Progress

Priorities for Addressing **O**pportunities and **G**aps of Industrial Biotechnology for an efficient use of funding **res**ource**s**

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Deliverable D 4.2: Workshop Report - Elaboration of an overarching vision [1]

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[1] In the Description of work the title of Deliverable 4.2 has been „Visioning Paper"

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About PROGRESS

PROGRESS is a coordination and support action for the European Commission and aims to support and accelerate the deployment of Industrial Biotechnology (IB) in the EU industry by identifying high-value opportunities for IB and proposing actions to address them successfully. For that purpose, we will first provide a comprehensive and dependable information base (including modelling and simulation approaches) which allows for plausible estimations on the future of IB in the EU in the short and medium-term. Second, in collaboration with stakeholders we will elaborate a future scenario and a common vision for IB in Europe containing the most promising value chains, related R&D&I needs and necessitated policies for IB in Europe. Based on these steps, we will provide strategic advice for research, industry and policy making regarding potential issues and topics for collaboration, future policy programmes, the required technological infrastructure, capabilities, and economic structures. A main focus will be to identify opportunities for collaboration between EU member states and proposed actions to increase awareness and incentives for those collaborations. For more information see www.progress-bio.eu

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Content

1 Scope and structure of this deliverable

This deliverable documents the results of Task 4.3: Elaboration of an overarching vision. This task comprises the elaboration of a vision for IB in Europe in the short to medium term, which includes a consistent setting of priorities and validation by various stake-holder groups.

In the following chapters, the results of an expert workshop are documented which took place on May 18th, 2017. In this workshop, important contributions to a vision for IB in Europe were discussed.

2 Aims of the workshop

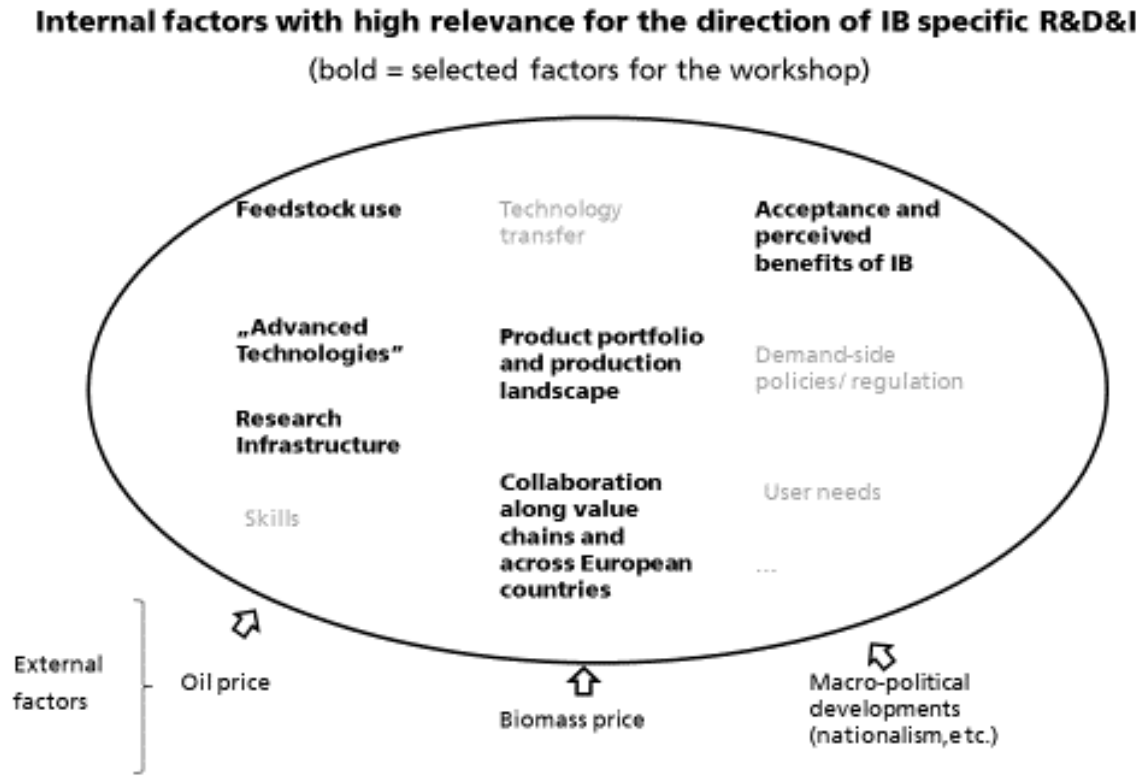
The aim of this workshop was to lay the ground for strategic advice by elaborating goals for R&D&I policy in Industrial Biotechnology in Europe and to provide argumentation for deriving certain focal points of R&D&I to reach these goals.

The workshop was based on results from task 4.2 (developing future paths for the selected value chains). From the value-chain specific scenarios, the project team derived policy-relevant factors which are of major importance for the future development of IB. These factors were presented to the workshop participants, discussed and modified. For these factors, potential goals for Europe in 2025-2030 were elaborated. In a pro and contra discussion potential uncertainties and conflicts as well as perspectives of other stakeholders were taken into account. On this basis, actions were deduced. The results of the workshop will be used to prioritize R&D&I needs and propose potential actions in later stages of the project.

The workshop required the active participation of the invited experts in moderated group discussions. Participants were leading experts from academia and industry.

3 Main influencing factors

The project team presented Top Influencing Factors, including critical questions that relate to each one (see slides below). Those factors had been derived from the previous value chain workshops.



Advanced Technologies

- "Advanced Technologies" of key importance for further evolution of the value chains

  Synthetic biology / Genome Editing / Next Generation Sequencing etc. are perceived as very important option for optimization and cost reduction for biopharmaceutical manufacturing, lignocellulosic ethanol, enzymes, F&F

- U.S. highly active in commercialization with dynamic start-up scene
- Public acceptance not totally clear, potential limited acceptance for some advanced technologies and applications (textiles, food)

  For F&F non-GMO scenario elaborated for which EU may have opportunities as well

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  Potential aims may consider: strategies in regard to other world regions etc. (e.g. Europe as a leader in some technologies?), the importance the EU states to Advanced Technologies, the direction of research, etc.

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Feedstock use

- High divergence in opinions whether biomass in EU is available in large affordable quantities without land-use conflicts
- Regional differences between feedstock availability and capabilities for processing
- Use of alternative resources (straw, wood, but to an increasing extent CO_2, municipal / industrial waste, etc.) considered to have high potential for Europe

  Use of waste etc. intensively discussed as future option for cellulosic ethanol and bio-based plastics

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  Potential aims may consider Europe's role in supply chains (e.g. import of feedstocks) use of alternative feedstock (which ones?), needed logistic concepts etc.

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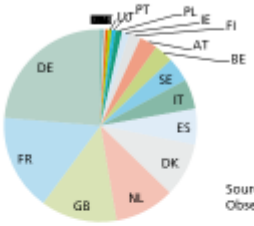
Collaboration along value chains and across European countries

- Innovation and commercialization activities in innovative biotechnology products and processes are geographically highly concentrated

  The patent analyses for all value chains show rather similar results

Market Share of IB patents (2012)



Source: KETs Observatory

- Assessment of collaboration across countries and among stakeholders differs between the value chains

  Networks / collaborations across Europe assessed as critical for F&F. For enzymes IPR issues as hurdle for industry / academia cooperation. No major issues / hurdle perceived for Lignocellulosic ethanol, Biopharma production

- Increasing nationalism as hurdle (e.g. BREXIT?)

Potential aims may consider the role of member states with to-date less activities in IB, potential aims for collaboration/international cooperation, etc.

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Product Portfolio and Production Landscape

- Potential product portfolio (high vs. low value, drop-ins vs. non drop-ins etc.) is debated
- High impact of external factors (oil /biomass prices and availability, world-wide policies)

  Oil price impacts strategies of companies (e.g. for enzymes, bio- based plastics), public funding may serve as a bridge until market conditions improve

- For production, different options regarding scale of facility, volume and number of products, flexible feedstock use exist

  For those value chains with high-volume products (e.g. ligno-cellulosic ethanol) debated whether the focus on small scale or large scale may be favourable. Important issues: feasibility (feedstock, logistics), desirability (regional distribution as goal?), cost competiveness (to fossil-based products and global competition in bio-based products)

Potential aims may consider the ratio of bulk to specialty products, different options for bulk production (global supply chains, single product plant, multi-product plant), etc.

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Acceptance and perceived benefits of IB

- Consumer or public acceptance important topic (almost) in all value chains
  - In some value chains key challenge is to underpin the benefits and to motivate consumers for higher "willingness-to-pay" for more healthy, more sustainable, natural products

  This applies e.g. for bio-based plastics, microbiome, F&F

  - In some value chains present general acceptance may erode in the future

  E.g. GMO-modified bio-production of food ingredients, textiles, enzymes
- It is often difficult to communicate the benefits of IB: often single best-practice cases, but challenging to provide data on meso level, because of heterogeneity and measurement challenges of impact

Potential aims may consider the realization of certain benefits of IB and its perception by the public and by customers, development of acceptance, etc.

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R&D Infrastructure

- Research infrastructures are major instruments, resources or service facilities for research. Access is at least to some kind "open".
- Missing links of research capabilities and capacities as cross-sectoral challenge for Europe

  For microbiome access to large-scale research (cohorts, biobanks, data), SOPs and standards are key issues
- Other CSAs (ERIFORE, IBISBA) for the bioeconomy that develop(-ed) proposals for ESFRI or other research infrastructures

Potential aims may consider the focus of R&D infrastructure in IB (e.g. innovation stage, thematic scope), geographical scope, physical vs. knowledge assets, certain models etc.

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After the presentation, the factors were discussed by the participants. The participants considered these factors as highly relevant.

- Regarding the factor "Acceptance and perceived benefits of IB", the discussion focussed on three aspects:
  - 1. rejection due to fundamental opposition and distrust to the use of certain technologies (e.g. genetic engineering, synthetic biology, nanotechnology)
  - 2. rejection due to unintended impacts of IB, e.g. land use changes, negative impact on food supply and prices, use of pesticides, etc.
  - 3. “demand pull” due to perceived benefits of IB products (compared to fossil-based products) required for future dynamic development of IB
- As additional factors, “skills”, “regulation” and “technology transfer” were considered.

For the consecutive working steps the factor “skills” has been added, and “technology transfer” was discussed as part of the factor “research infrastructure”.

4 Aims and Goals

For the validated factors the participants were asked to propose aims that should describe a favourable or desired state of the factor in the next ten years and to name critical issues for achieving that aim. The participants were divided into two groups, covering different factors with the exception of the factor “collaboration”, which was discussed by both groups, because of its high importance for the overall aim of the project. The group discussions focussed on the different aims. The resulting aims are documented in the following tables and are summarized shortly in text form. At the end of the group discussion, the most important aim (or two, if the rating was tied) was selected for the next step (see section 5).The aim which was rated highest is highlighted in green in the tables.

Advanced Technologies

With regard to improve the benefit for the EU by developing and deploying advanced technologies, two aims are highlighted. First, IB has to embrace a broad spectrum of advanced technologies (e.g. nanotechnology, smart-agriculture, microbiome (including e-health), bioinformatics, next generation sequencing, machine learning). In particular, the improved integration of biotechnologies and informatics was stressed. Second, the positive public perception for support of advanced technologies would have to be achieved. The critical issue here appears less to be dependent on the technology itself, but how it is applied, which (intended and unintended) impacts (could) arise from the respective application and how related effects are communicated.

Aim	Content (in 10 years)	Critical Issues
IB embraces a broad spectrum of advanced technologies	• IB embraces advanced technologies like e.g. ➢ nanotechnology ➢ smart agriculture ➢ technologies for microbiome research, also in combination with e-health ➢ bioinformatics ➢ next generation sequencing ➢ machine learning ➢ convergence of these technologies	• Not enough “joined up” thinking, i.e. thinking about complicated problems in an intelligent way that includes all the important facts and takes all relevant technologies into consideration • Skills gaps e.g. bioinformatics • Analysis of large amounts of data required, models of complex systems required • How to take advantage of data created?

Aim	Content (in 10 years)	Critical Issues
	• Exploit mathematics / statistics / informatics tools for faster R&D&I • Full integration of biotechnologies and informatics ➢ Big data analysis as novel R&D approach ➢ For improved resource management ➢ modelling of metabolic pathways and chemical reactions in order to develop novel synthesis routes by combination of bio- and chemocatalysis/-synthesis • Infrastructure to deal with all the “data” • Open access facilities for bioinformatics	
Positive public perception for support of advanced technologies	• Public is aware of and sees benefits of advanced technologies e.g. for artificial intelligence	• Clear and transparent communication required • NGOs have to be well informed and have to see long-term benefits

R&D Infrastructure

The aims relate to the network of (existing) R&D infrastructure in the EU, which should be well equipped and have a critical mass regarding different dimensions (skill training, open pilot facilities, etc.). Other more concrete propositions were e.g. Biobank of microbiomes from all habitats or an infrastructure for data analysis (big data, -omics data). For establishing such infrastructures, financing, scope and governance rules (such as access) have to be clarified.

Aim	Content (in 10 years)	Critical Issues
Network of R&D infrastructures	• Network of well-equipped R&D&I infrastructure in Europe ➢ Critical mass in each location ➢ Sufficient funding for flexibility to quickly take up "hot topics"	• How to move from R to I • Accessibility to infrastructure from another region • Knowing how and when to access a scale-up facility • Who finances? Region or Europe?

Aim	Content (in 10 years)	Critical Issues
	➢ Specialisation and a certain competition: not every region should have all or the same infrastructures ➢ Open access, i.e. open to clients from all regions ➢ Infrastructure management with entrepreneurial spirit • A network of cooperating open access pilot / commercialization centres; cooperating by passing opportunities to the most appropriate centre • Raise awareness and attract students from universities • Better entrepreneur support • Support of clients in skills, identification of steps to market, marketing of service, how to make money from this new technology	• ESFRI: presently focusses only on low TRL, infrastructures for higher TRL also needed
Linked network of scale-up infrastructure	• A linked network of scale-up facilities, including GMP	• Currently prohibitive costs of GMP products for human intervention studies (RCTs) in microbiome research
Biobank of microbiomes	• Large scale biobank of microbiomes from different sources (human, marine, soil, animal, plant), that is “open access”	• Funding • Collaboration • Regulation
Link basic-applied-transfer	• Strong connections / exchanges between “basic”, “applied” and “transfer” research	• Difficulties must be overcome how to find appropriate partners ➢ with the required highly specialised expertise ➢ in fields outside one's own expertise, outside one's own networks • Lock-in effects due to high specialisation are a hurdle; out-of-the-box thinking must be supported
Data	• Infrastructure to deal with all the “data”	

Feedstock use

While the use for food should be prioritized, the potential of other available biomass should be exploited for IB bio-based products. This includes waste streams of food production, reduction of overproduction of food or minimization of post-harvest losses, use of waste, etc. However, different hurdles to achieve that aim exist, such as regulatory issues for using waste, acceptance, creating benefits for farmers. Regarding supranational/global supply chains for feedstocks, participants were of the opinion that preference should be given to local/domestic (EU) feedstocks, but feedstock supply should not be limited to the domestic EU supply. However, critical success factors are the implementation and wide use of agreed standards for sustainably produced biomass (e.g. carbon footprint; indirect land use changes, social conditions of production). It might be easier to enforce these standards within the EU; but participants felt that they should become mandatory for feedstock use in EU IB.

Aim	Content (in 10 years)	Critical Issues
Maximization of non-food feedstock use	• Priority for food/feed uses • All parts of feedstock in use • Non-food/feed feedstocks or food/feed side streams are used for other purposes, e.g. IB: ➢ lignocellulose, CO2, algae etc. ➢ Food side streams ➢ Food overproduction ➢ Waste (e.g. now left on land)	• Regulatory status of waste may be a hurdle for certain uses -> regulatory amendment • Show benefit for farmer and for industry to debottleneck • Purity • Public perception
Accepted framework for LCA / ILUC / ETS	• Accepted framework for LCA / ILUC / ETS	• Uncertainty about regulations / pricing • Are ILUC- / LCA- / ETS – Standards realistic (as IB is very broad)
Common market for all feedstocks	• Broad feedstock base • Alternative feedstocks like CO2, waste streams can be traded like oil and gas • Characterization of feedstocks • Trading: efficiency of the CO2 footprint should be critical	• Constant feedstock supply and quality without compromising food supply

Aim	Content (in 10 years)	Critical Issues
Take “unexpected”/presently not yet considered feedstock sources and supply chains into consideration	• Consideration of “unexpected”/presently not yet considered/missed supply chains, e.g. Drax Power Station 8m tons of North American wood in the UK -> Supply of biomass can be increased	• Feedstock sources are "unexpected" because these sources had been missed in the established decision procedures. How can ways be established to screen and identify such sources? • Need to systematically identify opportunities • Grabbing opportunities early

Collaboration along value chains and across European countries (Group I)

Different aims have been proposed, which either relate to the collaboration among (certain) value chains or to the collaboration across EU countries and actors. Here it was often emphasized that the efficiency of funding should be improved, e.g. by exploiting synergies by more collaboration (instead of duplicating efforts) or by focussing of funding on certain regions instead of high diversification ("dilution of funding over all regions").

Aim	Content (in 10 years)	Critical Issues
Communication along value chains	• Well-established communication along value chains for IB • Dialogue between industry and academia, between biomass supply (e.g. agriculture, waste) and demand (e.g. IB) • Understanding of needs and aims of users/consumers in order to adapt the product/process to their needs and aims (e.g. consumers give feedback on the product, product is adapted, consumers give feedback on the adapted product)	• Understanding market drivers and barriers for all members of a value chain • Replacing only bilateral communication/collaboration between few members of a value chain by inclusion of all members in the communication/collaboration
Cross-Region collaboration in R&D	• Access from all regions to infrastructure of all other regions • Go from regional to European view	• Brexit • All regions should benefit (and feel that way) • Different scientific competence across regions

Aim	Content (in 10 years)	Critical Issues
	• Promote collaboration / collaborative research (through funding) • Excellence more important than geographical coverage	• Different innovation capacity across regions • In cooperation projects, geographical coverage sometimes more important than scientific-technical excellence • Specific measures are required to make access to established networks easier for young scientists, newcomers in IB or for countries which are not the major players
Value chains: market access for non-drop-ins	• Support for non-drop-ins. A forum for "new ways of doing things" to be received in open manner by end users	• To overcome industrial inertia, to overcome lack of awareness and openness • Support for these highly risky business decisions and business activities required
Across Europe: easy movement (people, products, ideas, technologies) across borders	• Easy movement of people, products, ideas, technologies across European countries post Brexit	• "Hard borders" • Transport costs • Regulations • Cultural differences
Large scale research plus cutting-edge small scale research esp. with respect to microbiome research	• Balanced portfolio of funded projects, comprising both: ➢ Increased funding for large-scale European collaborations ➢ Agile and fast funding mechanism for small numbers of countries / companies to develop "disruptive IP"	

Collaboration along value chains and across European countries (Group II)

The proposed aims are quite diversified. One relates to a better integrated analysis of needs, one to the overarching goal of a zero waste society and one to the integration of non-leader countries.

Aim	Content (in 10 years)	Critical Issues
Provide thorough analysis, assessment & integration of biomass availability and processing in the EU	Guiding principles: • From competition to integration (agriculture) • Cascading principles as main criteria • Biorefineries = opportunities for local / regional development • Biomass availability (for materials, chemicals, energy) • Analysis of supply and demand and the needs of ➢ Feedstock producers ➢ Processing centres ➢ End products and markets	• Lack of assessment of land/biomass availability in the EU and related impacts on land/biomass • Long distance between geographical locations for input -> processing -> markets • Biomass producer involvement should be intensified (farmers, cities (for e.g. waste, …))
Integrating non-leader countries	• From central/Eastern European countries' point of view it remains essential, that these countries are more involved in the international cooperation and thus keep up to date with current trends in R&D&I • R&D programs integrate academics, applied R&D and industrials	• Requirement to achieve good cooperation between industry (with the focus often being in leader countries) and academia (often focus of central/Eastern European countries) • Expectations with respect to speed of improvements may be too high, should be more realistic
Circular economy	• Sharing of facilities and waste management to ensure optimum value added and elimination of “waste” in favour of by-products/ side streams • Increased funding for international or interregional R&D • Increased placements/secondments, achieved by more grants for such exchange of qualified staff • Stimulate clusters to set up national / regional public private partnership • Support creation of innovative value chains	• Limited historical need for cross-sectoral collaboration • Should be a focus in the revised EU bioeconomy strategy/circular economy strategy

Product Portfolio

Most of the aims refer to a diversified product portfolio for IB products and processes, in which the importance of consumer products and products that do not need government support is emphasized. A critical issue to achieve this aim is to clarify and communicate the potential benefits of IB products.

Aim	Content (in 10 years)	Critical Issues
Diversified product portfolio	• Diversified portfolio, but with concrete consumer products	• Benefits of IB products vs. conventional products remains/is unclear
Product portfolio	• To have a broad portfolio of IB production technologies and products which enables switching to different products, depending on the market conditions	• Achieve a composition of the product portfolio which is less dependent on political support • To promote deployment/entering the market of IB products in more EU countries
R&D focus on new and novel products (substitution, IB meets social needs)	• Focus on new and novel products until oil price makes cost competitiveness of IB products more realistic • Substitution of harmful fossil for less harmful biobased products and processes wherever appropriate • IB products developed to meet social needs (e.g. decarbonisation of some form of transport, biobased plastics, etc.) • For biomass = see need to integrate agriculture value chain	• In the case of biobased biodegradable plastics, infrastructure and logistics must be put in place to deal appropriately with end of life stage of these biobased products • R&D priorities of critical product properties could be better defined if the dialogue between early and late members of the value chain (e.g. academia and producers of consumer products or brands owners) would be intensified • Cheap oil (subsidies, assets, ...) is main obstacle

Awareness

The aims refer in particular to the growing awareness and better understanding of IB by different target groups. Most critical issue is a proper communication, which is hindered by the broad range of IB products and the limited number of success stories. Moreover, the goal of intensified stakeholder participation in setting the research agenda (setting aims and priorities for R&D) was seen as desirable: A prerequisite or starting point for the development of the R&D strategies would be a consensus on guiding principles and on what is generally accepted. Therefore, a shared understanding of transition paths to biobased economies has to be elaborated, which includes an agreement whether disputed technologies (e.g. genetically modified crop plants, genome editing, synthetic biology) will have an important role or not.

Aim	Content (in 10 years)	Critical Issues
Target group understanding	• Better understanding by different target groups of what is (and what isn't) IB • Growing awareness of biobased products and processes and the related benefits (enabled by IB) • Growing acceptance of IB as technology which can provide solutions to many grand challenges • Need for EU-wide campaign, more examples of success stories	• Need for scoping exercise (e.g. Eurobarometer survey) as knowledge base for targeted information/communication activities • Clarification and coordination needed: communication and dialogue at what level? e.g. EU/national, IB/ specific sectors? • Critical success factor is choice of the correct canal/ origin of communication, communication formats • Trust and credibility must be established • Need for open dialogue on the ethics of advanced technologies • IB is too general to communicate, but limited number of concrete product success stories is a hindrance which needs to be overcome • Proactive teaching of regulatory issues
Safety assurance	• Knowledge: better understanding biotech	• Education/communication targeted to the specific

Aim	Content (in 10 years)	Critical Issues
	• Less questions about safety	needs of the respective targets groups
Participatory Research	• A clear agreement on what is generally accepted (see text above) and develop the R&D strategies accordingly • Improve stakeholders participation in formulating R&D aims and in design of policy instruments -> should be driven by market opportunities • Link-up to the EU policy priority of decarbonization • Developing regional approaches (EU + non-EU) • Focus on specific applications and/or biobased products which bring clear benefits to consumers/society	• To clarify the EU position about the use of GMO and other disputed technologies • common understanding of desired transition paths to bioeconomies required • Avoid “biofuels-syndrome”, learn from past experience for future developments

Skills

The aims refer to different aspects to improve the skill base for IB, which may be regarded as complementary to each other: Improving the overview of education courses in IB across Europe, high multidisciplinarity in IB curricula (basic understanding in a broad range of fields), a greater breadth of skills needed for scale-up, integrating industry needs in curricula.

Aim	Content (in 10 years)	Critical Issues
Multidisciplinary IB -> curricula	• Considering the multidisciplinary nature of industrial biotechnology, it is necessary that people (students) specialized in one field have basic understanding of other competences e.g. molecular biologists in process issues and vice versa process engineers in molecular biology issues. This should be developed basically within curricula	• Shrinking pool of talents; attracting talented students to studying science and engineering in general, (IB specifically)

Aim	Content (in 10 years)	Critical Issues
Database/ knowledge center for IB	• Database with IB courses on different levels (per country/ language), university level vs. more practical skills, industry feedback (“If you’d like to work in organization X you need skills in Y and Z)	• Co-develop curricula ➢ Cross-border ➢ Cross-industry
Breadth of skills for scale-up, and also for technology transfer of academic research results and commercialisation	• A greater breadth of skills is needed, e.g.: ➢ specific skills for scale-up of processes from lab to production ➢ Financial skills and business ➢ Better balance between theory and training ➢ Better match between academic research and industry/consumer product and manufacturers needs ➢ More IB Masters, BSc. and PhD courses ➢ More knowledge transfer by placements/secondments of academic scientists to industry	• The awareness of IB as a growth sector should be increased, so that respective activities rank high enough on the agenda ("multiplier effect")
Industry needs inform programs/ curricula	• Shaping curricula/industry skills come into academic programs early -> early start to advanced training	

5 Pros and Contras for selected aims

For each factor the highest rated aim(s) were selected and discussed in more detail. In order to avoid a "pure wish list" it was the goal of the discussion to assess the desirability of the aim and to identify critical issues for the feasibility to achieve the aims. Therefore, first a pro and then a contra discussion per aim was performed.

Factor: Advanced Technologies

For the factor Advanced Technologies two aims were discussed as they were rated equally.

Aim: IB embraces a broad spectrum of advanced technologies, among them bioinformatics which requires specific infrastructures (see below). Pros to the goal that IB embraces a broad spectrum of advanced technologies relate to the broad spectrum of opportunities and benefits that may be achieved. As IB may not always be a sufficient or optimal solution to a given problem, having more tools in the toolbox should be a competitive advantage, especially, if Europe can position itself as a world region with the specific ability to synergistically combine different technologies for superior solutions. On the con side it was mentioned that it is too costly and time consuming to develop all technologies, that there may be path dependences because of over investment in inferior technologies and ethical/acceptance questions may come up for certain technologies and applications. Moreover, there are hurdles to realize the technological potential, such as the missing skills. So the con arguments mainly focussed on the high level of complexity and the challenge to master and exploit this complexity successfully. Moreover, it bears the risk of "overengineered" solutions, which could also be achieved by simpler means (e.g. frugal innovations).

In the group discussions, bioinformatics was often referred to. Although bioinformatics was seen as a key enabling technology, the broad spectrum of technologies is not restricted to bioinformatics. Bioinformatics is considered as cutting-edge development and the multi & cross disciplinary work is of benefit for all involved disciplines. However, there are worries that there could be an overemphasis on computational approaches. High scientific expertise is most important, as there is (at least anecdotal) evidence that scientists not specifically trained in the advanced approaches used tools incorrectly and/or drew incorrect conclusions.

The group drew the following conclusions from the pro and con discussion of the advanced technologies goal:

- While the broad scope of technologies is necessary to elucidate and better understand the complexity of living organisms used in IB, use of this spectrum of technologies increases the complexity of the R&D process. Both aspects of complexity have to be taken into account in policy measures.
- Key to using a broad spectrum of technologies is the interdisciplinary cooperation of specialists in the different technologies. This requires the breaking up of existing silos, the development of a basic understanding for other disciplines/technologies and the ability for interdisciplinary communication and collaboration, both in education/training and work. Therefore, there is a close link to aims in the factor "Skills" and "collaboration across borders/value chains". Due to the controversies about the use of certain technologies or certain applications, there are also close links to the factor "Acceptance".

Description	**PRO**	**CONTRA**
• IB embraces a broad spectrum of advanced technologies	• Necessary for a deep understanding of complex systems • Competitive advantage for Europe: Although individual EU member states may be small, the EU as a whole is globally competitive if the potentials of collaboration within and beyond the EU are exploited, if the EU can position itself as the world region which is able to synergistically combine the different technologies and competencies • Broad spectrum of advanced technologies will ➢ lead to new disruptive technologies ➢ reduce costs ➢ speed up product development ➢ reduce waste ➢ enhance environmental performance • Potential to advance the state of the art significantly, compared to the performance of	• Difficult to develop and apply • Lack of trained personnel • Too broad to integrate in training • Low public acceptance/ scepticism for certain technologies and applications • Complexity to manage is too high, also IP issues and technology transfer become more complex • Risk of over-investment in over-rated ("bad", wrong) technology ; hence investment will be done too early and will be too big to fail • Too many options slow down progress • Ethical implications • Some technologies too dangerous (GMO, AI) • Too costly to develop all techs • Skills gap

Description	PRO	CONTRA
	conventional processes/technologies • As IB may not be the optimal solution, a broad spectrum of technologies increases the chance to develop optimal solutions for the societal challenges and to exploit the full potential of IB • High value creation • New business models and opportunities	
Within the broad spectrum of advanced technologies, specific attention should be given to bioinformatics. One central element is the bioinformatics infrastructure • Exploit mathematics / statistics / informatics tools for faster R&D&I • Full integration of biotechnologies and informatics ➢ Big data analysis ➢ resource management ➢ modeling of … pathways and chemical reactions -> synthesis routes • Infrastructure to deal with all the "data", e.g. open access facilities for bioinformatics	• Cutting edge development • Bioinformatics is the key for exploiting the full potential of IB • Integration of Bioinformatics into IB will: ➢ Improve data analysis ➢ Improve data flow / sharing ➢ More informed product development • Fills one important skills gap	• Risk of overreliance on modelling and simulations • Risk of overemphasis on computational vs. experimental approach • Risk that incoherent conclusions are drawn by mathematics-statistics-specialists without knowledge of the biological system, and risk that mathematics-statistics-tools are used incorrectly by non-specialists (e.g. biologists)

Factor: R&D Infrastructure

Aim: Linked network of scale-up infrastructure

The focus is on linking already existing networks around scale-up infrastructure, i.e. building a network of networks, with specialised individual "knots" (=infrastructures) in this network. The advantages would be that the services offered within this network would be of equally high quality due to specialisation of each infrastructure and mutual learning. Potential customers are guided to the most appropriate infrastructure for their respective R&D task through making the specific competencies of the individual infrastructures highly transparent and accessible. Such a network could become a key strength of Europe, creating synergies and more efficient use of resources, as duplication of efforts is reduced. However, the challenge lies in designing appropriate governance structures and processes which effectively deal with different and diverging interests of the involved parties (e.g. provider of services, customers of services, regions where the infrastructures are (not) located). Moreover, a good balance must be achieved between cooperation and complementarity of the interlinked infrastructures on the one hand, and a certain "healthy competition" on the other hand.

AIM	PRO	CONTRA
Network of well-equipped R&D&I infrastructures in Europe • Critical mass in each location • Sufficient funding for flexibility to quickly take up "hot topics" • Specialisation and a certain competition: not every region should have all or the same infrastructures • Open access, i.e. open to clients from all regions; Infrastructures cooperate by passing opportunities to the most appropriate centre • Infrastructure management with entrepreneurial spirit Additional services provided by the infrastructures • Raise awareness and attract students from universities • Better entrepreneur support	• Can be built on existing network, but governance needs to be improved • Avoid duplication of effort and funding: Fortification before replication • Investments will be done strategically in a coordinated manner • Potential to share best practice in technology transfer • Rational organization • Lower capital cost per project • Higher level of know-how and knowledge • Risk management: quicker decision taken: "kill" or "progress" • Awareness (with user)	• Very difficult to manage • Requires additional efforts by the infrastructure/service provider to meet the demands of the customers: it is (too) difficult to achieve a good intensity of cooperation if the network is too large • High costs of implementing and running the network • There is a lack of innovation and independent thought in the infrastructure management • If the competition between infrastructures is low to non-existent,

AIM	PRO	CONTRA
• Support of clients in skills, identification of steps to market, marketing of service, how to make money from their new technology	• Competitive advantage for EU	there is a negative impact on excellence • Local facilities could be closed in the process of consolidation of the network • Sunken investments in "old technologies and approaches", staying at the R&D&I forefront is difficult, hence new approaches can hardly be established

Factor: Feedstock use

For the factors feedstock two aims were discussed as they were rated equally. They are closely related to each other: the aim "Consideration of unexpected feedstock sources/supplies" can also be understood as a sub-aim of the aim "Maximization of non-food feedstock use". The rationale for these two aims is to provide sufficient amounts of feedstock for IB without compromising food and feed supply, and, ideally, in a sustainable way. In order to achieve these aims, different approaches should be pursued and combined (e.g. using all fractions of biomass by applying the cascading principle, using non-food biomass (e.g. lignocellulose, waste) or presently underused sources, import biomass from other countries, broaden the spectrum of biomass crops etc.). In addition to securing the food supply and providing sufficient amounts of feedstock for IB and enabling flexibility in feedstock supply, land use conflicts or land use changes could be avoided and new opportunities will open up from a broad spectrum of feedstocks. Major contra arguments are the established uses of waste or feedstock fractions (e.g. as fertilizer) which may significantly reduce the available feedstock potential for IB and/or which may require additional efforts to implement the switch from conventional to new uses of certain feedstock fractions. The other side of the coin of a broad spectrum of feedstocks and the flexibility in its use is the higher level of complexity, and it remains to be clarified which level of complexity is manageable in IB practice. Moreover, safety issues (e.g. accumulation or broad distribution of harmful substances) along the value chain and regulatory issues (e.g. to which extent can waste be used as feedstock) need to be clarified.

<u>Aim: Maximization of non-food feedstock use (Valorisation of all fractions)</u>

The pros for the goal of Maximization of non-food feedstock use relate to waste reduction, to minimise land-use conflicts and land-use changes and to enable a high exploitation of feedstock for non-food uses. Consequently economic and environmental gains may be achieved. The contras mostly rely not to the goal itself, but point out hurdles like current legislation, high processing costs, R&D needs etc. It was emphasized that the support should concentrate on research, not on the feedstock itself.

AIM	PRO	CONTRA
Maximization of non-food feedstock use	• Environmental gain • Economic gain • Less land use conflicts and changes • Waste reduction (and related impacts: reduced costs for waste treatment, reduced landfill need etc.) • Broadening the feedstock base • Minimise competition with food • More flexibility, option to change feedstocks if required • More possible value chains • Potential to overcome limiting availability of land in the EU • Improve and reduce use of harmful agrochemicals	• Support for uneconomic feedstocks relying on government subsidies • Processing cost too high • Other uses lost e.g. mulch/compost • Seasonality: challenge for security of supply, for constant feedstock purity and quality • R&D efforts become diluted over a multitude of feedstocks • Diversity of feedstocks is difficult to manage • Still a lot of research needed • Use of waste poses safety problems • Amendment of legislation required in order to use waste as feedstock • It is sufficient to apply this rule only for biofuels and bioenergy, but not for all biobased products

Aim: Consideration of unexpected feedstock sources / supplies

Arguments for the consideration of presently underused feedstock sources / supplies relate to having higher flexibility (e.g. react to fluctuating feedstock prices), getting new opportunities (e.g. discovering unexpected functionalities). However, specific investments are high and industry reluctant. Moreover, unintended consequences might relate to the creation of artificial feedstock markets for obscure plants or to negative impacts in the countries which provide the feedstock.

AIM	PRO	CONTRA
Take “unexpected”/presently not yet considered feedstock sources and supply chains into consideration	• Option to switch to alternative feedstocks if e.g. costs for conventional feedstocks fluctuate widely; more flexibility • Avoids the creation of „food mountains“ • Contribution to -employment -investment • Creates win/win for provider and user • Opens new opportunities • Not pushing „old“ technology • Bears the potential for unexpected functionalities	• Unaffordable specific investments • No acceptance from industry • Gives incentives to farmers to grow "obscure" feedstocks; artificial markets are created • Bears the risk of negative social/environmental impacts in the country which supplies the feedstock • Consider the composition of the EU (new member states) -> balance market changes

Factor: Collaboration along value chains and across European countries (Group I**)**

Aim: Cross-region collaboration in R&D (European instead of regional view)

On the pro side the improved allocation of resources and synergies by the use of complementary competencies was mentioned, as well as the equilibration of economic development across Europe. On the con side it was mentioned that probably the less developed regions would be left out and that considerable bureaucratic, cultural and language barriers for an efficient collaboration exist.

AIM	PRO	CONTRA
Cross-region collaboration in R&D • Access from all regions to infrastructure of all other regions • Go from regional to European view • Promote collaboration / collaborative research (through funding)	• Maximize investment by EU with FP7/H2020 etc. avoiding duplication of effort • More funding mechanisms available • Better use of complementary competencies • Better allocation of resources • Best team for job, team may know each other = more chance of success	• Some regions might be left out • Not the same benefit for all • Less developed regions will be neglected • Often established networks dominate, which pose high barriers for young scientists, newcomers in IB or for countries which are not the major players

AIM	PRO	CONTRA
• Excellence more important than geographical coverage	• Cross-regional collaboration: ➢ Improved information/ data/product flow ➢ Enhanced competitiveness of regions ➢ Brings regions into European network of development infrastructure • Equilibration of economic development across Europe • Cultural integration (already established tools and networks) • More exchange of ideas • General benefits (ROI), more value for money invested	• Too bureaucratic and impossible to coordinate • Language barriers

It was concluded that the aim of cross-regional collaboration in R&D bears the potential to bring the best-available and complementary expertise together in order to let the best team do the respective research job. Moreover, such projects are real-world, practical examples and role models for European inclusion and cultural integration. However, often established networks dominate, which pose high barriers for young scientists, newcomers in IB or for countries which are not the major players. Specific measures to make access for these groups easier would be required. Moreover, the bureaucracy often associated with cross-country collaboration was perceived as a significant burden.

Factor: Collaboration along value chains and across European countries (Group II)

Aim: Integrating non-leading countries

Main pro arguments to set the goal of integrating non-leading countries in the innovation and commercialization process of IB relates to advantages for the whole EU via increased collaboration (also in combination with non EU players and spillovers to fields outside IB) and use of biomass resources in those countries. As a result, this would lead to a more balanced regional development and more growth and jobs in the whole EU.

Main worries regarding that goal relate to a potential lower efficiency of funding, as capabilities to generate IB processes and products are lower. Moreover, the use of biomass of those countries may be not economically beneficial because of transport costs.

AIM	PRO	CONTRA
Integrating non-leading countries • From central/Eastern European countries' point of view it remains essential, that these countries are more involved in the international cooperation and thus keep up to date with current trends in R&D&I • R&D programs integrate academics, applied R&D and industrials	• New forms of collaboration across sectors • Potential sources of biomass can be tapped • Better overview of supply and demand: skills, biomass, markets • More opportunities for „outside EU“ collaboration • Greater coherence of EU countries • Improved cross EU collaboration in other (than IB) fields • Contribution to regional development • Jobs and growth	• Collaboration might feel „forced“ (if there’s money to be made, why isn’t there already more collaboration?) • Low efficiency of funds used • Dilution of funding; Instead support IB leading member states/regions? • Distance vs. economics (transport of biomass: eco-friendly?) • Even longer time-to-market

Factor: Product Portfolio

Aim: Diversified product portfolio

A diversified product portfolio with a focus on consumer products may lead to higher dynamics in the overall IB deployment due to multiplier effects: new potential applications may be discovered. In addition, the consumer understanding and acceptance may rise, if there is a broad range of products relevant for daily life. Biorefineries will manufacture a diversity of products. However, the diversity of products and their properties also hinders the communication of benefits to customers and consumers and to select success stories. Another objection relates to the financial viability of diversification of products and processes as resource costs for R&D, production and marketing may increase. In particular cheap oil prices impede the economic viability of bio-based mass products.

AIM	PRO	CONTRA
To have a versatile portfolio of IB products, with special emphasis on products less dependent on political support and with concrete consumer products	• Multiplication effect (rolling ball) • With a varied product portfolio, the understanding can be increased that IB products can be everywhere (daily life) • Potential for more people engaged • Consumer products = better understanding and acceptance • is a realistic expectation in terms of products from a biorefinery • Providing solutions for specific problems	• Cheap oil • Too diverse = too difficult to understand and to manage • Different degrees of bio-based origin of a product (e.g. 100% bio-based, partly bio-based, etc.) too difficult to communicate • How to communicate bio-based added value -> mostly invisible • Where are the real examples of commercially successful IB products? • How to select / define „success story product“? • Financial viability?

Factor: Acceptance

Aim: Improved Target Group Understanding of IB

A better understanding of IB (and what it is not) by different target groups would have different advantages: This goal would set the basis for establishing trust and credibility in IB and IB stakeholders through transparency of information and participation of different stakeholder/target groups. It is essential to differentiate between target groups, to identify their specific interests, goals and needs. Building on this knowledge, target groups could be prioritized, and constructive dialogues and communication measures could be designed accordingly. Potential disadvantages relate to the difficulties to achieve that goal: Previous attempts were even counterproductive when the claimed benefit was challenged, as in the case of GMOs or 1st generation biofuel. The key challenge is to establish trust and credibility, differentiated according to different target groups.

AIM	PRO	CONTRA
Better understanding by different target groups of what is (and what isn't) IB	• Differentiation of target and stakeholder groups (there is no uniform „general public") • Prioritization of target groups possible • Increased participation possible • Increased transparency of information flows • Knowing is understanding is accepting (less fear) • May contribute to Establishing trust and credibility	• Is the public even interested in understanding IB? • Is the subject (too) difficult or broad to understand? (e.g. specific terminology, e.g. „Drop-in") • Risk of „selling" an idea and lobbying, instead of informing objectively • Negative experiences undermines trust/ credibility; negative experiences with previous „good news" shows that turned out wrong (1st Gen Biofuels, GMO,…)

Factor: Skills

Aim: Breadth of Skills

The resulting advantages relate e.g. to a more flexible and efficient staff and especially to the improvement of links between different kind of fields (e.g. between academia and industry, IB and non-IB fields, basic and applied science, etc.). However, it was also discussed whether a higher specialization should be more important than a broad set of skills, and whether a sound implementation in curricula is possible due to short curricula times, fast changes in IB, etc.

All in all, there was consensus on the kind of required skills in the workforce: expertise in a certain scientific discipline is absolutely necessary, but not sufficient: also required are skills which support interdisciplinary, intercultural and intersectoral understanding and collaboration. Moreover, specific efforts are required to attract students and qualified staff to IB. No final conclusion could be reached during the workshop to which extent the required competencies should be present in individuals, or in teams, and what the role of cross-border collaboration between EU member states could be in education and training.

AIM	PRO	CONTRA
A greater breadth of skills is needed, e.g.: • Specific skills for scale-up of processes from lab to production • Financial skills and business • Better balance between theory and training • Better match between academic research and industry/consumer product and manufacturers needs • More IB Masters, BSc. and PhD courses More knowledge transfer by placements/secondments of academic scientists to industry	• More flexible and efficient staff • Enables collaboration • „Exploitable“ combination of basic and applied science • „Gateway“ approach: promote interest in IB via non-IB fields • Link between academia and industry • Better job opportunities for skilled workforce; supports development of internal markets • Raise the awareness for IB and the profile/perception of IB in students	• Curricula cannot be updated regularly enough to keep pace with the quickly changing IB • It would be better to „pick winners“ • There will never be a balance between the expectations and needs • Time in curriculum is too short to teach a broad set of skills with sufficient thoroughness • Danger of becoming a „jack of all trades“ lacking specific skills vs. need of experts who understand many fields • Unclear student target group: science or business? • Industry participation is required, but too low

6 Actions

In the last section the participants were asked to propose 1-2 actions and to describe them in more detail, e.g. who might be involved (countries, actors), which good examples may already exist, etc. Afterwards each participant presented one of the actions and all participants were asked to distribute a hypothetical amount of 5 mio euros funding to one or several actions (except for their own proposed action) in order to assess the perceived importance by the whole participant group.

The proposed actions by the participants are related to many different factors or aims identified in the earlier workshop phases (see table below). Important clusters of actions and aspects are:

Networks of Research Infrastructures:

The aim would be to promote integration & collaboration between R&D centres or regional networks within the EU. The network should be open to new entrants and would need a clear governance structure, one proposition is to install an independent secretary per type of activity. Funding would be needed e.g. for dialogue between the partners, mobility of students / post docs between the centres, preparation of joint applications for future projects, setting up the network; cover the costs of organization for an initial period of time.

Uniform monitoring of feedstock availability in the EU:

The propositions relate to a consistent uniform assessment across the countries regarding the amount of available biomass potential and type of feedstock, which comprise not only conventional plants but also agricultural residues, side streams from industry, waste (municipal and other waste), new sources (e.g. aquatic biomass). Those actions should include all countries and may be managed on the EU level.

Acceptance and perceived benefits of IB:

In order to stimulate public awareness and acceptance of IB, additional and targeted dialogue and communication activities were proposed. First, public debates on IB topics among different stakeholder groups should be fostered. Second, the potential benefits of IB should be communicated via different channels (learning materials, media, prices etc.). Here, a specific approach for different target groups, e.g. for younger people, is proposed. Potential messages for the broad public could be the contribution of IB to the quality of life.

Cross-border collaboration within the EU

The action would be to elaborate a more structured approach for collaboration possibilities via geographical assessments of capabilities and biomass resources as well as to provide a platform and programme for enhancing cross-border R&D projects.

Other actions

Besides, different actions were proposed. As overall highest rated proposition a revision of the Bioeconomy Strategy was proposed: a focus should be the support of Industrial Biotechnology in the context of the circular economy. Besides, the proposition of a European microbiome initiative gained high ratings. Other propositions included measures to encourage changes in supply chains, changes in European Fund for Strategic Investments (EFSI) funding and the phasing out of subsidies for fossil fuels, and support for marketing of bio-based products.

Overview of actions, proposed by the workshop participants

Aim	Content, who (should participate), good practice examples	Amount of rating points*
Networks of Research Infrastructures		
Network of research infrastructure	• Gap analysis; •What is offer, What is need, what is impact? • Elaborate a clear governance structure • Fund the establishment of a network of networks • Needs independent secretary per activity • Who: EU (including assoc. countries) • Example: Pilots 4U-BBI.CSA	n.a.*
Research infrastructure	• To promote integration & collaboration between R&D centres within the EU • Encourage sharing of data from projects (solving of IP issues required) • Sponsor joint workshops • Fund mobility of students / post docs • Support joint application for future projects • Who: Funding by EU, participation of research infrastructures and research groups	n.a.*
Create network of pilot-centres (Scale up support / Communication)	• Provide administration / governance / marketing support for networks of scale up centres in EU • Funding will be used to fund the general cost of collaboration / dialogue between them • Needs independent secretary per activity	6 Mio

Aim	Content, who (should participate), good practice examples	Amount of rating points*
	• Future funding programmes should encourage H2020 applicants to include scale-up in their project work plan, if appropriate, and provide funding for these scale-up activities • Who: Scheme must be EU wide and allow new entrants • Existing examples of cross-European networks: Smart Pilots, Biobased Delta, IAR & German Bioeconomy Cluster, Biopilots, Clib2021, etc.	
Uniform monitoring of feedstock availability in the EU		
Identify feedstock opportunities	• Creating and updating inventory of existing and new feedstocks at EU level • Communicate this free of charge to IB stakeholders • Who? ➢ Coordinated and partly funded by EU: design and implementation of the inventory in a EU-funded pilot project, followed by routine updating of the inventory. A EU body (e.g. JRC) should coordinate the routine updating; data are provided by EU member states ➢ EU Member States provide input (= statistical data) on - Agricultural residues, crop, climate, … - Side streams from industry, waste - Municipal and other waste - New sources (e.g. aquatic biomass) ➢ Start with a couple of countries, then expand	7 Mio
Feedstock use	• EU's inventory of available biomass potential from non-forest, non-protected land • Who: All EU member states	n.a.*
European bio-based feedstock market	• Establish a pan-European feedstock trading platform (not just the already traded bio-based feedstocks at the spot markets) ➢ Prices should be formed by supply and demand ➢ should provide and implement a framework for assessing the availability and quality of biomass (establish norms, etc.) • Who ➢ Agriculture and forestry, bio-based industries (construction, chemistry, food & feed, …) ➢ All EU countries	n.a.*
Acceptance and perceived benefits of IB		
Enhanced public perception / acceptance	• Foster the public debate on IB topics • Who?: Academia (lead), industry, media, public interest groups, government	n.a.*

Aim	Content, who (should participate), good practice examples	Amount of rating points*
Acceptance and perceived benefits of IB	• Take IB to the public: Key message: IB can improve quality of life! • Promote these benefits of IB at all age levels and target groups (from 5 years olds to retired people) • Make use of different communication and PR formats, e.g. open forums, appointment of an IB champion (media personality), Prizes for products • Use different communication channels (e.g. media, TV)	11 Mio
Improve public perception of IB for 14-26 year olds	• Purpose? Develop communication and teaching materials for 14-26 year olds • How? ➢ Develop material in 3 languages ➢ 3 Groups: 14-16, 17-18, 19-26 ➢ Start with EU-funded project, then expand • Advantages: ➢ Better public perception ➢ More interested students -> more scientists later	
Public support	• Communication of the advantages of IB for daily life • Use mainstream media	4 Mio
Cross-border collaboration within the EU		
Collaboration across VC / EU	• Integrate geographical (landscape, topology, climate features) assessments with partnerships and collaboration	n.a.*
Biocross	• Develop a platform / programme for selecting and supporting R&D • Additional funding for a selected product chain (e.g. F&F) extending their portfolio and improving cooperation between old & new member states	3,5 Mio
Other actions		
Phasing out subsidies	• Phasing out subsidies for fossil fuels by 2025 • Who: All EU member states	n.a.*
Make EFSI (II) financing	• Funding of Innovation projects on IB • Who: Commission, EIB, EU members	3 Mio
Bioeconomy 2.0	• Revision of current EU Bioeconomy strategy to include these supportive measures for IB deployment	14 Mio

Aim	Content, who (should participate), good practice examples	Amount of rating points*
	• Idea for development of circular economy strategy[2]	
Encourage whole supply chain overview	• People tend to know only what they know. With respect to long IB value chains, experts often do not have a full overview of the whole value chain and problems that exist in more distant parts (relative to the experts' own position) along the value chain • Against this background, various measures should be implemented to address this issue, e.g. conferences/workshops, CSAs, integral part of VC-R&D projects • Who: Public funding bodies, industry associations, scientific associations, CSA project teams, clusters, research infrastructures	n.a.*
European microbiome initiative	• To link all relevant research / infrastructures / industry / tools / advanced technologies in microbiome area in Europe ➢ To develop large scale infrastructures (e.g. biobanks, bioinformatics data) ➢ Training networks ➢ Standardised procedures / SOPs ➢ Standardized "regulations" across Europe ➢ Link all parts of the value chain from inputs to end consumer	7 Mio
Marketing for bio-based products	• Goal, purpose: establishing successful marketing of bio-based products • Make bio-based "sexy" for the broad public (not just for richest) • Learn from successful brands • Adopt existing marketing instruments from other segments • Who should be involved?	4 Mio

[2] Because of time shortages the design and contents of such a strategy was hardly discussed at the workshop. Based on the overall discussion it can be delineated that the continuation of strategies itself is a key necessary signal for many stakeholders. Moreover, such update should take into account the profound changes in the framework conditions such as the low price for fossil resources and the increasing importance of concepts such as cascade use, circular economy and achieving goals related to sustainability.

Another potential issue is the rather higher concretization of goals or principles in order to delineate concrete actions (see e.g. SCAR (Standing Committee of Agricultural Research) (2015): Sustainable agriculture, forestry and fisheries in the bioeconomy. A challenge for Europe: 4th SCAR foresight exercise; SCAR Foresight expertise for guiding and principles and SCAR recommendations on the update of the bioeconomy strategy (SCAR Bioeconomy Strategic Working Group 2017, POLICY BRIEF ON THE FUTURE OF THE EUROPEAN BIOECONOMY STRATEGY, https://www.scar-swg-sbgb.eu/lw_resource/datapool/_items/item_28/policy-brief-23082017_final_template.pdf)

Aim	Content, who (should participate), good practice examples	Amount of rating points*
	➢ Bio-based companies (start-ups), marketing experts, economies science ➢ all EU countries	

* n.a.; only one action per participant was presented and rated by the others

Abbreviations

GMO	(non-) Genetically Modified Organism
AI	Artificial Intelligence
CSA	Coordination and Support of Action
EFSI	Fund for Strategic Investments
ERIFORE	European Research Infrastructure for Circular Forest Bioeconomy
ESFRI	European Strategy Forum on Research Infrastructures
ETS	Excellence through Stewardship
F&F	Flavors & Fragrances
FP	Framework Programme
GMP	Good Manufacturing Practice
H2020	Horizon2020
IB	Industrial Biotechnology
IBISBA	Industrial Biotechnology Innovation and Synthetic Biology Accelerator
ILUC	Indirect Land Use Change
IP	Intellectual Property
IPR	Intellectual Property Rights
LCA	Life Cycle Assessment
RCT	Randomised Controlled Trial
ROI	Return on Investments
SOP	Statement of Purpose
TRL	Technology Readiness Level