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3

4 **The territorial biorefinery as a new business model**

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12

13 **Abstract**

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

26

27 **Keywords:** territorial biorefinery, innovation, business model, industrial and territorial ecology.

28 JEL Classification: O33, Q16, R11

29

30

31 **1. Introduction and objectives**

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

38 First, we empirically characterise the concept of 'territorial biorefinery' as a new means of biomass
39 development based on the "doubly green" chemistry (in the sense of Nieddu, 2010; Octave and
40 Thomas, 2009) and the principles of territorial and industrial ecology applied to this industry. Second,
41 we identify a theoretical corpus proposed for the understanding of this field. The corpus of the socio-
42 economics of proximity (Bouba-Olga and Zimmermann, 2004, Torre and Filippi, 2005) and its
43 developments for agricultural and food sectors (Requier-Desjardins, 2003) make it possible to identify
44 the different approaches of the territory. Third, we highlight the definition of the territory, not as a
45 passive registration of economic activity, but rather as an endogenous variable resulting from a socio-
46 economic process of building territorialized assets.

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

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

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

58 **2.1 Definitions**

59 According to Naik et al. (2010), “the term ‘Biorefinery’ was initially established by NREL¹ (1990) or the
 60 utilization of biomass for production of fuels and other bioproducts”. The technological objective of
 61 biorefineries is to split biomass and recover the essential components, namely carbohydrates, proteins
 62 and fats. These raw materials are then processed and transformed, by way of various technologies,
 63 into different final products. As Wagemann et al. (2012) outlines, “a biorefinery is characterized by an
 64 explicitly integrative, multifunctional overall concept that uses biomass as a diverse source of raw
 65 materials for the sustainable generation of a spectrum of different intermediates and products
 66 (chemicals, materials, bioenergy/biofuels), allowing the fullest possible use of all raw materials
 67 components”

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

73 The territorial biorefinery (hereafter, TB), as a new concept, is put at the crossroads of several
 74 theoretical approaches. Before evaluating the concept in terms of existing theories, it is necessary to
 75 clarify the framework. We initially provide an empirical definition of the object of "biorefinery" followed
 76 by the definition of the “territorial biorefinery”. In 2011 the IAR³ competitiveness cluster proposed the
 77 following definition: “a biorefinery is an industrial complex, located on the same site, which turns
 78 agricultural and forest biomass into a variety of bio-based products (food, feed, chemicals,

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>

³In 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.

79 biomolecules, agro-materials) and bioenergy (biofuels, electricity, heat) as part of a sustainable
 80 development strategy. So it is both the transformation of the vegetal–plant by valorising all its
 81 components and the integration of the components of an industrial site to achieve an original
 82 “industrial metabolism” and an “industrial symbiosis” (Beurain and Brulot, 2011). Two large
 83 biorefinery models (Europabio, 2011; European Commission, 2012) have emerged: (i) a model of the
 84 ‘port-biorefinery’ which is strongly connected to global flows of raw materials, and the economic logic
 85 of which is based on threshold effects, specialisation, and economies of scale; and (ii) the ‘territorial
 86 biorefinery’, which is strongly connected to its surrounding territory and the economic logic of which is
 87 based on a more diverse and more thorough valuation of various biomasses of agricultural origin.

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

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

98

99 **2.2 The territorial biorefinery approach: territorial engineering and the territorial project as** 100 **‘action tools’?**

101 The territorial biorefinery puts forward its distinctive features, notably geographical proximity,
 102 institutional proximity⁴ (linked to the existence of a “territorial project”⁵) and organizational proximity
 103 (multiple and multi-level interactions between local actors in an “eco-systemic logic” of industrial and

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).

104 territorial ecology). Another distinctive feature of the TB is its relationships, which are developed within
105 a given territory. Indeed, territorial engineering⁶ could be applied to the biorefineries insofar as they all
106 have the attributes of territorial projects. According to Piveteau (2011), territorial engineering is
107 synonymous with some forms of territorial organisation. There is a link with territorial projects
108 characterised by hybrid forms of control (development councils and elected bodies) and an ascending
109 construction which claims external support: technical and financial support from the State, regions and
110 the European Union.

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

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

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

127 The development of this type of biorefinery is born from the logic of economic incentives as a result of
128 the transition from a socio-technical system to another through the innovation and learning-by-doing of
129 economic players at several geographic scales. These could be public-private partnerships following a

⁶ Territorial engineering ("ingénierie territoriale") 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).

130 'bottom-up logic involving local authorities and private actors with democratic legitimacy or 'top-down'
131 policies, according to the economic and socio-political conditions at stake.

132

133 **3. The territorial biorefinery: approaches by the conceptualization of the** 134 **territorialization**

135 **3.1 Overview**

136 The territorial rootedness of a biorefinery in a given territory can be approached initially from the role of
137 the territory in the location of the economic activity. The contributions of the concept of proximity
138 provide an expanded role to the territory, which acquires a status of an endogenous variable
139 (Camagni, 2002). Institutional and competitive changes in the agro-industrial sector incite to shed light
140 on the question of the role of territorial assets in building the competitive advantage of firms localized
141 *in situ*. Over the past 15 years the research on firm organisation and strategy was highly relevant to
142 this question (Bencharif and Rastoin, 2007, Brechet and Saives, 2001; Depret and Hamdouch, 2007)
143 and has led to several approach concerning the spatialization of productive activities.

144 **3.2 The territory as a passive registration of agribusiness and agricultural activity**

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

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

168 A second stream focuses on how firms are spatially distributed within a given industry. For Lauriol et
169 al. (2008), the logic of spatial activities and firms cannot be reduced merely to a firm’s individual choice
170 of location. According to Sierra (1997), a territory is not reducible to its spatial or localization dimension
171 but is an entity that operates as a complex spatial organisation and as an economic, political and
172 social mode of organisation between a set of economic agents anchored locally. Indeed, there are
173 many favourable effects ('spillover effects'), for example related to knowledge, know-how etc., which
174 lead to an aggregation process of activities or agglomerations. These activities may involve
175 aggregations of firms in the same industry or different industries, but these companies are looking for
176 positive network externalities that it is those of logistics, applied or basic research, services, etc. The
177 logic of competitiveness clusters, or Marshallian districts, are prominent examples. The competitive
178 poles or clusters concept has been widely used in the academic literature when related to the
179 localization of firms in a common geographical area. The concept has been widely popularized by
180 Michael E. Porter in its seminal work “The Competitive Advantage of Nations” (Porter, 1998) where a
181 cluster is seen as “a spatially concentrated group of firms competing in the same or related industries
182 that are linked through vertical and horizontal relationships”.

183 **3.3 The territory as an endogenous variable: the contribution of socio-economics**

184 Yet a territory is also seen as a spatially built entity the constitution of which is based on the intentional
185 combination of individual and/or collective actions, and the mobilization of specific resources (Rallet

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

199

200 **3.4 The governance of territorial resources**

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

208 Questioning the role of territory in agribusiness activities within the new competitive and institutional
209 context requires the consideration of a complementary perspective, namely that of governance (or
210 more generally of the organisation) of strategic assets. As a corollary we issue the question of the
211 articulation of two often disjointed concepts: the concept of the value chain and the territory concept
212 seen as a basis for a strategic asset. The study of agro-industrial group strategy shows that this
213 construction is contingent on searching for a competitive advantage (Kotbi and Sauvée, 2010) and the
214 goal of competitive advantage varies greatly from one group to another (Kotbi et al., 2011).

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

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

226

227 **3.5 The global value chain approach**

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

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

238 Concerning the biorefinery and its market, there are new challenges with respect to the integration of
239 its output into existing global value chains and in this respect can describe several classes of
240 relationships (King et al., 2010): a) “bio-based products that directly replace molecules in existing
241 value-chains”; and b) “bio-based products that are novel or that cannot easily be integrated into

242 existing value chains". In other words, this question puts forward the articulation between existing and
 243 new value chains and the possible flexibility between these chains.

244 Renewed by the works of Dicken et al. (2004), Coe et al. (2004, 2008), Dicken starts from a critique of
 245 Gereffi noting that the spatial dimension of GVC is treated in fairly abstract terms and is incomplete..
 246 The spatial scale the GVC approach is basically between a centre and a periphery that organises the
 247 international division of labour based on skills. On the contrary, for Dicken the territory must be
 248 addressed in relationship with the GVC and its configuration of activities. The interface between global
 249 production networks (Dicken et al. 2004) and the spatial level is validated by the so-called "strategic
 250 linkage". This interface is strongly inserted in the institutional and competitive context locally and
 251 regionally. The quality of this coupling, including its ability to create and maintain a tension for the *in-*
 252 *situ* actors, explains the choice of spatial configurations of firms and their durability over time, hence
 253 their territorialisation. This concept, which is significant to Dicken, is also found in the work of Réquier-
 254 Desjardins (2003 et al.) on the location of agrifood activities and LAS⁷ (or 'Localized Agrifood
 255 Systems').

256

257 **4. The territorial biorefinery: approaches through the organisational and socio-** 258 **technical break (transition)**

259 **4.1 The approach of industrial and territorial ecology**

260 The emergence of the territorial biorefinery can also be understood as a potentially sharp break
 261 (transition) with the existing model of traditional oil refinery. Territorial and industrial ecology (hereafter
 262 TIE) is based on four principles: localization, closing of flows, diversity and gradual evolution (Beaurain
 263 and Brulot, 2011). Designed by engineers, and focusing on technology from the outset, the approach
 264 of industrial and territorial ecology emphasizes two radically opposed visions (Beaurain and Brulot,
 265 2011). These authors point out that the first approach, developed by Allenby (1992), is mostly positive,
 266 with a scientific principle of weak sustainability while the second approach, that of Ehrenfeld (2004), is
 267 more social, with a normative principle of strong sustainability.

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

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

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

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

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

288 In terms of methods, the TIE has its own territorial engineering, which includes all the resources used
289 to design, plan, implement, monitor and evaluate the collective schemes to identify and characterise
290 the flows of energy and matter and its synergies (including the optimization, the description tools of the
291 metabolism, the conception of an ecological or territorial footprint, the approaches of an environmental
292 assessment, and several multi-criteria approaches of performance or risk evaluation, etc.).

293 The theoretical contribution of TIE is also based on the creation of new forms of territorial
294 development. The idea here is to focus on the potential forms of territorial development induced (or
295 made possible) by the implementation of industrial and territorial ecology approaches and question

296 their potential for structuring or territorial planning and their sustainability criteria for integration
 297 conditions. Through the study of two cases Beaurain and Brulot (2011) show that the TIE “becomes a
 298 structural element of the strategy for the economic development of the territory”. In this sense the
 299 public and private actors are sharing a common goal to fight air pollution in the first case and
 300 economic decline in the second. According to all particular territorial specificities, TIE can be seen as a
 301 consistent development strategy involving various environmental approaches, including the
 302 rebalancing between urban and industrial activities/or rural areas in order to organise economic
 303 clusters around local resources.

304 **4.2 The biorefinery in the dynamics of socio-technical transition**

305 The socio-technical transition approach (Geels, 2002),⁸ which encompasses the notions of
 306 technological niches⁹, socio-technical systems¹⁰ and the socio-technical environment¹¹ distinguishes
 307 breakthrough innovation that occurs once these multilevel interactions between actors have been
 308 triggered. These sociotechnical niches can enable the development of production systems via a form
 309 of transition that disseminates innovation (Lopolito et al., 2010). Regarding the socio-technical regime,
 310 there is a multitude of institutional rules of the actors that allow us to understand the dynamics of
 311 innovation. The socio-technical system "is a grammar, that is to say, a set of rules defined for a set of
 312 products, qualifications and procedures [...] embedded in institutions and infrastructure" (Kemp, 1994;
 313 Geels, 2002, 2004, 2005; Rip and Kemp, 1998). The last element that characterises the socio-
 314 technical transition is indicated by the socio-technical environment which "represents the upper level
 315 and consists of institutions, social, political and cultural norms guiding the existing socio-technical
 316 system" (Kemp, 1994; Geels, 2002).

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

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 sociotechnical development" Geels (2002).

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

328

329 **5. What theoretical approaches for the territorial biorefinery: an attempt to** 330 **synthesize**

331 The territorial biorefinery is fundamentally a specific mode of using biomass resources. The
332 foundations of the territorial biorefinery, seen as a new business concept, are based, according to the
333 desire of its designers, on the idea of a transition within the logic of production. It is part of a broad
334 socio-technical transition, allowing for the passage from the petrochemical model to the model of
335 renewable carbon molecules. We are in the presence of a new way of organising production and
336 processing, affecting a multitude of value chains in the energy, material, chemical, and food sectors,
337 etc. A second transition that is brought forward by the territorial biorefinery is the significant reduction
338 in GHG¹² of economic activities. With regard to the specific case of biorefinery, it is therefore important
339 to introduce a new dimension into the economic calculation of costs. The costs are not added *ex post*,
340 as in conventional approaches impact on GHG emission levels of various productive activities, but *ex*
341 *ante*, in the design of chains value. A third break in the logic of production methods is based on the
342 idea of a total valuation of the plant through its circularity of processes. In the conception of the
343 territorial biorefinery, each component is considered from the standpoint of its productive purposes,
344 but this logic goes further by establishing a principle of circularity in the transformation of the product,
345 each sub-product being directly or indirectly reintroduced into the economic circuit.

¹² Greenhouse gases.

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

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

356 We have seen that it seems possible to identify a first difference between the theories of territorial
357 anchorage - theories which place the territory as a major dimension in the definition of the territorial
358 biorefinery as a concept, and also theories of disruption, placing the territorial biorefinery as one
359 element in an overall transition from a petrochemical system to a renewable carbon-centred system
360 (Colonna, 2013).

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

370 This epistemological and methodological reflection seems particularly fruitful for us to question the
371 concept of territorial biorefinery. Indeed, beyond the diversity of theoretical approaches that can be
372 mobilized to address the object of territorial biorefinery, two questions remain open: the
373 epistemological presuppositions of the theoretical approaches and the researcher's position relative to
374 the concrete reality on the ground. According to the main theoretical approaches developed in this

375 article, the definition of the territory and, more importantly, its role for the biorefinery, differs widely. It is
376 possible to sketch, along a continuum, the situation of these theories. At one end of the continuum, the
377 territory serves simply as an optimisation function for the costs. At the other end, the BT is seen as the
378 active development of territorial assets and relationships by actors. In between, we find theories
379 combining local conditions and a global (meaning geographically integrated) configuration of activities.
380 Considering the position of the researcher with regard to the object under examination, we find here
381 the classical opposition between positivism and constructivism. Indeed, we suggest on this point that
382 the researcher should also make explicit his/her positioning: is the researcher a neutral observer of the
383 reality, providing an in-house model of the optimisation of the territorial biorefinery? Or is the
384 researcher involved in one way or another in the changes that occur? We have seen that the BT as an
385 *ex ante* designed business model introduces a new role for the researcher, being actively concerned
386 by its object, as in the research-action models.

387

388 **6. Conclusion**

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

399 To conclude, a key issue seems to crystallize the importance of the definition of the TB, namely its
400 scale levels. The issue of territorial scales and related integration (in their economic, strategic,
401 organisational and eco-systemic dimensions) characterises the TB as a concept and we have seen
402 that it is not independent from the way the micro, meso and macro scales are operationalized by the
403 various theoretical approaches. Future research on this topic should focus on the active development

404 of territorial assets and their activation by partners (institutions as well as companies), at these micro
405 and meso levels as this is the main component of the specificity of the territory for a biorefinery that is
406 anchored in its local supply base. Similarly, the dynamic aspects, i.e. the capacity of a given set of
407 actors in a territory to learn and improve themselves in the long run and to create ultimately a
408 competitive and sustainable business model is also an important field of investigation. Eventually the
409 territorial biorefinery could create one of the building blocks of the bioeconomy of the future.

410

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