

ARE BIO-BASED PLASTICS THE FUTURE FOR TOY APPLICATIONS?

A multi-stakeholder dialogue
on the sustainability of the toy industry

Focus group report
and recommendations for policy



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

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Executive summary

This report summarises the findings of a multi-stakeholder dialogue conducted by the University of Bologna on November 11th 2022 at Ecomondo¹, and presented on March 22nd, 2023 at the bio!TOY2023² conference.

The initiative is part of BIO-PLASTICS EUROPE project and aims to investigate the potential of bio-based plastics to increase the sustainability of the toy industry. In the form of focus group, the discussion was joined by experts and stakeholders from public and private organisations representing the whole toy value chain.

With the use of system thinking and multi-dimensional analysis, the findings reveal that bio-based plastics have high potential to contribute to the sustainability of the toy industry if:

1. Eco-design for recycling criteria are defined
2. Strict methodology to assess environmental benefits is established
3. Robust communication about product sustainability is introduced
4. Clear information about the bio-based content is provided
5. Rigorous assessment of recyclability and biodegradability properties in range environments is performed.

It follows that bio-based plastics are not conceived as a stand-alone solution but as one alternative in a more comprehensive sustainability roadmap.

These elements reveal the necessity for a systemic joint policy intervention in the sector oriented to build up new business ecosystems, going beyond the boundaries of a single business to embrace collective actions.

¹ More information here: <https://en.ecomondo.com/>

² More information here: <https://www.bioplasticsmagazine.com/en/event-calendar/termine/bio-toy-2023/>

About BIO-PLASTICS EUROPE

BIO-PLASTICS EUROPE is a research and innovation project, funded by the European Commission Horizon 2020 Framework Programme under Grant Agreement N° 860407.

The vision of the project is to develop and implement sustainability-based solutions for bio-based biodegradable plastics production by turning knowledge into practice through technical, policy and managerial innovations. One way to accomplish this vision is to explore and gather insights regarding the frameworks, mechanisms and business models required for bio-based and biodegradable plastics' social and business expectations. To ensure that the BIO-PLASTICS EUROPE journey is successful, it is vital to integrate the viewpoints of different experts, actors, and stakeholders across value chains. This initiative contributed to achieve the goal and support the definition of policy recommendations.

About Department of Management - Alma Mater Studiorum Università di Bologna

Founded in 1088, the University of Bologna (UNIBO) constitutes the most populated university community in Italy, with 86.000 enrolled students, 2800 teaching professors (full, associate and assistant) and 3000 technical-administrative staff. UNIBO is a comprehensive higher education institution with 32 departments and 219 Degree Programmes: 92 first cycle programmes (BA), 114 second cycle programmes (MA) and 13 single cycle programmes. UNIBO also offers 45 PhD programmes, 52 specialisation schools, 74 professional courses, 16 of which are international.

The Department of Management works in different research areas ranging from Accounting, Banking, and Finance, to Entrepreneurship and innovation, Marketing, Organization, and Human Resources, Arts and cultural organisations, Social management and sustainability, and Strategy.

The authors of this report have expertise in Circular economy, sustainable business models, performance management systems, governance and accountability for sustainability.

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- **Aiju** - Technological Institute for children's products & leisure (www.aiju.es)
- **ART-ER** - Attractiveness Research Territory (www.art-er.it/)
- **Byewaste** (www.byewaste.nl)
- **Clementoni** (www.clementoni.com/)
- **eKoala** (www.ekoala.eu)
- **Enea** - National Agency for New Technologies, Energy and Sustainable Economic Development (www.enea.it)
- **EuBioNet** - European Bioeconomy Network (www.eubionet.eu)
- **Bioplastics magazine** (www.bioplasticsmagazine.com)
- **European Commission** (www.commission.europa.eu)
- **Jiminy Eco Toys** (www.jiminy.ie)
- **MMU** - Manchester Metropolitan University (www.mmu.ac.uk)
- **Quercetti** (www.quercettistore.com)
- **Sonia Sanchez Impact and Sustainability consultancy** (www.sonia-sanchez.com)
- **TICASS** - Tecnologie Innovative per il Controllo Ambientale e lo Sviluppo Sostenibile (www.ticass.it)
- **TicToys** (www.tictoys.de)

Disclaimer

The content of this report reflects the views of the authors and participants to the focus group, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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1. Introduction and background

Knowledge about market and industrial configuration is crucial to understand how the sector dynamics influence sustainability transition processes in the toy market.

The toy and game industry is characterised by a variety of products, including goods for the entertainment of children and adults but also indoor and video games.

Global revenue from the toy and game industry accounted for **298 billion US\$ in 2019**, with the highest revenue generated by videogame consoles, mainly commercialised by the Japanese companies Nintendo Co., Ltd. and Bandai Namco Holdings Inc. (Statista, 2020).

In Europe, the toy and game industry revenue increases year by year moving from **34.5 billion US\$ in 2019** to **40.4 billion US\$ in 2022**. While the Covid-19 disease had a negative impact in most sectors, its effect on the toy industry has been mitigated by the need to keep children entertained at home during the pandemic

(Technavio, 2020). As reported in Fig.1, plastic toys most contribute to the revenue of the industry (Statista, 2022).

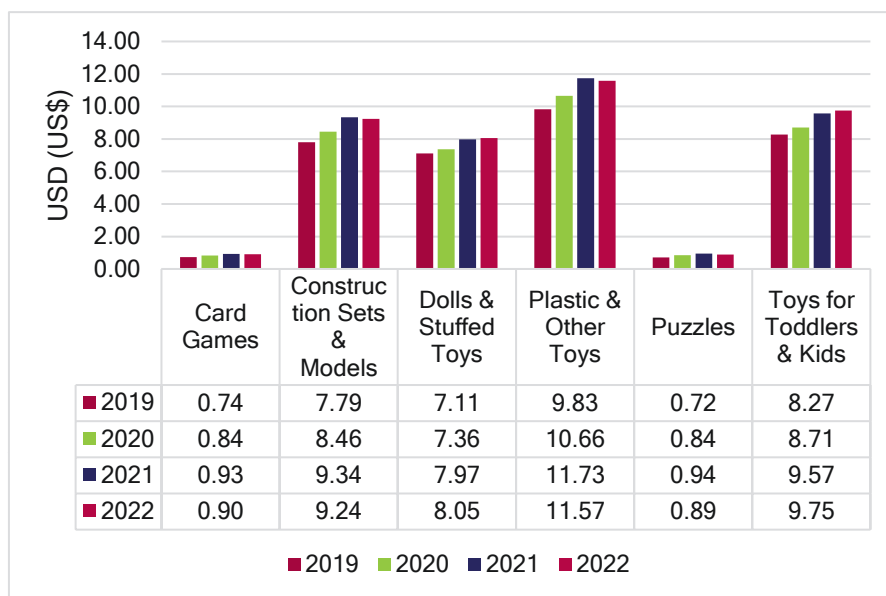


Figure 2 - EU toy industry revenue. Source: www.statista.com

The EU market of plastic toys shows a high level of concentration with the presence of key global players such as, Clementoni Spa, LEGO System A/S, Mattel Inc., Hasbro Inc., Goliath Games LLC, TOMY Co. Ltd., VTech Holdings Ltd. However, many small manufacturers, such as Dantoy A/S, TicToys GMBH, eKoala Srl, Quercetti Spa, are detected in the EU market. Specifically, most EU toy manufacturing companies are SMEs (European Commission, n.d.). However, the EU is a net importer of toys from the rest of the world since **more than 80 % of toys distributed in Europe are made in China** (Eurostat, 2018).

2. Methodology

Sustainability requires the integration of different viewpoints at different levels to analyse complex issues, provide reliable and legitimate solutions, and create substantial changes in production and consumption patterns (Starik & Rands, 1995).

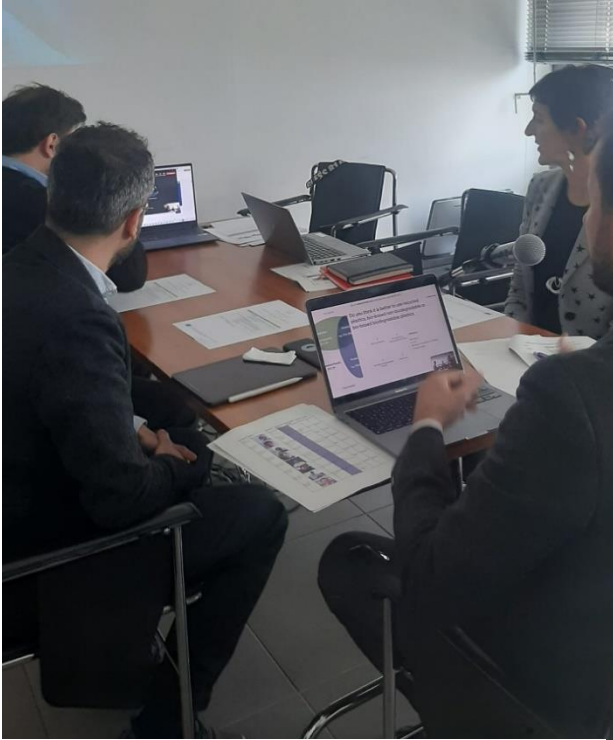


Figure 2 - Focus group organized by University of Bologna

This can be applied through **multi-stakeholder dialogue**. Generally, 10-15 participants create a group large enough to gain various perspectives and small enough not to become disorderly or fragmented (Krueger, 1994). In this case, the multi-stakeholder dialogue is enforced by a focus group. A **focus group** is a qualitative research methodology aimed at gaining an in-depth understanding of opinions, knowledge, perceptions, and attitudes (Nyumba et al., 2018) of a group of people in collective discussions about a "focused" issue (Glitz, 1997; Sim & Waterfield, 2019). Focus groups do not use probability or random samples since it

generally draws on convenience sampling (CAPA). Specifically, participants have been identified through the implementation of the **Prospex-CQI methodology**. CQI methodology is part of the stakeholder-integrated research (STIR) approach to stakeholder engagement (Gramberger et al., 2015) and considers a set of criteria affecting the topic of research, quota, and individuals fitting the quotas set and the expertise required. Specifically, a **value chain approach** is used with the criterium to engage at least, one representative per step, from raw materials providers to recyclers.

The focus group is organised in a hybrid form, both online and in presence, with the goal to discuss present issues and trends in the toy industry and investigate **the role of bio-based plastics in accelerating sustainability transition processes**. Although the engagement rate was higher, accounting for more than 40 people, the focus group is finally attended by 16 people (9 female and 7 male) representing the following domains: Industry (n.7); NGOs (3); Public Entities (n.1); Research Institutions/Academia (n.4), Others (n.1).

The dialogue is organised in opening, introductory, transitioning, key and closing sessions (Creswell & Clark, 2011) with open-ended questions designed through a "funnel" technique, moving from general to specific issues, and considering the most important and representative themes.

The overarching themes, addressing both general and specific issues, are represented in the figure below (Fig.2).



Figure 3 - Themes addressed in the focus group

The discussion is enabled by a facilitator and supported by the use of Mentimeter³ platform.

³ Mentimeter is an online presentation-building tool with real-time feedback, available at: www.mentimeter.com. The answers collected via Mentimeter.com are voluntary based. It means that only participants with specific expertise on the field are invited to answer.

3. Findings

Theme 1 - ALTERNATIVE MATERIALS SUPPLY

The use of alternative materials to conventional plastics has received increasing attention in recent years (Paletta et al., 2019). The awareness about marine plastic pollution, the normative pressure, together with the ambitious mission to become climate neutral by 2050 (European Commission, 2019), are among the elements that encourage companies to innovate their product portfolio and business models. General trends in the toy industry reveal the supply of potential environmentally friendly materials, such as wood, bamboo, recycled plastics, and bio-based plastics (Sanchez, 2010). This trend is registered in both big and small enterprises. For example, Lego launched the *LEGO® elements* made from bio-polyethylene (bio-PE) in 2018 and a prototype *LEGO® brick* made from recycled polyethylene terephthalate (rPET) in 2021. Chicco has adopted a similar strategy with the *Eco+* range of infant toys. As part of the *Play for the Future* strategy, Clementoni communicates the use of 100% safe recycled plastics. Similar supply chain strategies are detected among European small and medium enterprises such as Dantoy, eKoala, Quercetti and TicToys. Dantoy declares using bio-PE for the *I'm green* range, made from at least 90% sugarcane. TicToys makes use of sugar resins and wood fibers while Quercetti uses both recycled and bio-based plastics (made of 40% wood fiber) respectively for the *Green* and *Play Bio* ranges. Finally, eKoala toys' production is fully based on bio-based and potential biodegradable plastics.

- *From your professional perspective, what would be your opinion on using alternative materials versus conventional plastics. Do you think it is better to use recycled plastics, bio-based non-biodegradable or bio-based biodegradable plastics?*

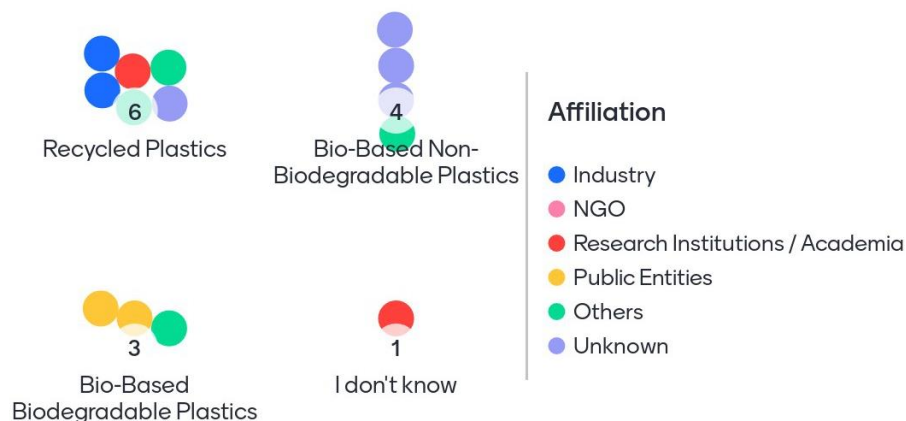


Figure 4 - Alternative materials supply: answers collected via Mentimeter.com

The discussion shows diverging opinions. While there is a prevalence for recycled plastics due to higher durability and lower prices compared to other materials mentioned, bio-based non-biodegradable plastics are perceived as a good alternative for the lower carbon footprint. Although the skepticism, some highlight that using bio-based biodegradable plastics makes sense in specific applications and with certain circumstances. However, in all the alternatives, problems persist: a. recycled plastics still pose issues with safety requirements; b. compostable and biodegradable plastics do not have dedicated waste governance and infrastructures and c. consumers do not fully understand their features nor are able to recognise and dispose them correctly.

The CO₂eq estimation during the whole value chain of a product makes the difference about sustainability. So, I wouldn't say I prefer recycled, I prefer bio-based or I prefer biodegradable. It's really a matter of understanding better the overall impact of the value chain.

Theme 2 - THE ADDED VALUE OF BIO-BASED PLASTICS - ENVIRONMENTAL AND ECONOMIC PERSPECTIVES

In the report "*Environmental impact assessments of innovative bio-based products*" (European Commission, 2018), the EU Commission analyses five environmental impact categories (climate change, abiotic depletion, particulate matter, photochemical ozone formation, and terrestrial eutrophication) to compare bio-based plastics (bio-PET, PLA, and starch plastics) and petrochemical references (PET, LDPE, PS) in seven different cradle-to-grave case studies. The results reveal that bio-based materials offer environmental benefits in two impact categories, i.e., climate change and abiotic depletion of fossil fuels. However, it is well-known that the price of bio-based plastics is 2-3 times higher than the price of conventional plastics.

- *In your opinion, do the environmental benefits of these bio-based materials justify the high cost of their supply?*



Figure 5 - Added value of bio-based plastics - environmental and economic perspectives: answers collected via Mentimeter.com

From the resulting discussion, it emerges that the environmental issue remains in the background, and although stakeholders agree on prices, the main divergences can be found in the motivations respondents believe underlying the high cost of raw materials. On the one side, stakeholders highlight the lack of subsidies; on the other side, reasons need to be found in the very mature petrol industry and the infancy stage of bio-based plastics industry and policy.

- *Are the consumers aware of these benefits? Would they be willing to pay more?*

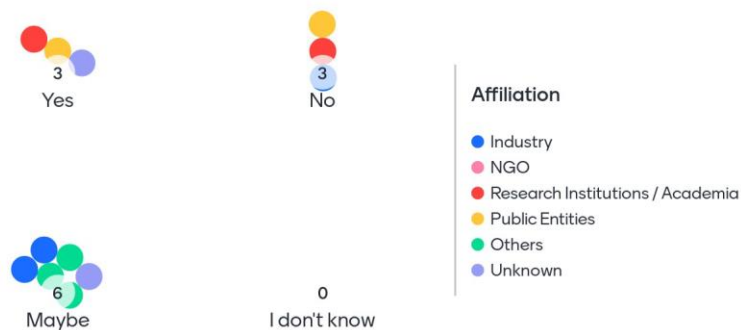


Figure 6 - Added value of bio-based plastics - consumer perspective: answers collected via Mentimeter.com

The market type strongly influences reflections here. Companies operating in mass markets are not ready to introduce premium prices, which is common in the niche market.

However, a premium price theoretically implies higher quality or value. The added value of bio-based materials is not easy to communicate and deliver since the topic is complex and not fully explored. Additionally, there is the problem of what bio-based precisely

means. So, one need is to inform consumers and customers about the sustainability of products as a first matter. And then, another crucial need is to educate people about the proper end-of-life, which may be linked to biodegradability, recyclability, or both. Additionally, being durable goods, proper communication campaigns aimed to maximise their uses may be beneficial for the community.

Every toy should be forced to be more sustainable without asking the consumer to choose. The concept that consumers have to pay for their sustainability causes limited impacts since only highly specific segment of consumers can have access to this kind of products, while the mass market is still looking for cheap products. If sustainability is a niche, we have failed.

Theme 3 - THE ADDED VALUE OF BIO-BASED PLASTICS - SOCIAL PERSPECTIVE

The EU toy market represents one of the most regulated and dynamic in the globe. It is subject to frequent and continuous changes regarding safety criteria that toys must comply with in order to be commercialised. For example, in 2009, the Toy Safety Directive 2009/48/EC introduced limits on specific heavy elements and allergenic fragrances (European Commission, 2009). However, there are many toys manufactured in not-European countries and sold in the EU that still pose a significant threat. Furthermore, more and more consumers are buying infant toys online, where it is not easy to appreciate differences in material compositions and quality of manufactured parts. Indeed, while usual sales channels for infant toys are exclusive stores, hypermarkets/supermarkets, and retail stores, the online sales channel is becoming appealing for many toy manufacturers because it increases their consumer base and reaches remote locations (Statista Consumer Insights, 2020).

- *Do bio-based plastics contribute to increase the efficacy of the Toy Safety Directive?*



Figure 7 - Added value of bio-based plastics - social perspectives: answers collected via Mentimeter.com

Discussion requires technical knowledge about physical and chemical safety. The type of material is not going to affect, in some manner, the physical toy safety. Regarding the chemical safety of toys, the material choice is important because it relies on the chemical process used to produce the material itself. Different from recycled plastics, bio-based plastics may help with the Toy Safety Directive because controlling the contamination is easier. However, all toys made of any materials should guarantee safety requirements. Even more, if the current kind of level of safety is not enough, that should then be applied holistically to every toy that's made, not just those that are bio-based. Still, there is a need for greater transparency on the chemical composition of products.

Theme 4 - VALUE LOSS: A GLANCE AT END-OF-LIFE SCENARIOS

Data from Ellen MacArthur Foundation reveals that 80% of toys ends up landfills, incinerations, or the ocean. The JRC technical report on “Top Marine Beach Litter Items” highlights the presence of 1234 toys and party poppers in transect lengths of 100m (Addamo et al., 2017). In France, more than 40 million toys are wasted annually (Ellen MacArthur Foundation, 2021). To address these issues, there are toy manufacturers, like MGA Entertainment, that cooperate with TerraCycle and material recycling facilities to collect non-recyclable post-consumer waste on behalf of corporate donors or municipalities and turn it into raw material for new products. Moreover, there are start-ups, like ByeWaste, which collect toys from consumers to give them a second life. However, no harmonized waste governance and infrastructure exist today for toys.

- *Can Extended Producer Responsibility be applied in the toys industry?*

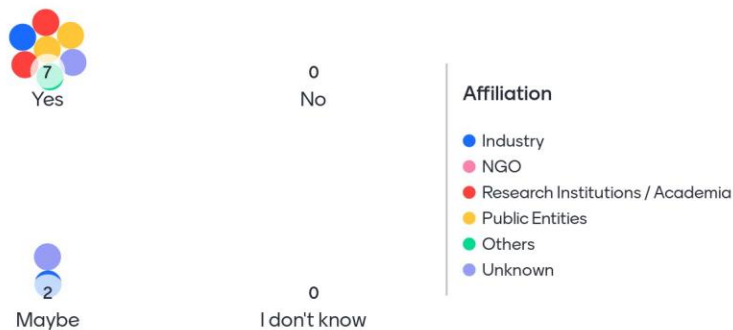


Figure 8 - Toys end-of-life: answers collected via Mentimeter.com

The discussion mainly converges on the need to establish an Extended Producer Responsibility (EPR) scheme to manage the end-of-life of toys. EPR is an environmental policy approach in which

Extended Producer Responsibility requires system approach and multi-stakeholder involvement to make sure materials are effectively reused. However, the first responsibility is for toys manufacturers and how they design toys, starting from material selections, size, durability, recyclability etc. Then, responsibility is extended to recyclers to make materials reusable.

producers and importers have responsibility for the post-consumer stage of a product's life cycle, including waste recovery and recycling (Hilton et al., 2019). Although implementing an EPR scheme for toys is a good solution, participants find another crucial challenge, technical-oriented and related to the nature of toys. Indeed, toys are generally multi-component and multi-material, so they are challenging to recycle mechanically. Chemical recycling is still in its infancy. Conversely, biodegradability in open environments might be helpful in specific toy applications (e.g., sand toys unintentionally littered in marine environments) but no evidence about biodegradability in specific timeframe and range environment exists today.

Theme 5 - VALUE RETENTION: THE CIRCULAR ECONOMY OPPORTUNITY

Circular economy aims to retain the highest value possible along the life cycle of products. Different strategies can be applied to close, narrow and slow resource loops. In the toy industry, the majority of circular strategies in place are related to reuse models. Lego's *Replay* initiative encourages owners to donate their used bricks to children's charities. The French association Rejoué collects, repairs and re-sells used toys. Whirli offers toy subscription services and token systems to recirculate toys (Ellen MacArthur Foundation, 2021). Other toy manufacturers, LIKE Dagoma and Modutoy, opt for remanufacturing by substituting broken or missing parts with 3D-printed elements.

- *Do you think that the industry is pushing towards innovative circular solutions, or are they still sporadic?*

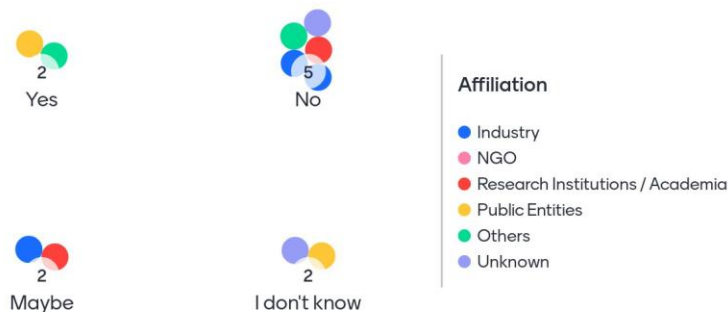


Figure 8 - Circular economy of toys: answers collected via Mentimeter.com

The dialogue on circularity makes evidence of the sporadic nature of circular economy strategies in the sector. Although crucial, eco-design for recycling is still understudied in this sector. The exploitation of innovative business models is confined to a few players, mainly innovative start-ups.

Supplying bio-based or recycled plastics should not be considered as circular strategies on themselves. Circular economy requires a life cycle approach to ensure the maximization and retention of the intrinsic value of materials in each step of the lifespan of a toy up to create circular bio-based systems.

4. Conclusion and recommendations for policy

As part of the *EU Green Deal*, the EU Commission introduces the ambitious target of becoming climate neutral by 2050. The *Circular Economy Package II* is the primary building block of the Green Deal, fostering a 50% reduction of plastic litter, a 30% reduction of microplastics release by 2030, and other reducing, reusing and recycling targets. With 35 actions, the Commission plans to: a. set up a sustainable product policy framework, b. introduce measures to increase product value chains' circularity and c. establish actions to harmonise waste reduction, collection, and recycling initiatives. Among others, a *Policy framework for bio-based, biodegradable, and compostable plastics* was published in 2022. This document aims to support a more systemic approach to underpin decisions by both the public and private sectors and provide orientations for better industrial and commercial uptake of these materials.

Although UNEP (2014) defines the toy industry as the most plastic-intensive in the world, toy applications are not part of the *EU Plastics Strategy*, published by the Commission in 2018. Nonetheless, companies operating in the toy sector, both big and small, are in turmoil to guarantee the alignment of their strategies with the EU policy vision and ensure their strategic positioning in the long term.

The focus group conducted by the University of Bologna aims to examine the potential of bio-based plastics to accelerate the sustainability transition of the toy industry. The discussion is based on: a. a value chain approach to consider the perspectives of the different players working in the toy sector; b. a multi-dimensional analysis to assess environmental, economic and social aspects and their interconnections c. a system thinking to investigate cause-effect relationships related to the use of bio-based plastics in the sector.

Notwithstanding that bio-based plastics may represent a solution for the future of the toy industry, many open issues remain. Pragmatically, the use of bio-based plastics and their limited availability in the right quantity, at the right price, place and time pose questions about bio-based (but global) supply chains vs local supply chains. Besides, safety requirements, ecotoxicity risks, clear labelling informing about material composition, strict standards and certifications, appropriate waste governance and infrastructure, eco-design for recycling, and business models for circular economy appear to be fundamental needs for the experts and stakeholders joining the discussion.

- *From your point of view, what needs to be prioritised to make the toy industry more sustainable by 2050?*

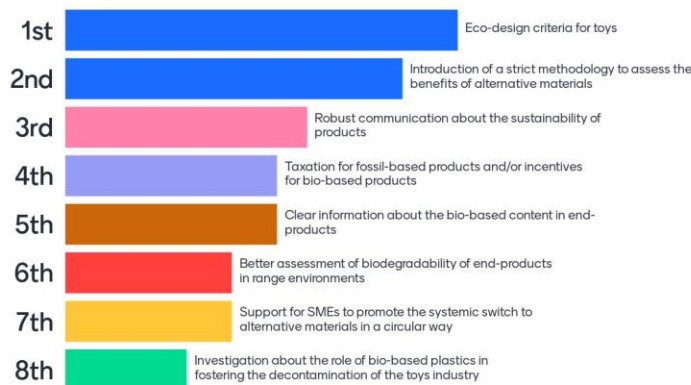


Figure 9 - Priorities of the toy industry: ranking collected via Mentimeter.com

In accordance with the multi-stakeholders and experts' priorities, bio-based plastics have a high potential to contribute to the sustainability of the toy industry if:

1. Eco-design for recycling criteria are defined
2. Strict methodology to assess environmental benefits is established
3. Robust communication about product sustainability is introduced
4. Clear information about the bio-based content is provided
5. Rigorous assessment of recyclability and biodegradability properties in range environments is performed.

These elements reveal the necessity for a **systemic joint policy intervention in the sector**. The findings demonstrate that the sustainability of the toy industry cannot be limited to the supply of alternative materials.

Whilst R&D activities are crucial to address specific challenges (e.g. valorisation of second and third generation feedstock, biodegradability conditions, ecotoxicity risk etc.), sustainability requires a new logic, going beyond the boundaries of a single organization to create an ecosystem based on collective actions. This is demonstrated by the need for eco-design requirements, considered by participants as the highest priority. As part of the design decision, information about the benefits of alternative materials are essential to orientate business and consumer choices. At once, a strict methodology to assess the higher environmental performance of alternatives is necessary to prove the eventual benefits of the materials. Still, clear labelling is essential to promote transparent information. Standards informing about the bio-based content as well as the

disposal procedure are requested. And being durable goods, efforts should be made to extend the lifespan of these goods. Indeed, bio-based plastic toys are not circular by default. Circular economy should be boosted in the sector to allow the highest value retention from toys.

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