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Collective stakeholder representations and perceptions of drivers of novel biomass-based value chains

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ABSTRACT

EU policies aim to enable novel biomass-based value chains which require collaboration among their stakeholders. However little is known about how stakeholders collectively represent the scope and boundary of drivers that enhance or limit these novel biomass-based value chains. Thus, the objective of this article is to present the first comprehensive set of results about the collective representations and perceptions of novel biomass-based value chain drivers held by German stakeholders. These results were produced by drawing upon Group Concept Mapping (GCM), a bottom-up and participatory mixed methods-based approach. The results include a multivariate estimated concept map comprising 54 drivers spatially distributed across eight interrelated clusters. The spatial organization of clusters on the concept map provides insights on their interrelatedness and conceptual configuration which reveal stakeholders' concept breadth and depth of novel biomass value chains. Moreover, the relative importance and relative feasibility measures for each cluster of drivers were obtained. These measures indicate significant statistical differences between perceived relative importance and feasibility ratings. A discussion compares the results with available empirical evidence to further interpret the interrelatedness of the clusters, and provide additional insights regarding effective policy formulation for enabling novel biomass-based value chains.

1. Introduction

The transition toward a biomass-based economy has the potential to alleviate some of the major energy and environmental threats of the 21st century (European Commission, 2012). A biomass-based economy can be defined as one that uses renewable biomass resources and employs sustainable production systems across a spectrum of industries such as agriculture, food, pharmaceutical, chemical and energy (Besi and McCormick, 2015; Lewandowski, 2015; van Lancker et al., 2016). To mobilize the biomass potential, novel value chains or chain connections are needed (Boehlje and Bröring, 2011; Carraresi et al., 2018; Lewandowski, 2015). Based on concepts introduced by Porter (1985), value chains are typically understood as the: *"Full range of activities which are required to bring a product or service from conception, through the intermediary phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use"* (Kaplinsky, 2000: 121).

However, the transition from a fossil to a biomass-based economy creates biomass demand pressures on the multiple entry points of agricultural, energy, food, chemical and pharmaceutical value chains (Jernström et al., 2017; Piotrowski et al., 2016; Verdonk et al., 2007). This means that value chains which rely on biomass are increasingly interdependent as they share similar technology bases (Golembiewski et al., 2015). The competition between biomass-based sectors over land use for biomass production has fueled a heated debate: food versus fuel (Chen and Önal, 2016; Shortall et al., 2015). Hence, the Standing Committee on Agricultural Research (SCAR) of the European Commission, has suggested key bio-economic transition guiding principles to abate trade-offs and tensions associated with multiple demand requirements for biomass: (1) food first to ensure its security; (2) sustainable and regenerative crop yields; (3) cascading biomass use; and (4) reuse and recycling for improved resource circularity (Kovacs, 2015). The circular economic flows and cascade principles to optimally valorize available biomass trigger the emergence of novel or newly

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linked biomass-based value chains. Hence, the Bio-based Industries Consortium (BIC) that represents the private sector, calls for a strong collaboration among different stakeholders for a successful transition toward a biomass-based economy (Carrez, 2017).

In the literature, however, little remains known about how different stakeholders are coordinated in novel biomass-based value chains (Musiolik and Markard, 2011; Swinnen and Riera, 2013), which require shared mental models among stakeholders (Nucciarelli et al., 2017). As an example, in Germany, the biomass cascade utilization encourages innovation across firm boundaries to enable coordination in value chains among buyers and sellers with no prior business relationships (Golembiewski et al., 2015; Shortall et al., 2015; van Lancker et al., 2016). These interactions and chain structures are further challenged by technological innovations on the input side and by the changing demand priorities on the output side (Dautzenberg and Hanf, 2008; Vecchiato, 2012). This evolution challenges the current competitive positions of stakeholders and impacts existing business models (Golembiewski et al., 2015; Shortall et al., 2015; van Lancker et al., 2016). Moreover, actors across emerging value chain segments need to organize upstream as well as downstream activities, particularly, if they hold an intermediary position, as it is often the situation in bioenergy (Musiolik and Markard, 2011). This leads to new collaborations and networks given that innovations within a biomass-based economy are developed based on, and subject to, knowledge distributed among stakeholders in different segments of the value chain (Golembiewski et al., 2015; Shortall et al., 2015; van Lancker et al., 2016).

However, in order to align bioeconomic policies in support to stakeholders in the transition from a fossil to a biomass-based economy, it seems pivotal to better understand how drivers of novel biomass-based value chains are represented and perceived from a collective stakeholder perspective. In addition, taking a collective perspective improves the understanding of stakeholders' scope of boundaries of novel biomass-based value chains. But, so far, research on drivers enabling novel biomass-based value chains has focused mainly on individual or case-specific perspectives on biomass value chains. For example, Mertens et al. (2018) focus on feedstock supply and conclude that actors' willingness, coordination and supply reliability play an important role for novel biomass value chain. Stadler and Chauvet (2018) conclude that the interplay between regional and national public partners is crucial for innovative biobased ecosystems in France. Scheiterle et al. (2018) with the case of sugarcane in Brazil show that political incentives were the main driver for Brazil's biomass-based economy and insist on the need for stronger collaboration between invested stakeholders. Kedron and Bagchi-Sen (2017) identify uncertainty in feedstock supply as well as technology and market conversion as barriers to novel value chains. Other research considers the collective perspective of stakeholders, but misses to take the interrelationships among a broader set of drivers into consideration (Devaney and Henchion, 2018; Levidow et al., 2012; Shortall et al., 2015). Taking into consideration that the EU employs a broad and collective strategy for a transition toward a biomass-based economy, including the interrelationships of drivers is highly useful to anticipate the effect of future policies.

Thus, existing results only partially cover the set of drivers needed to inform current debates about emerging value chains in the biomass-based economy. Hence, the lack of breadth and depth to account for the stakeholder perspective which also take the interrelationship of drivers into account (Bérard et al., 2017), presents a knowledge gap for establishing effective governance frameworks and foster the transition toward a biomass-based economy (Röder, 2016; Thompson, 2008). A significant hurdle associated with the estimation of the collective conceptualization of stakeholders is the paucity of appropriate methods combined with the opportunity to access a relevant group of participants (Meinzen-Dick et al., 2004). Group Concept Mapping (GCM) is a multi-step mixed methods-based approach (qualitative and quantitative), as used in this research, that is employed to generate representations and perceptions in complex systemic settings (Kane and Rosas, 2018; Kane and Trochim, 2007; Trochim and Cabrera, 2005). The method takes into account that an individual stakeholder within a group (e.g. as part of the value chain) holds a unique perspective; and there is also an uneven distribution of the overall available information among stakeholders in a group. Thus, grouping and formalizing a framework by sharing the information contributes to the group conceptual representation (Rosas, 2017b).

Hence, this method is employed to identify drivers, clusters of drivers, and the collective interrelationships that stakeholders conceptualize as key to examine novel biomass-based value chains. Given the use of the GCM with stakeholders of biomass-based economy value chains as participants in the process, the proposed study examines three research questions: First, what are stakeholders' collective representations of novel biomass-based economy value chain drivers? Second, what are the interrelationships among clusters (as set of drivers) identified by value chain stakeholders? Third, what are the perceived relative importance and relative feasibility of clusters (as a grouped and coherent set of drivers)? [1]

Thus, the objective of this paper is to develop a better understanding of the interrelationships and complexity of novel biomass-based value chains drivers from a collective stakeholder perspective. Indeed, a finer understanding of representations and perceptions held by stakeholders is relevant to the bioeconomy incentive alignment and prospect. It would give a well-needed conceptual understanding of biomass-based value chain stakeholders. The paper is structured as follows. The GCM method is detailed in section 2. Results are interpreted in section 3. In section 4, the discussion provides an examination of the matching patterns between the relative importance and relative feasibility of drivers contrasted with available evidence about novel biomass-based value chains. The summary of findings is outlined in section 5 with policy implications and directions for future research.

2. Methods

2.1. Research approach: group concept mapping (GCM)

The GCM approach was introduced in program evaluation and planning as a multivariate bottom-up participative stepwise mixed methods-based framework (Rosas and Kane, 2012; Trochim, 1989a). Its research steps are used to examine an array of questions in areas such as technology assessment, health care policy, service management, strategic management, IT adoption and use, entrepreneurship, and value-enhanced food network formation (Cloutier et al., 2017b; Cloutier and El Ourabi, 2014; Cloutier and

[1] According to Danks (2014) a "representation" is the product of the cognitive structure of individuals regarding an object and it is often intertwined with the process that generates it. Hence, models, artifacts, equations are often employed as means to render explicit representation by individuals and groups. As such, concept maps generated as part of a GCM framework is a collective representation of individual representations (for a detailed understanding see Cloutier et al. (2017b) and Rosas (2017a)). Hence, "perception" measures are also obtained as part of the GCM framework to better understand how participants perceive the collective conceptualization representation generated.