SESSION 4

Sustainable bio-based plastics innovation ecosystems through disruptive business and regulation

Wednesday, May 19th 2021 at 14.15-16.00 (EEST, UTC+3)

Session conveners

Associate Professor **Rosa Ballardini** (University of Lapland), Professor **Jan Holmström** (Aalto University)

Description

Interactive and multi-disciplinary discussions on the disruptions needed in the business, legislative and policy frameworks to transition towards a more sustainable innovation ecosystem for (3D printable) bio-based plastic products.

One of our major global challenges in materials science relates to the transformation from fossil-based polymeric materials to sustainable, renewable and carbon-binding ones, to enable resource efficient production and foster re- and up-cycling of plastics. Raising technologies like 3D printing might bring great benefits in this process. Enabling this transformation requires looking at all the steps of the value chain, for the production of materials, to the use of materials in final products, all the way to the recycling and disposal of products. Notably, a key question in this exercise relates to depicting the characteristics that a business, legislative and policy framework should have in order to foster this transformation. In a market economy, this requires examining the complexities of the exiting business and policy structures, as they are often hindering rather than facilitating disruptive changes like the one envisioned by a (3D-printable) bio-based plastic innovation ecosystem. Business disruptions might be needed in order to develop novel decentralized sustainable business models that support a smooth transition towards distributed, local manufacturing of bio-based polymeric products. Legal and policy disruptions might be necessary to provide with the right incentives to create economic benefits, while also prioritizing ethical values like strong sustainability.

Presentation titles and speakers

- Opening words, Professor **Jan Holmström** (Aalto University) and Associate Professor **Rosa Maria Ballardini** (University of Lapland).
- Decolonizing and rebalancing the value discourses of nature, Doctoral candidate and Researcher **Corinna Casi** (University of Helsinki and University of Lapland).
- Transition to bioplastics: technological, economic and regulatory challenges and emerging transitional pathways, Post-doctoral researcher **Jaakko Siltaloppi** (Aalto University).
- Sustainability in competition law: alternatives to a consumer welfare standard?, Post-doctoral researcher **Juha Vesala** (University of Lapland).
- Brand-driven Transition to Bio-based Plastics Supply Chain, Doctoral candidate **Alireza Jaribion** (Aalto University).
- Use of the VTT Proper Tune materials modelling concept for the fast development of sustainable bio-based plastic composites, Senior Scientist **Stefania Fortino** (VTT).

Reflection and discussion: Can we identify likely and desirable plastics futures?, chaired by Research Scientist **Henri Wiman** (VTT).

Decolonizing and rebalancing the value discourses of nature

Corinna Casi

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Based on the current events – from the widespread of information about Covid-19, to loss of biodiversity, from the windmills for decentralized energy generation to the role of social media in the 'Black lives matters' protests - the clear impact of values on the everyday human life is remarkable. By the same token, the impact of values is also significant on environmental decision making and environmental policies.

This paper examines the value discourses of nature, and advocates for a pluralistic view of environmental values, as a perspective that better emphasizes the diversity and the richness of nature. However, the novelty of this article pertains to the uncovering of colonial perspectives within environmental value discourses.

In environmental ethics, different types of environmental values and value discourses have been identified. While the major divide is between economic and non-economic values of nature, this paper nonetheless aims to highlight the colonial approach of the environmental value discourses. On one hand, environmental economists - but not only - largely emphasize the environmental economic value which is identified as environmental goods that can be purchased in markets. They measure those good, also called 'commodities', via tools or techniques such as 'willingness-to-pay' (WTP), cost-benefits analysis (CBA) etc. On the other hand, the non-economic values of nature refer to a set of environmental values which highlight aspects other than the monetary considerations, such as the moral, the aesthetic, the historic, the relational, the scientific or ecological and the Indigenous value of nature. This set of values are mainly emphasized by environmental philosophers, natural scientists, and Indigenous scholars.

The three research questions guiding this work are: 1) Does nature have other values which are different than its mere monetary value? 2) If so, what are they and why it is important to focus on the non-economic values of nature? 3) What does it mean to decolonize the value discourses of nature?

This article seeks to show that non-economic types of environmental values can play a role in guiding environmental decision-making and policies. With regard to the colonial perspective of value discourses of nature, this article shows that the uneven significance of different values of nature -referring to the higher importance of the economic aspect vis-à-vis the devaluation of non-economic aspects of nature- is a sign of colonial attitudes undermining part of environmental value discourses.

From this perspective, I claim that decolonizing environmental value discourses means rebalancing the different values of nature, allowing the non-economic aspects to offer their due and therefore to show their potential. A change in the focus of the non-economic values of nature can also reflect the acceptance of our responsibilities toward other humans (such as minority groups and Indigenous people for instance) and other non-human species belonging to the present and future generation inhabiting the planet earth.

Transition to bioplastics: technological, economic and regulatory challenges and emerging transitional pathways

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Abstract:

Climate change is calling for significant political, economic and societal actions. An important target relates to curbing the use of fossil oils, including the share used in the production of plastics. While currently plastics comprise only around 5% of world's annual use of fossil fuel, it's share is expected to increase as transport shifts toward renewable energy sources. Coupled with the growing waste problem (e.g., marine litter, microplastics), new solutions are needed for the production of plastics from bio-based and recycled raw materials.

In this paper, we investigate the technological, economic and regulatory factors that both limit and enable the transition to renewable raw materials in the ecosystem of plastics production, manufacturing, use and recycling. While the research on sustainability transitions and sustainable innovation offer insights into the transitioning of industries toward sustainable practices (e.g., Smith et al., 2010), we need to develop a context-specific understanding of the opportunities for, and barriers of, the transition toward "bioplastics".

To this end, we conducted interviews with various actors in the plastics ecosystem comprising oil refinement, polymer synthesis, plastics manufacturing, distribution and use, as well as recycling. First, the findings reveal a plethora of challenges, which relate to: the limitations of biofeedstocks, the material properties of bio-based plastics, the multi-tier value chain, consumer behavior, lack of feasible models in recycling, and dependency on regulation. Second, the findings identify certain avenues for speeding up the transition: progressive policy (especially in the EU), growing societal awareness and associated interest among consumer brands, parallel developments in biofuels, local / regional clusters in the bio-economy, and joint development initiatives within specific industries. The findings create a basis for future research on the development and scale-up of bioplastics. The findings also extend the scope of the sustainability transitions research especially by investigating a context in which the material production is intertwined with use and recycling.

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Smith, A., Voß, J.-P. & Grin, J. (2010). Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. Research Policy, 39(4), 435-448.

Sustainability in competition law: alternatives to a consumer welfare standard?

Postdoctoral researcher, **Juha Vesala**, University of Lapland (VALUEBIOMAT)

Abstract

Modern competition law focuses on protecting the sovereignty, choice and welfare of consumers – how well their preferences are met on the market. This theoretical and legal basis poses a challenge to recognizing sustainability aspects in competition policy and application since sustainability issues often do not directly or immediately affect consumers or their economic interests in a way captured in competition law analysis. As a result, practices that harm consumers by, for instance, raising prices of products may be found unlawful even where from a broader perspective they would be societally desirable due to sustainability benefits achieved. This can hinder development and supply of sustainable products and technologies and adoption of sustainable business models and practices.

This paper develops ways for capturing sustainability benefits in EU competition law. As its main research question, it focuses on the aims and ultimate balancing tests in competition law and considers alternatives to the prevailing consumer welfare test. These include, for instance, extending consumer welfare considerations to include preference for sustainability, widening the interests considered in competition analysis and other ways how the balancing could be achieved. Although theoretically established approaches for doing so exist (e.g. in economics and ethics), the legal and institutional features of competition law affect which theoretical approaches would be desirable in view of the goals of competition policy and from the perspective of promoting sustainability. These limitations need to be recognized when considering how sustainability issues could be taken into account in competition law and policy.

The paper provides a tangible illustration of the tensions that exist between sustainable business models and the current legal framework. The paper contributes to the ongoing scholarly debate on the doctrinal competition law issues relating to sustainability which so far has focused on the possibilities under existing legal doctrines without sufficiently considering the underlying, fundamental questions on the aims and possibilities of competition law. By offering theoretically, institutionally and legally robust approaches for accommodating sustainability in EU competition law, the paper also contributes to the policy work in the EU relating to whether and how sustainability aspects could be taken into account in EU competition policy.

Brand-driven Transition to Bio-based Plastics Supply Chain

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The world has been seeking operations and processes that were competent and efficient in terms of output and quality for several years. Today, solutions exist that are not only effective and efficient but also sustainable and positive for both the economy and society. However, introducing change and innovation into a stable and working social system has always been a risky endeavor; hence, companies and entrepreneurs should catalyze this transition with a comprehensive plan that considers the influencing factors.

Plastics encompass an essential part of many products that are used in humans' daily lives. As the plastic industry relies strongly on petroleum—a scarce resource—for raw materials, there is a potential threat regarding its availability and cost. Consequently, bio-based materials and specifically, bioplastics are now being widely used as these make plastic products more sustainable. In this context, through case studies, this article describes different approaches toward the transition to bioplastics in supply chains and compares traditional and bio-based plastics supply chains across a range of indicators.

The proliferation of products, processes, suppliers, and markets coincides with the rise in the *complexity of supply chains*. Moreover, *circularity* and *cost*—two basic pillars of circular economies—offer integration between sustainability and business development. Further, the *corporate image*, which is equally important, refers to the company's reputation—description of its perception, activities, and products/services by outsiders. Based on these significant indicators, in this article a novel framework, *4C*, has been introduced to examine the transition to the bio-based plastics supply chain. Additionally, the impact of this sustainable transition on circularity, cost, complexity, and corporate image for each presented case within the proposed framework is scrutinized. Based on the results, the concept of "brand-driven transition" is elucidated upon, and its benefits and barriers are highlighted and discussed. These results have the potential to help companies realize business logic in the light of the discussed opportunities and obstacles; thus, they could then opt for the right trajectory regarding transition to the bio based plastics supply chain for their products. Notably, by utilizing the proposed framework, companies can assess whether they should move toward a bio-based plastics supply chain for their products.

Use of the VTT ProperTune materials modelling concept for the fast development of sustainable bio-based plastic composites

Stefania Fortino[1,*], Kirsi Immonen[1], Sini Metsä-Kortelainen[1], Katri Valkokari [1], Peter Ylén [1], Tuukka Verho[1], Geza Toth[1]
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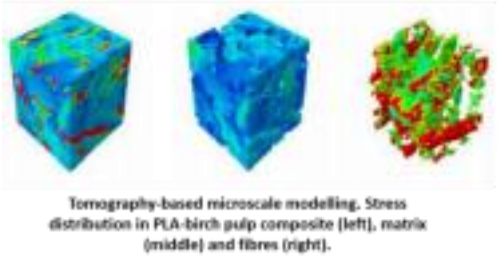
Sustainable bio-based materials used in construction and automotive fields, such as wood plastic composites (WPCs) and natural fibre composites (NFCs) are easy to recycle and less expensive compared to the traditional glass fibre composites. These materials consist of plastic or bio-based plastic matrix, wood or other natural fibres (and/or fillers), and additives [1]. Plant fibres are particularly suitable to reinforce plastics due to their relative high strength and stiffness, low density, low CO2 emission and biodegradability. In the last decade, the scientific research on WPCs and on NFCs has been strongly motivated by the market increase of these materials [2]. Unfortunately, a large number of laboratory tests is usually required to optimize the composite properties for different fibre volume fractions, moisture contents, additives and other variabilities related to various manufacturing processes (extrusion, injection molding, 3D printing etc.) This can considerably slow the assessment of proper business models, novel value chains and regulations for the development of sustainable bio-based plastic composites.

In this context, the numerical tools of VTT ProperTune materials modelling can efficiently help to speed the development of bio-based composites [3]. ProperTune is based on an Integrated Computational Materials Engineering (ICME) concept developed at VTT over the last two decades. It uses multiscale modelling to optimize the material design, replacing expensive and time-consuming laboratory testing and shortening the time-to-market for new products by an average of 50%. It allows to digitally creating accurate material microstructures to be analyzed under various loading and environmental conditions in order to optimize the material properties. The material microstructural investigations also helps to better understand the manufacturing process effects on the composite (fibre shape and distribution, voids, etc.) Within the VTT ProperTune literature on the topic, [4-5] show 2D microscale finite element (FEM) models based on X-ray microtomography (XµCT) images where created for PLA-birch pulp composites. For the same composites, 3D synthetic models in conjunction with stochastic methods for geometry description where developed in [6]. In future work, the microscale models can be integrated with atomistic models, suitable to simulate the effects of additives, and with macroscale FEM analyses, able to analyze the final product performance.

As example in the present work, the XµCT-based microscale FEM modelling of ProperTune (Figure 1) is used to digitally design targeted bio-based WPCs of industrial interest. The idea is that material manufacturing companies provide input data on the raw materials, while the material properties of the composites in different service life conditions are digitally predicted. The ProperTune concept is planned to be used at VTT in future research by integrating materials modelling methodologies with business models for decision making in order to develop new advanced bio-based plastics. This will also assist the systematic assessment of regulations for the new materials. Similar approaches are used in on-going European projects about open access materials modelling platforms [6].


Tomography-based microscale modelling. Stress distribution in PLA-birch pulp composite (left), matrix (middle) and fibres (right).

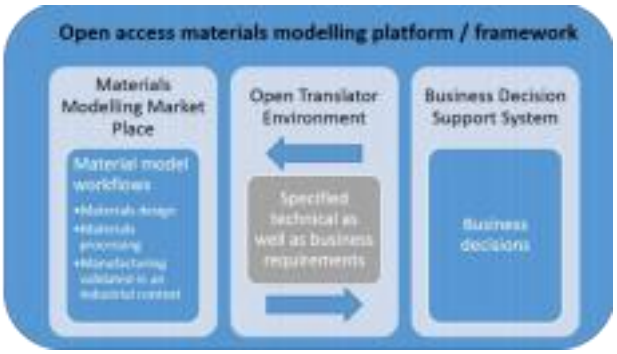


Figure 1. Left: example of microscale modelling for bio-based plastic composites. Right: scheme of open access materials modelling platform/framework showing the connection between materials modelling and business models.

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