Business logics for bioeconomy collaborations

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Abstract
Fossil fuels constitute the core of the linear socio-technological order on which our modern society is built. Through a combination of ambitious goals to foster the bioeconomy, Sweden wants to achieve zero net greenhouse gas emissions by 2045. The move towards a bio-based economy represents a transformative force for economic development which builds on the access to, and use of, forest-based resources. The commercialization of sustainable innovations that utilize renewable feedstock is a central challenge when managing the transition to a bioeconomy. Collaboration between actors from diverse industries is seen as a solution to tackle the systemic challenges that this transition entails.

This paper reports on novel cross-industry value chain collaborations in a Nordic context that have the purpose to bring new sustainable innovations to the market. Data was collected by way of four case studies of collaborations along diverse newly formed industrial value chains with varying scope and at different stages in their development. From these case studies, four distinct business logics (secondary product, bundled product, mixed product, and multi product) for bioeconomy collaboration were derived that enable the commercialization of sustainable innovations. While all four logics hinge on substituting environmentally less favorable products, different collaborative mechanisms are at play. Results show that basing new bioeconomy ventures on existing well-developed processes, industrial infrastructure and distribution systems is beneficial. Additionally, processes of market building need attention, especially in terms of product legitimacy and policy support. The potential to scale up these types of bioeconomy ventures appears to be dependent on feedstock availability and market size.

Introduction
Fossil fuels are at the core of the linear socio-technological order on which modern society is built. Following recent reports (IPCC 2018, 2019), anthropogenic CO_2 emissions must decline by about 45 % by 2030 and reach zero net emission around 2050 in order to limit global temperature increase to 1.5 °C above pre-industrial levels. Failure to take immediate action is highly likely to result in substantial risks for natural and human systems due to abrupt and irreversible climate changes such as ocean warming and sea ice change, putting the stability and resilience of the planet in peril (Lenton et al., 2019).

Sweden has the long-term target to achieve zero net greenhouse gas emissions by 2045 (Swedish Environmental Protection Agency, 2019). Adopting cleaner production patterns by way of renewable technologies and resources is an important step towards this target. The envisaged transition towards a bio-based economy represents a development path that can leverage Sweden's abundant forest-related assets and resources. The pursuit of a bio-based economy is regarded as a transformative force and a means to ensure the competitiveness of Sweden's manufacturing industry (Formas, 2012; UNEP, 2011). Nevertheless, this strategy proves to be challenging at the firm level, especially for established firms. Firms working with product and process innovations based on renewable raw materials and technologies encounter numerous obstacles (e.g. Iles & Martin, 2013). Sustainable innovations must not only match firms' needs from a technical, organizational and financial perspective, but should also contribute to solving sustainability challenges (Carillo-Hermosilla et al. 2009). This means meeting sustainability criteria from a social, environmental and economic perspective (Hall & Vredenburg 2003). Many of these innovations have difficulties moving forward from the demonstration stage to the market, not only due to competition from fossil resources and the lack of sufficient policy support, but also insufficient knowledge on consumer needs and commercialization opportunities (Bauer, Hansen & Hellsmark, 2018; Growth Agency 2011; Hellsmark et al., 2016).

The successful commercialization of sustainable innovations based on renewable feedstock is a central question when managing the transition to a bioeconomy (Iles & Martin, 2013). The emergence of niche markets for sustainable innovations are dependent on the interaction between business strategy, consumer behavior and policy instruments (Andrews & DeVault 2009). Research has explored how national innovation systems, incentives and market structures influence the development and commercialization of sustainable innovations (cf. Geels, 2011). The innovation system needs to foster an industrial landscape that develops bio-based, sustainable innovations that are commercially viable in the face of international competition. Due to the scale of the commercialization challenge in relation to the size of the Swedish market and the interconnectedness of modern industrial production systems, a transition to more sustainable production and consumption systems requires systemic changes. These may only be achieved through collaborations between a wide range of actors of different sizes, active in several, often distinct, business environments (Bauer, Hansen & Hellsmark, 2018; Roome, 2004).

The importance of collaboration for the development of a sustainable industrial production system is broadly acknowledged and highlighted in key policy documents, publicly funded innovation initiatives and private sector statements (OECD, 2009). In recent years, major innovation initiatives funded by national and EU sources have emphasized collaboration as a key theme for the development of more sustainable industrial sectors (BMBF 2016). Due to its key role in relation to systemic challenges, collaboration is a topic that permeates much of the research literature. For instance, collaboration between companies is considered to enable the sharing of risks and costs and to improve their ability to deal with complex conditions more broadly (Gray & Stites, 2013; Schibany et al. 2000).

Although value chain collaboration aiming at contributing to the emerging bioeconomy has become more common, the processes of collaborative business development along new value chains have so far received little attention from researchers. Previous research on value chains has focused almost exclusively on collaborations to improve the sustainability of already established value chains (Boons & Mendoza 2010). So far, the question how actors from different industries collaborate to create entirely new value chains and build niche markets for sustainable innovations has received little attention. Our research addresses this gap, intending to shed light on the business logics of newly formed cross-industry value chain collaborations that aim at creating new markets for bio-based, sustainable innovations. Knowledge about such business logics could potentially guide industry and facilitate the transition to the bioeconomy.

Theory

The value chain explains how to arrange organizational functions and relationships in order to create value (Porter, 1985), and an industrial value chain thus explains how resources are extracted, refined and sold to end users (ibid). Hence, the industrial value chain is a link of the individual value chains of involved business entities. The "the external value chain" was recognized in early business model research (Timmers, 1998) and value chain configuration has been considered in research that investigates the relationship between network relations and business model innovation (Allee, 2009; Oskam, Bossink & de Man, 2018). Value chain collaboration that builds on the ambition to introduce sustainable innovations is considered to build more sustainable business models (Boons & Lüdeke-Freund, 2013). As a concept the business model explains how a business generates financial value from the production and delivery of specific value propositions to customers (Teece, 2010). Actors may use business model innovation to modify or improve the performance of the entire value chain (Linder & Cantrell, 2000) and the role that a firm has in a value chain will influence, and be influenced by, the business model (Giesen, Berman, Bell & Blitz, 2007). Yet, reviews of business model literature indicate that research on the relationship between value chain and business model configuration is underdeveloped (Zott, Amit & Massa, 2011).

Business models and value chains are shaped by a wide range of factors both internal and external to a business. Many factors (e.g. legislation and technical standards) tend to develop along industry-specific pathways which are considered stronger in mature industries due to the fact that established actors coevolve with political and bureaucratic institutions (cf. DiMaggio & Powell, 1983). In such contexts industry-specific vocabularies and perspectives develop in similar ways as they do in specific organizational contexts — a phenomena which is often described as the development of a dominant logic (Prahalad, 2004). The concept of dominant logic is centered on managerial cognition within a specific organization which means that the collective learning process that managers participate in with important stakeholders (cf. Calton & Payne, 2003; Svendsen & Laberge, 2014) is overlooked. Managers and stakeholders generate knowledge on how a specific sector functions while interacting with institutions such as universities and authorities. At an aggregated level there is knowledge building about business models and strategy that is industry specific in nature and possible to conceptualize as a "business logic" (Sandoff and Williamsson, 2016). The term describes the general perception that dominates a sector with regard to issues such as dominant production technology, business model layouts, value chain configurations, principles of regulation and other important contextual factors (Williamsson et al., 2019). The business logic concept thus focuses on perceptions of an industry's structural conditions which define the conditions for the content and development of business models within that industry. Hence, business logic is a description of success factors that builds on an overlap of theory, history, experimentation and practice (ibid.).

Method

Collaboration is a complex social phenomenon and should thus be investigated with the help of methods that allow building a contextual understanding of the specific collaboration. A case study approach was chosen as it accommodates these considerations, allowing for the exploration of a complex social phenomenon in the context in which it developed (Flyvbjerg, 2006; Yin, 2003). Four diverse newly formed cross-industry value chains with varying scope and at different stages in their development were used as case studies. Data was collected through interviews with company representatives involved in bioeconomy oriented value chain collaboration, complemented with secondary data such as press releases, company webpages and news coverage. In addition, interviews with bioeconomy experts were held. All interviews followed a semi-structured qualitative approach based on an interview guide. Qualitative interviews enable the researcher to discover and identify different perceptions, characteristics or manifestations of a specific phenomenon (Patel & Davidson, 2011). In total, 24 interviews were conducted in either Swedish or English, in person or over the phone, depending on the respondent's preferences and location. The interviews ranged from 30 to 75 minutes and were transcribed in their entirety. Interview respondents were offered anonymity, which may promote openness. Respondents were also given the opportunity to examine interview transcripts and provide feedback on preliminary results.

The analysis was carried out in two stages. During the process of data collection, the material was compared for each case, allowing for a "within-case analysis" of the information that each respondent contributed with. This analysis resulted in case descriptions of the four cases studied. Please note that the case descriptions are not critical examinations of the collaborations, but a portrayal from the respondents' perspectives. No appraisal has been made as to technical aspects, potentials or alternative uses of raw materials. The second analysis phase encompassed the entire material, using an iterative process to categorize the empirical data. Categorization was based on different themes identified in the empirical data and in the reference literature. This enabled a cross-case analysis based on a thematic breakdown of the empirical data. The aim was to detect similarities and differences and identify aspects specific to newly established bioeconomy-oriented value chain collaborations. This resulted in the conception of different archetypes of bioeconomy-oriented value chain collaborations, from which specific business logics have been derived. The concept of business logic is used to deepen the understanding of the four cross-industry value chain collaborations. By describing a distinct business logic for each collaboration, a structured narrative is created. To identify important features of the business logics, these are elaborated on with respect to categories of interest identified, i.e. collaborative focus, technology and infrastructure, substitution strategy and market scope.

Results

In the following, descriptions of the four bioeconomy-oriented value chain collaborations studied are provided.

JOINT VENTURE FROM "WOOD TO WHEEL"

Based on cross-industry collaboration, three established industry leaders and an entrepreneurial company formed a joint venture to explore the entrepreneur's business idea and patents for the production of tall diesel from raw tall oil. Given favorable Swedish climate policy, i.e. the exemptions from CO_2 and energy tax on the final product, the partners in the joint venture, the technology provider, two forest companies and a fuel company, decided to jointly invest in a crude tall diesel plant based on the new technology. After the plant in the north of Sweden was built, the fuel company contributed to developing and improving the production processes to meet the needs of the users better. The fuel company also invested in upgrading its own refinery to which the crude tall diesel was shipped for further treatment. These measures ensured that the final product met the specification demanded by customers. In addition, the network of petrol stations owned by the fuel company was used to distribute the biodiesel to end consumers all over Sweden. Within three years from building the production plant, the target production capacity was reached, and the joint venture became profitable. When an international chemical firm joined the collaboration a few years later, the possibility to extract further valuable products from by-products was explored, which was the first step towards developing the production plant into a full-scale biorefinery.

The collaboration builds on trustful relationships and the sharing of risks and rewards. Thanks to the tight collaboration between the owners (see ownership structure in Figure 1), value chain coordination and the development of products and business model were facilitated. Together, the owners cover the entire industrial value chain from the extraction of forest resources to the distribution of the final product to consumers, bringing in the knowledge and resources required for each step in the new industrial value chain. The joint venture is tightly linked to the value chains of the established firms and represents a good fit with both, the existing value chains and the greater strategic scope of the firms. Moreover, there is good congruence between the joint venture and existing technical and institutional systems on which the established firms rely. Over the last decade, the joint venture has developed into a world leader in the production of second-generation renewable fuels from raw tall oil.

ETHANOL-BASED SYSTEM SOLUTION FOR HEAVY TRANSPORT

The collaboration is based on a partnership between three established actors, a Swedish truck manufacturer and two producers of ethanol. The firms joined forces to create a joint systemic offer to customers, consisting of ethanol truck engines, ethanol-based biofuel for heavy transport, ED95, and customized ethanol filling stations. ED95 is a high blended biofuel produced from agriculture or forestry residues, enabling a reduction in CO_2 emissions in heavy transports of up to 90 %, compared to fossil fuels. ED95 technology enables sustainable ethanol to replace large volumes of fossil diesel in heavy vehicles. With this initiative, the partners want to contribute

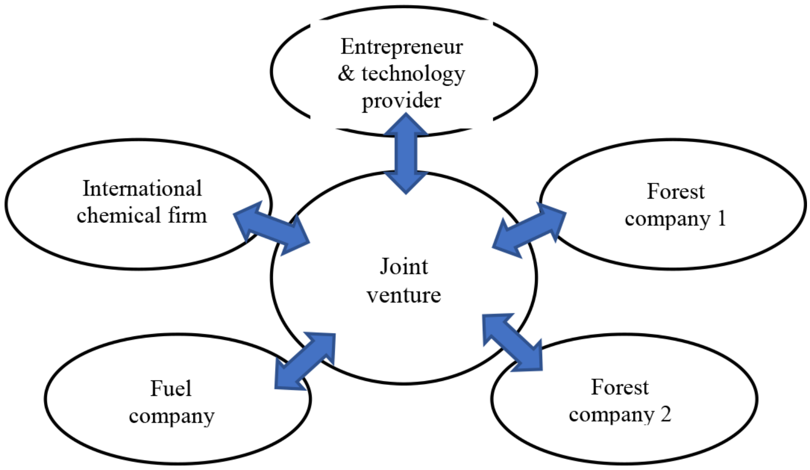

Figure 1. Ownership structure of the joint venture from "wood to wheel".

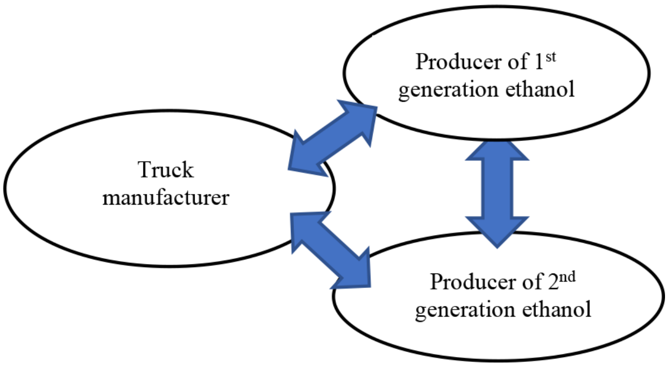

Figure 2. Actors and linkages in the collaboration promoting ethanol for heavy transport.

towards the goal of a 70 % reduction of CO_2 emissions in the Swedish transport sector by 2030.

The goal of the partnership is to create a system solution that includes the entire value chain from the renewable fuel to the transport itself. The partners want to increase the market for ED95 and make the fuel an important heavy-transport solution. However, as the solution requires new technology and new infrastructure with customers, initial investment costs are higher than other solutions (e.g. hydro-treated vegetable oil (HVO)). Given the strong cost focus in the transport sector, the ambition of the partnership was to provide a competitive offer, without major cost increases, compared to fossil diesel.

The partnership was keen to highlight the competitive aspects of the offer, allowing customers to choose between two suppliers of ethanol and infrastructure offers. Giving customers a choice between first-generation and second-generation ethanol increases the credibility of the initiative. This, however, involved competition between two fuel suppliers within the collaboration, which required balancing between collaborative and competitive aspects. Partners needed to be clear about what areas to collaborate around (e.g. communication, joint offering, message to politicians, etc.) and which areas required a separate dialogue (e.g. pricing). Although competition within the partnership may complicate the collaboration, the benefits were seen to prevail. Actors and linkages in the collaboration are depicted in Figure 2.

The partners have a collaborative mindset and share a common understanding of the broader challenges that need to be overcome to make ethanol play an important role in the transition towards a sustainable transport sector. They also share the insight that collaboration is particularly important with regard to implementing dedicated infrastructure. Collaboratively offering a systemic solution is seen as a successful strategy to facilitate switching heavy transport to ethanol. The collaboration represents a prominent example of value chain actors joining forces explicitly for market creation.

WOOD-BASED BEVERAGE CARTONS

The partners in this value chain collaboration are established actors, i.e. large multinational companies or subsidiaries thereof that share an interest in the bioeconomy. Under the collaboration, a Finnish producer of renewable diesel and renewable naphtha (subsidiary to a global forest industry company), a European chemical company and a Norwegian global supplier of paper-based packaging solutions for the dairy and juice industries have joined forces (see Figure 3). The latter perceived a growth in customer interest in sustainability issues. Hence renewability and reducing CO_2 emissions need to be consid-

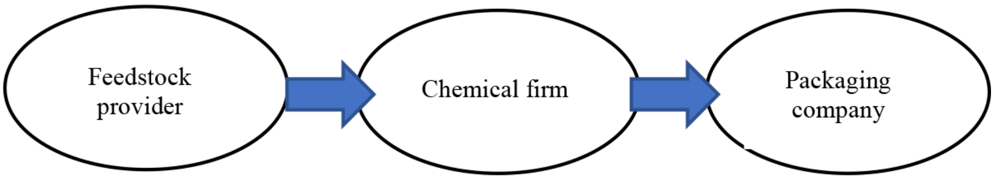

Figure 3. Actors and linkages in the value chain collaboration for wood-based beverage cartons.

ered when developing their beverage cartons. The aim of the collaboration initiated by the Norwegian packaging company is to substitute the fossil-based plastic in beverage cartons with renewable polyethylene, using feedstock from sustainable forestry. For this purpose, the company encouraged its supplier of polyethylene to get in touch with the Finnish producer of renewable naphtha to investigate the possibilities to use this feedstock to produce renewable polyethylene. This naphtha is chemically equivalent to fossil-based naphtha and proved to be a good match with the existing production system of the chemical firm.

The wood-based naphtha is fed into an existing petrochemical plant and processed into renewable polyethylene, using the mass balance approach. Mass balance accounting is a chain of custody approach designed to trace the flow of materials through a value chain (Ellen MacArthur Foundation, 2019). The approach provides flexibility and does not require any new factories to be built. The renewable polyethylene is then manufactured into components of packaging products, such as caps and films.

To verify the sustainability of the value chain, all parties agreed to be certified in accordance with a widely recognized, international sustainability scheme, ISCC Plus. This guarantees that the feedstock is sustainably produced, which was seen to bring additional value to the collaboration. The relationship between the collaboration partners is predominantly contract-based, which minimizes risks.

The partner highlight that few suppliers currently provide renewable naphtha for petrochemical crackers and thus, the feedstock is seen as quite unique. Additionally, it has several favorable sustainability attributes: It is forest-based from sustainable forestry within the Nordic region, there is no competition with food or land-use change, and finally, the greenhouse gas reduction potential is high.

SYMBIOTIC INDUSTRIAL SYSTEMS

This cross-industry collaboration joins three businesses that have symbiotic and interdependent relationships: a salmon farm, an algae cultivation and a wastewater treatment and biogas production company, as depicted in Figure 4. At the core of the collaboration lies the salmon farm that developed a method for land-based, organic salmon farming in saltwater tanks. Said method uses an innovative, recirculating aquaculture system (RAS). The salmon farm is connected with the algae cultivation where the wastewater from the fish tanks is purified. The algae cultures provide natural wastewater treatment and a GHG trap. The algae feed on the nutrients (nitrogen and phosphorus) and the CO_2 it contains. This produces oxygenated freshwater, which is recycled back to the fish tanks, enabling 100 % water recovery. The method ensures environ-

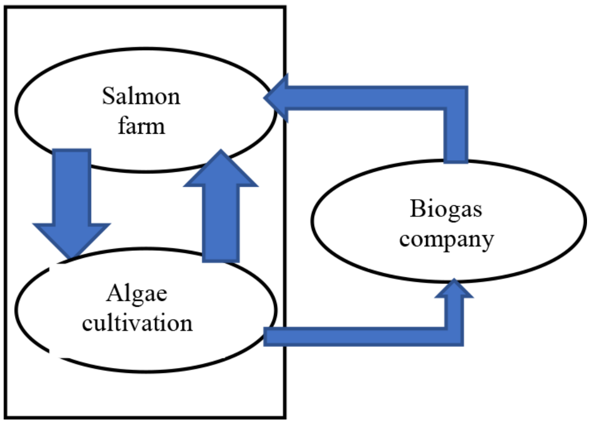

Figure 4. Actors and linkages in the symbiotic industrial system.

mentally friendly fish farming that is a major improvement compared to conventional fish farming methods. The salmon is processed at a local fish processing plant that is more loosely connected to the collaboration, from where it is sold as ecologically farmed.

The algae cultivation works with a group of microalgae called diatoms, from which a nanoporous material with multifunctional properties is extracted. After harvesting the algae, it is separated into two fractions: porous silicon dioxide and biomass. The former could potentially be used in several industrial applications (e.g. improving solar cell efficiency or as an environmentally friendly UV-filter in sunscreens). Nutrient-rich biomass and oil are extracted as by-products that can be valorized as fish feed or human food supplements. The two companies started collaboration within the frame of a testbed for land-based aquaculture in the coastal municipality.

The biogas producer takes care of the residues from the salmon farm and three established firms in the local fish processing industry. Wastewater and fish waste are digested into biogas that is converted into electric power and hot water and fed back to the fish processing industry. Local farmers then use the solid residues as organic fertilizer. Embeddedness in the local context and the presence of entrepreneurs, some of which have long experience in the fishing industry, are characteristics of this collaboration. Together, the companies form part of a larger circular-economy venture that delivers environmental benefits and contributes to the prosperity of the coastal municipality.

Considering the four case studies as different archetypes of bioeconomy-oriented value chain collaborations, business logics for each of them have been derived that are presented in the next section.

Analysis – four business logics for bioeconomy-oriented value chain collaborations

From the case studies outlined above, four distinct business logics for bioeconomy collaboration were derived that enable the commercialization of sustainable innovations. The business logics are named after the type of product that the different collaborations manufacture and highlight key collaborative characteristics. The four product types and respective business logics are: secondary product, bundled product, mixed product and multi product. The business logic for each collaboration is described in terms of business-related characteristics, such as how operations are set up, manufacturing is organized, products are brought to market, and how cost disadvantages are mitigated. While all four logics hinge on substituting environmentally less favorable products, different collaborative mechanisms are at play. Table 1 establishes the link between the four value chain collaborations and the respective business logic, as well as describes their features in a number of important categories.

SECONDARY PRODUCT BUSINESS LOGIC – GREENING THROUGH JOINT VENTURES

One of the promises of the bioeconomy is the development of different secondary products such as materials, chemicals and fuels based on renewable feedstock. To help procurement, quality control and sales, these products adhere to standardized formulas.

The challenge for upstream suppliers of bio-based feedstock (e.g. different bio-based raw materials or residues) is to valorize their products or to tap into the added value of later production stages (e.g. fuels and plastics). For manufacturers developing bio-based intermediate products, the challenges are mainly technological uncertainties and subsequent difficulties in making large, risky investments. The risks for the downstream manufacturer (e.g. refineries and chemicals companies) are twofold: the raw material may fail to meet specifications and does not have the same qualities as the corresponding fossil raw material; risks related to product acceptance, e.g. reputational risks from unsustainable sourcing (e.g. involving land-use change), competition with food or the continued use of fossil-based feedstock.

Close collaboration is a way of sharing risks and rewards. By creating a joint venture with downstream and upstream actors, it is possible to: capitalize on similarities between adjacent industries; lengthen existing value chains; share risks through mutual investments; and, collaborate on knowledge development and business intelligence. Through close collaboration it is possible to have a greater influence and control over the sourcing of the intermediate product and by that decrease risks of using feedstock of unwanted or unknown origin. An important driver for such collaboration is the strategic match between the technological uncertainties associated with the construction of a full-scale production facility; and, the technological know-how and process-industry experience jointly possessed by the actors. Another driver is the possibility to apply stepwise reconfiguration, using existing production facilities and distribution infrastructure as much as possible (cf. Peck et al., 2016a). This minimizes the necessary investments. Furthermore, if the bio-based intermediate product is functionally equivalent to fossil-based products, it is fully compatible with the existing fossil fuel infrastructure. This enables a drop-in strategy, which can be very valuable when the original feedstock is in limited supply. Use of the product does not involve any upfront investment and can be tailored to fit different customer groups' preferences and willingness to pay. This incremental feature is thus attractive for producers and customers alike.

BUNDLED PRODUCT BUSINESS LOGIC – MARKET CREATION FOR SYSTEMIC BIO-BASED OFFERS

In infrastructure systems such as transport, market creation is dependent on the parallel development of vehicles and fuel distribution infrastructure. Road transport, ships and aircrafts provide illustrations of interdependence within solutions. The systemic nature of the type of solutions in question here is particularly evident in the case of high blended biofuels with the need for dedicated vehicles and infrastructure. Investing in a new system requires customers to go "all-in". Uncertainty may however complicate the purchase decision. A bundled product offer can lower the high threshold that such systemic change entails for customers. By collaborating and bundling products, new business models that facilitate market development can be devised.

Table 1. Four business logics for bioeconomy collaboration.

Case study	Business logic	Collaborative focus	Technology and infrastructure	Substitution strategy	Market scope
Joint venture from wood to wheel	Secondary product	Combining resources	Mix of new and existing technologies and infrastructure	Drop-in fuel, incremental	Existing market
Ethanol-based system solution for heavy transport	Bundled product	Combining products	New technology and new infrastructure with customer	Dedicated infrastructure and fuel ("all-in")	New market
Wood-based beverage cartons	Mixed product	3rd party certification based	Mostly existing technologies and infrastructure	Drop-in chemical, mass balance	Existing market
Symbiotic industrial systems	Multi product	Combining processes	New infrastructure, mix of new and existing technologies	Various strategies	Several new markets

The combination of separate value chains and different industry logics is specific to this type of bundling. The different parts of the bundle are not manufactured by the same supplier and thus complementary value offers are necessary for creating such bundle. The value chains remain separate and each manufacturer competes with its products on a different market. However, the suppliers' investments in technology development (e.g. engines) and in capacity for the distribution of consumables are considerable and both value chains must be commercially viable. By bundling their products, manufacturers can capitalize on their existing production, distribution and sales infrastructures. Product bundling also enables manufacturers to expand their value proposition and offer joint, bio-based system solutions. By reducing complexity, the purchase decision is simplified. A strength of dedicated systems (based on bio-based technologies and consumables) is that climate benefits usually are higher compared to a drop-in strategy.

Following this logic, risk reduction is the main driver for collaboration. This is achieved by developing a joint strategy for creating a new market for bio-based technologies. Introducing a new systemic bio-based offer is not only associated with substantial risks from a producer point of view, it also presents considerable risks for early adopters of the new technology. This "all-in" business logic is characterized by risks for lock-in effects such as stranded assets and high switching costs. Customer trust is decisive for the purchase decision. A further important part of the business logic is to create a competitive market by offering customers a choice of several product suppliers. Secondary products are the products of a process that have inelastic supply with demand. Even if the market value of a secondary product increases, one would not expect more of it to be produced from that process (ICF International, 2015).

MIXED PRODUCT BUSINESS LOGIC – 3RD PARTY CERTIFICATION FOR CREDIBLE SUBSTITUTION

This business logic can be considered the most straightforward way of setting up a collaboration to promote biobased products. In this model, risks and upfront investments are relatively low. It is based on existing value chains and already established buyer-supplier relationships. However, suppliers offering bio-based feedstock replace fossil feedstock suppliers.

In the mixed product business logic, the underlying driving forces are market demand, corporate climate commitments and opportunities for environmental differentiation. The starting point can be a manufacturer aiming at lowering the carbon footprint of its products and substitute fossil or other less desirable feedstock with renewables. By contracting a bio-based feedstock supplier and using the mass balance approach, the equivalent amount of bio-based intermediate can be delivered to the manufacturer of the final product. This manufacturer can use the intermediate in its existing products, resulting in the corresponding number of fully bio-based products or, using a drop-in strategy, manufacture products that contain a certain percentage of bio-based raw materials.

Potential risks related to collaboration are addressed via elaborate contracts. Risks associated with potential asset-specific investments by the chemicals firm producing the bio-based intermediate are lowered by signing long-term contracts. This also helps address the price risk for the manufacturer of the finished goods. Thanks to the standardized quality of the bio-based feedstock, the finished goods have the same properties as those based on fossil feedstock, which lowers the risk of sub-par quality. Standardization also opens up for external quality control and the use of technical standards and certifications. These are important for the transparency and ultimately the legitimacy of the products and manufacturers along the value chain. Transparency and trustworthiness are key enablers in this business logic. The mixed product business logic has high potential for consumer goods and other markets with good opportunities for environmental differentiation, high brand image and visibility.

The strength of this approach lies in building on existing infrastructure and processes. This enables a transition within the established regime. Responses are fast and flexibility is high. As a result, technical, financial and political risks are low. However, attention must be paid to consumer acceptance to avoid potentially high reputational risks that could negatively affect brand names and trademarks. A limiting factor for the mixed product business logic is the scarcity of suitable raw materials.

MULTI-PRODUCT BUSINESS LOGIC – CIRCULAR ECONOMY-THROUGH SYMBIOSIS

The multi-product model is the most demanding and systemic collaborative business logic. Based on symbiotic interdependencies, it connects several firms and enables development and production of multiple products and (ecosystem) services. Ideally, collaborating firms come from different backgrounds, e.g. a mix of entrepreneurial and established actors. These firms may be active in diverse industries and value chains. Embeddedness in a local cluster seems to be a feature of collaborations with a multi-product business logic. In order to finalize the setup and optimize the synergetic capacity of the production system, the needs and potentials of local actors must be considered. This makes local knowledge, networks and legitimacy important assets. Driving forces for this kind of collaboration and benefits gained from it are multi-faceted. Besides a general interest in developing and commercializing sustainable innovations, one of the more important drivers may be local business development.

The joint technical system based on the symbiosis between the firms is the hub of the collaboration, but each firm runs its own product and market development activities. As every product has its own specific market, the multi-product business logic demands intimate knowledge of the commercial conditions for each product. Frequently, markets for these types of products are underdeveloped or non-existent. Several development steps for market creation may still be required, making entrepreneurial capabilities and zeal necessary. Multiple sources of income are a characteristic of the business models used. The high interdependency of the collaborating firms increases the vulnerability of the collaboration. Risks however differ for each collaborating firm and the combined risks are complex. Depending on the fit between the sustainable innovation policies and regulation, political risks may be pronounced.

Given the high degree of complexity of the symbiotic setup, the number of integrated production processes and the presence of immature and partly place-bound markets, these collaborations are most suited for actors and entrepreneurs with the necessary finance. A multi-product business logic is best created from scratch, based on local conditions, opportunities and demands. However, in more mature stages, it would be possible to package an established model for this type of symbiotic, multi-product set-up and commercialize it either on a transactional basis or as a franchise.

CONDITIONS FOR GOVERNANCE SUPPORT IN COLLABORATIVE ARCHETYPES

The collaborative archetypes described indicate generic pathways for phasing out fossil-based raw material based on distinct business logics. They outline four fundamental types of cross-industry value chain collaborations covering potential collaborative situations, each with its own challenges. In general, closer collaboration, e.g. large collaboration-specific investments, co-owned or co-managed assets and the existence of sunk costs, increase complexity. This is also true for the presence of value chain interdependence, e.g. the creation of two or more products marketed independently by different partners, where success requires each of them to do well. Several interdependent value chains are more complex to manage and demand greater effort. Figure 5 is an illustration of the four collaborative archetypes.

Circles represent collaboration partners. Lines represent collaborative links and boundaries of each business logic. Line thickness indicates collaborative closeness. Arrows represent commercialization of bio-based products.

Discussion and conclusions

The goal to phase out fossil-based raw material is demanding and involves changes to a large number of value chains. Collaboration is an important tool to create new and reconfigure existing value chains by decreasing risk and increasing efficiency. This paper outlined four archetypes of cross-industry value chain collaboration for the bioeconomy, representing four distinct types of business logics, each demonstrating a unique collaborative approach with a varying degree of complexity. The results indicate that a successful transformation through different collaborative efforts will require a diverse landscape consisting of different solutions and engaging various types of companies. This research can improve the capacity for discussing and analyzing the role of collaboration in a bio-based economy and how different forms of collaboration can be used as a transformative force. It should however be note that the cases analysed are examples of success stories and the potential for scale-up may be restricted. For instance, the limited availability of tall oil (Peters & Stojchva, 2017) sets clear limitations for potential upscaling in a Swedish as well as an international context. The limitations to bio-based feedstock will most certainly demand innovative practices, new technologies and utilization of many different types of bio-based feedstock. Although national and international policy support play a vital role in realizing these goals, market-based competition will also be central. These changes may demand considerable efforts, investments and risk taking by private actors. Processes of market building require attention, especially in terms of product legitimacy and policy support. Overall, the potential to scale up these types of bioeconomy ventures appears to be dependent on feedstock availability and market size.

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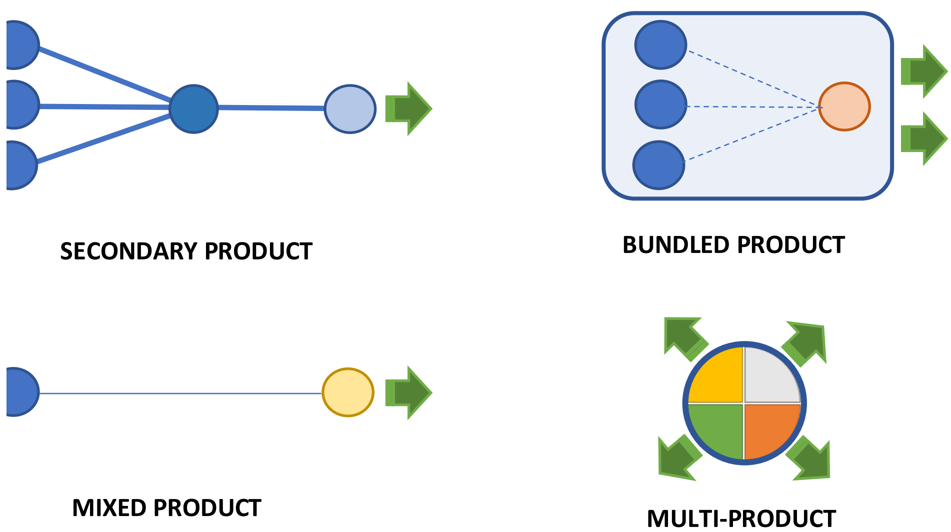

Figure 5. Four Business logics for bio-economy collaborations.

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