Insights from 10 Horizon projects: EU policy for bio-based and biodegradable plastics

Questions & Answers

6th EBRN EVENT

22nd June 2022, 10-12h CET

As a fruit of this meeting, the organization of the 7th EBRN meeting is already established with the strong collaboration of the European Bioeconomy Network and EUBP!

Please save the date: 23rd November from 9-12 CET! Again ONLINE…more projects, more EU representatives, more information on bio-based biodegradable plastics!

Horizon 2020

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement BIO-PLASTICS EUROPE No. 860407.

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Questions from the EU Officers

EU Officers participating in the event

Hans-Christian Eberl – Policy Officer – Circular Economy
Silvia Maltagliati – Policy Officer – Biobased and biodegradable plastics
John Hanus – Policy Officer – Horizon Europe Mission Ocean / All Atlantic Ocean Research Alliance
Werner Bosmans – Policy Officer – Plastics strategy / biodegradable plastics
Silvia Forni – Policy Officer – Plastics strategy/ biobased plastics / microplastics
Olga Pozlevic – Policy Assistant – Bioplastics
Christina Paducea – EU Officer BIO-PLASTICS EUROPE
Dimos Paraskevas – EU Officer – upPE-T
Verle Lammens – EU Officer – SEALIVE EU Officer

Biodegradability

John Hanus:

Are there coherent testing and certification standards for the biodegradation of plastic in the open environment including the marine environment?

Glaukos (Zsofia Kadar/Susanna Albertini).[1] Methods to assess the biodegradability of plastics, particularly in marine environments, and at the micro-scale, are still insufficiently standardized. Equally important is that there are not yet adequate methods to use available information on the biodegradability and ecotoxicity of (micro)plastics specifically intended to redirect developments in the textile industry. With regards to currently available methods for the assessment of polymer biodegradation in marine environments, those are frequently unpractical and not representative of environmentally relevant marine conditions. They also lack an ecological perspective and do not consider how to design materials that mitigate the current impact on marine fauna. When speaking of 'materials', we refer both to the polymers and the additives used in the manufacturing and/or finishing process and whose purpose is to provide these materials with properties such as, for example, colour, ductility, elasticity, UV filters or fireproof character, to name but a few [1]. To the best of our knowledge, the more comprehensive and pioneering effort to set standards for harmless plastics in the marine environment was ASTM D7081-05, which included the three aspects of mineralization, mechanical degradation, and non-toxicity. Unfortunately, this standard was withdrawn in 2014. Another shortcoming of most standards is the long incubation periods demanded (frequently 180 days and up to 2 years). Those time frames prevent high through-put, unacceptably increase the risk of accidental failures, and would make the testing of newly developed materials unfeasible in the lifetime of a project the duration; projects like Glaukos, in particular, and/or any other research project since we are talking about duration periods usually in between 2 and 4 or 5 years. Glaukos project has a publicly available deliverable entitled "Standardized

[1] This project has received funding from the Bio Based Industries Joint Undertaking under the European Unions Horizon 2020 research and innovation programme under grant agreement No. 887711.

methods" related to the question of coherent and standardized testing procedures. We also recommend reading the recently published article by López-Ibáñez & Beiras (2022), work financed thanks to the Glaukos project [2].

[1] Prior knowledge of UVIGO (ie., ECOTOX research team): "Aquatic toxicity of chemically defined microplastics can be explained by functional additives". **Ricardo Beiras**, Eva Verdejo, Pedro Campoy-Lopez, Leticia Vidal-Liñán, *Journal of Hazardous Materials*, Volume 406, 2021, 124338 (https://doi.org/10.1016/j.jhazmat.2020.124338)
[2] "Is a compostable plastic biodegradable in the sea? A rapid standard protocol to test mineralization in marine conditions". Sara López-Ibáñez, Ricardo Beiras, *Science of The Total Environment*, Volume 831, 2022, 154860, ISSN 0048-9697 (https://doi.org/10.1016/j.scitotenv.2022.154860)

UpPE-T (Ines Fritz/Henar Araguzo/Fuensanta Monzó).[2] Yes, there are a couple of standards already released from CEN TC 249, some more from CEN TC261 SC4, and a lot from multiple ISO committees, such as ISO TC61. The problem is man-made: each working group in CEN and ISO „likes" to have its own standards, so we have biodegradability standards for packaging, non-packaging, fibers, elastomers, water-soluble polymers - and each of those separately for soil, wetland, sediment, compost, marine environment swimming, marine environment sinking ….Currently, there are about 40 such standards, multiples of them dealing with the same topic in different ways. While generally good, the multiple overlapping standards need to be fused. CEN/ISO standardization bodies (including working groups) in the area of biodegradation that could be of interest:
CEN/TC 249/WG 9, "Bio-based and biodegradable plastics"
SO/TC 61/SC 14/WG 2, "Biodegradability"
CEN/TC 261/SC 4, "Packaging and Environment"
ISO/TC 122/SC 4, "Packaging and the environment"
Current standards for biodegradation of plastic in the open environment need to be improved. The standards have been designed to simulate marine or soil environments, however frequently experimental conditions are far from real environmental parameters. These environments have specific ranges of microbial activity, pH, temperature, salinity, and pressure that are not fully covered by any technical standard. Ideal standards should consider real and challenging conditions like those in deep-sea, which could provide a more appropriate assessment of material biodegradability for these ecosystems. Moreover, promoting consensus to develop standards among the European Standardisation Organisations is necessary.

PlasticsFatE (Rudolf Reuther).[3] The question is also how well our current analytical methods perform to identify, detect, and quantify bio-degradable microplastics in certain test media, such as cell culture media, biological fluids simulating the human lung or gut system, or particle dispersions?

LABPLAS.[4] There are certifications that cover some environmental scenarios, such as OK biodegradable Soil, OK biodegradable Marine, and OK biodegradable Water. These certifications

[2] This Project has received funding from the European Unions Horizon 2020 research and innovation programme under grant agreement No. 953214.
[3] This Project has received funding from the European Unions Horizon 2020 Research and Innovation programme, under the grant agreement No. 965367.
[4] This project has received funding from the European Unions Horizon 2020 research and innovation programme under grant agreement No. 101003954.

have been developed by the certification body TÜV Austria based on existing standard methods. However, these methods are for specific environmental compartments and, thresholds in some cases have been decided by the certification body.

Further testing schemes have been developed in the ECHA restriction proposal for intentionally added microplastic, however, the applicability of these tests/schemes has been missing validation because round robin tests and data on microplastic materials and their behavior are either very scarce or do not exist.

Whereas biodegradability is an inherent property of a given material, dependent on its molecular structure, actual biodegradation in the natural environment is dependent on other factors that influence microbial activity, including oxygen availability, nutrients availability (N, P, and other potentially limiting inorganic nutrients), presence of water, light, temperature, and the composition of the natural consortium of heterotrophic microorganisms present in a given environmental compartment. Therefore, a standard intended to investigate the biodegradability of a material must consider that there will be different conditions affecting biodegradation rates. By far the hardest condition to be standardized is the composition of the microbial inoculum.

Since oceans are the final sink for plastic litter, the assessment of marine biodegradability is particularly relevant to pursuing the aim of designing new plastic products that ensure genuine environmental benefits. More efforts must be invested in the development of cost-effective, rapid (with high throughput), and ecologically relevant standard tests representative of marine biodegradation.

BIONTOP (EUBP).[5] Currently, there is no international standard that appropriately defines the biodegradation of plastics in marine environments. However, several standardization projects are in progress at ISO and ASTM level. Even though plastics that are biodegradable according to established standards are not and never were intended to be a solution against marine littering, they may be part of a solution. We fully support more research into the biodegradation behaviour of existing material types and applications, and we call for the establishment of standards to measure and affirm (or reject) claims of biodegradation in the respective marine environments, as it has already been achieved by the biodegradable industry for the issues of land-based use and end-of-life scenarios.

Recycling of biobased plastics

Werner Bosmans:

How to take care that biobased plastics will be effectively recycled, seen that value chains need to be set up, and that market volumes might be low?

BIONTOP (Maria-Beatrice Coltelli). Methodologies to make sorting and recycling of PLA-based materials were developed in the framework of BIONTOP. A value chain that fully recycles a biobased and biodegradable (Home-compostable) material in a closed loop way (from packaging to packaging) was yet demonstrated at a semi-industrial scale. The materials that were tested were recovered from partners' facilities, so they were clean and not contaminated. This can be different in a real waste management system.

[5] This Project has received funding from the Bio Based Industries Joint Undertaking under the European Unions Horizon 2020 research and innovation programme under grant agreement No. 837761.

A real chain should include the collection of PLA-based materials from urban waste. In Italy, compostable plastics must be put by citizens in the humid fraction of waste. Hence PLA-based materials should be separated from food waste and other polymers (for example starch based) in collection plants, washed, dried, and then recycled. The effect of all these operations should be analysed better.

BIONTOP (EUBP). EUBP would like to highlight that bio-based and compostable plastics can be sorted from plastic waste very efficiently using the industry standard NIR (near infra-red) and density (sink-float) sorting technologies. We would therefore propose that the definition includes a roadmap and relative timeframe to allow for different bio-based polymers to be "aggregated into defined streams". Concretely, the Commission should define a realistic timeframe to upscale the proper sorting technologies which would enable better waste streams and allow all available recycling technologies (mechanical, chemical, and organic) for bio-based and/or compostable plastic packaging. To accelerate this process, the EPR fee paid by producers should be "earmarked" for the upscale of NIR sorting technologies as well as, in the case of compostable packaging, of the composting infrastructure.

The current proposal to set up the period for recycling at maximum of 5 years for innovative packaging placed on the market will hamper innovation and will in fact be counterproductive to our efforts to develop alternatives to conventional plastics. Innovative bioplastics can be on the market for more than 5 years without being able to develop a new recycling stream – for several reasons, such as market demand or technological advances. We would therefore ask the Commission to extend the maximum period of recycling for innovative packaging to 10 years. Otherwise, we will face a real risk that companies will not be incentivized to invest further in innovative packaging.

SEALIVE (Andrew Farmer).[6] This is a really important issue. It is also relevant to several conventional plastics. A problem is that the problems of scale needed to develop value chains vary across Europe (a lot!). Further, there are developments with chemical recycling which also change what may be appropriate in some locations. This suggests that a blanket EU policy might not be appropriate if it is too rigid.

UpPE-T (Ines Fritz/Fuensanta Monzo). Policymakers have ordered technical rules to be included in laws and regulations (mandated standards, such as EN13432). In addition, we can talk to our national authorities and from time to time the EC is publishing open questionnaires which should be answered and returned by as many people as possible (= do not collect opinions and send them only once). Reaching out to the public is essential but of limited effect with the budget of a research project. Communication to the public should be done via official announcements from the authorities. We need to convince authorities to become active! Reaching out to them via the channels they frequently visit: social media! But not only text and photos, but video messages may also be the way to go. Communication at all levels, from schools, associations, municipalities, and organizations. Administrations should also lead by example. And I also consider it very important to be clear and to speak bluntly about the problems we face and the solutions that are on the table. Developing tailored actions involving key actors, including policymakers, and creating favorable environments. For example:

[6] This project has received funding from the European Unions Horizon 2020 Research and Innovation prgramme under grant agreement No. 862910.

- promoting the collaboration between the industry, academic actors, and research organizations.

-creating specific platforms involving relevant actors across the innovation chain to share their results, experiences, and good practices but also challenges and problems to overcome.

- provide scientific research data to guide policy implementation.

LABPLAS

- By facilitating science-industry connections
- By funding initiatives following a multi-stakeholder approach

Citizens are extremely aware of issues related to plastic pollution. In fact, the public perception of risk by these issues goes further beyond scientific evidence. A more educated perception of plastic properties and actual hazards should include the following aspect: *It is the potential use of some chemical additives that may render a plastic product toxic.*

A key step to making progress in this field would be to indicate at least the qualitative composition of the commercial products, in terms not only of the polymer but also of the intentionally added chemicals needed for the product to meet the functional requirements demanded by the market (plasticizers, stabilizers, flame retardants, pigments, etc.). Interesting developments/initiatives for a more transparent communication on the composition of materials are currently ongoing within the context of the Ecodesign for Sustainable Products Regulation and in the related Digital Product Passport development.

Microplastic in wastewater

Olga Pozlevic:

Almost 90% of microplastics from wastewater are captured in the sewage sludge. In the EU 40% of this sludge is applied to the land. How could we solve this issue?

PlasticsFatE (Rudolf Reuther). This is good for the receiving waters but bad for soils exposed to MP contained in the sludge! One way would be to revise relevant EU directives, such as for WWT or application of sewage sludge on soils in relation to MP (and associated chemicals), and set up regulatory monitoring to ensure compliance with these new requirements, and at the same time make sure that the necessary analytical and testing methodology is developed, harmonized and applied.

System perspective: bio-based plastics vs. conventional ones

Werner Bosmans:

How to be sure that bio-based plastics are better than conventional ones (system perspective)?

BIONTOP (Maria-Beatrice Coltelli). The reason is the carbon neutral effect of biobased plastics. Each polymeric material (also fossil ones) cannot be recycled too many times (real data say they are not recycled so much). Biodegradable and recyclable plastic will be composted at the end

(not incinerated). Not biodegradable and recyclable biobased plastics will be incinerated. Considering both biobased streams the balance of emitted CO2 will be zero and not positive.

Glaukos (Zsofia Kadar/Susanna Albertini). A comprehensive environmental Life Cycle Assessment of the new solutions needs to be compared with conventional alternative solutions, taking into account the biobased nature of the materials and biodegradability aspects, defining the value chains and the system boundaries.

SEALIVE (Andrew Farmer). I don't think it is about being "better". What we need is to determine what we need materials to do and then what materials are best able to deliver these needs, taking into account other impacts they may have. We need some plastics not to degrade – strength, lightweight, and long-lasting can be desirable. Other times those qualities are a serious problem – especially if connected to social misbehavior in case of e.g. littering... Effectively the Plastics Strategy needs to evolve to set out what we want plastics for and which types of plastics. In effect, the SUPD does this in a limited way by saying we do not want plastics for some things.

UpP-ET (Fuensanta Monzó). Through a proper Life Cycle Sustainability Assessment (LCSA), comparing conventional plastic with biodegradable plastic for every specific application.

LABPLAS Durable materials suitable for reuse are preferred for items intended for a long-life service, whereas biodegradable materials are preferred for items or item components with a shorter life span, but for which biodegradability must bring a value for a circular use of resources (e.g. recollection of organic waste through organic waste bags) or for which a loss in the environment cannot be avoided due to their applications (in the case of biodegradable mulch films for which full recollection is extremely difficult at low thicknesses and truly marine biodegradable plastics that will be beneficial for fisheries and aquaculture applications in which accidental loss in the sea is difficult to avoid).

Whereas biobased products play a role in reducing dependence on fossil fuels, they do not necessarily affect plastic litter reduction. There is no evidence so far that fragmentation of biodegradable polymers produces lower levels of MP than fragmentation of conventional polymers. Therefore, biobased plastics should be designed to minimize the release of micro and nanoplastics. The combination of performance in use (similar to conventional plastics) and biodegradability is technically challenging.

Biobased plastics must consider not only the origin and biodegradation properties of the material but also the non-toxicity of the released metabolites and micro and nanoparticles produced during the degradation process. Otherwise, the cure may be worse than the disease, (materials with lower environmental persistence but higher ecotoxicity).

Current levels of microplastics in the environment pose a low risk for marine ecosystems, including the potential transfer of chemicals across food webs. However, we need to cut down the input of land-based plastic into the seas to keep this risk low. Concerning SMNPs, research should focus on those size fractions more susceptible to getting across biological membranes. For example, macro-pinocytosis is restricted to particles between 0.2 and 5 µm. Monitoring these size fractions in environmental samples is currently beyond the state-of-the-art.

BIO-PLASTICS EUROPE (Jelena Barbir). It is important to understand what we want to achieve. Bio-based materials have a great potential to increase sustainability of the final products. However, it is important that production of this material is not in competition with food chain, and that we are sure that final product and its usage is actually more sustainable solution when compared with fossil-based plastics. We cannot allow ourselves mistakes in decisions here.

System perspective: compostable and biodegradable plastics vs. conventional ones

Werner Bosmans:

How to be sure that compostable and biodegradable plastics are better than conventional ones (system perspective)?

BIONTOP (Maria-Beatrice Coltelli). From biodegradable plastics, valuable compost can be obtained in the case of aerobic biodegradation. This compost is a valuable carbon sink if used for "refertilization" of karst regions. Anaerobic digestion (that gives methane, to be exploited as an energy source) can be also possible.

BIO-PLASTICS EUROPE (Jelena Barbir). When we compare, we do not search for better only, but it is a complex system of decisions in order to decide when this characteristic is desirable and leads to better solution, and when it is not. This is the key question we have to ask before we explore how better it should be. Especially, since the application of the product marks its future characteristics.

Future of biodegradable plastics: consumer behavior

Werner Bosmans:

What is the future of biodegradable plastics when taking consumer behavior into account?

BIONTOP (Maria-Beatrice Coltelli). Green-minded consumers are also oriented to be informed about the end of life. For these consumers a clear end-of-life organization of the product is important. In case they do not understand, they will be lost as consumers of biobased products.

LABPLAS. Biodegradable plastics are not the solution to plastic littering. This must be fought at the source by changing consumer behavior concerning intentional disposal and preventing accidental release of litter into the environment. However, biodegradable plastics that exhibit shorter environmental lives than conventional plastics, will play a key role in reducing plastic litter in the environment. Examples are certified compostable bags that will reduce the amount of conventional plastic ending up in compost and afterward on the agricultural fields, certified soil-biodegradable mulch films that will not create persistent microplastic after use, and truly marine biodegradable plastics that will be beneficial for fisheries and aquaculture applications in which accidental loss in the sea is difficult to avoid.

Labeling of plastic items must clearly distinguish between the origin (e.g. biobased) and intended end-of-life (e.g. recyclable, home compostable, etc.). This labeling should be ideally internationally harmonized and consumers and the waste management sector should be aware of the meaning of these labels.

Project results

Silvia Forini:

Please explain your project results on:

- Sustainable sourcing of bio-based plastics

BIONTOP (Maria-Beatrice Coltelli). Materials developed in the project are based on poly(lactic acid). Wheat bran was also considered for biocomposites, but the recyclability is worsened.

- Comparing alternative feedstock over a life cycle perspective
- Use of biodegradable and compostable plastics in a circular economy, where the priority is to reduce, reuse, and recycling (applications and criteria for such applications)

BIONTOP (Maria-Beatrice Coltelli). Biontop is much focused on these objectives and demonstrated that circularity is possible.

- Recyclability of biobased plastics

BIONTOP (Maria-Beatrice Coltelli). Biontop demonstrated the recyclability of a biobased and home-compostable material suitable for films and trays.

- Consumer behavior – claimed biodegradability as a factor potentially influencing littering
- Safety / toxicity issues (use of additives in biodegradable plastics (e.g. agri-plastics))
- Complexities of the biodegradation processes (e.g. transfer from one environmental compartment to another, long-term impacts of biodegradable in soil plastics)

In this way, projects results can still contribute to the Draft Communication on biobased, biodegradable and compostable plastics (Public consultation on biobased, biodegradable and compostable plastics (europa.eu)

Scaling up solutions

John Hanus:

How can we ensure that scientific knowledge and solutions are transferred to relevant actors in society (including policymakers) and implemented at a large scale?

BIO-PLASTICS EUROPE (Eleonora Foschi).[7] The knowledge transfer from research to industry and society by the establishment of business cases and dissemination activities. In the BIO-PLASTICS EUROPE project, we interviewed the key players of the bio-based and biodegradable plastics industry (from raw materials producers to compounders and crucial converters) to understand business models comprehensively. Specifically, we investigated the motivations guiding the supply of bio-based and biodegradable plastics, relative challenges and impacts on business processes, and the potential financial feasibility study and/or sustainability impact measurement. It facilitated the identification of gaps. Findings reveal that while collaborations in the supply chain (what we call value network) are crucial to exploit innovative materials, the relationship with end-users and actors operating at the end-of-life (municipalities, waste collectors, waste recyclers, EPR schemes) should be reinforced. After a call to action, we identified and engaged converters to a. test the compounds developed within the project in end-products, b. analyzes existing business models to find out problematic elements c. redesign business models by integrating circularity and sustainability in business processes and operations d. measure and make evidence of resulting benefits. It is done by arranging business

[7] This project has received funding from the European Unions Horizon 2020 research and innovation programme under grant agreement No. 860407.

modeling sessions with the company first and focus groups with multiple relevant actors (including policy-makers, public entities, associations, etc.). Specifically, inside-out and outside-in techniques support the identification and discussion of elements that can mutually impact or be beneficial for the company and/or the ecosystem in which the company operates.

BIO-PLASTICS EUROPE (Alexandra Wu). In my opinion, the communication efforts must be strategic in that it goes beyond simply transferring (broadcasting) knowledge and solutions on biobased and biodegradable plastics. Rather, it is about tailoring the communication and knowledge transfer such that each type of actor is aware of their role and contribution in relation to the solution. This means that the communication must be targeted – that the actor receives clear and obvious information about the properties of the product (as relevant to them) and how they specifically should deal with it during the lifecycle phase where they are involved, and similarly for other actors like producers and waste managers. And to dispel common myths about biodegradable plastics (e.g., that biodegradation can occur anywhere, so it doesn't matter where the products are disposed).

European Bioeconomy Network (Susanna Albertini).[8] The experience of the H2020 BIOVOICES project (BIOVOICES Project - Bioeconomy for a Sustainable World) can be very inspirational. The project organized more than 70 Mobilisation and Mutual Learning Workshops involving quadruple helix stakeholders, stimulating the debate around a conceptual model developed by Wageningen University. The MMLs hosted case studies from research projects and industrial innovation in the bioeconomy and bio-based sectors in order to inspire and inform policies at European, national, regional, and local levels.

BIOVOICES contributed to stakeholder empowerment and facilitation of systemic thinking for the uptake of the bio-based economy.

UpLift (Alberto Barranca).[9] Without a doubt, I believe that following the strategies listed below could ensure transfer between the scientific community (in terms of plastic recycling) and the rest of society's actor:

a) Support European funding projects in which new alternatives aimed at promoting the circular economy, such as bio-recycling, are put to good use. It is important that, in order to make society aware of the innovation in this scientific field, dissemination of these options should be promoted with a clear objective of social awareness through events, special dissemination campaigns, informative material, congresses...
b) Promote aspects such as transparency for the end customer of recycled products in the projects. To this end, it will be important to include in the projects dynamic activities for the social actors, in which they show their opinion regarding this type of products and are made aware of the efforts that are being implemented to bridge the possible existing gaps.
c) Incorporate into projects work packages especially focused on the standardization of new scientific alternatives to plastic valorization (for example biological recycling). In this way, knowledge will be promoted through standardization/legislation committees, really important groups in normalization/policymakers.

[8] The European Bioeconomy Network is supported by the EU funded projects BIOVOICES grant agreement No. 774331 and Transition2BIO grant agreement No. 101000539.
[9] This Project has received funding from the European Unions Horizon 2020 research and innovation programme under grant agreement No. 953073.

d) Incorporate work packages/objectives based on standardization or legislation of new recycling alternatives will allow the development of position papers addressed to policymakers who will know the news on the state of the art of recycling alternatives. This fact will help policymakers identify possible gaps in the current framework in legislation/normalization and they will work on solving them.

John Hanus:

More specifically, how can we best connect initiatives at local, national, and EU level to reach a critical mass?

European Bioeconomy Network (Susanna Albertini). The European Bioeconomy Network experience was very effective in connecting projects and initiatives, specifically:

- EuBioNet stimulates the debate through thematic working groups to discuss relevant challenges, aggregate results from different projects, and facilitate their exploitation in local and regional contexts, in order to support the bioeconomy ecosystem creation. The thematic working groups facilitate mobilization and mutual learning of the relevant EuBioNet partners and expand the discussion to a larger community of stakeholders.
- EuBioNet bridges EU-funded projects and their outcomes with the stakeholders, including civil society and policymakers, encouraging wide diffusion, exploitation, and adoption
- It connects projects and initiatives at multiple levels (European, national and local level). Case study: Transition2Bio capacity building for regional actors “how to communicate the bioeconomy” deployed with GoDanubio, Be-Rural, and BIOEAST initiatives, empowering around 50 regional bioeconomy ecosystem enablers.

- EuBioNet Facilitates the replication of good practices, methodologies, contents, and tools t, with a special focus on civil society (through projects like Transition2Bio, AllThings.BioPro, GenB, BioGov.net, BIOVOICES, etc.)

The EuBioNet methodology and experience could provide inspirational insights for future projects and initiatives connecting EU-funded research with the local, national, and EU beneficiaries.

BIO-PLASTICS EUROPE (Jelena Barbir). To my opinion, every Horizon project does some small steps forward, but what we miss is to combine those in a bigger structure. This should be the role of the EU. A good example from our project are networks. We are having many stakeholders actively engaged, but once the project is over, we do not have perspectives for those networks, and the work cannot continue. It is sort of loosing resources combining many short-term solutions, but lacking long-term ones.

John Hanus:

How can we best mobilize citizens and society for the implementation of solutions (including through citizen science initiatives)?

European Bioeconomy Network (Susanna Albertini). Building on the experiences of projects like BIOVOICES, BIOWAYS, Transition2Bio, BIObridges, AllThings.bioPro, LIFT and other CSAs or CSA-like projects, the awareness and education of consumers (but also the end users like fishermen) is key for the sustainable uptake of bio-based and biodegradable solutions. Key elements like motivational drivers (economic, social, environmental) and barriers

(misconceptions, resistances, behaviors) should be considered in the design of effective policies and actions supporting the transition.
The public is getting more mature and open to sustainable switch, but, according to the BIObridges survey (2020 Biobridges Consultation (biobridges-project.eu) they look for transparent, coherent, and scientifically solid communication and education to make decisions.

Transition2Bio (Home - transition2bio) contributed to the conceptualization of awareness, communication, and stakeholder engagement in the bioeconomy by creating the three-dimensional model "BIOWHAT, BIOHOW, and BIOACT", stemming from the extensive and impactful communication activities that have been implemented by several European-funded projects. This model's objective is to provide a framework by which to map and organize bioeconomy communication activities, thereby targeting stakeholders with different levels of maturity with regard to awareness of and engagement with the bioeconomy.

NOTE: We are available to share more insights about this, having an overview of several projects and initiatives among the 108 EuBioNet projects and initiatives members. Susanna Albertini albertini@fvaweb.it

Policy targets

John Hanus:

What role for biobased and biodegradable plastics in reaching the 2030 targets of the EU Zero Pollution Action Plan (Reduce by at least 50% plastic litter at sea, Reduce by at least 30% microplastics released into the environment.

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How do you consider the recommendation from the EU Science Advisory Mechanism Opinion on Biodegradable Plastics (2020) to limit the use of biodegradable plastics in the open environment to specific applications for which reduction, reuse, and recycling are not feasible

SEALIVE (Andrew Farmer). The SAM recommendation is odd. Its report details evidence on behavior in the open environment but then makes this recommendation without evidence on the behavior of the materials capture and recycling system. Indeed, the PEW Plastic Wave report, by contrast, states "stopping plastic pollution by capturing all plastic materials in the recycling process is neither technically nor financially feasible". The SAM recommendation is more based on a wish that the circular economy would work, but real-world experience suggests that plastic leakage will continue.
As a general policy principle, it is correct to prioritize reuse and recycling. Having said this, this option does not do this. It only does it for biodegradable plastics. It is not unreasonable to ask why a policy should not aim to limit the use of all plastics to specific applications for which reduction, reuse, and recycling are not feasible. Many plastics in the EU are not recycled. To deliver a circular economy, why not seek to replace polymers (where possible) with those that are more easily recycled? Why are biodegradable plastics need to meet a higher expectation in the circular economy than other plastics?
A further problem is interpreting what is meant by "feasible". Is this feasibility of retention/collection? Is it feasible of recycling once collected? The answer varies across the EU. On the feasibility of retention (i.e. not leaking to the environment), there are few plastics that do not leak into the environment somewhere. Thus, does "feasible" mean some may be recycled or all can be recycled? One may argue, therefore, that material that leaks is not feasible for

recycling (noting that even collection from the environment is partial). Arguments that suggest such leakage should be tackled are correct, but arguments that suggest such leakage will be fully stopped are naïve given the history of implementation failure of waste policy. The systemic institutional failures must be understood.
On the feasibility of recycling the material that is collected, there are different possible views. Many biodegradables are recyclable, but they are not separated (due to a lack of financial justifications). Also, given that there is some chemical recycling in the EU, it is theoretically possible to recycle biodegradables. Therefore, there is not an either/or option between biodegradability and recyclability. If one considers mechanical sorting and recycling, what is currently separated and recycled is different from what could be separated and recycled if it was cost-effective and desirable. This applies to conventional plastics as much as biodegradables. It is important, therefore, that any policy focused on limits to recycling consider what is needed for the future of plastics in a properly functioning circular economy and not limited to today's thinking and institutional constraints.
Finally, there is the problem is moving from a general policy goal (e.g. recycling is best where feasible) to an obligation in law (in a directive). This is for the following reasons. First, feasibility (leakage, sorting, recycling) does and will vary across the EU. Therefore, it may not be appropriate to make an EU-wide determination on the suitability of biodegradables. Second, who will interpret the law? If a manufacturer makes a new product, are they in a position to determine what is, or is not, feasibly recyclable and so make it of biodegradable plastic or not? Are national authorities? In either case, different decisions may be reached in different Member States and this would be an issue for products placed on the single market. If the Commission were asked to make an EU-wide determination, could it assess the different recycling feasibilities across all Member States?
One possible route to avoiding some of this confusion would be to interpret the general policy statement that where products are made from conventional plastics and there are already very high levels of reuse/recyclability, they should not be replaced by biodegradables. Where there are products where there is considerable leakage or disposal (incineration, landfill), then replacement with biodegradables should not be avoided unless a radical change in their recycling was likely to occur.

UpPE-T (Fuensanta Monzó): I think the role of biodegradable plastics is fundamental to reaching these targets, especially in the cases of products that have more risk of ending up on lands and oceans. An important point is to specify clearly in which specific environment the bioplastic products are biodegradable (soil, seawater, freshwater), and study the toxicity of the bioplastic product (including additives and coatings). Moreover, considering the end of life from the bioplastic product design according to its target applications is important for sustainability. This point is also key to reducing the microplastics released into the environment.
If the biodegradable plastic cannot be incorporated into the collecting and recycling system, yes. We must ensure that the use of biodegradable plastics does not generate new problems, and citizens must know very well how biodegradable plastics should be used and how they work in order to ensure their correct use. It is important to advance in the recycling of bioplastics. In case of establishing limitations of use, it should not be for biodegradable materials, but rather for non-recyclable ones. It is important to remember that biodegradable plastics must be recyclable and work on the recyclability of biodegradable plastics. Limitations shouldn't be focused only on biodegradable plastics.

BIONTOP (Maria-Beatrice Coltelli). alerting campaigns that induce citizens to having care of their own waste (biodegradable or not, made in plastic or other materials), without abandoning it in the environment, should be done frequently. Biodegradable plastics can be useful because recycling polymeric materials can be done only a few times. When it is no more possible to

recycle, the production of valuable compost can be a good option. Moreover, anaerobic digestion is another option that would give methane for energy.

LABPLAS. Biobased and biodegradable plastics are two different categories that should not be mixed. Whereas biobased products play a role in reducing dependence on fossil fuels and are only connected to the origin of the raw materials, biodegradability is the property that will play a role when talking about the end of life.

Biodegradable plastics are not the solution to plastic littering. This must be fought at the source by changing consumer behavior concerning intentional disposal and preventing accidental release of litter into the environment. However, biodegradable plastics that exhibit shorter environmental lives than conventional plastics, may play a key role in reducing plastic litter in the environment. Examples are certified compostable bags that will reduce the amount of conventional plastic ending up in compost and afterward on the agricultural fields, certified soil-biodegradable mulch films that will not create persistent microplastic after use, and truly marine biodegradable plastics that will be beneficial for fisheries and aquaculture applications in which accidental loss in the sea is difficult to avoid.

Concerning microplastics, most of them stem from the fragmentation of macroplastics. There is no evidence so far that the fragmentation of biodegradable polymers produces lower levels of MP than the fragmentation of conventional polymers. Therefore, the certification of degradable plastics as environmentally safe should also consider the lack of a substantial release of microplastics (a negative experience has been had with oxo-degradable materials).

The recommendation from the EU Science Advisory Mechanism Opinion on Biodegradable Plastics (2020) to limit the use of biodegradable plastics in the open environment to specific applications for which reduction, reuse, and recycling are not feasible seems sound since reduction, reuse, and recycling, by that order are preferable to environmental biodegradation. A realistic estimation of the feasibility of recycling needs to be made as well as a holistic analysis of the more sustainable approach in terms of overall resources.

BIONTOP (EUBP). On reaching targets for the EU Zero Pollution Action Plan, biodegradable polymers have the advantage that they do not erode into permanent secondary microplastics upon degradation because most natural environments habit microbes that can metabolize these polymers. The residence time is considerably lower for biodegradable polymers compared to conventional plastic materials. Therefore, biodegradable plastics can help in minimizing environmental impacts, while reducing the accumulation of plastic particles in different environmental habitats. I.e., industrial compostable plastics significantly reduce the amount of persistent, non-biodegradable microplastics in the compost and thus a subsequent leakage into the environment.

Although certified soil-biodegradable and compostable plastics do – as all solid materials – produce small particles through abrasion when in use, they are not the same kind of persistent microparticles that are caused by conventional, non-biodegradable materials. Instead, these particles will biodegrade.

On the recommendation from the EU Science Advisory Mechanism Opinion to limit biodegradable plastics in the open environment, it is important to stress that biodegradability in an open environment (especially marine) is “desirable” only for very few, highly specific, applications. These could be applications that would be difficult to find and recover, such as firework casings, or could be applications intended to be used by professionals (e.g., farmers or fishermen/fisherwomen) under specific circumstances. For other applications, mainly falling

within the category of packaging, "biodegradability in an open environment" is neither to be promoted nor endorsed, and the industry fully agrees that this principle should not change. However, if an overall assessment of the persistence of items that are of consequence for "littering" is to be carried out, it should incorporate a risk assessment for all materials that are found in an open environment.

Biodegradable and compostable materials offer benefits for applications that are not able to be reused or (mechanically) recycled. Yet, instead of limits or lists of certain applications that should be biodegradable, we recommend to rather introduce criteria to assist in the search for new applications that promote R&D and innovation and improve the management and/or treatment of bio-based, biodegradable, and compostable plastics. In this regard, we would consider the following criteria as important to be taken into account: applications that facilitate the collection and composting of biowaste; applications that are liable to contaminate compost; and/or those applications that cannot or are not prone to be recycled because they are contaminated with food waste, made of non-separable multi-layer films, or hard to be recycled otherwise. Where reuse is not appropriate, closed-loop systems can operate well by allowing compostable packaging to be collected together with the food waste.

A product should always be designed with an efficient and appropriate recovery solution in mind. In the case of biodegradable plastic products, the preferable recovery solution is the separate collection together with the biowaste, organic recycling (e.g., composting in industrial composting plant or anaerobic digestion in AD plants), and hence the production of valuable compost or biogas.

BIO-PLASTICS EUROPE (Alexandra Wu). Based on our work in the BPE project so far, my personal opinion is that increasing the use of biobased and biodegradable plastics alone would not necessarily contribute to the goal of reducing ocean plastic litter and microplastic pollution. This is because it is not guaranteed that the introduction and upscaling of biobased and biodegradable plastic would replace conventional plastic use, i.e. there remains the risk of the net accumulation of plastic volumes in society, especially if it ends up justifying the greater use of plastics overall when other more sustainable material options are available. Considering also the risk of incomplete and unsafe degradation of biodegradable plastic, this may result in increased pollution in waters. As such we must be very careful and stringent to ensure that the biobased and biodegradable plastic that are allowed to enter the market come with minimal risk if it enters the environment – this is of course where standardization and regulation play a key role.

Policy recommendations

Werner Bosmans:

Do you have any policy recommendations to share now? Either based on early results or on the available research which forms the base of your project?

BIONTOP (Maria-Beatrice Coltelli). Consider that currently plastic is demonized and also bioplastics are. In this framework, bioplastics companies can be negatively affected while they could be useful for green transition and for fighting against climate change.

LABPLAS.

- Bio-based and biodegradable plastics are different concepts.

- Understanding that the qualitative composition of polymeric products is protected by IP rights, the presence of chemical additives should be regulated for specific applications to protect consumers, as already happening for food contact or toys.
- Standard requirements and specifications, as well as certification for biodegradable materials, must consider not only the biodegradation of the material, but also exclude the use of substances not compatible with the application (e.g. SVHC or toxic additives) and ensure the non-toxicity of the degradation products in the intended end of life scenario.
- Concerning SMNPs, research should focus on those size fractions more susceptible to getting across biological membranes. For example, macro-pinocytosis is restricted to particles between 0.2 and 5 µm. Monitoring these size fractions in environmental samples is currently beyond the state-of-the-art.

Questions from the projects

? How to make sure that also bio-degradable or "green" plastics do not cause any harm to humans (e.g. at workplaces, such as exposure to PLA particles from FFF 3D printing) or the environment along their life cycle?

? How to sustainably and safely handle and regulate the vast amount of plastics that already occurs especially as MNP in the environment considering the long period involved?

? What is the Commission's reaction to the recent Material Economics report concluding that plastics recycling in Europe is at a much lower rate than previously thought? If true would this have implications for the timing of targets, thinking about the role of plastics more strategically, control of leakage to the environment, etc?

? With reference to the EU Green Deal, several instruments have been noted such as the product passports, extended eco-design, and the safe and sustainable design concept. Are there any intentions or indications that these instruments may be expanded or tailored to cover biobased and biodegradable plastics?

? Also mentioned in the EU Green Deal, is an ambition for the commission to step up its regulatory and non-regulatory efforts to tackle false green claims. With respect to biobased and biodegradable plastics, how are the commission planning on going about this?

? With regards to commercial applications of breakthrough technologies, what role can the bioplastic industry play (and what incentives are available) for them to become the 'climate and resource frontrunners' that the commission has indicated a need for in the Green Deal?

? Since the investigation of the bio-based and biodegradable plastics industry done within the BIO-PLASTICS EUROPE project led to identifying an emerging one-to-one substitution trend among some converters, a clarification about the criteria used by the Commission to identify the relevant applications where these materials can effectively add value compared with their fossil-based counterpart.

Additionally, we found increasing use of 100% bio-based and biodegradable plastics in durable goods (rigid packaging, toys, etc.). Therefore, there is an issue concerning the relationship between biodegradability and durability. Is the Commission intended to invest in biodegradable and durable goods?

? Although circularity is a system property, the fragmentation of waste governance, the lack of dedicated waste management, or still, the lack of information about the waste infrastructure facilitating the valorization of compostable plastics make the validation of circular strategies challenging. A comprehensive description of each European country's existing waste management system is crucial to understanding the value retention potential.

? Due to the limits of the European projects concerning time (most cases of four years), apart from alternatives such as workshop agreement, what could be possible options for the standardization of a novel biological recycling plastic alternative within the limits of the project?

? What should or will be the strategies of the competent European organisms to adapt the existing legislative/regulatory framework to the new options for chemical recycling in general and biological recycling in particular?

Future research project ideas

European Bioeconomy Network/Glaukos (Susanna Albertini).

In organizing the Glaukos stakeholders workshop it was clear that the uptake of biobased and biodegradable plastics to tackle environmental challenges requires addressing all the challenges through a systemic approach. This approach should involve all the “voices” to identify barriers, resistances, risks, interests, innovation drivers, etc., involving policymakers, researchers, industries, primary sector, markets, but also consumers (awareness and education). Cross-fertilization among projects, but also more mature sectors (like the food packaging or mulching films) could provide fresh insights. All these ecosystem facilitation activities could be supported by a connecting project, that could also undertake the awareness (terminology and misconceptions) and capacity building of the stakeholders, also involving running projects and initiatives as contents providers.

Another interesting idea for a topic is the creation of a Marketplace for BBPs. The marketplace should also provide information about the materials, EOL, impacts, etc., to facilitate informed choices for industries (B2B), brands (B2B), and consumers. As far as I know, this marketplace doesn’t exist. It could also be connected to current databases (like Pilots4U and biomass marketplaces) to facilitate the creation of the value chains.

BIO-PLASTICS EUROPE (Jelena Barbir)

As an outcome of this meeting, the urge for communication between the EU Policy Officers and projects in this kind of dialogue has been identified as crucial. Therefore, it has been already agreed to join forces again and next meeting scheduled for 23rd November (9-12 CET) with the EU Policy Officers. Besides this, preparatory workshop for

this meeting will take place on 3rd November (9.30-12h CET) with more projects, to shape the message and dialogue with the EU Officers. This time EBRN (BIO-PLASTICS EUROPE) is not alone in preparation, we are joining our forces with European Bioeconomy Network and European Bioplastics Association in order to boost the impact and increase the visibility of this kind of dialogues. Stay tuned on our website: https://bioplasticseurope.eu/news-events