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Full Research Article

The territorial biorefinery as a new business model

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Abstract. The transition toward more sustainable industries opens the way for alternative solutions based upon new economic models using agricultural inputs or biomass to substitute oil-based inputs. In this context different generations of biorefinery complexes are evolving rapidly and highlight the numerous possibilities for the organization of processing activities, from supply to final markets. The evolution of these biorefineries has followed two main business models, the port biorefinery, based on the import of raw materials, and the territorial biorefinery, based on strong relationships with local (or regional) supply bases. In this article we focus on the concept of the 'territorial biorefinery', seen as a new business model. We develop the idea of a link between the biorefinery and its territory through several relevant theoretical approaches and demonstrate that the definition of 'territorial biorefinery' does not achieve, from these theoretical backgrounds, a consensus. More importantly, we emphasise that the theoretical assumptions underlying the different definitions used should be made explicit in order to facilitate the manner in which practioners study, develop and set up businesses of this kind.

Keywords. Territorial biorefinery, innovation, business model, industrial and territorial ecology

JEL Codes. O33, Q16, R11

1. Introduction and objectives

In the context of the energetic transition and the emergence of a new bioeconomy, the issue of defining innovative business models to support this fundamental change is crucial for policy makers and researchers alike. Considering this policy background, the objective of this article is to identify the relevant theoretical contributions to the understanding of the territorial biorefinery as a new business model. Underlying this objective is the importance of developing innovative research capable of providing insights and recommendations at the policy level.

First, we empirically characterise the concept of 'territorial biorefinery' as a new means of biomass development based on the "doubly green" chemistry (in the sense of

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Nieddu, 2010; Octave and Thomas, 2009) and the principles of territorial and industrial ecology applied to this industry. Second, we identify a theoretical corpus proposed for the understanding of this field. The corpus of the socio-economics of proximity (Bouba-Olga and Zimmermann, 2004; Torre and Filippi, 2005) and its developments for agricultural and food sectors (Requier-Desjardins, 2003) make it possible to identify the different approaches of the territory. Third, we highlight the definition of the territory, not as a passive registration of economic activity, but rather as an endogenous variable resulting from a socio-economic process of building territorialized assets.

Understanding biorefinery as a new concept assumes therefore that we should consider all the dimensions of its roots. From these preliminary remarks we distinguish two possible theoretical frameworks. The first focuses on the various forms that biorefineries can take in a given territory (second section), from the passive biorefinery to the socially constructed biorefinery. The second framework immediately places the territorial biorefinery as a source of profound rupture and originality (third section). The biorefinery is thus no longer only a concept to be understood, but also an object to be invented and built as the conditions of its appearance and development are not given *a priori*.

In Section 5 we provide a synthesis of the approach toward developing the territorial biorefinery as a conceptual object. In Section 6 we provide concluding comments regarding the interests and limitations of the article.

2. Biorefinery, plant refinery, territorial biorefinery: what empirical definitions?

2.1 Definitions

According to Naik *et al.* (2010), "the term 'Biorefinery' was initially established by NREL[1] (1990) or the utilization of biomass for production of fuels and other bioproducts". The technological objective of biorefineries is to split biomass and recover the essential components, namely carbohydrates, proteins and fats. These raw materials are then processed and transformed, by way of various technologies, into different final products. As Wagemann *et al.* (2012) outlines, "a biorefinery is characterized by an explicitly integrative, multifunctional overall concept that uses biomass as a diverse source of raw materials for the sustainable generation of a spectrum of different intermediates and products (chemicals, materials, bioenergy/biofuels), allowing the fullest possible use of all raw materials components".

An initial definition proposed by the International Energy Agency (IEA) in its Bioenergy Task 42 describes biorefinery as "… the sustainable processing of biomass into a spectrum of marketable products and energy"[2]. According to Cherubini (2010), "a biorefinery is a facility (or network of facilities) that integrates biomass conversion processes and equipment to produce transportation biofuels, power, and chemicals from biomass"

The territorial biorefinery (hereafter, TB), as a new concept, is put at the crossroads of several theoretical approaches. Before evaluating the concept in terms of existing theories,

[1] National Renewable Energy Laboratory "located in Golden, Colorado, is the United States' primary laboratory for renewable energy and energy efficiency research and development" (Wikipedia, 2015).
[2] http://www.iea-bioenergy.task42-biorefineries.com/en/ieabiorefinery.htm.

it is necessary to clarify the framework. We initially provide an empirical definition of the object of "biorefinery" followed by the definition of the "territorial biorefinery". In 2011 the IAR[3] competitiveness cluster proposed the following definition: "a biorefinery is an industrial complex, located on the same site, which turns agricultural and forest biomass into a variety of bio-based products (food, feed, chemicals, biomolecules, agro-materials) and bioenergy (biofuels, electricity, heat) as part of a sustainable development strategy. So it is both the transformation of the vegetal-plant by valorising all its components and the integration of the components of an industrial site to achieve an original "industrial metabolism" and an "industrial symbiosis" (Beaurain and Brullot, 2011). Two large biorefinery models (Europabio, 2011; European Commission, 2012) have emerged: (i) a model of the 'port-biorefinery' which is strongly connected to global flows of raw materials, and the economic logic of which is based on threshold effects, specialisation, and economies of scale; and (ii) the 'territorial biorefinery', which is strongly connected to its surrounding territory and the economic logic of which is based on a more diverse and more thorough valuation of various biomasses of agricultural origin.

These two types of biorefineries have developed a strong reputation in Europe. The first model focuses on aggregated value chains based on low-cost imports of vegetable raw materials. It is logically located near major communication routes (ports, channels etc.) to achieve an agglomeration of resources (Colletis *et al.,* 1999) and economies of scale. The territorial biorefinery strongly integrates value chain actors according to logic of proximity (in the sense of the economics of proximity), resource requirements (Colletis *et al.*, 1999) and complementarities between actors.

These second generation biorefineries are built on the synergies between public-private stakeholders (farmers, local professional communities, etc.), researchers and different communities that enable the transformation and the development of a territory. Thus, local resources and territorial strategic assets interact in terms of localization and geographical proximity with the presence of local actors.

2.2 The territorial biorefinery approach: territorial engineering and the territorial project as 'action tools'?

The territorial biorefinery puts forward its distinctive features, notably geographical proximity, institutional proximity[4] (linked to the existence of a "territorial project"[5]) and organizational proximity (multiple and multi-level interactions between local actors in an

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[3] In the French context, IAR means "Industries & Agro-Resources"; which is a competitive cluster of global importance (or 'Pôle de Compétitivité' (i.e. competitiveness cluster) that brings together large and small firms, research bodies and educational establishments, all working together in a specific region to develop synergies and cooperative efforts around a shared theme" (www.competitivite.gouv.fr). It has been launched in 2005.

[4] "Based on the adherence of actors to a common space of representations and rules of action directing collective behavior, this institutional proximity has more or less influence on the conformity of different modes of coordination between actors, and therefore on the emergence of patterns of localized productive coordination. "(Colletis *et al.*, 1999, pp. 27-28).

[5] The territorial project design stage is crucial in the process of territorial development, as it broadens the scope of possible actions and the possibility for action of the actors" (Lardon *et al.*, 2005). The territorial engineering is seen as "the set of concepts, methods, tools and devices available to actors in the territories, to support the design, implementation and evaluation of regional projects", (Lardon *et al.*, 2005).

"eco-systemic logic" of industrial and territorial ecology). Another distinctive feature of the TB is its relationships, which are developed within a given territory. Indeed, territorial engineering[6] could be applied to the biorefineries insofar as they all have the attributes of territorial projects. According to Piveteau (2011), territorial engineering is synonymous with some forms of territorial organisation. There is a link with territorial projects characterised by hybrid forms of control (development councils and elected bodies) and an ascending construction which claims external support: technical and financial support from the State, regions and the European Union.

According to Bayrand and Sergeant (2007), the use of the territorial engineering concept is all the more necessary for the development of territories that involve the cooperation and consultation of local actors and territorial development actors. These actors employ complex procedures in relation to new territorial projects that may be located on territories that are increasingly competitive with each other. This concept "makes use of different tangible and intangible resources, which make up the territory to accompany the process of territorial development" (Lenormand, 2011; see also Lamara, 2009).

Regarding the actors, the concept of territorial engineering mobilizes "not only the local development actors, politicians, residents and local leaders, but all the players facing the challenges of territorial development" (Lardon *et al.*, 2005). To do so the emergence of a project on a territory (for example a biorefinery) implies the coordinated mobilization of various public and private engineering skills around territorial projects, which is a territorial intelligence.

Related to the territorial development of a biorefinery, territorial engineering can accomplish the mission to support "projects for the establishment or expansion of private companies" but also "interventions for the maintenance of jobs". One can also add any "design approach and co-construction of a project to which the concerned community is associated without necessarily being main carrier of the project" (Bayrand and Sergeant, 2007).

The development of this type of biorefinery is born from the logic of economic incentives as a result of the transition from a socio-technical system to another through the innovation and learning-by-doing of economic players at several geographic scales. These could be public-private partnerships following a 'bottom-up logic involving local authorities and private actors with democratic legitimacy or 'top-down' policies, according to the economic and socio-political conditions at stake.

3. The territorial biorefinery: approaches by the conceptualization of the territorialization

3.1 Overview

The territorial rootedness of a biorefinery in a given territory can be approached initially from the role of the territory in the location of the economic activity. The contributions of the concept of proximity provide an expanded role to the territory, which acquires

[6] Territorial engineering ("ingéniérie territorale") is seen as "the set of concepts, methods, tools and devices available to actors in the territories, to support the design, implementation and evaluation of regional projects", (Lardon *et al.*, 2005).

a status of an endogenous variable (Camagni, 2002). Institutional and competitive changes in the agro-industrial sector incite to shed light on the question of the role of territorial assets in building the competitive advantage of firms localized *in situ*. Over the past 15 years the research on firm organisation and strategy was highly relevant to this question (Bencharif and Rastoin, 2007; Brechet and Saives, 2001; Depret and Hamdouch, 2007) and has led to several approaches concerning the spatialization of productive activities.

3.2 The territory as a passive registration of agribusiness and agricultural activity

Scientific research approaches dealing with space and territory in business strategy are not uniform. Lauriol *et al.* (2008) distinguish two major trends. The first stream is interested in the spatial dimension of strategies. Strongly influenced by the work of economists, this stream of thought mainly deals with the role of productive activities according to the characteristics and attributes of a given territory. Since these attributes are not mobile, firms define their spatial location based on real or perceived territorial benefits, resulting in a certain spatial localization of firms. Space is seen in this work as a largely external dimension to the firm, the choice of which is guided by an optimal choice of spatial localization given the strategic choices of the biorefinery system. By this we mean that location decisions should be considered as strategic and "immobilizing a large amount of resources and involving an important group of industrial actors" (Serrano *et al.*, 2015). The localization choice could have a significant importance when referring to environmental footprint and when taking into account "transportation and logistics activities because of the supply chain procurement" (Serrano *et al.*, 2015).

The approach concerning the optimal location of a facility (in this case a biorefinery) is related to location science or facility location which is a field addressed by Operations Research (OP) (Melo *et al.,* 2009). According to Melo *et al.* (2009), "the facility location decisions play a critical role in the strategic design of supply chain networks" and "the optimal location of a new facility is determined with respect to cost, profit, distance, service time, market coverage, or some other desired attribute" (Bowling *et al.*, 2011). The theoretical framework of facility location is derived from the area of industrial organisation and uses "specific geographic information in location-allocation problems" (Tittmann, 2010). Several examples can be mentioned when locating a biorefinery using a geographic resource estimation. Authors like Perlack *et al.* (2005), Walsh *et al.* (2000), Graham *et al.* (2000) have proposed a model of the optimal location of biorefineries through the use of "feedstock input based on the marginal cost of an energy crop feedstock delivered to the site" (Tittmann, 2010).

A second stream focuses on how firms are spatially distributed within a given industry. For Lauriol *et al.* (2008), the logic of spatial activities and firms cannot be reduced merely to a firm's individual choice of location. According to Sierra (1997), a territory is not reducible to its spatial or localization dimension but is an entity that operates as a complex spatial organisation and as an economic, political and social mode of organisation between a set of economic agents anchored locally. Indeed, there are many favourable effects ('spillover effects'), for example related to knowledge, know-how etc., which lead to an aggregation process of activities or agglomerations. These activities may involve aggregations of firms in the same industry or different industries, but these companies are look-

ing for positive network externalities that it is those of logistics, applied or basic research, services, etc. The logic of competitiveness clusters, or Marshallian districts, are prominent examples. The competitive poles or clusters concept has been widely used in the academic literature when related to the localization of firms in a common geographical area. The concept has been widely popularized by Michael E. Porter in its seminal work "The Competitive Advantage of Nations" (Porter, 1998) where a cluster is seen as "a spatially concentrated group of firms competing in the same or related industries that are linked through vertical and horizontal relationships".

3.3 The territory as an endogenous variable: the contribution of socio-economics

Yet a territory is also seen as a spatially built entity the constitution of which is based on the intentional combination of individual and/or collective actions, and the mobilization of specific resources (Rallet and Torre, 2005; Torre and Filippi, 2005; Réquier-Desjardins *et al.,* 2003). One of the key concepts of these approaches is the notion of activation. Activation is defined as the finalized interaction of an actor with a tangible or intangible resource (registered within a territory or mobile) (Réquier-Desjardins *et al.,* 2003). The territory is then no longer a passive provider of resources, but rather a place of active construction on behalf of the economic and institutional actors (local authorities, for example). These actors intentionally participate through their interactions in building competitive advantages related to the territory. Consequently, the dimension of intentionality of the actor acquires a particular resonance when addressed to the strategic approach linked to the territory. This conception of territory, as a built entity, broadens the scope of strategic issues faced by firms, such as how best to build and maintain territorialized assets over time, and how to better coordinate these resources at the local or regional level, including for firms operating in several countries, or at the global level. This dimension of coordination and asset control refers to the issue of governance and its relationship to the geographical space.

3.4 The governance of territorial resources

Governance, and more precisely the territorial governance, is strongly linked to the performance of clusters (De Langen, 2004) and to the coordination of activities between local actors. Two important attributes of clusters should be mentioned, namely the network attribute and the spatial attribute (or the territorial attribute) (Berthinier-Poncet, 2015). In the case of France, territorial governance is defined as "a complex institutional process combining cognitive and political dimensions, in which institutional proximity appears as a precondition of collective action and so organizational proximity at the micro-level of coordination" (Carrincazeaux *et al.*, 2008).

Questioning the role of territory in agribusiness activities within the new competitive and institutional context requires the consideration of a complementary perspective, namely that of governance (or more generally of the organisation) of strategic assets. As a corollary we issue the question of the articulation of two often disjointed concepts: the concept of the value chain and the territory concept seen as a basis for a strategic asset. The study of agro-industrial group strategy shows that this construction is contingent on searching for a competitive advantage (Kotbi and Sauvée, 2010) and the goal of competi-

tive advantage varies greatly from one group to another (Kotbi *et al.*, 2011).

In a context of the globalization of markets, the agribusiness enterprise considers the increasingly strategic assets in terms of a portfolio, where the vertical governance related to the territory is substituted by the global governance of the industrial group. This mode of governance of the territory is more horizontal and flexible, and cannot escape either the institutional and competitive environment of each region or the heavy constraints of the productive dimension typical to any agricultural activity.

Each agribusiness group (enterprise) helps define a unique combination of territorial assets, a territorial value chain, given its internal and external situation and its objectives for building a competitive advantage. The sources of competitiveness and/or attractiveness of regions reside mainly in the specific attributes or characteristics (Colletis *et al.*, 1999) largely specific to local conditions (such as adequate soil and climatic conditions, the density of producing farms, and logistical conditions, Camagni, 2002).

3.5 The global value chain approach

The approaches focused on the global value chain (hereafter GVC) provide a good starting point for understanding the global strategies of firms, articulating both an organisational and a spatial dimension. Initiated in the early 1990s by the American sociologist Gary Gereffi (Gereffi *et al.*, 2001), these approaches have found practical application to agri-food sectors (Bencharif and Rastoin, 2007; Ghersi and Rastoin, 2010).

For Gereffi, the global value chain consists of four elements: the sequence of activities, the mobilized geographical space, the institutional environment and the governance structure. The approaches in terms of the global value chain (GVC) lead to the identification of typical configurations defined primarily by the characteristics of the modes of governance of these GVC: the market, the network, the captive network, and the hierarchy (Gereffi *et al.*, 2001).

Concerning the biorefinery and its market, there are new challenges with respect to the integration of its output into existing global value chains and in this respect can describe several classes of relationships (King *et al.*, 2010): a) "bio-based products that directly replace molecules in existing value-chains"; and b) "bio-based products that are novel or that cannot easily be integrated into existing value chains". In other words, this question puts forward the articulation between existing and new value chains and the possible flexibility between these chains.

Renewed by the works of Dicken *et al.* (2004), Coe *et al.* (2004, 2008), Dicken starts from a critique of Gereffi noting that the spatial dimension of GVC is treated in fairly abstract terms and is incomplete. The spatial scale the GVC approach is basically between a centre and a periphery that organises the international division of labour based on skills. On the contrary, for Dicken the territory must be addressed in relationship with the GVC and its configuration of activities. The interface between global production networks (Dicken *et al.,* 2004) and the spatial level is validated by the so-called "strategic linkage". This interface is strongly inserted in the institutional and competitive context locally and regionally. The quality of this coupling, including its ability to create and maintain a tension for the *in-situ* actors, explains the choice of spatial configurations of firms and their durability over time, hence their territorialisation. This concept,

which is significant to Dicken, is also found in the work of Réquier-Desjardins *et al.* (2003) on the location of agrifood activities and LAS[7] (or 'Localized Agrifood Systems').

4. The territorial biorefinery: approaches through the organisational and socio-technical break (transition)

4.1 The approach of industrial and territorial ecology

The emergence of the territorial biorefinery can also be understood as a potentially sharp break (transition) with the existing model of traditional oil refinery. Territorial and industrial ecology (hereafter TIE) is based on four principles: localization, closing of flows, diversity and gradual evolution (Beaurain and Brullot, 2011). Designed by engineers, and focusing on technology from the outset, the approach of industrial and territorial ecology emphasizes two radically opposed visions (Beaurain and Brullot, 2011). These authors point out that the first approach, developed by Allenby (1992), is mostly positive, with a scientific principle of weak sustainability while the second approach, that of Ehrenfeld (2004), is more social, with a normative principle of strong sustainability.

While these approaches have in common a cyclical conception of how natural ecosystems function, the approach developed by Allenby (1992) is positioned "in highly restrictive conditions of competition" (that of perfect competition) as highlighted by Beaurain and Brullot (2011: 317). Ehrenfeld paves the way for the consideration of human factors and industrial actors, as is also the case for the authors Beaurain and Brullot and the economy of proximity. We have classified industrial ecology as an institutionalist approach of the economy and thus providing a richer approach to the process.

Thanks to this approach it is possible to consider the emergence of radically new economic systems in a much more integrative way (Figuière and Metereau, 2012a, 2012b). This approach takes into account all the activities and actors at all levels of the socio-economic system.

In this way, the industrial and territorial ecology approach calls for a profound transformation of the organisation of the territory, from the point of view of its territorial metabolism (balance of flows of input and output materials and energy through the territory) and its relations with public and private actors.

TIE approach emphasizes the territorial governance practices presented in the previous section. The organisational and human dimension of industrial and territorial ecology is based on the study of current practices and the emergence of new practices such as: *i)* the *ex-ante*, in terms of intentionality, coordination of actors, *ii)* the implementation of new governance modes based particularly on the effects of experience made possible by collective learning mechanisms, both technological and organisational, *iii)* the conception of a shared repository of values, and *iv)* the creation of organisational and institutional proximity in addition to the geographical proximity related to the territorialisation (Beaurain and Brullot, 2011).

In terms of methods, the TIE has its own territorial engineering, which includes all the resources used to design, plan, implement, monitor and evaluate the collective

[7] In French literature, LAS is translated by the term SYAL ("Systèmes Agroalimentaires Localisés"; Réquier-Desjardins, 2010)).

schemes to identify and characterise the flows of energy and matter and its synergies (including the optimization, the description tools of the metabolism, the conception of an ecological or territorial footprint, the approaches of an environmental assessment, and several multi-criteria approaches of performance or risk evaluation, etc.).

The theoretical contribution of TIE is also based on the creation of new forms of territorial development. The idea here is to focus on the potential forms of territorial development induced (or made possible) by the implementation of industrial and territorial ecology approaches and question their potential for structuring or territorial planning and their sustainability criteria for integration conditions. Through the study of two cases Beaurain and Brullot (2011) show that the TIE "becomes a structural element of the strategy for the economic development of the territory". In this sense the public and private actors are sharing a common goal to fight air pollution in the first case and economic decline in the second. According to all particular territorial specificities, TIE can be seen as a consistent development strategy involving various environmental approaches, including the rebalancing between urban and industrial activities/or rural areas in order to organise economic clusters around local resources.

4.2 The biorefinery in the dynamics of socio-technical transition

The socio-technical transition approach (Geels, 2002),[8] which encompasses the notions of technological niches[9], socio-technical systems[10] and the socio-technical environment[11] distinguishes breakthrough innovation that occurs once these multilevel interactions between actors have been triggered. These sociotechnical niches can enable the development of production systems via a form of transition that disseminates innovation (Lopolito *et al.*, 2010). Regarding the socio-technical regime, there is a multitude of institutional rules of the actors that allow us to understand the dynamics of innovation. The socio-technical system "is a grammar, that is to say, a set of rules defined for a set of products, qualifications and procedures [...] embedded in institutions and infrastructure" (Kemp, 1994; Geels, 2002, 2004, 2005; Rip and Kemp, 1998). The last element that characterises the socio-technical transition is indicated by the socio-technical environment which "represents the upper level and consists of institutions, social, political and cultural norms guiding the existing socio-technical system" (Kemp, 1994; Geels, 2002).

According to Coenen *et al.* (2013) the transition refers here to the changes between different socio-technical configurations that include not only new technologies but also the changes that occur in the markets and for the consumer and institutional actors (Geels, *et al.*, 2008). The interaction between the socio-technical transition and the geog-

[8] For more details on the socio-technical transition approach, see Geels (2002, 2004, 2005).

[9] Niches act as incubation rooms for radical innovations, nurturing their early development. Niches may take the form of small market niches, with specific selection criteria that are different from the existing regime. These can be R&D projects, but also experimental projects, involving heterogeneous actors, e.g. users, producers, public authorities" (Geels, 2002, 2004, 2005).

[10] "Societal functions are fulfilled by socio-technical systems, which consist of a cluster of aligned elements, e.g. artifacts, knowledge-user practices and markets, regulation, cultural significance, infrastructure, maintenance networks and supply networks" Geels (2002, 2004, 2005).

[11] "…the socio-technical landscape, which refers to aspects of the wider exogenous environment that affect socio-technical development" Geels (2002).

raphy of innovation offers a new dimension for understanding the concept of transitional space. The analytical framework often presented simply for the trajectory of technological change, did not sufficiently take into account how this transition is "trapped" within a local area or region (McCauley and Stephens, 2012; Smith and Olesen, 2010). The integration of space and geographical proximity was recently assessed by a number of authors (Markard and Truffer, 2008; Coenen *et al.,* 2013; Spath and Rohracher, 2010; Truffer and Coenen, 2012), who substituted the idea of understanding a "sustainable socio-technical transition" with the idea of a "regional transformation."

5. What theoretical approaches for the territorial biorefinery: an attempt to synthesize

The territorial biorefinery is fundamentally a specific mode of using biomass resources. The foundations of the territorial biorefinery, seen as a new business concept, are based, according to the desire of its designers, on the idea of a transition within the logic of production. It is part of a broad socio-technical transition, allowing for the passage from the petrochemical model to the model of renewable carbon molecules. We are in the presence of a new way of organising production and processing, affecting a multitude of value chains in the energy, material, chemical, and food sectors, etc. A second transition that is brought forward by the territorial biorefinery is the significant reduction in GHG[12] of economic activities. With regard to the specific case of biorefinery, it is therefore important to introduce a new dimension into the economic calculation of costs. The costs are not added *ex post,* as in conventional approaches impact on GHG emission levels of various productive activities, but *ex ante*, in the design of chains value. A third break in the logic of production methods is based on the idea of a total valuation of the plant through its circularity of processes. In the conception of the territorial biorefinery, each component is considered from the standpoint of its productive purposes, but this logic goes further by establishing a principle of circularity in the transformation of the product, each sub-product being directly or indirectly reintroduced into the economic circuit.

Putting forward the conceptualization of territorial biorefinery therefore constitutes questioning the very object of its foundations: the theoretical foundations that govern its definition, the degree of departure from the existing model that this new valuation model assumes and the position of the researcher vis-à-vis this conceptual object. On this point we use the terminology of Gavard-Perret *et al.* (2012) which distinguishes between the "constructivism and methodological knowledge" to describe the relationship of the researcher to the object, and the "constructivism and object knowledge" to refer to the constructed nature of the studied object (Gavard-Perret *et al.*, 2012, p.90).

From an initial basic definition of the territorial biorefinery, we synthesised and identified two dimensions that seem essential for the approach of the territorial biorefinery as a conceptual object: the underlying theoretical approach and the situation of the researcher with regard to its object.

We have seen that it seems possible to identify a first difference between the theories of territorial anchorage - theories which place the territory as a major dimension in the definition of the territorial biorefinery as a concept, and also theories of disruption, plac-

[12] Greenhouse gases.

ing the territorial biorefinery as one element in an overall transition from a petrochemical system to a renewable carbon-centred system (Colonna, 2013).

In terms of epistemological position, we join the approach proposed by David (2012) who emphasizes an original reading of the different research approaches that can overcome the traditional dichotomy between positivism and constructivism. On one level David distinguished at first the contribution of research to the construction of reality: it may have implications for the action with a construct of reality. Instead, the research can be placed in a situation of intervention and transformation, more or less directly linked to this reality. Thereafter, David questioned the degree of contextualization of research in a classic, inductive approach of the existing. Yet the research approach can also place the concrete project or its idealized representation as a starting point for research, and consequently put itself in a situation of designing the organization of activities *ex ante*.

This epistemological and methodological reflection seems particularly fruitful for us to question the concept of territorial biorefinery. Indeed, beyond the diversity of theoretical approaches that can be mobilized to address the object of territorial biorefinery, two questions remain open: the epistemological presuppositions of the theoretical approaches and the researcher's position relative to the concrete reality on the ground. According to the main theoretical approaches developed in this article, the definition of the territory and, more importantly, its role for the biorefinery, differs widely. It is possible to sketch, along a continuum, the situation of these theories. At one end of the continuum, the territory serves simply as an optimisation function for the costs. At the other end, the BT is seen as the active development of territorial assets and relationships by actors. In between, we find theories combining local conditions and a global (meaning geographically integrated) configuration of activities. Considering the position of the researcher with regard to the object under examination, we find here the classical opposition between positivism and constructivism. Indeed, we suggest on this point that the researcher should also make explicit his/her positioning: is the researcher a neutral observer of the reality, providing an in-house model of the optimisation of the territorial biorefinery? Or is the researcher involved in one way or another in the changes that occur? We have seen that the BT as an *ex ante* designed business model introduces a new role for the researcher, being actively concerned by its object, as in the research-action models.

6. Conclusion

We have seen that the concept of territorial biorefinery can refer to different theoretical approaches that we have schematically grouped into two broad categories: approaches centred on territorial assets and the degree to which they are rooted in the local context, and approaches focused on the model of the territorial biorefinery, seen as a major sociotechnical transition. The demonstration of this diversity of theoretical approaches reflects a certain lack of consensus with regard to what actually constitutes a territorial biorefinery as a basis for a new business model. These divisions also reflect a diversity of epistemological issues, positivist, or constructivist, or of action research. We believe that it is useful, either from the point of view of research or for the practitioners involved in their development, to make them explicit and to identify how the coupling between theoretical and epistemological issues helps to define precisely what the territorial biorefinery should in fact be.

To conclude, a key issue seems to crystallize the importance of the definition of the TB, namely its scale levels. The issue of territorial scales and related integration (in their economic, strategic, organisational and eco-systemic dimensions) characterises the TB as a concept and we have seen that it is not independent from the way the micro, meso and macro scales are operationalized by the various theoretical approaches. Future research on this topic should focus on the active development of territorial assets and their activation by partners (institutions as well as companies), at these micro and meso levels as this is the main component of the specificity of the territory for a biorefinery that is anchored in its local supply base. Similarly, the dynamic aspects, i.e. the capacity of a given set of actors in a territory to learn and improve themselves in the long run and to create ultimately a competitive and sustainable business model is also an important field of investigation. Eventually the territorial biorefinery could create one of the building blocks of the bioeconomy of the future.

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