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Understanding the bioeconomy: a new sustainability economy in British and European public discourse

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Abstract. Over the past decade, the term bioeconomy has emerged in both policy and academic discourse. Implying a technology-driven approach to wealth generation from organic materials, the term has taken hold with so far limited critical engagement. It is a contestable rather than contested term. Noting the rise of numerous other 'economies' (blue, green, circular) on a similar timeframe, this paper undertakes a critical discourse analysis of academic literature and UK/EU policy documents using the term 'bioeconomy' to produce a contextualised understanding of how it is used in both theoretical and practical contexts. Our analysis shows that bioeconomy, as with the other 'sustainability' economies, which we term the 'S-economies', prioritises the economy and the markets as the solution brokers for the environmental and economic problems they seek to address. The apparent fragmentation of the theory and policy concerning the environmental sustainability of economic activity is expressed through the variability of terms that aspire to establish multiple economies functioning at the same time. Limited empirical analysis of the existing 'bioeconomy' is symptomatic of the dissociation between theory and practice, emphasizing technological approaches favouring capital intensive approaches over local solutions. The S-economies, including the bioeconomy, are an attempt to bypass economic structural realities that otherwise would need to be addressed.

Keywords: bioeconomy, knowledge-based economy, green economy, circular economy, sustainable economy.
JEL codes: L6, O1, O3, P2, P4, P5, Q1, Q2, Q5.

1. INTRODUCTION

In this study we are critically analyzing the role of the bioeconomy as a term and practice in academia and policy. Broadly, 'bioeconomy' refers to economic activity directly drawing on biogenic material (derived from recently living plants and/or animal matter), to be distinguished from non-biogenic based resources and fossil fuels. Bioeconomy, or bio-based economy, is an expression coined in recent years by experts and policy makers,

thereby integrating into a single term both the economic significance and awareness of the type of resources to be utilised (Albrecht *et al.*, 2010; Begley *et al.*, 2011; De Besi and McCormick, 2015; Allen *et al.*, 2017; University of York, 2017; Bell *et al.*, 2018; Aguilar and Patermann, 2018; Lewandowski et al., 2018). The bioeconomy has been represented as a way of addressing environmental emergencies and socio-economic challenges at the same time (OECD, 2006, 2009, 2018; Benner and Lofgren, 2007; Birch, 2007, 2017a; Cooper, 2007; Asveld *et al.*, 2011; Kitchen and Marsden, 2011; Kircher, 2012; Arancibia, 2013; Hanlin *et al.*, 2013; Kautto and McCormick, 2013; *Arts et al.*, 2014; Barben *et al.*, 2016; Viaggi, 2016; European Commission, 2018a, 2020a, 2020b). The bioeconomy has already had an important economic impact. For example, in 2018 in the UK the bioeconomy amounted to two hundred twenty (220) billion of pounds of Gross Value Added to the economy, supporting more than five million jobs (HM Government 2018). In 2015 the bioeconomy in the European Union reached an added value of 1,460.6 billion euros, which is eleven percent (11%) of overall GDP (Kuosmanen et al. 2020).

It may not be coincidental that the term has become prominent in an era of stagnating economies and high unemployment, following the financial crisis of 2008. Over this same timespan other 'economies' have become prominent too, including the green economy (UNEP, 2009; Pearce and Barbier, 2000; Bina, 2013; Baarsden *et al.*, 2014; Antikainen *et al.*, 2016; Viaggi, 2016; Ge and Zhi 2016; Ferreira Gregorio et al., 2018; Merino-Saum et al., 2020; Benson et al., 2021) promoted by the UN as an approach to implementing sustainable development (2012); the marine resources-based blue economy (UNCTAD 2014; Smith-Godfrey, 2016; Le Heron and Winder, 2017; Lee, Noh and Kim, 2020); the Circular Economy (promoted by the EU and others as a carbon control and competitiveness enhancing initiative; European Commission, 2015). Other terms such as the low carbon economy (Stern 2007; HM Government, 2009; Zhang, 2010; Foxon, 2011; Lyu, Ngai and Wu 2019) are also seeking to use environmental investments to correct an economic imbalance – i.e., to promote growth and with assumed social benefits (i.e., usually employment). In this paper we examine how the term bioeconomy is used, how it is connected or situated in relation to other terms that represent various types of economic activity with aspirations to deal better with nature and the resources nature offers to human societies, whilst preserving, if not promoting, economic growth.

Drawing on analysis of policy and scientific documents, this paper undertakes a critical discourse analysis of the use of the term bioeconomy in policy documents alongside a comprehensive review of the social science academic literature relating to the bioeconomy in order to gain a contextualised understanding of how the term is being used both theoretically and in practical terms. Research in critical discourse analysis stresses the significance of terms used in policy analysis as representing a social, political and economic context (Jessop, 2004; Farrelly, 2010; Farrelly *et al.*, 2019). Certain expressions or forms of expression become accepted as 'normal' or inevitable, and this promotes ease of communication with groups who have the same understandings of the terms used. However, usage and the approach it represents may reinforce the exclusion of other interests or groups, either by representing a barrier to entry in the dialogue or by perpetuating a policy that favours some interests over others. To achieve a contexualisation of the bioeconomy, we examine the concept within the context of the other discursive attempts related to the sustainable types of economies proposed during the last decades, and we also consider the limitations of the scope of existing applications of the bioeconomy.

The following section presents an outline of our approach and methods; section three examines the rise of the term bioeconomy since 1990s. Section four explores how the bioeconomy is used in policy discourse and the fifth section examines critically the academic discourse about the bioeconomy. Section six examines the various (aspiring to be) sustainable forms of economy that emerged in recent decades. The general discussion of our findings is presented in section seven and conclusions are presented in the final section eight.

2. APPROACHES AND METHODS

This paper stems from the THYME project, which is a research consortium comprising the University of York, Teesside University and the University of Hull in order to investigate ways to support the local economy of the North East of England through the mobilisation of bioeconomic processes. THYME project is, in other words, an umbrella project within which several approaches to the bioeconomy are used to develop new understandings, production processes and community engagement. The approaches are employed in sub-projects, of which one example is the research project this paper stems from.

In this paper we draw our methodology from two approaches. One is critical realism as a way to understand discourse and praxis in its historical context. Critical realism is the epistemological approach which acknowledges that 'real' events and processes may only

be observable through perceptions; the scholar is committed to what is possible to be known, while having in mind that this knowledge might not be perfect or objective (Sayer, 2002). In critical realism, both the reality we perceive and the knowledge we have access to are thought of as historically constructed through the social, economic and political contexts we live in. Through this approach, we aspire to present a version of discursive reality that is well founded on actual uses of the term of the bioeconomy and we also aspire to think in terms of the actual economic and political conditions that affect the use of the term or made the use of the term possible in the first place (Archer *et al.*, 1998; Birch, 2017b). We are aware that discourse is a political economic endeavour and that, just like the people who have written about the bioeconomy until now, we also have a certain positionality both as researchers and as human beings. This makes us ready to re-visit and refine our approach in the future, discard analyses that we now think are the best we can have given the limitations of our research and interpret both our data and our collection of data through new prisms if what we have at hand does not adequately provide us with the analytical and synthetic tools we need to understand our subject matter.

Our second approach to the examination of the policy documents as sources is informed by grounded theory (Charmaz, 2006; Glaser and Strauss, 2006). Grounded theory is the epistemological approach according to which a research project can start without a pre-established or existing theory. Gathering data with attention to detail and having as a priority to describe reality as it is possible to be approached by the researcher means that theory is chosen while or after the analysis of data. In case there is no theory with analytical capacity to explain the phenomena that the research data reveal, the researcher will attempt to create a theory based on the data, if that is possible. A grounded theory does not aspire to universality, although it can give results that can be widely applied, and is always well connected to research findings. We use this approach to ensure that our arguments stay as connected as possible to the texts we use as sources. This aids the uncovering of social and political context of the documents in order to identify possible understandings and interpretations (as opposed to an interpretation reflecting a theoretical position).

Concerning our sources: we used the existing academic literature, public statements and official documents, where "bioeconomy" as a term is mentioned. We use the search engines of Web Science, Scopus and Google scholar, and also using the snowballing method to find references used in published papers to make sure that we have not missed references that the search engines might miss for technical reasons. We are not addressing the engineering or scientific papers which currently dominate the field. For a recent review of these in combination with the literature of social sciences see Bugge et al. (2016). The search was done in four languages (English, French, Spanish, Greek). All lay articles we found concerning the bioeconomy were written by experts (who were using their expertise credentials in the texts they were writing), and only in one case we found the use of the term to be related to a community practice (in Greece) about which there is no public follow-up or further replication of the use of the term. In addition, we are not incorporating papers that address "bioeconomic" phenomena without mentioning the term. Although we acknowledge the contribution of such papers to the understanding of related issues, this paper is specifically concerned with the use of the term "bioeconomy".

This paper presents a major part of the theoretical or desk-research section of our project. We have also conducted extensive field research about the farmers markets and open-air markets in East Yorkshire, through the use of ethnographic methods (observation, observation by participation, interviews, analysis of public material released by the markets). Our purpose is to document bioeconomic practices that do not belong to big industrial process, yet might be crucial for both environmental sustainability and social sustainability of a region. We are preparing detailed accounts of the field research findings in other studies.

Table 1 shows the range of sources we have used in this paper. We categorised the papers according to their content in terms of discipline and not according to the discipline of the journal they are published in. In many cases, journals focused on technology or environmental sciences publish a study that belongs to another discipline, like a social science. For the table we used only the sources directly related to the bioeconomy and not other sources on peripheral topics.

Our turn to official documents and policy declarations in addition to academic literature was made because it seems that the role of the states and international organisations is fundamental in the history and discourse of the bioeconomy. A governmental role in the development of the bioeconomy also seems to be expected by both the private sector and academics (Brunori *et al.*, 2011; Pavone, 2012; Gustavsson *et al.*, 2013; Barben *et al.*, 2016; BBIJU and SCAR, 2019).

At this stage, we did not use linguistic quantitative methods, like corpus analysis, because we want to focus on notions themselves and how they are used within specific historically perceived political economic con-

Table 1. Bioeconomy literature used in the paper.

Sector of origin	Author role	Type of document	Scope	Number of texts
Policy	State	Report	Normative	6
	International organisation	Report	Normative	4
	Researcher	Report	Normative	2
Academia	Researcher – academic	Paper	Policy-descriptive	16
	Researcher-academic	Paper	Theory-descriptive	44
	Researcher-academic	Paper	Theory-descriptive	1
	Researcher – academic	Paper	Theory-empirical	10
	Researcher-academic	Book or edited book	Theory-descriptive	3
	Research – academic	Paper	Normative	3
Business	Business	Report	Normative	2

texts. In other words, we examine the context of the use of each word, the positionality of the user and the possible or intended effects of that use.

3. BIOECONOMY: RISE OF THE TERM BIOECONOMY IN THE 1990s AND BEYOND

The term bioeconomy is quite new. It appears to have emerged from the pool of ideas and interactions associated with the Biotechnology and the Cell Factory Key Action of the European Union (1998-2002), at least for the countries who were members of the European Union (European Commission, 2007; Aguilar and Patermann, 2018). The term "biotechnology" was associated with policies promoted through the perception of biological knowledge and know-how as a particular type of value in the economy, which were adopted before the emphasis on bio-materials emerged. Biotechnology refers to "the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services" (Arundel and Van Beuzekom, 2006: 7; Miller, 2007).

Biotechnology is broadly used in combination with the terms bio-based economy and knowledge-based economy, explicitly mentioning nowadays bioeconomic sectors like pharmaceutics, well before being combined as the "knowledge-based bio-economy" appeared in EU and OECD documents (OECD et al. 1997; Neef, Siesfeld and Cefola 1998; European Commission, 2002; OECD 2002, 2005). The term (bio-based economy) is also used in OECD documents, but there is no information in OECD archives who or which country first used the term bio-based economy (Begley *et al.*, 2011; Birch, 2017b; Aguilar and Patermann, 2018; Bell *et al.*, 2018). Before that, based on our search in English-speaking literature, we found the term "bioeconomy" only in a biology paper related to the behaviour of the house mouse (Berry and Bronson, 1992). Table 2 provides a timeline for the key terms addressed in this section.

The major emphasis of the EU policy in the late 1990s-decade of 2000s was on biomass to be used as non-fossil fuel and on the production of food (whether through agriculture or pasture/livestock production), including products that were not food but still were based on biological raw materials (Albrecht *et al.*, 2010). A second sector that has been strongly linked to the bioeconomy was pharmaceutical research and production. The documents of the European Union use the latter as an option or direction of bioeconomic activity with increasing momentum after 2010. A special emphasis on pharmaceutical aspects of the bioeconomy is also given by the OECD report on the bioeconomy, especially through the description of future crisis or disaster scenarios that the pharmaceutical bioeconomy would resolve (OECD, 2006, 2009, 2018; Albrect *et al.*, 2010; Styhre and Sundgren, 2011; European Commission, 2012, 2018a, 2020a, 2020b; Benini *et al.*, 2013; Bell *et al.*, 2018). The use of the term bio-economy within the phrase and/or acronym Knowledge-Based Bio-Economy (KBBE) was also linked to sustainability, though not as an inherent characteristic, but as a design element that can be possible, feasible and desirable, under certain policy choices (Albrecht *et al.*, 2010; Allen *et al.*, 2017; Birch, 2017b).

After the European Commission published their communication for sustainable growth in 2012 (European Commission, 2012), the bioeconomy (or bio-economy) became a prominent topic of debate concerning policies that can be related to improved economic pathways for the European Union. The main idea was to use bioeconomy as an engine of economic sustainability, to support innovative solutions in a variety of sectors using policies that are coherent among each other. Bioeconomy would be the umbrella term which would allow this coherence, or at least, this was the plan. Moreover, the bioeconomy was supposed to provide answers to issues or provide opportunities that had emerged as a consequence of waste policies that were restricting the landfilling of biodegradable waste (Girardin and Peigne, 2003; Taiwo, 2011; Cal *et al.*, 2017). The wide-

spread uptake of composting and anaerobic digestion in response to the Landfill Directive pointed to biodegradable residues as a valuable commodity, from which added value could be extracted by the application of science and technology (Boons *et al*., 2015).

Economically, in the 2000s the bioeconomy was represented as able to provide new investment opportunities for the few who had access to capital and new job opportunities for the many who were experiencing a job market with high long-term unemployment rates and increasing employment instability at the same time (Albrecht *et al*., 2010; Styhre and Sundgren, 2011; Birch *et al*., 2012a, 2012b; Dallemand *et al*., 2015; Goven and Pavone, 2015). This provided an attraction for policy makers similarly to other economically-driven environmental approaches (further discussed in section 6). The widespread concerns relating to the social and environmental consequences of biofuels (displacement of food crops and consequent reduction in the affordability of food) resulted not in the abandonment of biofuels, but in the drive for a technological solution via a "second generation" of biofuels, that would be more sustainable or possible to be sustainably managed although they are more costly to produce (Boody *et al*., 2007; Jordan et al. 2007; Horlings and Marsden, 2011; Bhandary *et al*., 2013; Hanlin *et al*., 2013; Mohr and Raman, 2013; Eggert and Greaker, 2014; Lewandowski, 2015; Bell *et al*., 2018; Brent *et al*., 2019).

One should note that up until now (2021), although different sectors of the bioeconomy are described as part of an integrated policy vision, questions of sustainability or the connections with other economic activities are not well developed in the literature or policy statements. In them, the economy is compartmentalised; the bioeconomy is perceived more as an exogenous economic design rather than organic part of economic activity. Nonetheless, there is an implicit assumption that the wider economy can be made use of, with the addition of some technological solution, without an analysis of how the interconnection of the bio- and the wider economy might work or of what the consequences might be. Technology is the assumed solution to problems of human societies; thus the problems faced by human communities can be ameliorated by further technology-drive research.

The use of the term bioeconomy in support of the economy as presently structured and in favour of the bioeconomy-investing companies means that the state authorities had a crucial role not only in shaping bioeconomy as a notion but also in the creation of a bioeconomic market. No doubt, nation states were already in search of possible solutions to the problems and contradictions mentioned above. At the same time, their intervention was supported or even demanded by the bioeconomic industries in a straightforward way (Albrecht *et al*., 2010; Brunori *et al*., 2011; Pavone, 2012; Arancibia, 2013; Kautto and McCormick, 2013; Birch *et al*., 2014; Dallemand *et al*., 2015; Goven and Pavone, 2015; Barben *et al*., 2016). A prominent role was also undertaken by international organisations like the OECD and the European Union who were trying to promote bioeconomic policies and support bioeconomic activity within this big business setting (OECD, 2006, 2009, 2018; European Commission, 2012, 2018a, 2020a, 2020b; FAO, 2018; US Department of Energy, 2016; BBIJU andSCAR, 2019). Given the rapid rate of diffusion to the term bioeconomy through national, EU, OECD policy documents, it is difficult now to trace the lines of influence between the different organisations. The following section examines in more detail the recent developments in the use of the term in the EU and the UK.

Table 2. Bioeconomy timeline. This table summarises the key concepts relating to the bioeconomy to provide a timeline. For sources, see the text.

Date	Term	Emphasis
Late 1990s	Biotechnology	Economic benefits from the development of commercial application of biological research
Early 2000s	Biofuels	Carbon reduction and energy security
Later 2000s	Bioeconomy	Biofuels – second generation emerging Options for pharmaceutical industry emerging
2010		Social benefits considered (e.g., employment)
2012		Identified as sustainable growth strategy in the EU – but with economic emphasis focused on capital intensive industry
2010s		Organic waste management potential and biorefining
2018		EC address wider sustainability benefits and refer to small scale bioeconomic activity Link made to circular economy
		UK re-emphasis the large-scale industry aspect

4. CURRENT USAGE OF THE BIOECONOMY IN POLICY DISCOURSE

Having briefly examined the development of bioeconomy as a policy in the EU, we now apply Critical

Discourse Analysis (CDA) to the text of key EU and UK policy documents.

The original EU policy statement on the bioeconomy was the European Commission Joint Research Centre report (Benini *et al*., 2013), which shows how an international institution steps into the production of knowledge while creating policy at the same time. This report was a study made by the researchers of the Centre, which is a research facility under the auspices of the European Commission. Here we reproduce extracts (pp 18-20) to illustrate the aims and intentions for a bioeconomy [emphasis as in original text]:

> "Towards this end, management of the bio-economy would imply: i) optimizing resource allocation by addressing multi-dimensional and potentially conflicting issues (for example, the "food versus fuel" debate); ii) driving research and innovation in the primary production and processing sectors; iii) developing new industrial concepts and business models, and open new markets, iv) and the creation of new high-skill jobs.
> …
> While having research and development at its core, EU bio-economy strategy aims also to reconcile sustainable agriculture, forestry and fisheries, food production and industrial use of biological feedstock. In addition, EU Bio-economy Strategy stresses the crucial importance of non-technological factors, such as wide stakeholder involvement and partnering, and the necessity of developing a coherently integrated EU policy framework for the bio-economy, including regional, agricultural, industrial, environmental and energy policy.
> The Action Plan focuses on *three key pillars*:
> i) Developing new technologies and processes for the bio-economy, by using R&D and innovation to produce renewable raw materials sustainably in agriculture, forestry, fisheries and aquaculture, and to process renewable raw materials into value-added products in the bio-based sectors.
> ii) Developing markets and competitiveness in bio-based industries. Concrete actions include support for: development of new markets and bio-based value chains, and commercialization of new bio-based products; demonstration plants and up-scaling facilities, and establishing R&D public-private partnerships.
> iii) Collaboration between policymakers and stakeholders by means of a more co-ordinated bio-economy governance mechanism (i.e. including CAP, CFP; RTD[1] and innovation; industrial policy and competitiveness; employment; energy and public health policies; EU environmental policies on: resource efficiency, sustainable use of natural resources and protection of biodiversity)."

In these two passages the bioeconomy is used as a panacea to address and also interconnect other policies of the European Union. The emphasis is on the economy and how the economy can be supported by the bioeconomy (see the frequent use of the word 'competitiveness'). The bioeconomy is expressly seen as being related to and covered by EU environmental policies. There is reference to coordination of policies, e.g., bioeconomy as aiding sustainability (e.g., of agriculture), but the document does not indicate how that might function in an environmental sense. Several references in the text are made to stakeholders – indicating that a common cause is sought with at least the business community, and recognition that although policy makers and scientists may collaborate in research and development for policy priorities, the implementation requires active engagement from other sectors of society. The public is referred to implicitly as consumers, i.e., passive stakeholders who will respond to the policy and buy or use the products, but will not participate in the formulation of the policy. The document is more a future-research-oriented document rather than an appraisal of current bioeconomic processes. Even for the future, the focus is on certain industrial procedures and aims related to industry aspiring to development in biofuels and chemicals. The policy steps undertaken however, induce an effort to protect the food supply, thus tacitly acknowledging the issue of the first generation of biofuels i.e. the risk of competition for land with the potential to increase the price of food (Jordan et al. 2007; Ajanovic, 2011; Baldes *et al*., 2013; Brent *et al*., 2019).

The EU approach to the bioeconomy has, however, changed since that initial report in 2013. In the 2018 report by the European Commission (2018a, A sustainable bioeconomy for Europe) the discourse has greatly changed. We observe some indirect reference to sustainability with respect to production sectors like forestry, fisheries, food, and feedstock as well as to environmental or energy policies. Moreover, within a wider interpretative context the stakeholder engagement can be perceived as including community engagement procedures. The report, however, does not expand beyond a purely economy-focused approach. The wording would allow further sustainability negotiations or contestations, if the politics in the EU member states and institutions were to use this document as a starting point for a debate. In the European Commission (2018b) Staff Working Paper we can see that a major emphasis is given on sustainability and more details concerning how the bioeconomic policy of the European Union can be deployed to support specific environmental and economic activities. However, the disparity of the focus between the two docu-

[1] CAP: Common Agricultural Policy. CFP: Common Fisheries Policy. RTD: Research Training and Development, which is the EU Directorate General for Research and Innovation

ments reveals the internal tensions within the Commission. Some parts of the bioeconomic policy remain at wishful thinking or debate level in the Working Paper. The parts of the debate which are receiving a consensus are those appearing in the main policy document (European Commission, 2018a). The same disconnection we observed between perceptions of farming policies and the role of the bioeconomy and the bio-based economy can also be observed in the more recent Farm to Fork Strategy of the EU (European Commission, 2020a, 2020b).

There is a close association between the bioeconomy and circular economy. The latter refers to the maximisation of value from resources by design of products to promote longevity and recovery of materials at end of product life (European Commission, 2015; 2019). The principle of circularity can be applied to the bioeconomy as well as to non-biogenic resources. The European Commission Report about the sustainable bioconomy in Europe links bioeconomy to sustainability and circularity from the very first part of the Introductory section (European Commission, 2018a, p. 4), where in the box containing the definition of the term we read:

> "Sustainable & Circular: Bioeconomy the European way
> The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services. To be successful, the European bioeconomy needs to have sustainability and circularity at its heart. This will drive the renewal of our industries, the modernisation of our primary production systems, the protection of the environment and will enhance biodiversity."

In this document responses to climate change and also the need to protect the economy (notwithstanding environmental constraints) are very visible. In the following sections the linkages to the circular economy concept are represented as more or less overlapping actions that the bioeconomy can deliver better than circular economy or at least more comprehensively than other alternatives (European Commission, 2018a: 5-14). Environmental constraints on the economy are perceived as an argument for more research and data collection for the bioeconomy in order to abide within those constraints (European Commission, 2018a: 15):

> "The Commission will implement an EU-wide, internationally coherent monitoring system (Action 3.2) to track the progress towards a sustainable, circular bioeconomy in Europe and to underpin related policy areas. Knowledge gained will be used to provide voluntary guidance for operating the bioeconomy within safe ecological limits".

Contrary to that declaration, the report by the British Government that very same year (HM Government, 2018) seems to express a more economic orientation, reflecting previous EU policies and statements.

> "What is the bioeconomy?
> The bioeconomy represents the economic potential of harnessing the power of bioscience, using renewable biological resources to replace fossil resources in innovative products, processes and services. The bioeconomy in the UK in 2014 has been estimated to have contributed to £220bn of output across the UK economy, supporting 5.2m jobs. Building a world-class bioeconomy will transform our economy by removing our dependence on finite fossil resources. Bioscience and biotechnology has the potential to create new solutions that are economically and environmentally sustainable as well as resource efficient. These solutions will help to tackle global challenges and create opportunities in agri-food, chemicals, materials, energy and fuel production, health and the environment."
> (HM Government, 2018: 9).

The economic orientation is not just a misrepresentation due to the short length of a definition. In pages 16-17 of the same report we read the goals of the bioeconomic policy [emphasis with bold is in the original text]:

> **"Goals**
> We have set out four high level goals, which are reflected in the actions of this strategy.
> **1. Capitalising on our world class R&D:** We will continue to advance our world class research, development and innovation base, leveraging greater investment to turn our cutting edge ideas into commercial success in the global marketplace.
> **2. Maximising productivity:** We will maximise the potential of our bioeconomy assets right across the UK, making the most of our knowledge, facilities and people to increase productivity from our existing renewable biological resources,
> **3. Delivering benefits:** We will support Industry sectors to ensure that this strategy delivers real, measurable benefits for the UK, creating jobs, increasing productivity and doubling the size of the impact of the bioeconomy to £440bn by 2030.
> **4. Creating the right market conditions:** We will create the right national and international market conditions to allow innovative bio-based products and services to thrive, raising public interest, increasing skills in the workplace and sales to the market."

Searching to see what role has been assigned to sustainability in that same British Government report, we see that it is mostly linked to the plastic packaging policies but apart from that (plastic packaging), it is used in a generic, more aspirational than action-based and rather limited way. Sustainability does not seem to take central role in the design of the UK bioeconomic policy (HM Government, 2018: 4-5,10-12, 16, 24, 35, 37, 48, 51, 53-55). The difference in emphasis between the UK Government and EU documents raises the question of the extent to which other member states have adopted the EU approach as opposed to devising their own variation, and indeed where the push for the EU approach came from. An example is the French bioeconomic strategy as it was announced in 2017 by the Ministère d' Agriculture et Alimentation (2017). Sustainability issues, society's involvement and even agroecology appear in the French Ministry's leaflet. In the report of the German Bioeconomy Council (2019: 72-106) one can see the stark difference between the UK bioeconomic strategy and the strategies of other countries like Spain, Latvia, Italy, France and Norway. The UK focuses on the economy only (plus reduction of waste) while the other countries are explicit in connecting environmental sustainability and/or climate change to the bioeconomic activities. Nevertheless, the Bioeconomy Strategy adopted in January 2020 by the German Government seems to be closer to the 2018 UK strategy, mentioning only the economic sustainability that the bioeconomy can bring and leaving as implicit or assumed any discussion about protection of the environment or environmental sustainability of the bioeconomic processes (Federal Government of Germany, 2020).

As we have mentioned above in Section 3, the major effect of policy-makers and academics both being involved in the promotion and design of the bioeconomy has been that the term itself has been constructed around top-down policies and big corporate structures as the most probable private agents of bioeconomic activity. From the excerpts and examples used in this section, we see that this direction is normalised in official documents. In the European Commission 2018 report, the word "small" referring to small farmers and businesses is used in a way that reflects more an awkwardness that the EU policies have to take into account the small production modes and arrangements that exist in the continent rather than supporting them by priority or as an inherent characteristic of the regional economy. We have to comment, though, that the quest for bioeconomic solutions that can be adapted to small production exists explicitly in the report although most of the details are placed in the Staff Working Paper (European Commission, 2018a: 11; 2018b: 46, 58, 60-62). Conversely, in the British government report the word "small" does not exist at all.

The bioeconomic strategy in the UK seems to have been heavily influenced by industry perspectives and by the perception that it is the economy which is the first priority in the debate about the bioeconomy. It is indicative of this orientation that the British Biotechnology and Biological Sciences Research Council has commissioned a private company named Capital Economics to prepare a report (2015) in order to assess the importance of the bioeconomy for the British economy. This shows that the prioritisation of the economy, especially the large industrial mass-production based economy, in perceiving the bioeconomy is a more or less political trend or medium-term occurrence in British research priorities.

An example of prioritising large industrial mass-production in the bioeconomy is the THYME project itself, in which this paper originates. The project is the only major one that we could find, after searching the projects funded by the UK government until 2020. Sustainability as a goal of the project refers to the industries of the region and this is very understandable given that this industrial sustainability is the most common understanding of the bioeconomy (Goven and Pavone, 2015; Aurambout *et al.*, 2016; Mustalahti, 2018; University of York, 2017).). The local character of entrepreneuship is not taken into account by mainstream economic assessments of the regional economy (Charles and Hodgson, 2008, Viaggi, 2016; University of York, 2017) and our economic understandings/theories for this scale are very limited. The bioeconomic process of food production can thus have various aspects and it can be small scale and follow various routes of generating income for the producers. Those possibilities, however, are very rarely discussed as a possible and viable approach in national or supranational visions of the bioeconomy (Gustafsson *et al.*, 2011).

5. ACADEMIC DISCOURSE ABOUT THE BIOECONOMY: A CRITICAL APPROACH

We now turn to reviewing the academic literature on the bioeconomy, in order to see how the academics, some of whom in one or another advise or influence policy-makers, perceive or develop the notion of the bioeconomy.

In most cases academic discussion of the bioeconomy is normative, i.e., relates to advancing the bioeconomy through technological developments, whilst assuming those to be economically and/or environmentally

beneficial (the distribution of those assumed benefits being unquestioned). The term, as we have already mentioned, has been used extensively within a big-business and big-policy framework (OECD, 2006, 2009, 2018; European Commission, 2012, 2018a; HM Government, 2018; BBIJU, 2019). The big-industry orientation of the bioeconomy has been noted by the Food and Agriculture Organisation of the United Nations in their relatively recent report about the bioeconomy (FAO, 2018). Scientific attention has been focused on specific technological advances e.g., the chemical engineering of biofuels, or derivation of high value constituents like pharmaceutical products (OECD, 2006, 2009, 2018; Albrecht *et al.*, 2010; Asveld *et al.*, 2011; Brown *et al.*, 2011; Styhre and Sundgren, 2011; Bringezu *et al.*, 2012; European Commission, 2012; Dallemand *et al.*, 2015; Barben *et al.*, 2016; Cal *et al.*, 2017). In particular, the bioeconomy became the byword for people who wanted to believe, or actually believed, that mass production of biofuels would be the most effective solution to the problem of maintaining vehicle-dependence whilst reducing fossil fuel-related carbon emissions and also circumventing fuel security issues (Hilgartner, 2007; Jordan et al. 2007; Gustavsson *et al.*, 2013; Lewandowski, 2015; Brent *et al.*, 2019). This narrow focus on the bioeconomy as synonymous with technological advancements (i.e., biotechnology) overlooks the perceptions and practices related to the existing economy that it was supposed to be connected with. The connection is seldom analysed, leaving at best a partial understanding of the likely and actual impact of biotechnology on the economy.

For some time, the bioeconomy was perceived by academics precisely in the way that policy-makers do, i.e., an opportunity for capital-intensive economic development, as indicated by the technical literature (whether pharmaceutical or relating to enhancing the efficiency of technologies for extracting value from bio-residues). There are academic writings where the bioeconomy is a framework that is treated as known and non-problematic by the authors (Duchesne and Wetzel, 2003; Dech and Pocharel, 2011; Galt *et al.*, 2017). This is also more often observed in papers that have more of a technical or engineering character (Chandra *et al.*, 2011; Dech, 2011; Laserre *et al.*, 2014; Achury *et al.*, 2015; Le Heron and Winder, 2017). There were, however, voices who were critically assessing bioeconomy and were also offering to the debate other perceptions about it that went beyond the big corporation-oriented construction of a bioeconomy (Helmreich, 2008; Pavone, 2012; Mustalahti, 2018). Critique in particular focused on how the bioeconomy was functioning as a discourse to engage broader audiences and various social groups into economic decisions that were made while taking as their first priority the securing of the profits for companies who would invest in research and development of bioeconomic products (Birch, 2006, 2007, 2009, 2012; Larsen, 2007; Fumagalli and Morini, 2010; Brown *et al.*, 2011; Birch and Tyfield, 2013; Arts *et al.*, 2014; Goven and Pavone, 2015; Bell *et al.*, 2018).

The critique of the corporate orientation of the bioeconomy is something we should delve into a bit further. First, the critique shows the impasses of this approach taken by both the private and public sectors with relation to the bioeconomy and its use as a panacea for the environmental and economic problems of 21st capitalist economies (Cooper, 2007; Hilgartner, 2007; Kitchen and Marsden, 2011; Arancibia, 2013; Birch and Tyfield, 2013; Goven and Pavone, 2015; Birch, 2017a). Second, the most important arguments were related to accelerating and intensifying the pace with which nature and knowledge are privatised, commoditised and assetised (Cooper, 2007; Larsen, 2007; Helmreich, 2008; Fumagalli and Morini, 2010; Pavone, 2012; Hendrickx and Reis-Castro, 2013; Goven and Pavone, 2015; Birch, 2017a, 2019). Third, some authors are severely critical about seeing all production processes and all natural materials as part of a scientifically organised profiteering and management process (Brown *et al.*, 2011; Goven and Pavone, 2015). This scientised perception of production and nature is considered to turn all activity related to those processes and materials into a profit-making process based on values that have been defined in advance. Those same values are used as the targets and instruments of human activities that aspire to resolve the problems that the profit-making is creating (Larsen, 2007; Birch, 2012, 2019; Kitchen and Marsden, 2011; Hendrickx and Reis-Castro, 2013). Fourth, development of knowledge about nature and re-use of resources is a commodity that needs to be patented to become an asset, so that businesses can invest into that knowledge production by having secured that the knowledge or the practical implications of it will be privately owned by them (Pavone, 2012; Birch 2017a). That this would favour the development of specific types of knowledge and technology and specific ways of using natural resources suggests that the needs of the ecosystems would not be a priority or they would be subjected to the needs of the businesses to profit economically instead of the other way round (Birch 2012; Goven and Pavone, 2015). As a consequence, the entire bioeconomic activity would not be sustainable or it would even harm further degraded ecosystems and problematic economies (Birch, 2007, 2019; Cooper, 2007; Hilgartner, 2007; Fumagalli and Morini, 2010; Arancibia, 2013; Birch and Tyfield, 2013; Delvenne

and Hendrickx, 2013; Delvenne et al., 2013; Hendrickx and Reis-Castro, 2013; Bugge *et al*., 2016; Gawel *et al*., 2016; Gawel *et al*., 2019).

Sustainability, especially the environmental part of it, is perceived as being distinct from the bioeconomy. We saw this in policies providing nothing to ensure the short or longer term sustainability of the bioeconomy. And likewise in the academic literature, the bioeconomy is seen as either sustainable or not without this ambivalence being thought of as problematic (Jordan et al. 2007; Baardsen *et al*., 2014; Dankbaar *et al*., 2014; Olikainen, 2014; Caivano *et al*., 2015; Sauvee and Viaggi, 2016; Viaggi, 2016; Allen *et al*., 2017; Szekacs, 2017; Heijman and Shepman, 2018; OECD, 2018: 25-68). In most cases it is assumed implicitly that the bioeconomy could be sustainable if we do not have not evidence to the contrary (Passet, 2012; Kircher, 2012; Kautto and McCormick, 2013; Goven and Pavone, 2015; Lasserre *et al*., 2014; Aurambout *et al*., 2016; Ferreira Gregorio et al. 2018). And we note that there is very little research outside of laboratories and academic spaces that attempts to judge the sustainability of the bioeconomy (Larsen, 2007; Fror *et al*., 2017). In other cases, the sustainability of the bioeconomy is conflated with the renewability of resources, and those two are both thought to be interchangeable with the sustainability or renewability of capital (Gawel *et al*., 2019; Birch and Tyfield, 2013). In reality, the sustainability of capital is taken for granted and because capital can renew itself indefinitely in time (or so it is perceived to be able to do), nature and knowledge are also perceived to do the same. If they do not, it is because better (i.e. more intensive) management and resource utilisation is needed (Birch, 2007, 2012; Birch *et al*., 2010; Dankbaar *et al*., 2014; De Besi and McCormick, 2015; Gawel *et al*., 2016; Birner, 2018; Lewandowski, 2018; Pulzl and Ramcilovic-Suominen, 2018) rather than a radically different approach – such as potentially a less intensive use of resources.

However, bioeconomy can be given other meanings than the ones that have been constructed through policy documents and many academic documents. Thus, we suggest it is a contested field for both theoretical debate and economic practice. Contrary to the big-corporation-oriented bioeconomy, there is the organic[2] or agroecological approach. With agroecology we mean that agricultural production is taking place in modes that sustain the local ecosystem and local natural resources with a long-term view (Altieri, 2009; Levidow *et al*., 2012; Martinez-Torres and Rosset, 2012; Altieri *et al*., 2015, Bugge *et al*., 2016; Levidow, 2015). Agroecological practices also seek to provide adequate income to the producers through the production of quality agricultural products, mostly food. Given that agroecology focuses on synergies between the ecosystem as such and the human communities that are producing their food/agricultural products within it, it is more labour intensive than the big bioeconomic industries, but its mode of production is the one of the small farmer or the small producer in general. The specificity of ecosystems (soil, geography, climatic conditions, availability of local seeds, fauna of the region that feeds off or uses agricultural fields for habitat) does not allow sweeping decisions about practices and it requires adaptation of the production processes to the conditions of each place/community. In this framework, the production of food is the core activity of the bioeconomic process. Organic agriculture and agroecology are perceived as methods of cooperating with nature to produce adequately, instead of perceiving nature as a space from which resources are extracted. In that way the mode of production is adapted to this production of food within the context of the local ecosystems (Kitchen and Marsden, 2011; Birch *et al*., 2012a, 2012b; Levidow *et al*., 2012; Esposti, 2012; Levidow, 2015; Bugge *et al*., 2016; Viaggi, 2016; Hausknost, 2017).

We need to note here that bioeconomic processes, such as anaerobic digestion, or value-added approaches to dealing with agricultural waste have proven so far to be quite beneficial to farming and food production on a big scale (De Meester *et al*., 2012). Farming and the 'official' view of the bioeconomy are not totally divorced from each other and given that policies are constructed through the official corporate-oriented view of the bioeconomy, the bioeconomic influence on farming is also corporate-based. We would need more research and a longer-term experience to have a sound conclusion about the interconnection of bioeconomic processes used to reduce waste and environmental degradation in farming. Moreover, we would need a more holistic approach to assess the potential of the technological bioeconomy to decide whether as a production process is more ecologically sound than other ways of production.

The published critique of the bioeconomy is very much an academic debate; it seems not to have been enjoined by practitioners or social movements. From all online investigations we have conducted (July 2019, October 2019, December 2019, April 2020), it seems that, to the best of our knowledge, the term bioeconomy is not used broadly by grassroots initiatives in their public activity, much less by people who might be small produc-

[2] We do not conflate organic with agroecological. Those are two different approaches to agriculture and even if they sometimes overlap, they can be structured in various ways concerning their economic expression. However, we use them here together in the way they are used in the academic literature, that we examine in this paragraph.

Table 3. Academic discourse on the bioeconomy. This table is a visual presentation of basic perceptions of the bioeconomy as presented in academic literature. For sources, see the text.

Perception	Focuses on	Tries to attract
Normative	Technology	Big businesses, policy-makers
Given-Not discussed	Technology	Big businesses, policy-makers, greater audience
Panacea	Environment Economy Knowledge	Big businesses, policy-makers, greater audience, environmentally aware individuals and groups
Sustainable	Renewability of resources Renewability of capital Efficiency	Big businesses, policy-makers, greater audience
Organic Agroecological	Agriculture Food	Big and small businesses, policy-makers, greater audience, food producers and farmers

ers, even if they practically follow bioeconomic processes in their activities. Furthermore, the academic literature largely overlooks small scale activities which might be construed as part of the bioeconomy. We have found very few mentions of farmers' markets, for example. Thus, so far academic consideration of the bioeconomy is mirroring the policy focus on technology-driven, capital-intensive approaches to the economic opportunities arising from organic resources. We consider this further below, but first address the bioeconomy in the context of other approaches to addressing economic benefits.

6. SUSTAINABILITY ECONOMIES

To understand better the context of the use of the term bioeconomy, we turn to the other types of economies that have emerged during the last decade or two as policy options. These concepts including (the bio-, green, blue, low carbon, and circular economies) we term the sustainability or S-economies (see Table 4 later in this section for a summary of the features of a non-exhaustive list of these economies). The S-economies are named types of economic activity favoured by policy makers as offering potential for a better, or at least different, connection between the natural and human environment via focusing on particular activities as a route to value creation. In many cases, they are represented as attempting to achieve environmental sustainability, although the perceptions of sustainability to which each type of economy is connected might differ. In all cases, the debate that connects those economies to sustainable arrangements is being developed within the confines of the capitalist economy, i.e., to achieve economic growth whilst balancing environmental and social priorities in a manner protective of future generations' abilities to do the same (following on from the WCED in 1987 with Brundtland Report).

We have already mentioned that the bioeconomy emerged initially under the rubric knowledge-based bioeconomy. Knowledge (-based) economy was a term that the European states were using for some decades before the bioeconomy emerged as a term. The term was not just implying that the economy has parts where knowledge, or advances to it, were less significant, but also that people should continuously receive training (for which they should be paying, i.e. they should become clients of educational services providers) in order to adapt to the needs of the markets, i.e. unemployment and low wages were constructed as the result of lack of knowledge on the part of the workers and the businesses (OECD 2002, 2005; Olssen and Peters, 2005; OECD et al. 1997; Jessop and Sum, 2013; Birch *et al*., 2014; Birch, 2017a, 2017b). Nevertheless, the knowledge-based economy can also be interpreted as an attempt by the capitalist economy to recognise and handle profitably the changes to the economy, brought about by the advance of information and communication technologies and by the creation of new jobs and new demand for advanced or new skills.

By the time the bioeconomy arose as a policy concept, the idea that knowledge itself is a panacea to a stagnating economy was already a well-established one (Godin, 2006; Brine, 2006). The bioeconomy arrives to highlight that with new research and development of more intensive use of biogenic resources we can solve at once both the problem of production costs and job availability and the problems of waste management and environmental degradation. Similarly, the green and blue economies, which were boosted in prominence by the Rio 2012 summit, were seen as means to reignite the faltering global efforts for sustainability. The green economy argues for economic and social benefits to accrue from environmentally focused and social equitable investments, with the blue variant emphasizing marine-based economic opportunities (UNEP, 2009; Bina 2013; UNCTAD, 2014; Smith-Godfrey, 2016; Lee, Noh and Kim 2020; Benson et al., 2021). In practice green economy policies have tended to favour the more mainstream solutions over the more adventurous, socially progressive options (e.g., in building design; Pearce and Barbier, 2000; Gibbs and O'Neill, 2015; Ge and Zhi 2016; Ferreira Gregorio et al. 2018; Merino-Saum et al., 2020). Approaches ostensibly designed to protect the environ-

ment by slowing consumption (e.g., bike share schemes) can nonetheless primarily benefit those financially better able to consume (Médard de Chardon, 2019). These outcomes may reflect the contradiction of an apparently anti-consumption policy being driven nonetheless by the profit motive.

The circular economy is a further S-economy, which has risen rapidly to prominence in policy and academic circles in the last few years and which promotes sustainable resource use via design for longevity of product/material use recovery at end of life (Bocken et al., 2016; Geissdoerfer et al. 2017). As discussed above, the bioeconomy and circular economy are closely associated with each other in EU policy debates. The bioeconomy highlights a specific resource type and certain technologies for utilisation, whilst the circular economy proposes principles for using any resources. The circular economy for example favours design for sustainability over marginal improvements to recovery at end of life, but is nonetheless fundamentally seen as a strategy for economic growth by policy makers (European Commission, 2015; 2019). Whilst understandings of the circular economy vary considerably in their degree of social emphasis (e.g., Kirchherr et al., 2017), its origins lie with explicitly corporate-oriented approaches to resource efficiencies such as industrial ecology and industrial symbiosis (Mathews and Tan, 2011; Lieder and Rashid, 2016). The efficient use of raw materials and the recovery of materials from waste, residues and production by-products are the central argument.

Industrial ecology and industrial symbiosis are approaches to economic-environmental benefits that argue for the ability of companies to collaboratively (through networks or business clusters) or collectively (as sectors) produce the necessary technology for avoiding a negative impact on the environment. Business models have to evolve to suit not only changes of technology and social demands but also to be capable of surviving as businesses in a turbulent economic framework (Boons *et al*., 2015; Cecchin *et al*., 2020). Industrial symbiosis therefore can be seen as a transition technology on the way to more profound solutions. By contrast, some understandings of the circular economy (e.g., Ellen Macarthur Foundation, 2015) favour renewable resource use, as opposed to more efficient use of non-renewable resources prominently discussed in industrial ecology. The implied shift towards the bioeconomy is assumed by circular economy discussion to promote sustainability. We have argued, though, that bioeconomy policy and theory does not engage prominently with sustainability debates – leaving the outcome of expanding the use of bio-resources as uncertain. Notably, though, bioeconomy literature has also called the adoption of circular practices (e.g., industrial symbiosis-style use of residues produce other products that could have economic value) (Viaggi, 2016; Sariatli, 2017; Allen *et al*., 2017; Pulzl and Ramcilovic Suominen, 2018).

Lately, the term of smart economy has emerged as a way to show that the economy as we know it can be better organised in order to become sustainable or more sustainable, by using technologies, especially the digital technologies that have been developed during the last decades (Bronstein, 2009; Caragliu et al. 2011; Kumar, 2017; Ruhlandt, 2018). Again, we see the same pattern, of knowledge and advanced technology been assigned the role of the quasi-*deus ex machina* to save both the environment and the economy.

Within the broad remit of sustainability, the relative emphasis of the different pillars of sustainability varies between these different initiatives (Cecchin et al., 2020). The bioeconomy, and mainstream understandings of the circular economy, can be seen as examples of ecological modernisation, the idea that policy-driven technological change can foster economic and environmental benefit (Huber, 2008; Horlings and Marsden, 2011). That is, with a suitable regulatory framework, industry can make profit out of meeting the environmental needs of our societies –creating a win-win situation where the environment would not be harmed and the economic activity would continue unabated. That is, sustainability of the economy and the sustainability of nature are firmly entwined (Pearce and Barbier 2000; Olikainen, 2014; Dankbaar *et al*., 2014; Antikainen *et al*., 2016; Allen *et al*., 2017). Notably the same vision of the green economy is understood differently, along with more radical perspectives on the circular economy, which tend towards the field of degrowth (e.g., Latouche, 2009, Cecchin et al., 2020) increasingly discussed academically though hardly a serious policy contender.

The economies we have described in this section have important differences between them. For example, the knowledge-based economy and smart economy are mostly oriented towards technological solutions that are directly invented in laboratories and research centres. The green economy and ecological modernisation are very much practice-oriented, with a special emphasis on the business activities that will define aims for research and also disseminate the new sustainable technologies through the market. Circular economy and the bioeconomy stand between the two groups, attempting to combine both a strong scientific component with a major role for the business world. Some conceptualisations of the circular economy share the visions of the green economy that seek bottom up, even degrowth, approach-

es. We argue also that the bioeconomy could be understood as contributing in this area, albeit this aspect has so far been overlooked. Despite these differences, we cannot ignore the similarities among those types of economies and how they emerged at similar historical and geographical points in contemporary economic history, with significantly overlapping aims and intentions. The central aims and economic scope of the various types of sustainable economies are shown in Table 4, along with key policy documents and references to the related academic literature.

From the above we see that the use of the term of bioeconomy, and related ones like green economy, circular economy, or sustainable economy, reveals a commonly accepted, although implicit, assumption that 1) the economy cannot address its own problems but that 2) with some change of emphasis solutions can be found within that same growth-oriented economic approach. The proliferation of terms reveals the pressure to distinguish the contemporary proposals for solutions from recent previous solutions that are facing challenges. Alternatively, the terms imply targeting a different *partial* approach to promoting growth (with sustainability priorities embedded to various degrees), without consideration of the interrelatedness of different aspects of the economy. An analysis of the terminology might reveal the intertwined character of the roles undertaken by state institutions, businesses and academia to promote each and all of those terms/economies and how this intertwinedness can have a potential for both achievements and failures, exactly because the spreading of the use of a certain discourse arguably frames the issues in ways that the various actors and social groups involved with them cannot address effectively from the within the frame/discourse (Birch, 2007, 2012). This is a hypothesis, though, that will be the scope of another paper.

7. DISCUSSION: REFLECTIONS ON THE MEANING(S) OF THE BIOECONOMY

The bioeconomy as a discourse and industrial sector can be credited to the authorities and policy makers who have been steering it over the years since its identification (Benner and Lofgren, 2007; Birch *et al.*, 2010; Birch, 2012, 2017a, 2019; Pavone, 2012; Esposti, 2012; Birch and Tyfield, 2013; Gustavsson *et al.*, 2013; Caivano *et al.*, 2015). Discourse is coming from policy-makers and academics, often in documents that explicitly combine both policy and scientific expertise, i.e. the experts are assigned by the states to provide policy-making advice on the bioeconomy.

From our literature review and to the best of our knowledge it seems that questions like "Why bioeconomy? Why bio-? Why biological? What is new about it? Didn't we have any bioeconomies before 1990?" have not be considered in the literature. The question that any broad definition of bioeconomy raises is whether this type of economy is different from the economy in general, if we accept definitions which state that all biological material is perceived as raw material in the bioeconomy (Albrecht *et al.*, 2010). Apart from seeing such statements as problematic (because they identify all biological substances and all organisms primarily as production inputs), we need to clarify here that not all raw materials are biological materials. Nevertheless, all raw materials are originating in nature ultimately, even if they have been produced in a laboratory or factory. In all cases, human production is based on taking resources from plants and animals. This human production can also be done through the destruction of an ecosystem (e.g. the cutting of a forest) in order to extract minerals from the Earth or the diversion of essential parts of that ecosystem, like water, to benefit human activity instead of the water being available to plants and animals. In other words, whether we choose to deplete or not to overuse the water of a river, we are still (co-)producing the ecosystem.

Although the use of non-biological resources impacts on nature (as above), it could nonetheless still useful to distinguish a specifically 'bio'-aspect as distinct from the wider economy. Destruction is very different to using 'nature' to produce resources. The latter may equally be destructive of habitats but it is not always inherently destructive. The discourse of ecological modernisation has been based on the assumption that more management can be considered as the solution to a lack of sustainable outcomes. The previous section about sustainability economies gave some examples for this use of discourse. The question is whether we need the "bio-" component of the name to stay aware of this use of natural resources.

Furthermore, the bioeconomy, like all S-economies, is vested in the implication that the previous (if recent) economies were based on beliefs and lack of scientific knowledge, or that they were somehow non-, or not adequately, green or sustainable. These hidden critiques concerning the previous economies might have some seeds of truth. But one cannot help recognising that the critiques overlook efforts by several social groups or regions to be less linear and unsustainable through the use of local knowledge and inventiveness. Despite that, the environmental knowledge of those communities has recently begun to be appreciated when the environ-

Table 4. A non-exhaustive list of what we term the Sustainability or S economies. These various expressions have been adopted to promote a particular economic activity as approaches to value generation. The decade of origin and key policy and academic references are provided.

Name	Aims – Vision	Scope	Since	Know-how	Reference
Bioeconomy	Support economic sustainability through capital-intensive use of organic resources	Big industries, biotechnology, pharmaceutics, Energy, waste Efficiency-oriented	Mid-2000s	Edge-research based. Laboratories, industrial applications	OECD 2009, Lewandowski 2018 European Commission 2018 Ferreira Gregorio et al. 2018
Blue economy	Sustainable management of marine resources Profit making from marine nature can be sustainable	Small & big production. Closely associated with to island and coastal economies	2010s	Research & business based Aspects of community economies	UNCTAD 2014 Smith-Godfrey 2016 Le Heron & Winder 2017 Lee, Noh & Kim 2020
Circular economy	Instead of resource depletion & accumulation of waste, design for reuse, repair, upcycling of products and byproducts of each supply chain	All sectors of the economy, but very important for industrial products the raw materials of which are not renewable & after use they cannot be degraded in nature	1990s, but prominent since 2015	Research-based, laboratory-oriented, industrial & consumer orientation	Ellen MacArthur Foundation 2015 European Comission 2015 Bocken et al. 2016 Allen et al. 2016 Geissdoerfer et al. 2017 Cecchin et al. 2020
Green economy	Sustainable solutions that can be profitable – profit making can be sustainable for the environment; some visions emphasise social benefits e.g., via community scale initiatives, and resemble degrowth initiatives	All sectors of the economy	1990s, but prominent since 2000s	Economic & environmental research, industrial applications are preferred, even for the banking sector	Pearce & Barbier 2000 UNEP 2009 Bina 2013 Gibbs & O'Neill 2015 Antikainen et al. 2016 Ge & Zhi 2016 Allen et al. 2017 Ferreira Gregorio et al. 2018 Merino-Saum et al. 2020 Benson et al. 2021
Knowledge-based economy	Make profit out of using advances in research and technology, along with better management of human knowledge	All sectors of the economy, emphasis on industrial sectors and on digital technologies	1990s	Research-based	OECD et al. 1997 Neef, Siesfeld & Cefola 1998 OECD 2002, OECD 2005 Olssen & Peters 2005 Godin 2006 Albrecht et al. 2010 Jessop & Sum 2013
Low carbon economy	Reduce emissions of carbon in production & distribution chains without disturbing profit flow	All sectors of the economy, but mostly industrial plants & other work spaces, food production, transport	2000s	Research-based, business oriented	Stern 2007 HM Government 2009 Zhang 2010 Foxon 2011 Luy, Ngai and Wu 2019
Smart economy	Organise the economy through digital technologies so that costs are minimised and production is more efficient and profitable	All sectors of the economy, emphasis on ICT sector	2010s (or late 2000s).	Research-based, very technology oriented	Kumar 2017 Bronstein 2009 Caragliu et al. 2011 Ruhlandt 2018 (Olikainen 2014)

mental management techniques originating in capitalist economies cannot tackle the implications of the environmental degradation associated with those economies (Berkes and Parlee, 2006; Goodall, 2008). What also needs to be further examined is the variability of types of economies that have been marginalised in the public discourse but still existed and might have been experimenting with smart, green, sustainable and production-symbiotic solutions. The interaction of these marginalised ('grassroots', 'alternative') economies with the mainstream economy, their coordination and potential lessons for sustainability needs much more examination.

8. CONCLUSIONS

For the purposes of this paper, the bioeconomy literature was critically examined in order to investigate how policy-makers and academics perceive economic activity involving the production, use and/or disposal or re-use (whether through upcycling or downcycling) of plant-based products, or products containing substances extracted from plants and animals. We stick with a very broad definition of the bioeconomy and do not assign any inherent sustainability goals to it. Rather than assuming that the bioeconomy is inherently sustainable, we suggest that it can display various characteristics depending on its economic and political context.

What we have seen from the examination of the policy documents and the academic literature is that for the policy-makers and for most academics, the bioeconomy is perceived as a dissociated activity from what everyday people do and from how they understand their relationship to natural materials used for production. At the same time, in cases like the United Kingdom government (or the German government in 2020), the bioeconomy is perceived in a very narrow way which gives emphasis to the economy and sees sustainability as a mainly or only an economic problem. In other words, the corporate direction that the bioeconomy took since its beginning reflected neither the potential of the term nor the bioeconomies that already exist and are largely absent from policy documents and the academic writings relating to the term.

We also showed that the bioeconomy has been developed within a broader context of various named 'economies' (which we call S-economies). These are presented by policy-makers, and analysed by academics, as possibilities for more sustainable economic activity. Ironically, the periodic (if rather frequent) appearance of a new S-economy term in recent decades presents the solutions as something novel, despite that they are all based on common assumptions. Each is aiming to identify a particular field of activity which can generate value within the capitalist economy by offering both a competitive edge and a perceived sustainability advantage (e.g., avoiding fossil fuels).

However, the sustainability credentials may be uninvestigated or in any case contingent on circumstances. Placing the bioeconomy within the broader context of the S-economies makes visible the potential of the bioeconomy to provide at least some environmental benefit, whilst indicating its economic and social limitations. Neither the bioeconomy or other S-economies can overcome the internal contradictions of capitalism. They may generate new opportunities for investment, but also new areas for competition, which may favour some locations/people and may rearrange rather than eliminate inequalities (e.g., Deutz, 2014). It would be the purpose of a future study to investigate 1) how the biotechnology economy articulates with the wider bioeconomy and 2) how the bioeconomy articulates with the wider economy, alongside the other comparable initiatives, which we term the S-economies.

The bioeconomy is generally under-researched as a concept and even more as an economic practice. Some of the literature is descriptive rather than presenting a critical exploration, or incorporates policy-related wishful thinking and academic visions rather than actual findings from the field. We note that there are few policy documents referring to the bioeconomy, and these share a representation of bioeconomic governance as top-down. This lack of extensive academic and political debate and contestation on the concept of bioeconomy obscures the struggle that is taking place among the various social groups who promote and practice the bioeconomy. These we are exploring in further research, especially as relates to small scale, grass-roots practices of the bioeconomy. Our sub-project within THYME investigates the farmers markets in East Yorkshire as small-scale bioeconomic practices on a local collective level. More details about the research findings from that field research will be considered in subsequent papers in order to explore the variety of notions and practices that the bioeconomy can include.

Through our research we have reached the conclusion that the bioeconomy is a contested concept. This is despite fact that it was constructed within a certain geographical and socio-economic framework that was prioritizing corporate and top-down understandings of bioeconomic processes. We also showed that the role of states and international organisations is prominent in this construction of meanings, although a detailed examination of this role should be the focus of future research. Finally, we also showed that evolving perceptions of the bioeconomy, especially in the policy documents, indicate that if we want to develop a *sustainable* bioeconomy, we need to start considering limitations from the side of both ecosystems and our economies. Our paper contributes to a more critical perception and use of the term bioeconomy. which we hope can inform decision-making for both policy-makers and experts.

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