



Bio-based Plastics: An Exploration of Drivers and Barriers for Products that last

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Bio-based plastics are gaining increased attention as possible environmentally friendly alternatives to fossil fuel-based polymers. As part of a circular economy transition, bio-based plastics hold many interesting opportunities.

On the 27th of October 2020 TU Delft, in collaboration with KPN, ran a workshop with 57 members from Industry, Policy and Academia. This workshop investigated the drivers and barriers that stimulate or hinder the use of bio-based plastics for products that last that are developed within the telecommunication supply chain. Topics focused on; 1) technology and design, 2) regulation and policy, 3) end-user and economic and, 4) forward and reverse supply chains. The aim was to identify opportunities and challenges as well as future research areas.

Bio-based plastics are made, at least partially, from renewable, biological matter and can be categorised as Unique or Drop-in. Unique bio-based plastics do not have fossil fuel-based equivalents, so are novel materials derived from bio-based sources that offer the potential to design new properties that can become desirable features of a product. Whereas, Drop-in plastics are chemically identical to available fossil fuel-based plastics, meaning they can be processed using existing recovery systems. It should be noted that bio-based plastics are not automatically biodegradable. Rather, their ability to decompose needs to be a designed property. Bio-based plastics are already in use, replacing current fossil fuel-based plastics, although these are mostly commodity plastics used in applications such as packaging. Examples of durable products are rare but growing, such as LEGO botanical elements, IKEA tableware and bio-based plastic housing of electronic products by Fujitsu, to name a few.

Key drivers identified for using bio-based plastics are:

In the short-term, the positive end-user perception and a demonstration of a willingness to pay more provide marketing advantages. This 'Green premium' can also contribute to increasing awareness and interaction of the debate between policy, industries and consumers with regards to what and how we use plastics. Furthermore, current research funding programs (e.g. Green deals and Horizon Europe) promote exploration of bio-based plastics as alternatives to fossil fuel-based plastics to stimulate research and innovation.

In the medium-term, testing new design properties and the desirability, feasibility and viability of closed-loop business models, reuse or refurbishment strategies can drive scale for bio-based plastic production, increased new varieties and use cases.

In longer-term, the lower carbon impact of bio-based plastic manufacture and recovery and the ability for local feedstocks provide opportunities to create localized or regional plastic supply chains. This promotes improved sustainability, resilience and circular recovery systems.

Key barriers identified for using bio-based plastics are:

In the short-term, knowledge gaps on material properties, the need for policy direction, accreditation and certification were identified.

In the medium-term, material costs and the costs needed to adjust the production facilities and plastics supply chains were identified as a challenge. This presents a 'chicken and egg' story with regards to the low levels of use and therefore volumes available, which means low investments in infrastructure. Yet, when bio-based plastics are used in greater volumes, they will become cheaper, and infrastructure will receive greater investment and can be improved. Further, the issues of costs can be minimised, especially if considering future projections for increased fossil fuel feedstock costs and carbon pricing. Costs can be further reduced with the increased focus on bio-based plastics suitability to facilitate and advance circular business models and multiple life cycles, especially considering plastic components are not commonly critical parts within electronic products. This would also provide opportunities to increase close-loop or recovery systems after the bio-based plastic parts are discarded.

In the long-term, key challenges identified are the availability and suitability of feedstocks that can meet the growth in plastic demand, whilst still being environmentally friendly. Yet, once bio-based plastics are used in high volume products, this can create sufficient volume for recyclers and the set-up of new and more localised production, consumption and recovery systems. On the other hand, if drop-in bio-based plastics are used these can feed existing recycle streams.

In summation, bio-based plastics offer much promise, yet there is still much work and research to do to overcome knowledge gaps across the supply chain, policy and to increase end-user awareness. So we need to start here by advancing research and education activities. Further, increasing the application of bio-based plastics will lift many of the most important barriers.

Recommendations identified were:

- 1) Costs of bio-based plastics are high, yet user perception and willingness to pay is growing. So this offers the opportunity to explore the use of bio-based plastics within new product development and marketing strategies.
- 2) If using bio-based plastics, their impacts should not be overstated, at least without quantifying these first. Doing so can backfire and slow down the progress of bio-based materials.
- 3) Start communication with end-of-life actors to define and plan recovery options before bringing products to market.
- 4) Think about sustainability impacts within each step of the innovation process, e.g.;
 - a. Where and from what material source are the plastics made?
 - b. Does this material source compete with food sources?
 - c. Will you use a Drop-in or Unique Bio-based plastic?
 - d. Does the material offer properties relevant to your new product development process or customer experience?
 - e. How will you incorporate the sustainable, natural and renewable characteristics of bio-based plastics?

Interested to learn more about TU Delft's research into Bio-Based Plastics? Please follow or contact our PhD Candidates via LinkedIn.

Puck Bos explores: How can designers make a bio-based plastic choice in a circular economy?

Linda Ritzen explores: How do we design durable products sustainably with bio-based plastics?