TRANSFORMATION TO THE BIOECONOMY – ANALYSIS AND SCENARIOS FOR SELECTED NICHES

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Decision makers worldwide place great hopes in the concept of the bioeconomy to provide solutions to major economic, societal and ecological challenges like resource depletion, food insecurity or climate change. However, despite of the launch and further development of EU and national strategies, the transition to the bioeconomy is still in an early stage and the associated goals with the bioeconomy haven't been achieved yet. Numerous bio-economic innovation are still in the research and development stage or not yet adopted. In many segments like plastics, fuels, or flavors and fragrances, bio-based products hold less than 5 % market shares. Moreover, even for the next 10 to 15 years, one should not expect them to reach a double-digit percentage range (Wydra et al. 2017).

It turns out that the bioeconomy transition is a complex undertaking, which faces a plenitude of challenges at the same time. There is a high uncertainty concerning the technology development and which kind of bio-based product and process paths are most competitive to fossil-based products. Moreover, bio-based innovations evolve not independent from each other, but they are interrelated. They are often in a competition for resources (e.g. biomass, skills) or policy support. However, due to the intricate technological interrelatedness among bio-economic innovations, transition efforts could leverage synergies in terms of knowledge, infrastructure, standards, logistics or public acceptance.

Current analysis on the bioeconomy (e.g. see Hellsmark et al. 2016; Giurca/Späth 2017; Purkus et al. 2017 for studies with the technological innovation system approaches well as the almost countless applied studies), that identify drivers and barriers to a bioeconomic transition, do not explicitly address the relation between different bioeconomic sub-fields. Hence, the question arises how the transition of the bioeconomy may evolve and can be coordinated regarding the complexity within the bio-economy. With the present article, we aim to broaden the awareness for bio-economy internal dynamics and interlinkage. We explore possible simultaneous transition pathways of distinct bio-economic niches that are consistent with each other, by taking into account synergies, but also limiting factors, such as the availability of sustainable biomass).

Therefore, we contextualize technologies with their wider environment in order to study complexities in a structured manner. For that purpose, we apply the Multi-Level-Perspective (MLP), one of the most influential research approaches in sustainability transitions, which sees technological transition as the result of interlinked developments on different analytical levels

(Fuenfschilling / Truffer 2014). In order to anticipate potential future developments to further analyze synergies and conflicts, we orient to the work by Geels und Schot (2007) and Geels et al. (2016) who provide a taxonomy of transformation pathways in line with MLP thinking.

We focus our analysis on the four distinct niches of (i) bio-plastics, (ii) bio-lubricants and of biofuels for (iii) road and for (iv) aviation. These segments represent a portfolio of different innovations and regimes in the bioeconomy. Scrutinizing respective product and technology histories for Germany, but with an international focus, allows for delineating a set of parameters, which apparently influence the intended bioeconomic transformation in each case. Moreover, a forward-looking scenario exercise, that combines possible transformation paths of these niches, enables us to explore the special relation between material (i and ii) and energetic (iii and iv) bioeconomic applications in order to detect possible synergies or conflicts.

The described approach analysis is guided by the following key questions:

- What are key transformation factors in the evolution of the different niches?
- What are plausible future evolution paths for the niches? Which implications would changes in transformation factors have for the transformation of the individual niches?
- Are the various possible transition paths and related factors for the niches consistent to those of other niches? What kind of consistent scenario emerge from this consistency analysis? Which Implications and strategies for businesses and policy makers arise in the complex economic transition process?

By the time of the SFER 2019 Symposium, all findings will be validated by and commented on by experts from each niches and sustainability transition scholars. Some main interim results of those analyses can be specified as follows.

All niches share some common factors and patterns regarding their evolution in the last decades. In all cases, basic technology options have already exist for decades. Furthermore, either share a resurgence of public interest over the last four decades mostly due to pressure in the wider socio-environmental landscape. However, actors from both fields have not been able to use public awareness, i.e. to gather momentum for a bioeconomic change. Hence, market diffusion has remained far below expectations yet. Interestingly, bio-plastics and biofuels are confronted with opposition from environmental actors, which mirrors the ambiguity that the whole bioeconomy is subject to (Dubois / Gomez San Juan 2016). In addition to niche similarities, also differences between niches exist. For example, one can observe a more active discourse and actor engagement in the regime change for bio-plastics, but not for bio-lubricants. That is, parameters, which pertain to activities (e.g. lobbying, kindling demand) and corresponding niche properties (e.g. force of niche momentum) are found to have been of some importance for the development of the bio-plastics niche. Other differences relate to existing policies, while biofuels for transport

have been supported by demand-side policies (quotas) the other niches had to compete with existing fossil-based production without such regulations.

Regarding the future outlook, a variety of transition paths or mixture between two transition paths appear plausible for the niches, and 2-4 paths per niche can be identified. In most cases, climate and environmental policies are most crucial for successful transition, in some cases consumption patterns, disruptive technology advances or resource prices are main drivers as well. On this basis, we elaborate four different forward-looking scenarios that combine different transition paths (including stagnating developments) for the niches in the next 20 years. A very strong shift in all niches simultaneously is hardly plausible given biomass constraints. However, a substantial transition to the bioeconomy is imaginable with very different evolutions of the niches in each of the scenarios. E.g. in two scenarios, the transition is dominated by large expansion of biofuels with significant changes in actor landscape. In the others, a more balanced transition in different niches would take place, e.g. sustainability oriented evolution of certain rather low-volume bio-based, biodegradable plastics (e.g. PHA, PEF) in combination with a moderate growth of biofuels. Thereby, policies play a key role, such as the dimension and design of climate policy as well as international agreements in the case of aviation for biofuels.

Based on these insights and the upcoming stakeholder feedback process in the project, we aim to derive conclusion about appropriate governance arrangements of the bioeconomy, which take into account the rational of different actors.

References:

Dubois, O., Gomez San Juan, M. (2016). How sustainability is addressed in official bioeconomy strategies at international, national and regional levels: An overview. Environment and Natural Resources Management. Working Paper (FAO) eng no. 63.

Fuenfschilling, L., & Truffer, B. (2014). The structuration of socio-technical regimes—Conceptual foundations from institutional theory. Research Policy, 43(4), 772-791.

Geels, F. W., Schot, J. (2007). Typology of transition pathways in socio-technical systems. Research Policy, 36(3), 399-417.

Geels, F. W., Kern, F., Wassermann, S. (2016). The enactment of socio-technical transition pathways: a reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990–2014). Research Policy, 45(4), 896-913.

Giurca, A., & Späth, P. (2017). A forest-based bioeconomy for Germany? Strengths, weaknesses and policy options for lignocellulosic biorefineries. Journal of Cleaner Production, 153, 51-62.

Hellsmark, H., Mossberg, J., Söderholm, P., & Frishammar, J. (2016). Innovation system strengths and weaknesses in progressing sustainable technology: the case of Swedish biorefinery development. Journal of Cleaner Production, 131, 702-715.

Purkus, A., Hagemann, N., Bedtke, N., & Gawel, E. (2018). Towards a sustainable innovation system for the German wood-based bioeconomy: implications for policy design. Journal of Cleaner Production, 172, 3955-3968.

Wydra, S., Hüsing, B., Fischer, P., Jäger, A., & Horvat, D. (2017). Priorities for Addressing Opportunities and Gaps of Industrial Biotechnology for an efficient use of funding resources.