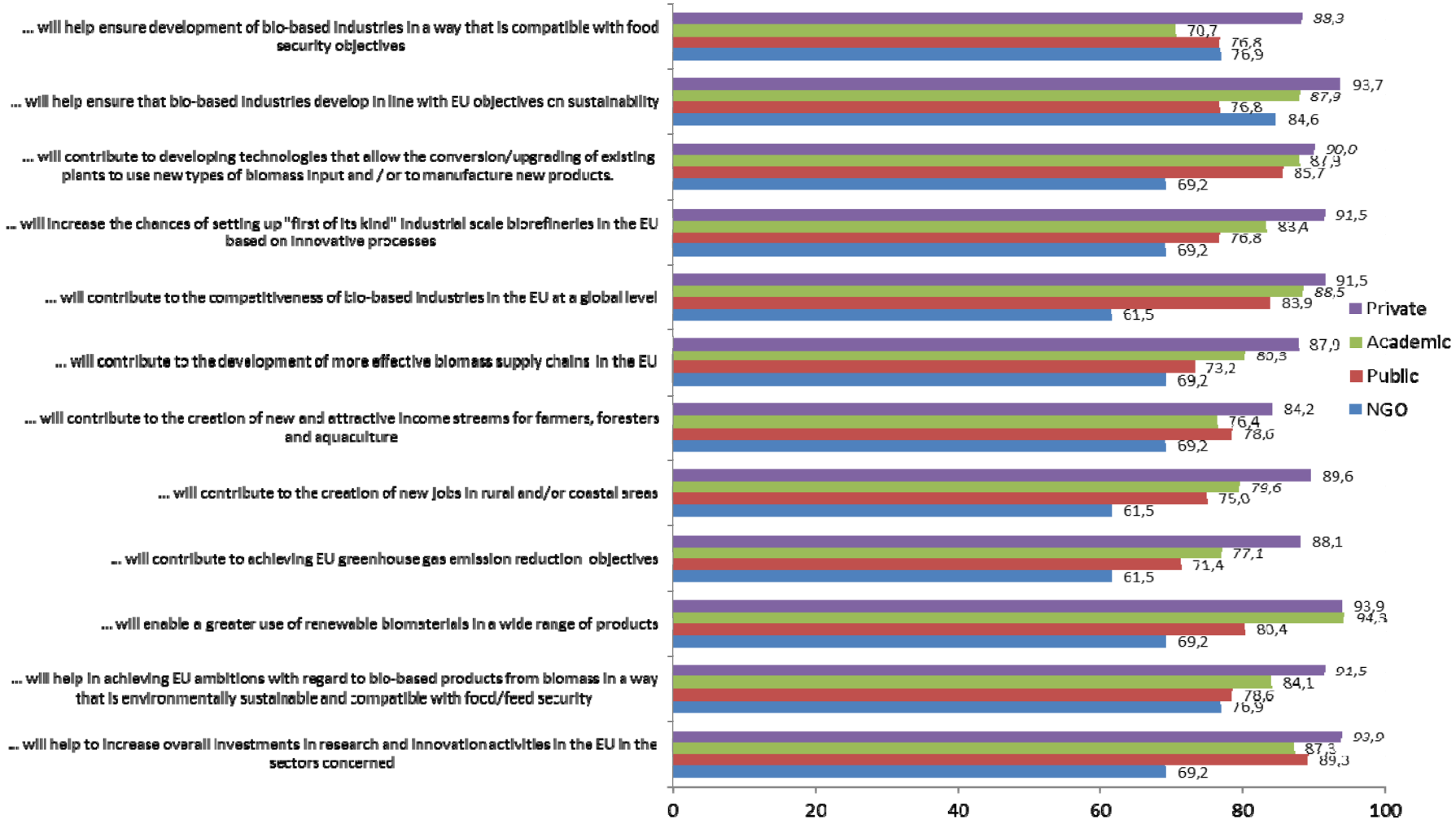


Fig. 24 - Achievement of Socio-economic Impacts: Research and innovation work done in the context of a PPP on bio-based industries (%; strongly agree + agree)

differences by stakeholders



ANNEX 5 - CURRENT AND FUTURE POTENTIAL OF BIOMASS AS A SOURCE OF MATERIALS AND ENERGY

This Annex presents some considerations regarding the availability of advanced sustainable biomass resources necessary to achieve the different quantitative targets envisioned for the EU's bio-based industries, in terms of production of materials, fuels and energy. These considerations rely on a number of studies authored e.g. by the European Environmental Agency. It is however important to acknowledge that the sourcing of additional biomass has to be fully compliant with the European agricultural, environmental and renewable energy/biofuels policies. This implies sustainability of agricultural production or forest management, sustainable utilisation of agricultural residues and organic wastes and smart use of marginal and degraded lands for production of dedicated industrial crops. Such considerations would need to be addressed at programme and/or project level, before any implementing actions would be carried out, e.g. in the form of life-cycle assessments.

Furthermore, this annex does not attempt to simultaneously assess whether the biomass flows that are theoretically available can also be mobilised at an economically competitive cost taking into account the current state of technology and other organisational factors.

It should also be noted that according to the National Renewable Energy Action Plans[3] (NREAP) of Member States, the production of biofuels from waste feedstocks and advanced biofuels technologies is not expected to be significant and lower than anticipated, reaching only 2.3 million tonnes of oil equivalent (Mtoe) (approximately 1.5% with double counting) in 2020. The Impact Assessment prepared in the context of amending Directives 98/70/EC and 2009/28/EC to better address indirect-land-use-change reports that the installed capacity for advanced biofuels is currently negligible in the MS, limited to a few pilot plants; it however does not reflect upon future national plans for increasing the industrial capacities to produce advanced biofuels.

Arriving at a substantiated and comprehensive overall view is challenging since it requires aggregating data for a number of sectors which are often considered separately in different studies. Aggregation challenges include (i) combining biomass supply data from agriculture, forestry and waste streams; and (ii) integrating materials and energy potential.

Current status – Use of biomass

Based on the Nova-Institute, an overall estimate of the total amount of biomass used in the EU for energy and material uses was provided[4]. Total use is estimated to amount to 470 million tonnes. This includes biomass from agriculture and biomass, including imported biomass (but not imported biofuels).

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3 Plans available under http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm

4 Bio-based Economy in the EU---27: A first quantitative assessment of biomass use in the EU industry; nova-Institut, August 2012.

The lion's share (400 million tonnes) comes from **forestry** with an estimated 230 million tonnes of wood used as a "classical" bio-based material for the woodworking and the pulp and paper industries. 170 million tonnes of wood are used for production of energy (mainly heat and power)[5].

The amount of biomass from agriculture, transformed in industrial material and energy is estimated to amount to 70 million tonnes, with energy use (40 million tonnes) estimated to be somewhat larger than material use (30 million tonnes). Obviously, a much larger share of biomass from agriculture (> 90 %) goes into food and feed applications.

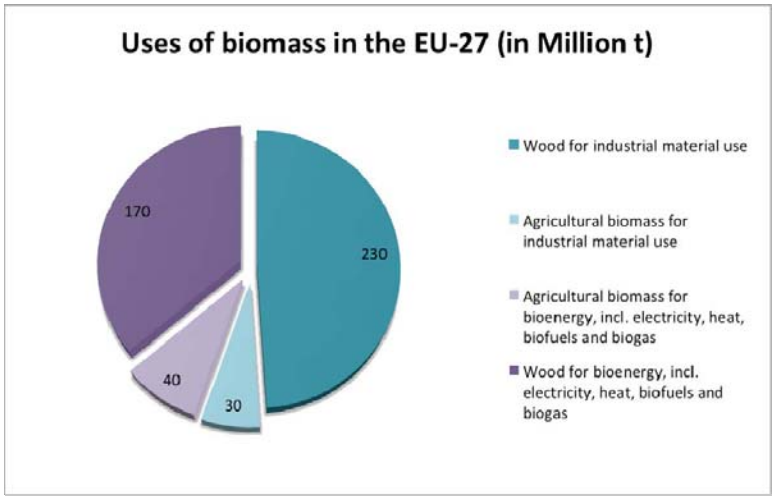

Figure 1

Important features to note:

- In spite of the fact that liquid biofuels are a subject of more active debate, on a weight basis, the use of wood for energy production (mainly heat and power) is estimated to exceed by a factor of > 4 the use of **agricultural** biomass for energy production.

- **Biofuels** are currently mainly produced from agricultural biomass, today mostly foodcrops. The estimated 2010 use of biomass in the EU for liquid biofuel production amounted to approximately 10 million tonnes of oil (of which 6.3 million tonnes are rapeseed oil) and approximately 17,5 million tonnes of starch/sugar crops (sugarbeet >>wheat > corn<other cereals.).

- Starch, sugar and oilseed crops are also the most important crops serving as a raw material input for producing **industrial materials**. According to Carus the estimated 30 million tonnes of agricultural biomass dedicated to the production of materials corresponds to some 16,5 million tonnes of pure starch (10,3 million tonnes), sugar (1 million tonnes), oils (3,1 million tonnes) and fibre (1,8 million tonnes) which are actually used by industry. This is in line with the 30 million tonnes estimated since the remainder of the biomass use represents the residual fractions of the crop.

[5] According to Wood Flows in Europe (U. Mantau) 577.1 million m3 of wood resources are used in the EU (estimated to correspond to appr. 450 million tonnes) ; with 36 % used for energy applications, 18,7 % for pulp and paper and 45,2 % for the woodworking industry.

In addition to European biomass supplies, imported biofuels and biomass (such as wood pellets) contribute to the total[6] and are important for Europe in terms of stabilizing supplies and price levels.

Current status – Production of energy and materials

Biomass contributes about 85 Mtoe (million tonnes of oil equivalent) to the EU energy mix. Biomass is thus by far **the single most important source of renewable energy in the EU.**[7] (source market observatory energy statistics EU). Renewable sources overall contribute 12.5 % of the EU's total gross energy consumption.

The EU's **liquid biofuel** production amounted to **12 Mtoe** with biodiesel (9,6 Mtoe) well ahead of bioethanol (2.3 Mtoe). The EU production of biofuels in 2010 thus represented appr. 3 % of the 370 Mtoe final energy consumption of the transport sector 370 Mtoe.

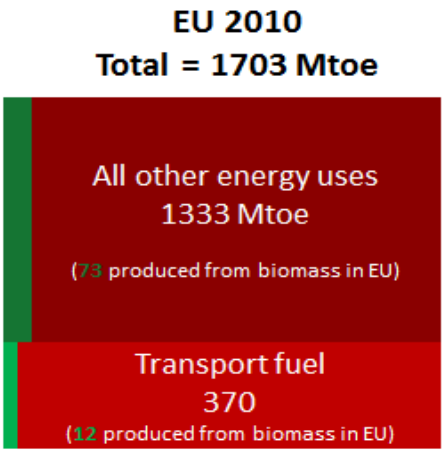

Figure 2

When looking at materials use of biomass, wood is by far the most important source of biomass with 230 million tonnes, primarily used in the woodworking and pulp and paper industry.

The amount of agricultural biomass dedicated to industrial material uses is estimated at 30 million tonnes.

- In the textile sector, the share of bio-based activities is estimated to be around 50 % (based on natural fibres).

- In the chemical industry, experts estimate that the current share by volume of bio-based inputs in the amounts to approximately 10 % (with a higher fraction for specialty and fine chemicals and a lower fraction for polymers and other bulk chemicals).

6 See e.g. Global wood chip trade for energy Lamers et al. 2012 – IEA Task 40

7 Appr. 57 % out of a total renewable energy production of 150 Mtoe.

- More specific estimates can be provided for certain specific subcategories of "chemicals": bioplastics (some 0.2 million tonnes or less than 1 % of all plastics), bio-composites (0.35 million tonnes representing some 14 % of all composite materials), bio-lubricants (0.15 million tonnes), bio-solvents (0.63 million tonnes). Bio-surfactants (1.5 million tonnes) represent the largest specific product category.

This short analysis clearly highlights that biomass is already today a very important source of energy and materials, at least when we combine "traditional" and "new" bio-based industries. It further puts in perspective the particular significance of the forestry component in total biomass use. As to the use agricultural crops for industrial applications, striking features are the predominant use of food crops. As of today, "residual" fractions and waste streams are still of very limited relevance in the overall picture of biomass-based energy and materials production.

Perspectives for sustainable growth

An increase in the share of energy and materials derived from biomass by in a 2020 to 2030 timeframe, can be achieved by

- making more efficient use of biomass resources as they already exist today (e.g. forest resources , agricultural residues and biowaste streams).

- producing more and/or different types of biomass e.g. by increasing agricultural productivity, expanding production of specific biomass crops.

Progress will further depend on the state of play with regard to biomass conversion technologies (e.g. making new types of biomass accessible to efficient conversion) and on possibilities to use biomass in a smarter way (e.g. producing multiple products from a single source material).

The echoes of the "food versus fuel" debate sometimes tend to lead to a perception that there is limited or no scope for making greater/better use of biomass for energy and/or materials production. A brief review of several in-depth studies on biomass potential and availability is therefore provided below. All studies conclude that there is significant potential to expand the share of energy and/or materials production from biomass in a 2020 to 2030 timeframe in a sustainable way and without entering into conflict with food and feed security.

Obviously, a number of conditions will need to be met to realize this potential in a sustainable way. Studies differ in their assessment of these conditions, and in the extent to which they have been taken into account. **A review of these issues is beyond the ambition of this annex.** Amongst the important parameters we can mention: further modernization and efficiency increases in conventional agricultural production and livestock management are essential, effective sustainability frameworks, proper zoning and evolution of agricultural policies.
A range of estimates is available for **three major sources of biomass** that could support further growth of the bio-based industries as compared to the current status.

A first source of biomass relates to different **types of agricultural residues** and waste that are currently underutilized. Estimates range from 70 million tonnes to 225 million tonnes in the 2030 timeframe. The lower estimates place strong restrictions on collection of agricultural residues, e.g. for reasons related to protection of soil fertility. In energy equivalent this corresponds to a range from 44 to 141 Mtoe.

So far however, a lack of studies was noted that quantify the biomass potential from agricultural production while taking fully into account current and upcoming EU policies on agriculture and environmental requirements. For instance, the utilisation of straw that otherwise would be incorporated into the soil in all cases reduces the carbon content in the soil. This can reduce soil fertility, which can imply a loss of productivity, water and nutrient retention and thereby overall increased greenhouse gas emissions. Life cycle analyses that compare the greenhouse gas balance of straw utilisation with soil incorporation in a quantitative way are not yet available.

Study	Agricultural Biomass Potential (million tonnes)	Comments
IEA, 2011 low scenario	90,3	assuming 10% of residues are collected
IEA, 2011 high scenario	225,7	assuming 25% of residues are collected
Elbersen et al., 2012	158	assuming 20% of residues are collected
BNEF, 2012	150	assuming 17.5% of residues are collected
EEA, 2006	70	very high restrictions for straw availability
Panoutsou et al., 2009	123	
EUBIONET, 2011	98	
BEE, 2010 low	73	
BEE, 2010 High	207	
RENEW	134	Only cereal straw
DBFZ & Oeko Institute, 2010	110	Only cereal straw
EEA, 2012	119	For 2020, in Storyline 1(economy & market first)
de Wit et al., 2010	206	

Table 1

A second source of biomass relates to **additional biomass from sustainable forestry**. Compared to an estimated current use of 400 million tonnes, it is estimated that EU forests could sustainably supply between 237 and 342 million tonnes of additional woody biomass (an energy equivalent of between 162 and 233 Mtoe) by 2030.

Study	Forest Biomass Potential (million tonnes)	Comments
EUWOOD low, 2010	625	the total potential that could be supplied by forests in the EU, regardless whether it is used for material or for energetic use.
EUWOOD high, 2010	898	
Elbersen et al., 2012	342	
EEA, 2006	326	
Panoutsou et al., 2009	267	
EUBIONET, 2011	237	Additional potential to exploit
BEE, 2010 low	222	
BEE, 2010 High	514	
RENEW	expecting data	
EEA, 2012	330	For 2020, in Storyline 1(economy & market first)
de Wit et al., 2010	750	

Table 2

Estimates strongly depend on assumptions related to the quality of forest management, constraints that may apply in terms of biodiversity safeguards as well as on projections with regard to future "conventional" demand for wood (e.g. in the pulp and paper industry).

Potential for increased mobilisation but need for better data: A clear potential to increase forest utilisation for energy exists in most countries of the EU as only 60 – 70% of the annual increment of EU forests is harvested. Much of the potential for expansion can be found in small private holdings, comprising forest residues and complementary fellings, namely first thinnings. The pattern of supply of wood for energy varies widely between countries, but calculations at EU – level on such a potential of wood for energy differ significantly. It will be important to improve the information available about it.

Forest fragmentation has an impact on mobilisation: The average size of forest ownership in the EU is only 12.7 ha in case of private holdings and about 975 ha in case of public holdings. However, there are also considerable differences in the average size of private forest holdings between individual Member States and regions. A further increase in the number of private holdings is expected in several Eastern European countries due to on-going restitution or privatisation processes. In other countries forest holdings may be subdivided, as a rule due to successive inheritances. Fragmented forest ownership structures will be of increasing relevance for the European forest sector, which has an impact on wood mobilisation.

Need to ensure sustainable forest management: For forest based biomass, the principles of Sustainable Forest Management that ensure safeguarding economic, ecological and social functions of forests should apply for forest management activities. The implementation of the new EU Forest Strategy will address this.

A third major source of biomass relates to **dedicated production of industrial crops on agricultural land**. Estimates for the EU in 2030 vary largely, see table 2.

Study	Agricultural Biomass Potential (million tonnes)	Comments
EEA, 2006	325	especially for innovative bioenergy crops.
EEA, 2012	217	**16.7 million ha available in 2020** in Storyline 1 (economy & market first)
Elbersen et al., 2012	234	**18.8 million ha in 2030**, reference scenario - Biomass Futures project
Fischer et al., 2010	575	Agricultural land potentially available for growing biofuel feedstocks in 2030: EU27 & Ukraine/ LU-Env scenario: **44.2 million ha**

Table 3

Net land availability for dedicated industrial crops depends strongly on various policies and trends (e.g. agricultural and environmental policies, international trade), time-frame and geographical scope. Assuming steady improvements in agricultural management, in line with what has been historically achieved, and measures to ensure compliance with sustainability criteria, industrial crops can be expected to represent a large resource category.

A consolidated picture then emerges, indicating that in addition to current uses of biomass, some 100 million tonnes of agricultural residues + 300 million tonnes of forest material + 250 million tonnes of biomass from industrial crops could serve as sustainable feedstock for new bio-based industries. This represents a total of 650 million tonnes. This figure however needs

to be ascertained through further research addressing the potential of producing industrial crops in dependence of EU sustainability criteria and policies.

The industry vision document aims for 30 % of all chemicals to be bio-based by 2030. Taking into account that the current share is approximately at 10 %, this would mean that biomass use for production of chemicals will need to be multiplied by a factor of approximately 3. Today's production of chemicals is primarily derived from food crops, with an estimated use of less than 30 million tonnes (this figures includes textiles). Extrapolating from the current status (and assuming the use of food crops is maintained at the current level) we can thus estimate that allocating around 60 million tonnes or only 10 % of the "additional biomass potential" to industrial materials uses should go a long way in supporting the projected transformation of the chemical industry to much greater use of bio-based resources. This overall estimate makes abstraction of specific types of biomass available and is obviously based on the assumption that suitable conversion processes will be developed for the types of biomass that is actually available.

If "industrial materials" targets can be reached with 60 million tonnes, close to 600 million tonnes of biomass could be left for energy related uses over and above current energy uses. This could represent an energy equivalent of 376.8 Mtoe. With projected transport fuel consumption in 2030 at around 400 Mtoe, biomass availability per se is not an obstacle to reach 100 Mtoe or a 25 % contribution of advanced biofuels to the transport fuel mix, thereby liberating the 30 million tonnes of agricultural materials currently dedicated to first generation biofuels. In fact, an additional 276.8 Mtoe could remain available to expand other types of energy uses. Non biofuel energy uses (e.g. production of electricity and heat, mainly based on wood resources) are estimated to amount to approximately 73 Mtoe today and could thus be expanded to reach well over 300 Mtoe. Biomass could thus support a total energy production (fuel + non-fuel) of around 400 Mtoe by 2030. EU total energy consumption (now 1703 Mtoe) is expected to remain constant or to decline in overall terms; hence a contribution of around 25 % renewable energy derived from biomass appears within reach from the perspective of theoretical sustainable biomass supply potential.

Economic factors such as cost of mobilising certain types of biomass and the availability of capital for the rapid development of biorefinery infrastructure are likely to lead to a growth scenario under which the theoretical potential of available biomass will not be exhausted in the foreseeable future.

ANNEX 6– OVERVIEW OF RESEARCH AND INNOVATION AT REGIONAL AND NATIONAL LEVEL

Germany

The BioEconomy Research and Technology Council (BioÖkonomieRat[8]), was founded jointly by the German Ministry of Education and Research and the Ministry of Food, Agriculture and Consumer Protection, and is an independent advisory body to the German government for all matters relating to bioeconomy. The Council is made up of experts from university and non-university research institutes, the federal government's own departmental research, and from research in the private sector. The mission of the BioEconomy Council is to improve parameters, accelerate the development of innovative technologies, and identify the need for future research. Another task of the Council is to analyse the strategic goals of Germany as a whole, the individual Regions, as well as those set within the EU and other international partner countries. The BioEconomy Council's first term has been set at three years, and is supported by an office in Berlin.

The concrete aims of the BioEconomy Council are:

- To offer an overview of the opportunities and prospects of the bio-economy in Germany;
- To deliver scientifically-based recommendations for measures to improve parameters;
- To develop scenarios to create parameters for research, education and training, and student support;
- To help strengthen networks of relevant actors from science, business and politics with a view to achieving maximum harmonisation on strategic questions.

In 2010, the Council published its analytical "Bio-economy Innovation Report[9]", placing emphasis on increasing biomass yield volumes and more efficient production processes in the food and energy sectors. Meanwhile, also two reports with recommendations were published: the report "Combine disciplines, improve parameters, seek out international partnership[10]" suggested for a restructuring of research funding and recommended incentive systems for private investment, and in the report "Priorities in Bio-economic Research[11]"), the BioEconomy Council defined the priorities with regard to relevance and urgency of the

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8 http://www.biooekonomierat.de

9 BÖR (2010). Bio-economy Innovation: Research and technological development to ensure food security, the sustainable use of resources and competitiveness. Bio-Economy Research and Technology Council. ISBN 978-3-942044-03-5. http://bioeconomy.dk/bioeconomyinnovationreport2010.pdf

10 BÖR (2009). Combine disciplines, improve parameters, seek out international partnerships. First recommendations for research into the bio-economy in Germany. Bio-Economy Research and Technology Council. ISBN 978-3-942044-16-5. http://bioeconomy.dk/GermanBioeconomyCouncil_RecommendationsNo.1.pdf

11 BÖR, (2011). *Priorities in Bio-economic Research. Recommendations of the Bio-economy Council.* Bio-Economy Research and Technology Council. ISBN 978-3-942044-20-2. http://bioeconomy.dk/GermanBioeconomyCouncil_Recommendations_No2.pdf

research topics. The Council has recently been very critical towards the focus on bioenergy alone, arguing for more actions on behalf of industrial biomass use[12].

Germany also developed an "Action plan for the industrial use of renewable raw materials[13]".

In 2007, the German Federal Ministry of Education and Research initiated the creation of five German regional industrial biotech clusters. Among these clusters is CLIB2021[14] (cofounded by the Ministry of Innovation, Science and Research of the German State of NRW) with 32 founding members. Since then the cluster grew to include more than 70 academic institutes, companies and investors, launched R&D projects with a total volume of 50 million Euros, founded 5 start-ups and attracted 10% international members. Another cluster is BioM WB[15] with two demonstration plants for cellulosic ethanol and acetic acid, a new multi-purpose pilot plant for and a degree programme of industrial biotechnology at the Technical University of Munich.

In order to develop visions for the next generation of biotechnological processes and their realization, the German Federal Ministry of Education and Research (BMBF) has started in 2010 a common and longterm (over the next 10-15 years) strategy process together with German Research Organisations (Max-Planck-Gesellschaft, Fraunhofer-Gesellschaft, Helmholtz-Gemeinschaft and Leibniz-Gemeinschaft) and German Universities. The cooperation of the research organisations has been documented in a Memorandum of Understanding. This strategy process is accompanied and advised by a newly founded coordination committee, in which all partners are represented. This strategy process brings the German research organisations, universities and ministry of education and research together to a common dialogue. Expert discussion meetings, a yearly congress and a website[16] describing a national competence map and the progress of this strategy process have been created to assist the strategy process. In addition a new research price has been installed this year, which will stimulate promising researchers, because they can apply for the creation and financing of their own independent research group for up to five years if successful. It is by the cooperation of all relevant drivers from science, industry and politics in the framework of this strategy process, by which a roadmap will be developed describing the most important scientific and technological milestones. This will form the base for future funding initiatives, which will accelerate the development of a next generation of biotechnological processes.

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12 BÖR, (2012). *Nachhaltige Nutzung von Energie aus Biomasse im Spannungsfeld von Klimaschutz, Landschaft und Gesellschaft.* Bio-Economy Research and Technology Council. http://www.bioenergie.uni-goettingen.de/fileadmin/user_upload/admin/PR/Bioenergie2011Projekt-lowres.pdf

13 BMELV (2009). *Aktionsplan der Bundesregierung zur stofflichen Nutzung nachwachsender Rohstoffe.* Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz. http://www.bmelv.de/SharedDocs/Downloads/Broschueren/AktionsplanNaWaRo.pdf?

14 http://www.clib2021.de

15 http://www.biom-wb.de

16 http://www.biotechnologie2020plus.de

The Netherlands

In the Netherlands, the previous Cabinet of Economic Affairs, Agriculture and Innovation has decided that the biobased economy is one of the strong emerging economic pillars to be supported. The development of the national strategy was the result of an on-going interaction between business, society, and science, stimulated by policy makers. In April 2012, the Cabinet presented a mid- and longterm vision and strategy for the biobased economy[17]. Also the new Cabinet "Rutte 2" has taken up the biobased economy as one of the priority themes.

The innovation contract biobased economy is a joint agenda developed by the industry and the research organisations. It contains 6 working packages, each covering the entire innovation chain (from more basic research to valorisation). 'Biobased materials' is one of the working packages. In total more than 100 companies will participate in the projects, and have committed more than EUR 200 million[18].

BE-Basic[19] (Biobased Ecologically Balanced Sustainable Industrial Chemistry) is a public-private partnership that develops industrial biobased solutions for a sustainable society, and has an R&D budget of more than EUR 120 million. Half of this is funded by the Ministry of Economic Affairs, Agriculture and Innovation. BE-Basic was founded early 2010, and puts its international focus into practice through strategic partnerships in a selected number of countries: Brazil, Malaysia, the US and Vietnam.

Sweden

In February 2012, the Swedish Government prepared a "Swedish Research and Innovation Strategy for a Biobased Economy[20]". The following research and development needs were defined: the replacement of fossil-based raw materials with biobased raw materials, smarter products and smarter use of raw materials, change in consumption habits and attitude and prioritisation and choice of measures (*e.g.* environmental consequences, socio-economic consequences, governing policies).

France

In 2005, the French General Directorate for Competitiveness, Industry and Services has created the so-called Competitiveness clusters, an initiative that brings together companies, research centers and educational institutions in order to develop synergies and cooperative efforts. The French Government accompanies cluster development by allocating financial support for the best R&D and innovation platform initiatives via calls for projects or by seeking assistance from local authorities, who can also provide financial support for cluster projects (R&D, innovation platforms). One of the clusters is the "Industries and Agro-

17 Dutch Cabinet (2021). *Hoofdlijnennotitie Biobased Economy.* Kamerstuk 02-04-2012, EL&I.

18 Innovatiecontract Biobased Economy 2012-2016 (2012). *Groene groei: van biomassa naar business.* http://www.biobasedeconomy.nl/wp-content/uploads/2012/04/7250-ELI-Innovatierapport-aanpv3.pdf

19 http://www.be-basic.org

20 FORMAS (2012). *Swedish Research and Innovation Strategy for a Biobased Economy.* The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning. ISBN 978-91-540-6068-9. http://bioeconomy.dk/Sweden_Strategy_Biobased_Economy.pdf

Resources" Cluster or IAR[21]. This cluster unites stakeholders from research, higher education, industry and agriculture in the Champagne-Ardenne and Picardy regions of France around a shared goal: the value-added non-food exploitation of plant biomass. In order to achieve this ambitious objective, the IAR cluster has defined four strategic fields of activity around the biorefinery concept: bioenergy, biomaterials, biomolecules, and green ingredients. A large number of international-scale R&D projects have already been launched covering the four target markets. A special relationship has been build up with several international clusters in Canada, Finland, Hungary and elsewhere.

UK

In the UK, the Technology Strategy Board has created an Industrial Biotechnology Special Interest Group (IB-SIG) to operate across its networks to implement the recommendations of the 2009 Industrial Biotechnology Innovation and Growth Team[22].

Also in the UK, the "Integrated Biorefining Research and Technology Club (IBTI Club)" was launched in 2009. This group consists of a research and technology partnership involving the Biotechnology and Biological Sciences Research Council, the Engineering and Physical Sciences Research Council, Industry and the Bioscience for Business Knowledge Transfer Network (KTN). The club will interface with the KTN's wider Integrated Biorefinery Technologies Initiative (IBTI) and will invest around GBP 6 million in industrially relevant, innovative, basic biological, chemical and engineering research in biorefining technologies.

Norway

In Norway, an official "Norwegian Industrial Biotech Network[23]" has been set up mid-2012. The main objective of the Industrial Biotech Network is to stimulate innovation through partnerships and dissemination of knowledge. The network will connect academia and industry across research disciplines, industry sectors and geography. The network is the result of a joint initiative by Innovation Norway, The Research Council of Norway, and SIVA[24].

In February 2011, a memorandum of understanding was signed between Innovation Norway and the Technology Strategy Board in the UK. This collaboration agreement intends to foster transnational collaboration between industries and research institutions in the area of industrial biotechnology and biorefining. Beginning of 2012, it was decided to work together to support nine new research and development projects that will create innovative processes to generate high-value chemicals through industrial biotechnology and biorefining. The UK Technology Strategy Board has offered grant funding totalling GBP 1.82 million to the nine UK-led projects (four full-scale collaborative R&D projects and five feasibility projects) and

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21 http://www.iar-pole.com

22 IB- IGT (2009). *IB 2025: Maximising UK Opportunities from Industrial Biotechnology in a Low Carbon Economy.* Industrial Biotechnology Innovation and Growth Team. http://www.berr.gov.uk/files/file51144.pdf

23 http://www.indbiotech.no

24 Industrial Biotech Network Norway (2012). *Virksomhetsplan for Industrial Biotechnology Network Norway (Network Vision and Strategy).* http://www.indbiotech.no/sites/default/files/Virksomhetsplan%20Norwegian%20Industrial%20Biotech%20Network%20ver10juni12%20%282%29.pdf

four of these will also be supported by Innovation Norway, which is providing additional funding of GBP 400,000 to the Norwegian businesses that are taking part. The projects will look at how industrial biotechnology and/or biorefining can be competitively applied to the production of high value chemicals and will see collaboration between industrial biotechnology developers, higher education institutions and the chemicals sector.

Finland

Also Finland has not yet an official bioeconomy strategy yet, but the authorities are working on an official strategy. In 2011, SITRA (the Finnish Innovation Fund) prepared a report "Sustainable Bioeconomy: Potential, Challenges and Opportunities in Finland[25]". The study claims that the market for small-scale solutions is large, which provides a basis for mass-production of bio-economic solutions. The side benefits can be identified and measured. A fully integrated solution creates a hybrid where different systems complement each other, thereby increasing the profitability of the investment. In addition, a system consisting of many small production plants is highly reliable. Functional modularisation provides economies of scale and adaptability which can be turned into a business-driven offering. Last but not least, the capability to develop, design, deliver and operate bioeconomic solutions can be exported.

Also in Finland, the BioRefine 2007-2012 programme of TEKES has allocated 137 million Euro to the development of innovative technologies, products and services related to biorefineries and the processing of biomass in general for the international market.

Denmark

Denmark has implemented a national bioeconomy strategy, via the 2009 agreement on Green Growth[26]. The purpose of the Agreement is to ensure that a high level of environmental, nature and climate protection goes hand in hand with modern and competitive agriculture and food industries. A total of 1.8 billion EUR funding until 2015 is foreseen, which is a 50% increase compared to previous initiatives.

Italy

Since the launch of the EU Bioeconomy Strategy, the Minister of Economic Development has set up a working group on green chemistry with the aim of starting at a national level the elaboration of possible national strategy. In May 2012 the Minister of Innovation launched a call for implementing clusters focused on top innovative sectors for the country and one of them is green chemistry.

25 http://www.sitra.fi/julkaisut/Selvityksi%C3%A4-sarja/Selvityksi%C3%A4%2051.pdf

26 http://www.mim.dk/NR/rdonlyres/54887891-D450-4CD7-B823-CD5B12C6867A/0/DanishAgreementonGreenGrowth_300909.pdf

Ireland

Already in 2008, Ireland published its Foresight Report "Towards 2030 – Teagasc's Role in Transforming Ireland's Agri-Food Sector and the Wider Bioeconomy[27]". The four pillars are: food production and processing, value-added food processing, agri-environmental products and services, and energy and bio-processing. In addition, in 2009 the Irish High-Level Group on Green Enterprise published "Developing the Green Economy in Ireland[28] ". The key actions of the "Green Economy" strategy are:

- Promote green sectors that drive exports and job creation (e.g. renewable energy, energy efficiency and management, waste management, water/wastewater);
- Deliver green zones and a green international financial services sector (IFSC[29]);
- Create world-class research centres and human capital;
- Remove hurdles to the development of the green economy (*e.g.* technical, regulatory and planning barriers to the development of renewable energy projects; implementing green public procurement in Ireland; ensuring that green firms can access finance and developing Ireland's brand).

Belgium

In Flanders, an interdepartmental working group started first half of 2012 to develop a regional vision and strategy for the biobased economy. A study was performed to to support the Government of Flanders in developing its own strategy for a biobased economy and to draft recommendations for an integrated and sustainable economic innovation policy. In order to develop this strategy, Flanders' assets were identified and used as the basis for defining policy choices. Key objective is to see how Flanders can optimally use its positive starting position with a strong chemical industry, a limited (in terms of surface area) but highly intensive agricultural and horticultural and thus likewise food industry, and a high population density with large and well-managed waste streams, in the transition to a sustainable biobased economy.

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27 TEAGASC (2008). Towards 2030. Teagasc's Role in Transforming Ireland's Agri-Food Sector and the Wider Bioeconomy (Foresight Report). http://www.teagasc.ie/publications/2008/20080609/ForesightReportVol1.pdf

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ANNEX 7 – EXAMPLE OF A REGIONAL BIOECONOMY CLUSTER MOVING UP-SCALING ACTIVITIES OUTSIDE THE EU30

The bio-based industries have a strong foothold in Bazancourt-Pomacle, in the North-East of France. Driven by a number of large agricultural cooperatives and well embedded in the strong Industry and Agro-Resources (IAR) bioeconomy cluster, an impressive site integrating several biorefineries has developed. The site harbours sugar industry, starch industry, ethanol production, production of cosmetic ingredients and a cogeneration plant. A lot of synergies between these activities are being exploited. For more than 20 years, the cooperatives and industries active on this site have jointly developed ARD, a research enterprise with approximately 100 employees now. ARD aims to develop innovation for the bio-based industries and to bring it to market.

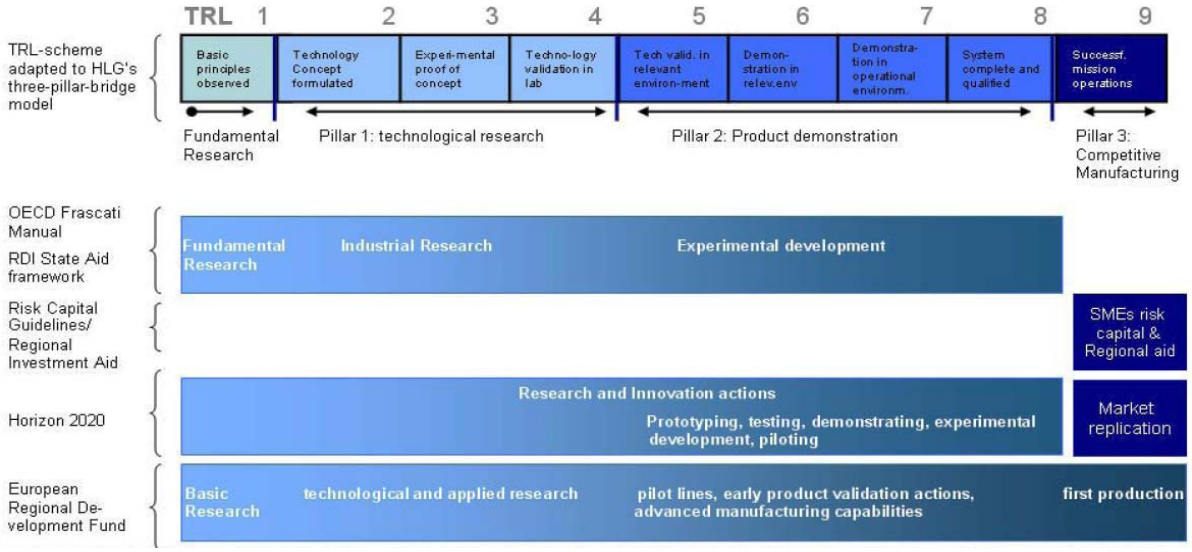
ARD decided in 2008 to build a 2000 tonne demonstration plant for innovative bio-based processes (BIODEMO). This represented a total investment of € 22 million of which € 17 million were privately funded and € 5 million were obtained from public funding (€ 2.5 million regional and € 2.5 million from the European Fund for Regional Development). This decision was made in the context of a partnership with an American technology company to develop an innovative process for the production of bio-based succinic acid, which is an important building block for the chemical industry. The research was successful. A bio-based manufacturing process was developed and optimised. It was shown to be economically competitive and to bring significant sustainability benefits.

Nevertheless, hopes to see the construction of a flagship type facility at industrial scale on site failed to materialise. The partners concluded a joint venture with Mitsui & Co. They were attracted to Ontario (Canada), apparently due to substantial levels of public funding. The government of this province explains on its website, that it granted about Canadian $ 35 million in "loans and subsidies" on a total investment of C$ 80 million. A facility with a projected capacity of 34,000 tonnes bio-based succinic acid is now reported to be under construction in Sarnia, Ontario. Europe thus misses out on an opportunity to bring the results of its successful research and demonstration work to commercial fruition on EU territory.

[30] Information provided by the Industry and Agro-Resources (IAR) bioeconomy cluster

ANNEX 8 – DEFINITION OF TECHNOLOGY READINESS LEVELS (TRLS)

Technology Readiness Levels (TRLs) are used to define the different research and innovation (R&I) steps from fundamental research to the commercialisation of a product. Financing instruments for R&I activities may focus on certain ranges of TRLs, e.g. Horizon 2020 on TRLs from 1 to 8, see Figure below.



Definition of TRL levels:

– **TRL 1 Basic principles observed and reported:** Transition from scientific research to applied research. Essential characteristics and behaviors of systems and architectures. Descriptive tools are mathematical formulations or algorithms.

– **TRL 2 Technology concept and/or application formulated:** Applied research. Theory and scientific principles are focused on specific application area to define the concept. Characteristics of the application are described. Analytical tools are developed for simulation or analysis of the application.

– **TRL 3 Analytical and experimental critical function and/or characteristic proof-of concept:** Proof of concept validation. Active Research and Development (R&D) is initiated with analytical and laboratory studies. Demonstration of technical feasibility using breadboard or brassboard implementations that are exercised with representative data.

– **TRL 4 Component/subsystem validation in laboratory environment:** Standalone prototyping implementation and test. Integration of technology elements. Experiments with full-scale problems or data sets.

- **TRL 5 System/subsystem/component validation in relevant environment:** Thorough testing of prototyping in representative environment. Basic technology elements integrated with reasonably realistic supporting elements. Prototyping implementations conform to target environment and interfaces.
- **TRL 6 System/subsystem model or prototyping demonstration in a relevant end-to-end environment (ground or space):** Prototyping implementations on full-scale realistic problems. Partially integrated with existing systems. Limited documentation available. Engineering feasibility fully demonstrated in actual system application.
- **TRL 7 System prototyping demonstration in an operational environment (ground or space):** System prototyping demonstration in operational environment. System is at or near scale of the operational system, with most functions available for demonstration and test. Well integrated with collateral and ancillary systems. Limited documentation available.
- **TRL 8 Actual system completed and "mission qualified" through test and demonstration in an operational environment (ground or space):** End of system development. Fully integrated with operational hardware and software systems. Most user documentation, training documentation, and maintenance documentation completed. All functionality tested in simulated and operational scenarios. Verification and Validation (V&V) completed.
- **TRL 9 Actual system "mission proven" through successful mission operations (ground or space):** Fully integrated with operational hardware/software systems. Actual system has been thoroughly demonstrated and tested in its operational environment. All documentation completed. Successful operational experience. Sustaining engineering support in place.

ANNEX 9 – DETAILED DESCRIPTION OF THE SPECIFIC OBJECTIVES AND LINK TO WIDER POLICY CONTEXT

Specific objectives	Operational objectives/results
Up-scale and validate at demonstration scale entirely new building blocks for the chemical industry produced from biomass of European origin.	By 2020: 5 new building blocks, to be increased to 10 by 2030)
Develop new bio-based materials (e.g. specialty fibres, plastics, composites and packaging solutions), which either substitute existing petro-chemical materials or offer entirely new characteristics and functionalities.	By 2020: 50 new bio-based materials
Demonstrate new, close to the market consumer products (advanced prototypes) that have been enabled by using bio-based chemicals and materials.	By 2020: 30 new consumer products
Set up flagship biorefinery plants for the production of new bio-based materials, chemicals and fuels from the PPP, which have proven to be close to cost-competitive to comparable fossil-based production plants.	By 2020: At least 5 flagship biorefinery plants (at least one per bio-based value chain, see above).
Establish new bio-based value chains, which will integrate players along the whole value chain. They will ensure sufficient supply of sustainable feedstock, develop conversion solutions for the transformation of the biomass, up-scale these conversion processes to commercial scale, develop new bio-based products, and support the uptake of these products by consumer markets.	By 2020: 10 new bio-based value chains
Create new cross-sector interconnections in bioeconomy clusters (new bridges creating cooperation between nine different sectors, i.e. farmers, agrofood industry, horticulture, forestry, pulp and paper, chemicals, pharmaceuticals, materials, fuel/energy))	By 2020: 36 new cross sector interconnections
Support cooperation projects through cross-industry clusters.	By 2020: >200 projects

The implementation of the specific objectives of the proposed Bio-based PPP will directly or indirectly contribute towards reaching a number of strategic medium- to long-term EU policy objectives.

In an attempt to link its specific objectives to the policy objectives, industry formulated a number of additional indicative objectives in the SIRA. These objectives have not been addressed in the Impact Assessment since they are likely to be subject to change in line with EU policy developments. Furthermore, their completion will not solely depend on the PPP's activities and progress would therefore be difficult to monitor.

Industry objectives	Indicative operational objectives/results
Help to guarantee a secure and sustainable supply of lingo-cellulosic biomass (including waste) for European biorefineries through the development of integrated and sustainable agricultural and forestry value chains	
Contribute to valorising better currently underutilised or not used agricultural land by improving its utilisation or putting it back into production.	
Contribute to increasing the current biomass supply in Europe by enhancing productivity and mobilisation in a sustainable manner while	

making best use of innovations in agriculture and forestry practices.	
Stimulate the mobilisation and utilisation of currently unused by-products and wastes from various bio-based sources (e.g. agriculture, forestry, waste water treatment, sludge, organic household waste, yard waste, food processing waste, debarking waste).	By 2020: 15% in the total amount of waste used By 2030: 25%
Contribute to maintaining and further developing a competitive and knowledge intensive rural economy in Europe based on biorefineries, which results in new, higher and more diversified revenues to farmers and cooperatives and creating new skilled jobs of which more than 80% will be in rural and today underdeveloped areas	By 2020: up to 400.000 new skilled jobs created by PPP By 2030: 700.000
Contribute to protein isolation and valorisation from additional biomass processing, that will result in 15% reduced import of protein (e.g. soy) for feed in Europe in 2020 (50% by 2030).	By 2020: 15% reduction in protein import for feed By 2030: 50%
Optimise soil fertility programmes including recovery and use of phosphate and potash, leading to reduced import of those components for fertilizers applied to feedstock production.	By 2020: 10% reduction in fertiliser component imports By 2030: 25%
Contribute to and trigger industrial deployment of bio-based chemicals, biomaterials and advanced biofuels, to:	
• Increase the share of bio-based production of chemicals and materials in Europe. The share today is of 10%	By 2020: 20% By 2030: 30%
• Ensure that there is a share of sustainable advanced biofuels in European fuel mix.	By 2020: 2% By 2030: 25%
• Realise first-of-their-kind flagship plants to optimise biomass conversion technology and ensure price-competitiveness for a second wave of commercial production to kick-in.	From 2017: 5 flagship plants
Contribute to the ambition that in 2020, the market supplied by bio-based polymers and composites at comparable quality-price ratio compared to the fossil alternatives will be 5 times higher than today (factor 10 in 2030.	By 2020: 5x higher market supplied By 2030: 10x

ANNEX 10 – EXAMPLES ILLUSTRATING THE POTENTIAL SOCIO-ECONOMIC IMPACT OF A OPTION I-PPP

1. EXAMPLES OF FLAGSHIP BIOREFINERY PLANTS FROM THE SIRA (SEE ANNEX 3) [31]

Example 1: Direct economic impact of a successful flagship biorefinery plant processing 1.3 million tonnes of forest material (value chain 2)

Outputs: High value fibers for textiles, bio-plastics, green power
Projected annual turnover: € 176 million
Projected annual feedstock cost: € 64 million, i.e. € 50 million revenue to primary producers and € 14 million transport costs
Jobs (recurring): 440

Example 2: Direct economic impact of a successful flagship biorefinery plant processing 1 million tonnes of biomass (value chain 5)

Investment: € 120 million
Outputs: Green power, cellulose fibers, chemicals.
Projected annual turnover: € 145 million
Projected annual feedstock costs: € 100 million, i.e. € 80 million revenue to primary producers and € 20 million transport cost.
Jobs (recurring): 35

2. EU ANNUAL ECONOMIC POTENTIAL FOR ADVANCED BIOETHANOL THROUGH REPLICATION OF A SUCCESSFUL BIO-ETHANOL FLAGSHIP PLANT

Feedstock: 225 million tonnes of agricultural & forestry residues and biomass fractions of municipal waste, sustainably mobilised.
Output: 75 billion litres of ethanol (energy equivalent of 10 % of current EU transport energy consumption).
Trade balance impact: Savings in EU gasoline importation of € 26 billion.
Infrastructure: 788 biorefineries across the EU (near biomass sources), representing a total investment of € 74 billion.
Jobs: 124.000 (peak associated with construction of biorefineries) levelling off to 87.000 in residue collection, transport to biorefinery and biorefinery operations
Farmer revenue potential: € 15 billion

3. SOCIAL IMPACT OF COMPETITIVENESS IN THE BIO-BASED SEGMENT OF THE CHEMICAL INDUSTRY

European chemical industry in 2010 realised total sales of € 491 billion[32]. Extrapolating from total sectoral employment, bio-based chemical sales of € 50 billion can be estimated to involve 120.000 direct and 340.000 total jobs. The vision paper prepared by the industry group backing the Bio-based PPP aims to increase the share of bio-based chemicals from 10 to 30 % by 2030.

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[31] Note: These figures have been provided by the BIC.
[32] CEFIC (2011) Annual Report 2011.

These basic Figures help to define a key challenge for the EU chemical industry: How to be a leader in the high growth bio-based segment, creating jobs in Europe to transform biomass grown in Europe into high-added value products with good prospects on the global markets. From 2011 to 2030, 20 % of the chemical industry business, corresponding today to some € 100 billion in revenue, will shift from fossil-based to bio-based. It is crucial for the competitiveness of the EU chemical industry to develop a position of strength in this market segment in order to maintain or grow its share in the domestic and global markets. Over the period from now to 2030, the difference between a position of leadership or a position of relative weakness will obviously have a major impact on the EU chemical industry's revenue and employment.

The impact on EU agriculture and forestry will also be substantial. Feedstock costs in a typical biorefinery are estimated to amount to between 25 and 40 % of final product value[33]. Taking 25 % of an estimated € 100 billion new bio-based product market value in 2030 (at 2010 prices) would then imply feedstock costs of € 25 billion. Allowing 20 % of this amount for transportation and logistics of the biomass supply chain, this could well represent around € 7.5 billion in revenue potential for EU farmers and foresters. This corresponds to >1 % of the total 2010 revenue for agriculture and forestry/wood combined and to >12 % of the support level provided by the EU's Common Agricultural Policy (with a total cost of € 55 billion).[34]

[33] Dalberg (2011) Biorefinery Feasibility Study

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