Workshop on Biosurfactants

Berlin (D) September 4, 2014

Summary

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 312121

BIO-TIC Workshop – Biosurfactants Business Case

Berlin (D), September 3rd 2014

Background

The BIO-TIC workshop on Biosurfactants was organized with the aim of seeking input from stakeholders familiar with the surfactants market, products and applications. BIO-TIC partners were successful in publicizing the event so that more than 50 registrations were recorded ahead of the event. A pre-workshop online survey was conducted in the last 2 weeks preceding the event, with 27 respondents, almost all of them from stakeholders un-related to the BIO-TIC project partners. 39 participants, 27 of which are un-related to the project partners, actually attended the workshop (appendix 1) and contributed additional information for completing the BIO-TIC roadmap.

Overall structure of the workshop

The workshop was structured in 3 main parts (see agenda in appendix 2):

- First part aiming at "setting the scene" with a brief introduction of the BIO-TIC project and methodologies. This first part included a 30 minutes presentation by Prof. Wim Soetaert (University of Ghent and Director of Bio Base Europe Pilot Plant, B), a prominent expert in the field of Biosurfactants
- Second part aiming at defining the key issues for the biosurfactants business case (based on active input from participants). The objective of this second part was to identify the most relevant topics for biosurfactants from the hurdles and solutions already identified in the current draft version of the roadmaps
- Third part aiming at defining a small set of concrete actions to help tackle the main hurdles identified in the previous section of the workshop

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The presentations made during the workshop are provided under the following link : http://www.industrialbiotech-europe.eu/presentations-from-the-bio-tic-biosurfactants-workshop-in-berlin/

Pre-workshop survey

The pre-workshop survey was conducted between 12 august and 1 September, and attracted responses from 27 people. This survey was intended to raise the awareness of the people attending the workshop, by asking probing questions, while gathering useful information which will contribute to the completion of the business case roadmap.

The results of the survey can be downloaded from http://www.industrialbiotech-europe.eu/presentations-from-the-bio-tic-biosurfactants-workshop-in-berlin/

The participants' organization types were well distributed over large industry, SMEs, RTO/Academics, consultants and others. This included people from R&D, Production/Commercialisation of surfactants, surfactants users, and consultants. The majority of respondents had technical expertise in the field of surfactants. Most people were not familiar with the BIO-TIC project before the workshop, where roughly half read the roadmap drafts.

It was found that bio-conversion, downstream processing and feedstock supply were the most important hurdles. Costs for bio-surfactants were also seen to be quite evenly distributed over these fields.

Many comments and views were shared on the hurdles and possible solutions. These were brought into the workshop discussions and will be incorporated into the final roadmap.

The respondents were quite optimistic that biosurfactants could be competitively produced in EU in the future, with an estimated average of 20-30% global share in 2020 and 2030. The price trend is expected to swing significantly between uncompetitive and competitive between 2020 and 2030. Approximately 50% of

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respondents believe that raw materials will be more than 40% oleochemical versus petrochemical for production of surfactants for Europe and globally from 2020 onwards.

Finally, a large majority of those who answered felt that costs could be reduced sufficiently to allow customers to buy based on environmental benefits rather than cost.

Introduction to Biosurfactants by Prof. Wim Soetaert

After a short summary of the global surfactants market and the main segments of applications, Prof. Soetaert provided a brief history of the development of the different generations of surfactants:

- Traditional surfactants are oil-based chemicals with associated environmental concerns since, he noted, surfactants are eventually released in the environment through waste waters
- For some decades oleochemicals have emerged (now 60 % of surfactants used in the US, 50 % of surfactants used in Europe); oleochemicals are still produced entirely by chemical synthesis and only the hydrophobic part comes from renewable feedstocks
- The first generation of biosurfactants include the well-known APG (Alkylpolyglucoside) made entirely from renewable feedstocks (starch and vegetable oils - fatty acids) through chemical synthesis. This first generation is now established and used in personal care and cleaning applications. They are more expensive but have also better overall properties. New 1st generation biosurfactants are available, such as sucrose esters (fatty acids chemically esterified on sucrose)
- The second generation of biosurfactants (defined by Wim Soetaert as “true biosurfactants”) is the latest wave in surfactants, produced from renewable feedstocks through microbial fermentation. He noted that APG could shift

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into the class of 2nd generation biosurfactants as it can now be made enzymatically.

Prof. Soetaert the reviewed the different classes of biosurfactants (giving a few examples for each class):

- Lipopeptides and oligopeptides (such as Surfactin)
- Glycopeptides (such as Sophorolipids and Rhamnolipids)
- Polymeric biosurfactants (such as Emulsan)
- Phospholipids

Pros and cons of these new biosurfactants were reviewed. A few strong points were made to correct wrong statements or beliefs with regard to biosurfactants, for instance:

- The yield for biosurfactants can be very high; sophorolipids can be obtained in high yield and with high productivity (up to 400 g/L)
- Biosurfactants are expensive (they were claimed to be typically 10 times as expensive as their chemical counterparts) but they are currently produced at a much smaller scale and their performance in specific applications can be higher
- Initial production methods of biosurfactants offered limited variation originating from the limitations on micro-organisms : same products obtained even if different feedstocks are used. However, metabolic engineering of production organisms offers wide opportunities for extending accessible structures and properties. Numerous examples from Prof. Soetaert's own work in Ghent were briefly reviewed. Larger scale production of some biosurfactants is now in place; a leading example is provided by the Bio Base Europe Pilot Plant in Ghent.

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This presentation proved to be an excellent introduction to the workshop and triggered discussion with the participants that was further elaborated in the working group sessions that followed.

Seeking input for the market roadmap

Anna Saarentaus (Poyry) introduced the relevant elements of the market roadmap and requested feedback of participants to comment the data and fill gaps. A major difficulty to provide and discuss market figures, estimates and forecasts stems from the lack of a clear definition of biosurfactants. Participants referred to Prof. Soetaert's description of different generations of biosurfactants as a good starting point. The discussion also suggested that the following elements would boost the development of biosurfactants (particularly "true biosurfactants"):

- Better characterization of individual biosurfactants; an issue with biosurfactants is that one deals very often with mixtures. Isolating (focus on DSP) and better characterizing individual biosurfactants would very much facilitate the search of a good match between biosurfactants and requirements of specific (possibly niche) applications.
- Better identification of where biosurfactants will be used first (linked to the first point above).

A market related on-site survey was distributed to the participants to get their view on statements extracted from the current draft roadmap. Close to 20 duly completed questionnaires were collected at the end of the workshop. The data will be analysed by Poyry and used for the final version of the market roadmap. A first digest of this market survey is provided in appendix 3)

The time available during the workshop did not allow a very deep discussion on market related aspects. Nevertheless, new contacts established during the workshop will be used in the following weeks to continue the discussion with a few participants.

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Defining the key issues for biosurfactants

Based on a presentation By Dr. Dirk Carrez (Clever Consult) of the currently identified hurdles (and possible solutions) by the project partners (appendix 4), participants were asked to select the most critical hurdles that prevent or slow down the development of biosurfactants and the recommended solutions that warrant further discussion for concrete actions. The detailed results of this selection process are given in appendix 5. The topics prioritized for further discussion in the workshop are listed hereafter:

- Bio-conversion: low yields with IB
- Feedstock: raw material is not economically available
- Market: Definition of biosurfactants is unclear which makes it hard to communicate use
- Market/Cost competitiveness: customers are unwilling to pay a premium for new products or pay a bio-premium
- Demand size policy barriers: absence of incentives or efficient policies
- Public perception: poor public perception and awareness of IB and biobased products

3 sub-groups of approx. 12 participants each were formed to discuss these 6 main hurdles and recommend possible actions to overcome them. The discussion in each subgroup was moderated by project partners attending the workshop; Prof. Soetaert also contributed to the moderation of the discussion on Bioconversion and on Feedstock.

Summary of key findings and recommendations from the 3 breakout sessions

The results of the discussion in the subgroups were recorded on posters, so that all raw data are available to the project partners for further analysis after the

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workshop. Each group provided a summary of its discussion (appendices 6, 7, 8). A summary of the key findings and recommendations is provided here.

Bio-conversion: low yields with IB

- Low yield not an issue in itself – some IB processes for making biosurfactants have been optimized and now perform well
- The issue is the balance between yield, performance and cost
    - Early investment in R&D is high (isolation of kg-scale quantities to start exploratory marketing activities – establish the match between properties and specific application)
    - Financial support is needed to boost such R&D and demonstration projects before upscaling
    - Once demonstration projects have been successful, the price of Biosurfactants will go down through upscaling benefits
- EU has leadership in expertise now, but investments are needed to keep its position

Feedstock: raw material is not economically available

- 2nd generation of Biosurfactants initially target high-value applications (cosmetics, personal care)
- Accordingly the question of feedstocks is not a burning issue today
    - Quantities are limited – the discussion between food/non-food feedstocks is marginal (unlike the case for biofuels f.i.)
    - Because of 1st wave of targeted applications, the distinction between 1st generation/2nd generation feedstock is not a priority – using bio-wastes as feedstock would be detrimental to marketing in targeted applications such as cosmetics
    - Priority for Biosurfactants producers is to establish their market – switching to 2nd generation of feedstocks can be tackled at a later stage.

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Market: Definition of biosurfactants is unclear which makes it hard to communicate use

- Some confusion exists between different generation of biosurfactants
    - From bio-based (to what extent ?) or 1st generation to « true » biosurfactants or 2nd generation
    - Some biosurfactants are based on bio-feedstocks (ex. oleochemicals) but are produced by chemical processes (→ not in the scope of BIO-TIC project)
    - Ongoing work within CEN-TC 276 (output in 2015) will help bring clarification to the situation
- Clarifying definition does not always impact the use of IB for surfactants but is necessary to report conclusions adequately (ex. market data)

Market/Cost competitiveness: customers are unwilling to pay a premium for new products or pay a bio-premium

- Reasonable price premium can be supported by communication on performance and environmental benefits (sustainability) – in some cases higher price can be warranted by higher performance
- Marketing efforts by companies based on the balanced cost/performance/sustainability profile can be supported by
    - appropriate labels (if appropriate standardization of labels)
    - customer awareness (general public education)
    - public authorities

Demand size policy barriers: absence of incentives or efficient policies

- Need to simplify registration and permits : modification of legislation (e.g. REACH) to enable easier registration of biosurfactants
    - This will reduce cost and complexity, introduce simplification and harmonization between member states (→ motivate companies to consider move to biosurfactants)

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  - Public authorities (EC and member states) need to be convinced by bio-based stakeholders
- This is a long term effort (by starting now, one might expect tangible results in 10-15 years from now

Public perception: poor public perception and awareness of IB and biobased products

- Need to raise awareness of the general public
- Bio-based products are already in use – in given applications, biosurfactants can be a preferred solution (performance, sustainability, environmental benefits)
- Provide facts about GMM and their use in biosurfactants production
- Develop tools, approach, common language , positive and consistent labelling …– as well as buy-in from NGOs and public authorities
- Results could be expected in approx. 10 years from now, if significant effort is spent now at a European level.

Presentation at the 3rd ICIS European Surfactants Conference

The BIO-TIC workshop on Biosurfactants was organized the day before the start of the 3rd ICIS European Surfactants Conference. On behalf of the project partners, Padraig Naughton (CEFIC) gave a presentation at the conference on the BIO-TIC projects and provided a preliminary summary of key findings of the workshop. (http://www.icisconference.com/EuropeanSurfactants/agenda)

The objective was to touch a wider audience from the surfactants scientific and business community and solicit further input from conference participants.

Conclusion

The BIO-TIC workshop on Biosurfactants reached its objectives of attracting a representative number of relevant stakeholders from the European surfactants

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community and of providing the BIO-TIC partners with additional, focused input for the next version of the roadmaps. From the current version of the roadmap the most important hurdles for the biosurfactants business case have been identified and targeted actions to tackle these hurdles have been discussed. New, very relevant contacts established during the workshop will be leveraged for further discussion (most likely through targeted phone calls) to deepen the definition of an action plan.

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Appendix 1 – List of participants (the label "x" refers to a project partner)

Prof. Ibrahim Banat	University of Ulster	
Dr. Pierre Barthélemy	CEFIC	x
Dr. Leen Bastiaens	VITO	
Mr. Frederic Bauer	BASF SE	
Dr. Marc Burke	KTN Ltd	x
Mr. Neil Burns	Neil A Burns LLC	
Dr. Dirk Carrez	Clever Consult	x
Mr. James Craven	PNO Consultants	
Prof. Dr. José Manuel Cruz	Universidad de Vigo	
Mr. Bart De Poorter	Cepsa Quimica	
Mr. Parimal Desai	Aarti Industries Limited	
Mr. Kedar Deshpande	VITO	
Dr. M A Diaz De Rienzo	The University of Manchester	
Prof. Dr. Karlheinz Drauz	KhD-Solutions	
Dr. Alex Foeller	Verband TEGEWA	
Dr. Claire Gray	EuropaBio	x
Dr. Jozef Grego	Evonik	
Mr. Fabrizio Guala	Zschimmer & Schwarz Italiana	
Mr. Michael Günther	Fraunhofer IGB	
Mr. Christophe Luguel	IAR	x
Mr. J A Magalhaes	Quimitecnica	
Tiego Magalhaes	Quimitecnica	
Mr. FG Martinelli	PNO Consultants	x
Ms. Elisabetta Merlo	Zschimmer & Schwarz Italiana	
Dr. Jochen Michels	DECHEMA e.V.	x
Mr. Bjoern Miller	Sasol Germany	
Prof. Dr. A B Moldes	Universidad Vigo	
Mr. Padraig Naughton	Cefic	x
Ms. Ioana Popescu	EuropaBio	x
Ms. David Pros	Barcelonesa	
Mr. Achim Raschka	Nova-Institut GmbH	x
Dr. Sophie Roelants	InBio.be	
Ms. Anna Saarentaus	Poyry Mgt Consulting	x
Dr. Kati Schmidt	BASF SE	
Dr. Roland Schroeder	Henkel AG & Co KGaA	
Prof. Dr. Wim Soetaert	Bio Base Europe Pilot Plant	
Ms. Elke Theeuwes	Ecover	
Dr. A L Vásquez Caicedo	Fraunhofer IGB	
Mr. Ron Weerdmeester	PNO Consultants	x

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Appendix 2 – Workshop agenda

12:00 - 13:00	On-site registration, get together and light lunch
13:00 - 13:05	Introduction
13:05 - 13:20	The BIO-TIC project overall
13:20 - 14:00	Introduction to Biosurfactants Prof. Wim Soetaert
14:00 - 14:15	Value chain and market estimates, incl. **first input** from participants
14:15 - 14:35	Main hurdles and solutions identified so far
14:35 - 15:05	**Second input** from participants : 1. additional hurdles and/or solutions? 3. rating (prioritization) of hurdles and solutions
15:05 - 15:15	Short summary of discussion
15:15 - 15:30	Coffee break
15:30 - 17:00	**Third input** from participants on items priortized before coffee break 1. Concrete actions and timeline (Who, Why, How, When) 2. Implications (cost, impact)
17:00 - 17:15	Short summary of proposed actions and implications
17:15 - 17:30	wrap-up, conclusions and next steps

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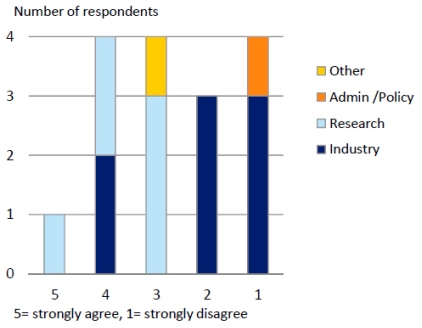
Appendix 3 – First digest of market survey

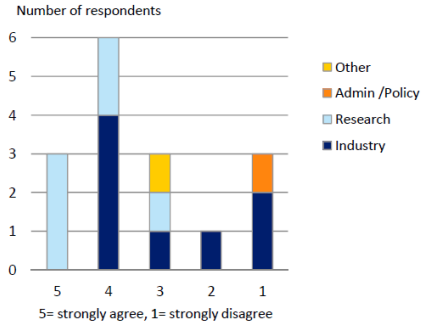
Market drivers

Workshop participants with research background considered policies / regulation in favour of and consumer attitudes towards bio-based products as market drivers. Many industry representatives did not, however, share this view. According to them, both fossil- and bio-based surfactants are checked about environmental aspects, and competitive price is the main market driver.

European bio-based surfactant market is driven by...

- Restrictions on the use of fossil-based surfactants
- Increasing environmental concerns and awareness

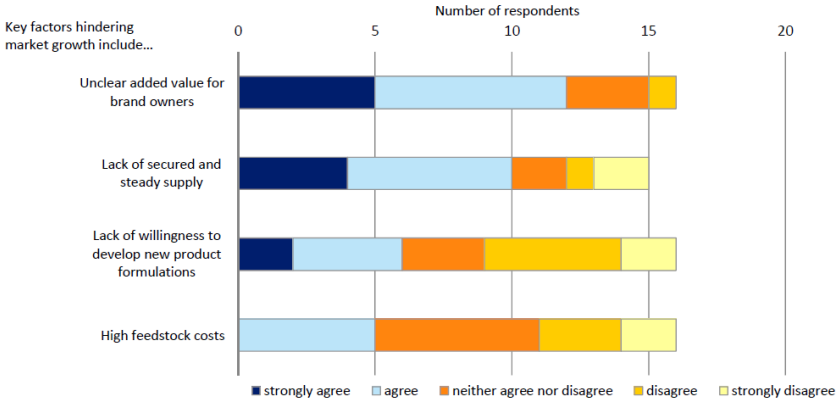




1

Market hurdles

Demonstration of added value and secured supply were ranked as top market hurdles. According to participants' comments, product development is motivated by cost savings or safety benefits but constrained by legislative hurdles. Feedstock was not considered the top hurdle thanks to opportunities in e.g. waste streams.



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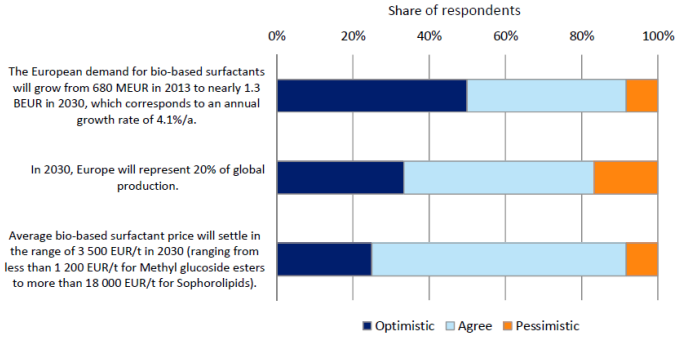
Appendix 3 (continued)

Market projections

Respondents found market projections optimistic or difficult to comment on, but on the other hand wanted to count on scientific breakthroughs and brands competitions during next few years.

With regard to market shares, respondents found the assumption realistic or had doubts concerning the competitiveness of Europe against e.g. China.

Market price assumptions were found realistic, but respondents emphasised uncertainties related to the realisation of economies of scale and to the price development of crude oil and 2G feedstocks.



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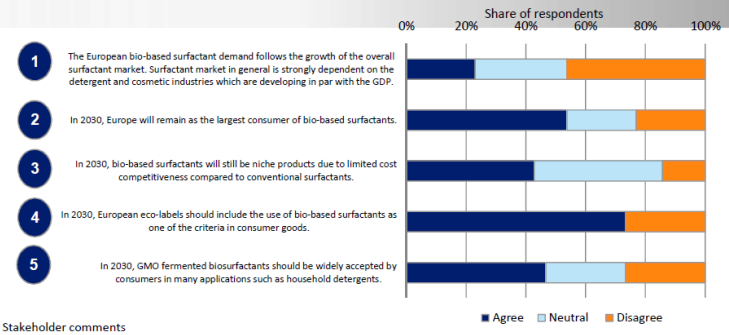
Market vision



Stakeholder comments

1. Respondents disagreeing with the argument had either a more positive (**biosurfactants** will gain more market share) or negative (**surfactant** market grows less than GDP today in Europe, there has been no **surfactant** market increase within the last 10 years) view of the market development.
2. Respondents disagreeing with the argument pointed out that the growth in surfactant use is much higher in less developed countries than in Europe.
3. Without a major supporting policy/regulatory framework, the respondents feel bio-based surfactants will remain as niche products due to their lower cost competitiveness. Some comments highlighted the importance of the ongoing standardisation work on the definition of biosurfactants/bio-based surfactants, and need for advances in R&D.
4. A majority of respondents were in favour of this suggestion. In some comments, however, the rational for the use of bio-based surfactants was questioned or the choice of communications tool was left to the marketers. The ability of consumers to distinguish between various labels was questioned, too.
5. A majority of respondents hoped that GMO fermentation would be well explained and acceptable to the general public.

3

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Appendix 4 – overview of hurdles and solutions identified in draft roadmap

Barrier	Possible solution
Feedstock supply: • Raw material cost and availability - Costs of feedstock produced in Europe are too high compared to other regions - Varying feedstock prices - (High) import costs for certain types of feedstock - No commonly accepted "sustainability" certification system	• Feedstock price is too high for bulk chemical market. • This will be an issue in the long term future. For now, the amounts of sugar and lipids needed are low compared to world markets. Also, the product is currently sold on 'low volume, high value' consumer markets. • Better collaboration with farmers and the feed sector. Install win-win scheme for buyers and producers (farmers) • Create new forms of ownership in the forest sector e.g. collectives rather than traditional family forestry • Re-utilization and recycling materials as a resource efficiency strategy, to decrease the demand for feedstock • Promotion of cascading use of feedstock in order to decrease the demand for feedstock • Feedstock diversity: look for alternative and explore new renewable and sustainable feedstock (e.g. algae, non-food vegetable oils, methane) • Reduction of import tariffs of certain types of feedstock like ethanol • Streamlining of certification schemes for the determination of biomass sustainability, taking into account cost effectiveness, resources and time scale at EU level (cfr. Bioeconomy Panel, CEN, etc.)
Logistics: securing large quantities of biomass all year round - Seasonality of biomass cropping versus need of continuous feedstock supply - Inefficient transport and distribution of biomass - Inefficient recovery systems for (bio)waste	• A supply chain for feedstock needs to be developed across Europe that allows compensating fluctuations in one feedstock, by using another • Dedicate de facto a percentage of agricultural land to cultivation of crops for solely industrial use and align this at national and EU level • Promotion of C5 lignocellulosic feedstock and woody biomass • Recovery of abandoned and marginal lands for cultivation of biomass • Increase yield productivity through high yielding crops (if needed with the use of GMO technology) and improved agricultural practices (e.g. development of more efficient and light weight machines for collecting straw) • Adapt Renewable Energy Directive in order to promote the production of biobased chemicals and materials • Develop storage possibilities that conserve the biomass in a better way • Construction of local facilities for waste conversion where local farmers can dispose of their agricultural waste ('biomass terminals') • Location of production sites close to the feedstock production sites • Identification of waste streams per region in order to develop the most efficient strategy, and joint cooperation with waste producers and incineration plants

Barrier	Specific issue (& questions)	Possible solution
Bio-conversion: • Low yields • Poor process performance	• It is difficult to produce biosurfactants via biotechnological approaches.	• Develop microbes that have an improved ability to convert feedstocks in products. • Use of waste and generally cheaper renewable substrates for biosurfactant production e.g. glycerol. • Develop new water management systems.

Down Stream Processing:
• Low yields
• Poor process performance due to toxic by-products
	• **Questions specific for biosurfactants:**
	  • are there any specific technical issues with DSP?
	  • how important is water management?
		• Increase the value of waste and by-products through improved DSP yields
		• DSP processes and equipment need to be designed so as to be able to operate with flexibility and accommodate various inputs while achieving product specifications.
		• Determine quality expectations of feedstocks, final product and byproducts to allow design and optimisation of DSP.

Knowledge infrastructure: • Lack of capital investments to promote R&D, pilot and demonstration activities. • Poor knowledge transfer between academia and industry	• **Question specific for biosurfactants:** • Is there still a lot of R&D required to bring biosurfactants to the market? Why?	• Integrated optimization and development of bioconversion, product recovery and DSP. • More capital to be made available for piloting and demonstration activities. • Support investors in risk-taking (also related to lack of knowledge of the benefits of IB).

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Appendix 4 (continued)

Barrier	Possible solution
Capital requirements • Limited availability of public R&D funding • Limited public support for scale-up activities • Limited access to finance for spin-offs and start-ups • Limited access to finance for SMEs • Limited financial support for new production facilities	• Increasing R&D funding at EU, national and regional level for pioneering public research in collaboration with the industrial sector in a co-funding scheme • Shift part of the funds allocated to biofuels research to biobased research on value added products • Development of technology & science parks, and bioclusters covering the entire value chain. Partners in the cluster can collaborate in the innovation process until market phase. • Share R&D facilities and attract joint and alternative routes for funding of demonstration projects and scale-up activities (public and private investors, private foundations etc.) • Implementation of R&D funding programmes for pilot and demonstration projects as proof of concept in cooperation with industrial partners at a 50% co-funding basis • Promotion and financial support for interregional pilot and demonstration activities in frame of a joint strategic bioeconomy agenda • Start specific national/regional PPP for projects starting at demo phase • Implementation of funding for feasibility studies for start-ups and special grants for product development and commercialisation such as the Small Business Investment Company Program (SBIC) • Allocation of funding for the construction of new large scale facilities and improvement of pilot facilities at interregional/national and EU level
IB perceived as sector with high investment risk • Too long "return of investment" time • Lack of visible tangible products and blockbusters • Lack of investors' confidence	• Attraction of foreign VC and private investors through capital fiscal incentives. • The implementation of tax reduction measures or tax bonuses • Creation of a stock option market for green (biobased) or environmental technology companies promoted at EU and national level • Development of new long term vision business models for the production of biobased products to attract new venture capital and large corporate investments, private foundations etc. • Development of demonstration projects as proof of concept and flagship projects that cover the whole product value chain will minimize the risk and install confidence • Develop a communication strategy with branche associations and companies involved to positively influence the image of IB. For instance by publication of reports and studies on successful cases will amplify the gained confidence

Barrier	Possible solution

Poor public perception and awareness of IB and Biobased products
• Advantages of biobased products are not visible enough
• Negative messages in the media on GMO and biofuels influence perception of IB
	• Reduction of the price through investments and payment of the premium by companies in a B2B environment
	• Stimulation of engagement of large consumer product companies in biobased products
	• More awareness of producers of Biobased products of the product functionalities and added value of their products compared to fossil based products
	• More communication towards consumers on added value of the Biobased products compared to alternatives on the market. This could be done by the authorities in collaboration with consumer organisations.
	• Awareness creation through outreach activities oriented to the public at large and other specific target groups (e.g. visits at biorefineries for secondary schools)
	• Develop a communications strategy addressing the following points:
	  ◦ Mobilization of intermediary associations (e.g. NGOs, umbrella organisations) to promote biobased products based on scientific fact finding.
	  ◦ Involvement of all stakeholders (including the media & consumers) in innovation projects from the beginning

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Appendix 4 (continued)

Barrier	Possible solution
Absence of incentives or efficient policies • No framework to promote biobased products • Lack of a "green public procurement" policy promoting biobased products • Wide variety of ecolabels and no uniform standard present for sustainable and Biobased products	• Setting up and implementation of an adequate legal framework for financial incentives and targeted subsidies, and tax reduction schemes facilitating the promotion of biobased products, e.g. a tax on non-biodegradable/biobased packaging, (mandatory) targets for specific applications • Include biobased products in the new Renewable Energy Directive • Especially for Biobased plastics and packaging: the fact that there is no willingness to pay a "bio-premium" can be overcome by the brand owners: they can make the "bridge" (from development phase until a certain market volume) so a products become "competitive", or pay the premium for a while. • Setting up dynamic public procurement systems coupled to environmental benefits • Develop clear European standards for feedstock and product sustainability, biodegradability, Biobased content, etc. • Branding of biobased through an ecolabel (Green Product) and/or "Biobased" label linked to sustainability criteria • Set up a harmonization strategy for ecolabels in Europe

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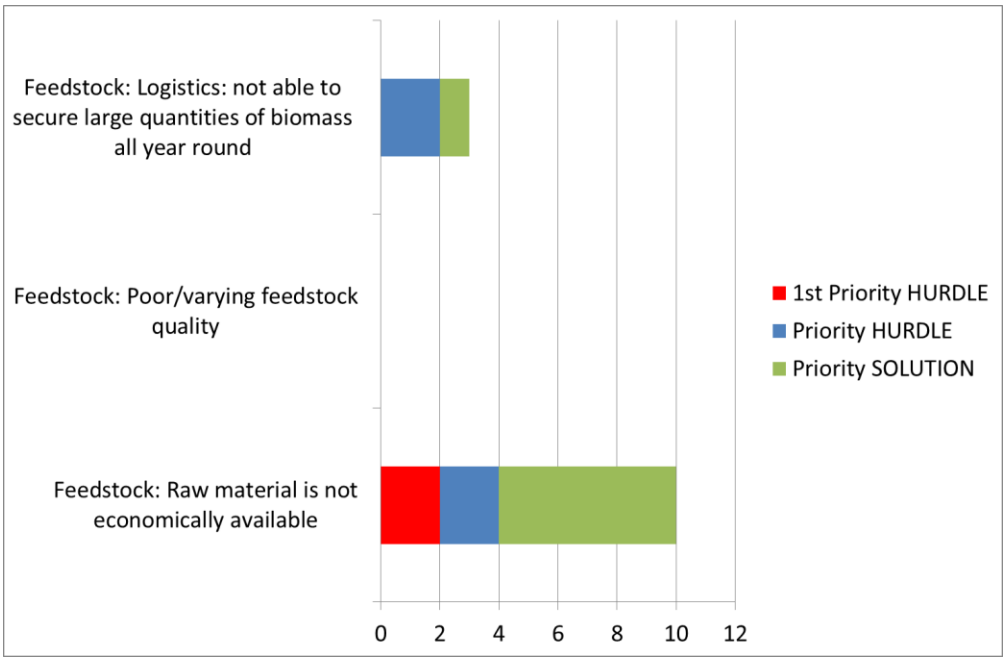
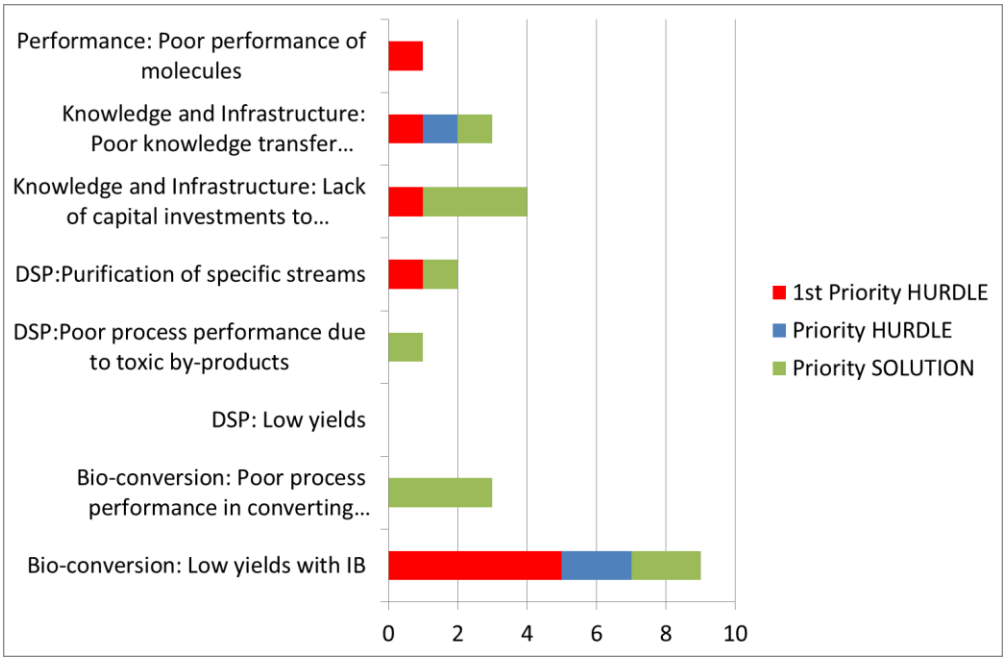
Appendix 5 – detailed results on selection of main hurdles and solutions by participants





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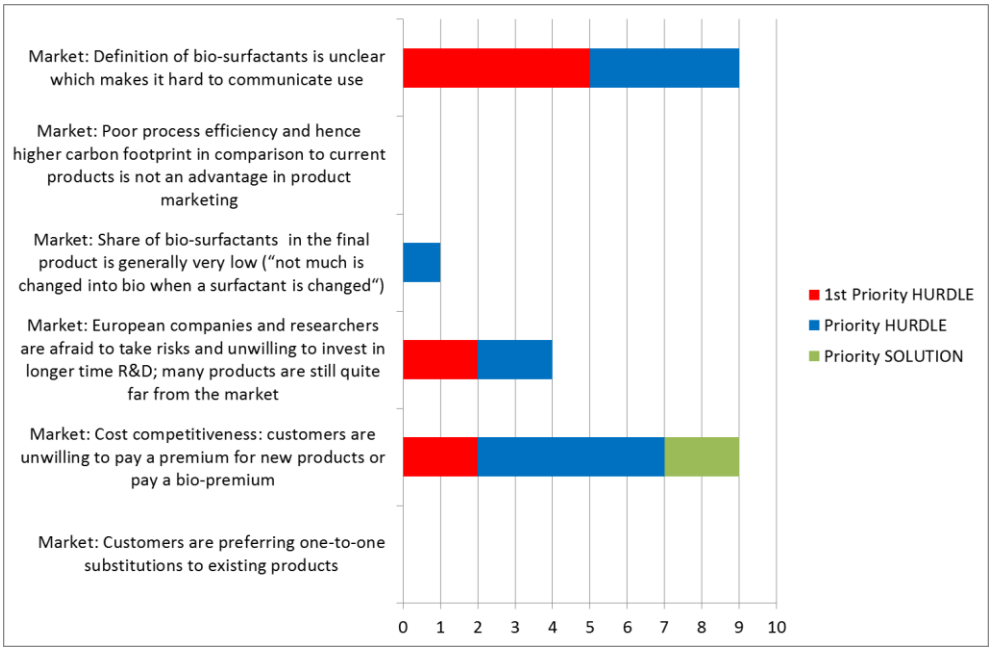
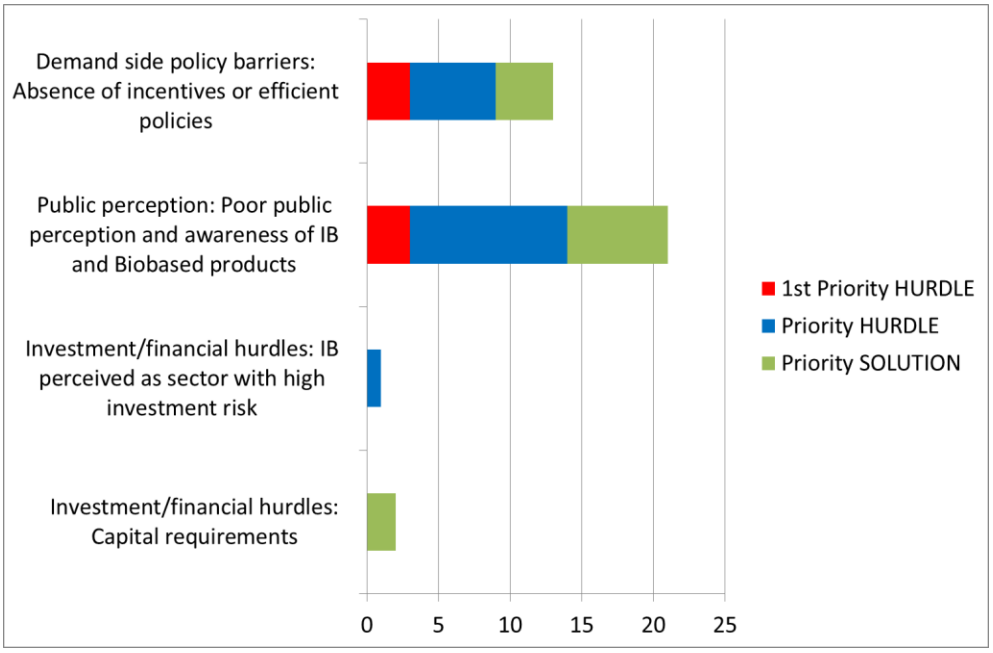
Appendix 5 (continued)





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Appendix 6 - Summary of discussion in sub-group 1

PROJECT: Bio-Tic

VENUE: BioSurfactants Business Case (post Roadmaps draft 2)

DATE: 04th/09/2014

LOCATION: The Westin Grand Berlin, Friedrichstraße 158-164, Berlin, Germany

EUROPEAN INDUSTRIAL BIOTECHNOLOGY FOR BIOSURFACTANTS

BIOSURFACTANTS HURDLES-TO-SOLUTION ROUND TABLE #01

1. Raw materials is not economically viable;

2. Low yield with IB.

SUMMARY OF THE DISCUSSION: from hurdle definition to solution suggestion

Having been assigned to evaluate in more details two of the six hurdles spotted during the business case, round table #01 quickly dived into the discussion. Firstly, these two hurdles were quickly recognised to be are not properly defined, and where thus suggested to be merged together, taking into consideration, not just low production yield or high production cost, but also product performance issues, thus obtaining the hurdle of "low performance/cost/yield".

Once such "upgraded" hurdle was defined, discussion started and soon it was clear that on one hand, many of the apparent hurdles are deriving from a lack of economy of scale, as well as the difficulty to properly match the chemical potential of a new molecule with it right specialty application due to lack of industrially relevant sample material available. If, in fact, on one hand lab scale production is able to deliver mg or g of material, on the other many industries will require kg of material for their functional tests. A gap was thus spotted, as well as the difficulty of such gap to be filled by traditional market forces alone. As a consequence, European Commission actions need was called for, this also to be able to leverage the current scientific and technological advantages that European academic world seems to have compared with the USA, BRICS and other economies. It was also pointed out that a similar advantage characterized the European context some decades ago within the biofuel sector, while in a few years the USA was able to catch up and widely surpass the EU due to a similar limit within EU

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Appendix 6 (continued)

market driven ability to scale up industrial biotechnology success stories. This case may be of significant interest due to the forecasted growth for the BioSurfactants sector, which is expected to follow a similar pattern than the bioplastics sector: the industrial biotechnology (IB) produced BioSurfactants, if properly helped in reaching the next level (economy of scale) have the potential to be the "next bioplastics" in Europe, in terms of both market size as well as employment potential.

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Appendix 6 (continued)

SUGGESTED SOLUTION: defined as an applicable (Why/How/When/Who/Cost/Impact) EC Action

WHY

1. Europe is the top player for research in the field of BioSurfactants (be aware that this may change fast as it happened in for biofuels in favour of the USA);

2. Feedstock availability is not an issue for such category of products which targets low volume markets (in terms of mass, not value), thus is convenient for Europe.

HOW

1. First the range of available new BioSurfactant molecules should be broadened, as it is currently being done, and then these should be matched with new performances/applications together with target industries;

2. Look for additional properties beyond "surfacting" which are considered a potential added value of BioSurfactants compared to traditionally (cheaper) petrochemical based Surfactants;

3. Invest in GMM to boost versatility of BioSurfactants which typically is a drawback of BioSurfactants compared to chemical Surfactants;

4. Need for a lot of open innovation for exploratory marketing through intensified dialogue between academia, BioSurfactant developers and users;

5. BioSurfactants is a wide field. More investment projects are required to boost the chances for identifying and upscaling valuable innovative BioSurfactant molecules;

6. IB for BioSurfactants should also be fostered for the production of pre-cursors (e.g. feedstock such as bio-oils) for the production of BioSurfactants.

WHEN

1. Market pull is needed (such as is happening with Coca Cola's BioPlastics): A widely focussed research and innovation base to identify new molecules, in combination with active upscaling projects will be required to stimulate the market, provide them insight in the potential for BioSurfactants (new properties, cost competitive Surfactants, while contributing to environmental objectives) and foster large industries to invest in full scale production to create a market breakthrough;

2. Innovation strategy should first focus on niche (e.g. cosmetics) applications where cost competitiveness may be less critical than performance and environmental/health aspects, in order to solve residual technical (e.g. DSP) and cost bottlenecks, and then commodity markets should be addressed to focus on new molecules, cost competitiveness (mostly solved by upscaling) including DSP;

3. By 2020, 4 to 5 large scale IB Demo plants projects are needed in EU, accounting for around 200 to 500 M€). Otherwise these may

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leave the EU and happen in the USA or other world regions.

WHO

1. Cosmetics as the launching market, due to its being relatively cost-agnostic => industries together with research to develop new molecules;

2. Economies of scale is the main issue (not technology), together with financing => industries in collaboration with research (to solve residual upscaling issues) as well as large industries and financing institutes backed by governments;

3. Sustainability criteria plus labels for biomass and products can help (for market pull) -> government;

COST/BOUNDARY CONDITIONS

1. The first 1 kg of a new BioSurfactant product costs 1 M€ to develop and supply;

2. More investments required in upscaling Pilot (to produce enough material needed to supply application companies with sufficient material for their explorative marketing) for some selected molecules;

3. Invest in Full Scale Demo (Showcases) for a few molecules;

4. 50 to 100 M€ per new BioSurfactant product is required.

IMPACT

1. The expected accelerated uptake of market growth and societal impact is expected to be comparable to the one that is being seen and forecasted for BioPlastics (unexpected fast uptake due to some large industries take-up);

2. Many of the items (FMCG, fast moving costumers goods) routinely purchased in a supermarket do contain Surfactants: a large part of these may be replaced by BioSurfactants, so huge potential consumer market (improved consumers perception is therefore a potential key impact factor for the take-up).

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Appendix 7 - Summary of discussion in sub-group 2

Group 2 voted "Cost competitiveness" and "Unclear definition of bio-surfactants" as the most relevant market and non-technology related hurdles.

"Cost competitiveness"

Cost competitiveness was seen crucial in a price-driven market such as surfactants, and it was concluded that customers are generally unwilling to pay a premium for new products or pay a bio-premium for IB-based biosurfactants. One participant pointed out, however, that this applies to the "commodities" market only and that higher prices may be accepted in specific high value applications.

The proposed solution was increasing actions towards product improvement and differentiation.

Why?

Superior properties and differentiation were seen as means to justify a higher price.

How?

More attention should be paid to communicating performance and sustainability of IB-based biosurfactants in marketing. Some participants noted, however, that biomass feedstocks bring along new challenges for sustainability claims, such as competition for land, food/feed disputes and impacts on ecosystems and biodiversity. Ecolabels and certification can be used as tools, and the actions could be aimed at companies with announced targets / a strategy on increasing the use of renewable resources.

In addition to the idea of improving B2B marketing, the participants expressed a need to raise consumer awareness about the benefits of bio-based products. This could be done by means of lectures and advertising.

A policy/legislative framework to support bio-based products was also called for.

When?

Given that the changes are slow, there is a need for immediate action. The group also discussed a vicious circle where there are no economies of scale without market demand and vice versa.

Who?

Marketing actions should be carried out by producers and formulators themselves. Ideally, consumers would be in a position to make informed choices and the role of governments would be to support labeling and certification schemes.

Costs / boundary conditions?

The main cost element would be production of communication materials. Marketing costs would be borne by companies but EU funding should be targeted for education campaigns. Lectures/advertising should be planned on the EU scale as the participants did not find local education campaigns effective enough.

Impact?

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Appendix 7 (continued)

"Unclear definition of bio-surfactants"

The unclear definitions in the field of bio-surfactants were mainly seen as a problem in conversation and focus of discussions and not as a problem for industrial biotechnology. For the BIO-TIC roadmaps we need a clear definition to know what we are discussing about.

Why?

In the discussion several types of definitions are used for bio-surfactants

- bio-based surfactants, derived from biomass (partly or whole)
- bio-degradable surfactants
- surfactants based on industrial biotechnology

Market data and discussions on these topics are not comparable if there is no clear definition.

How?

Standards and official definitions are needed and have to be discussed and explained to the stakeholders in academia, industry and the public. Maybe an additional positive list of named compounds can be useful.

When?

As soon as possible – There is a committee CEN TC 276 working on this topic and will publish results in 2015

Who?

The standardization process comes from the EU government for the work on regulations. A standardization on a global level would be crucial for the future.

Costs / boundary conditions?

The main costs are covered by the government and industry.

Impact?

The Impact will be a common terminology – there are no effects on the development of IB technologies.

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Appendix 8 - Summary of discussion in sub-group 3

Topic : "absence of incentives or efficient policies"

WHY

Permits and approvals make it difficult to introduce new products. The biotech community's view is that existing regulations favour non-biobased products (e.g. REACH)

HOW

1. Companies management need to be convinced to push for biobased products; reducing cost and complexity could be done via modification of REACH legislation

2. Harmonization of regulations between different member states would also reduce cost and complexity

WHEN

Actions should be started now, however group members recognized that implementation could take 5-10 years

WHO

The change to regulations involves the EC and member states, which need to be persuaded by biobased industry stakeholders.

COST/BOUNDARY CONDITIONS

The costs involved are difficult to estimate accurately. There is no large upfront investment needed (costs needed to bring together stakeholders, lobbying costs, costs of rewriting the legislation) but it can be a time-consuming process.

IMPACT

Reducing complexity and harmonization will make lead to cheaper legislation and hence cheaper registration of new products.

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Appendix 8 (continued)

Topic : “poor public perception and awareness of IB and biobased products”

WHY

1. There is a need to bring facts to address the legitimate questions that the general public may have regarding biosurfactants : why are biobased surfactants better (consider sustainability, performance, environment)

2. There is a need to overcome objections about GMM (Genetically Modified Microorganisms) which are used to optimize process performance and the range of accessible products.

HOW

1. The first focus should be on education based on the following topics:

- Make people aware of how much biobased products are already used

- Start at school level with positive messages

- Develop positive and consistent labelling and language (“EU-wide regulation”)

2. Promotion efforts of biobased surfactants should be consistent at the EU level and will be supported by consistent labelling mentioned above

WHEN

1. Actions should be started now (develop tools, approach, common language)

2. Also to be started short term is seeking buy-in from NGOs and Governments

WHO

1. Industry is to provide the necessary tools and develop training plans

2. Public authorities (EC and Member States) as well as NGOs should be part of the effort

3. Already existing channels should be used to promote action (Bioeconomy Panel, DG Sanco, panels on bio-based products …)

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Appendix 8 (continued)

COST/BOUNDARY CONDITIONS

1. Participants' view is that the actions required are low cost ("mostly time of people already involved with the subject"), but it requires commitment and buy-in.

IMPACT

1. Better acceptance of biosurfactants will create a larger interested customer base.

2. Awareness will create a market for industry.

3. It was noted that the full impact will arise in 10-15 years from now.

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