Philosophy & Technology (2023) 36:18
https://doi.org/10.1007/s13347-023-00617-8

RESEARCH ARTICLE

Ecomodernism and the Libidinal Economy: Towards a Critical Conception of Technology in the Bio-Based Economy

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Received: 30 August 2022 / Accepted: 23 February 2023

Abstract
In this paper, we carry out a critical analysis of the concept of technology in the current design of the bio-based economy (BBE). Looking at the current status of the BBE, we observe a dominant focus on technological innovation as the principal solution to climatic instability. We take a critical stance towards this "ecomodernist" worldview, addressing its fundamental assumptions, and offer an underarticulated explanation as to why a successful transition toward a sustainable BBE—i.e. one that fully operates within the Earth's carrying capacity—has not yet been reached. Bernard Stiegler has developed a philosophical perspective on the concept of economy, broadening it to include the human condition through the notion of desire. This theory can help to obtain a more profound understanding of why ecomodernist strategies are dominant today. Stiegler's theory of the libidinal economy offers an analysis of controlled and exploited human desire as a primary driver behind modern techno-economic structures. Our hypothesis is that a critique of contemporary technofixism *as* a critique of libidinal economy is a necessary step to take in the discussion around the BBE as a concept, if the BBE is ever to bring about a system that can truly operate within the Earth's carrying capacity.

Keywords Ecomodernism · Bio-based economy · Degrowth · Stiegler · Libidinal economy · Sustainability

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Published online: 22 March 2023

1 Introduction

As climate change has become a global topic of concern, major strategies are being deployed worldwide to address this challenge. In the European Union context, this project is called the "Bio-Based Economy" (BBE). The BBE is defined as "Production paradigms that rely on biological processes and, as with natural ecosystems, use natural inputs, expend minimum amounts of energy and do not produce waste as all materials discarded by one process are inputs for another process and are reused in the ecosystem" (European Commission, 2011: 5). The BBE, as a concept, expresses the idea that our "economy" would be more sustainable if we "base" it on processes present in the "bio"-sphere, as such natural cycles are deemed renewable and therefore sustainable in the long run.

There are several types of conceptualizations of the bioeconomy (Vivien et al, 2019: 189–190). A first type adheres to the idea of degrowth and was coined by Georgescu-Roegen (1971). This version of a bioeconomy recognises the ecological dangers of our rapidly growing economy and argues we should make fundamental changes in our economic system to recognise the ecological limits and foundations for human survival. Such degrowth oriented bioeconomies currently exist as concepts but not yet in practice. A second type is the "Knowledge and Technology-based bioeconomy" in which technological innovations are seen as the essential solution to ecological instability. As this perspective adheres to an "economy of promises", it is strongly related to the theoretical framework of ecomodernism, which essentially states that economic growth and ecological sustainability do not need to be mutually exclusive (Jasanoff & Kim, 2015; Vivien et al, 2019: 194). Another type demarcated in the literature is the "biomass-based economy". This type focuses on forestry, agriculture, fishing, chemistry and the use of (technologically complex) biorefineries, aiming to transform biomass into a diversity of resources. The biomass-type bioeconomy is not yet fully fossil-fuel free but might become sustainable in the future (cf. Asveld, 2019: 6f).

In this classification of bioeconomy conceptualizations, two opposite paradigms can be discerned. On the one hand, in the first conceptualization, we recognise the theoretical notion of a moderate, plant-based, *degrowth*-oriented economy. This degrowth paradigm might not seem exceptionally attractive, pleasant or even efficient because transiting into it would require a drastic revision of the contemporary economic system. On the other hand, we recognise a *growth*-oriented economy in the knowledge, technology and biomass types of the BBE. The latter paradigm explicitly seeks to maintain the contemporary neoclassical orientation on economic growth as well as growth of comfort and consumption (cf. Birch et al, 2010: 2903f). The assumption for the future here is that the BBE provides new opportunities for inventions and developments that will lead mankind into a sustainable era. It is presumed that innovative technologies, such as biorefineries, will *fix* the sustainability problems we face today as a society. We can frame this paradigm underlying knowledge and biomass-based BBE-conceptualisations in terms of an *ecomodernist* orientation of the BBE (Keith et al., 2015).

The ecomodernist orientation, which was described most explicitly in the 2015 *Ecomodernist manifesto* (ibid.), holds that the environmental crisis could best be dealt with by further modernising technological capabilities. The ecomodernist vision accepts that humanity has become and has been for a long time the primary geo-factor shaping the face of the Earth and proposes to continue this development forward in order to bring about a growing, flourishing and sustainable future for humanity. Contrary to the degrowth movement, which assumes that only the radical reduction of production and consumption can save the planet for future habituation, the ecomodernist attitude assumes that science and technology will create a sustainable future. Technological development and innovation are here understood as something that is supposed to offer—through vast amounts of institutions practicing science and R&D across the globe—eventually, some paradigm-shifting "green technology"-panacea for the sustainability problem. This perspective can as such also be understood as techno-optimism or the "techno-fix" approach, as it presupposes that we can innovate our way out of the climate crisis (Howson, 2020).

In current BBE practices, the techno-optimist orientation of ecomodernism is the dominant strategy in dealing with sustainability challenges (Veraart & Blok, 2021a, 2021b). BBE-policy consistently emphasises how biorefineries offer new business opportunities for value creation to remain competitive on the global market in the future, e.g.: "By supporting new bio-based industries and the 'greening' of traditional industries, a bio-economy will change Europe from being a net oil importer to exporter of technology and bio-based products" (European Commission, 2011: 12). The reasoning is that in order to base economic processes on biological cycles, new (industrial) technologies are to be employed. The main ideal of replacing linear fossil fuel economics with more circular or sustainable processes is, in practice, realised by the technology that is the biorefinery.

These industrial plants use advanced equipment to convert biomass into energy, in which they strongly depend on traditional technologies such as heavy machinery and fossil fuels to move, adapt and process the required resources (Dragone et al, 2020). The conversion and production of biofuel are a chemically complex process that requires specific scientific knowledge for each of its fields of application, such as heat, road transport and aviation (Tsiropoulos et al, 2018). Alongside these chemical engineering approaches, a variety of advanced technologies—such as metabolomics, genomics and proteomics—are deployed to produce biobased resources. In addition, these technologies are becoming more and more accompanied by digital tools. Machine learning and big data are key components in many bioeconomic practices today, such as smart farming technologies (van der Burg et al., 2019).

Because the current bio-based economy is exclusively established through advanced, industrial, chemical and digital technologies, this raises the question of how *bio*-based, *technology*-based and biotechnology-based strategies are related in the BBE. This is important, as it is not self-evident that technology-based strategies serve the BBE as a sustainable economy. Furthermore, technology can be considered to have been the major cause behind the environmental pollution since the industrial revolution, leading to the very climate crisis we face today. Despite these obvious ambiguities, the question whether a techno-optimistic ecomodernist approach is legitimate has not been explicitly raised in the context of the BBE.

Degrowth theory indeed opposes the ecomodernist narrative by proposing a hypothetical paradigm in which growth is suspended instead of encouraged. However, this anti-ecomodernist vision only reverses the central role of technology—e.g. by arguing we should abandon luxury gadgets—but does not offer an explanation as to why a fundamental economic transition has not occurred to date.

The main question of this article is therefore: *what explains the dominance of ecomodernism in BBE-strategies and what critique of it would be required for a transition into a truly sustainable system?* The hypothesis of this paper is that beyond the question of whether technological development is either harmful (degrowth) or helpful (ecomodernism) in answering to the climate crisis, a more fundamental reason exists for the current lack of initiatives to build a BBE that actually operates within the carrying capacity of planet Earth. Instead of policy decisions, stakeholder engagement, governance or consumer responsibility, we will here suggest the possibility that a "corrupted" mode of collective human *desire* is at the heart of humanity's current failing to establish a new paradigm of sustainability.

We begin by analysing biobased practice to understand what an ecomodernist, innovation-oriented techno-fix strategy entails concretely. We consider the biorefinery as an example of bioeconomic practice and discuss the manner in which such practices are currently criticised. We determine from the literature that what is lacking in the current conceptualisations is an encompassing view on the intertwined problematics of technology, society and nature at stake in the question after a bioeconomy (Sect. 2). Diagnosing the fundamental origins of the current ecomodernist worldview and practice to be driven by a corrupted mode of collective human desire, we consult the philosophy of technology of Bernard Stiegler. His notion of the libidinal economy enables us to show how it is human desire and consciousness itself that lies at the root of the current lack of actually sustainable practices (Sect. 3). Accordingly, we apply Stiegler's insights to the limits of technology, economy and the environment, arguing that the underlying problem of the BBE consists in the perpetuating of a past paradigm of economic growth as (exclusively) focused on (fossil) fuel energy needed for subsistence (cf. Stiegler & Ross, 2013: 91). We suggest that neither ecomodernism nor degrowth escapes the paradigm of natural energy and propose that a transition into a paradigm of libidinal energy needed for existence (ibid.) is required for a genuinely sustainable bioeconomy to ever exist (Sect. 4).

2 Towards an Encompassing Framework of Biobased Practice

Before moving on to a philosophical perspective on the economic assumptions involved here, it is necessary to elaborate upon the precise problem at stake in current BBE-practices. By discussing the biorefinery as a leading example of the BBE's current approach, we can see what the ecomodernist approach entails as a concrete technological strategy. Biorefineries compose a major part of the economic energy transition in the bioeconomy and as such constitute a prime example of contemporary biobased processes in practice. The International Energy Agency defines biorefining as "the sustainable processing of biomass into a spectrum of marketable biobased products (food and feed ingredients, chemicals, materials) and bioenergy

(fuels, power, heat)" and as "an innovative and efficient approach to use available biomass resources for the synergistic coproduction of power, heat and biofuels alongside food and feed ingredients, pharmaceuticals, chemicals, materials, minerals and short-cyclic CO2" (IEA, 2019). This processing of biomass is considered to be sustainable because bio-based products and energy do not require linear energy-use by fossil fuels but could be running in renewable cycles using non-polluting, reusable resources such as biomass. Biorefineries are generally viewed as a success when, e.g., new proteins can be converted or when lignin is made useable, or as a failure when, e.g., all the rare materials are delivered by diesel-powered trucks or the powering of the refinery itself is still fossil fuel-dependant. The structural ideal of the BBE-transition would be to have biorefineries replace all linear resource processing (European Commission, 2012a, 2012b).

In the current development of the transition towards biomass as a primary source for energy and products, it has quickly been made evident that just accounting for the sustainable processing of biomass itself does not reflect the complexity of the field in which biorefineries operate. Biorefineries are often surrounded by non-sustainable practices, jeopardising long-term viability (Parada et al., 2017). For example, higher rates of deforestation and soil erosion, biodiversity loss and increased pressure on water resources have been observed by adopting biofuels (Rafiaani et al., 2018). It is therefore often argued in the literature that biorefineries should be analysed from an encompassing perspective of environmental, economic and social integration and that a successful bioeconomy requires *a greater framework* than just the promise of technological innovation by also incorporating the social, natural and economic domains at stake (Dragone et al., 2020). Concretely, this distinction comes down to the replacement of fuel types, substituting fossil by biofuels, versus the broader replacement of production cycles, also including aspects such as stakeholder engagement and policy revision.

The ecomodernist narrative, being exclusively focused on technological innovations, appears too limited to address this greater framework. The production of innovative artefacts is only one dimension of the transition into a bioeconomy as a whole. In the field of social sciences, a lot of critical research regarding technological innovation has been done, pointing out how technological innovations, as drivers for economic development, are always already involved in a network of related dimensions (cf. Bijker et al., 1987). Rafiaani et al. specifically investigate one of these related dimensions in depth by analysing a dataset of 103 studies on the *social* dimension in bioeconomies. They explain that new kinds of investments in infrastructure are necessary in order to further change a fossil-based economy into a biobased economy in an encompassing way. They argue that if society is not convinced by the sustainability of the biobased economy, the costs involved in such a fundamental restructuring of factors like production location, storage, refining and transportation cannot be justified. According to them, it is social institutions that should provide the right policies, values, identities and relationships in which technological innovations operate. If societal institutions fail, so will the employed technological innovations (Rafiaani et al, 2018). They demonstrate that biorefineries are in no way isolated artefacts but, rather, inherently connected to all kinds of cultural, societal, environmental, political and economic processes. The technology that

is the biorefinery has already come into existence as a result from past economic, political, social and environmental developments.

In the book *Bioeconomy – Sharing the Transition to a Sustainable, Biobased Economy,* Pyka and Prettner likewise highlight a multitude of sociological, political and societal aspects that should be adopted in an encompassing perspective required for a sustainable bioeconomy. For example, they explain how innovations are only broadly adopted when they attract interest from consumers, whose purchasing power is guiding for market forces. Seen as such, institutional change must coevolve with technological developments for sustainable practice to occur. Pyka and Prettner also criticise innovation processes that are only result-oriented and argue the focus should be on social changes and changing lifestyles that are both an expression and a driver of the general transformation process. They conclude that if new sustainable technologies are to achieve the aspired transformation of the economic system, the technological potential of a bioeconomy is an insufficient condition for an encompassing transition, which also requires democratic consensus on the broad development and wide application of this technological potential (Pyka & Prettner, 2018: 340–341). Mapping out these intertwined aspects, Pyka and Pretnner provide a clear insight into the complexity and relatedness of social, natural, economic and technological elements involved in a future bioeconomy.

The analyses above demonstrate that the ideology of ecomodernism, by being overly focused on technological solutions, falls short of providing a fundamental perspective to make sense of the relations between humanity, technology and nature. The ecomodernist conception of technology as a deployable means able to "fix" an all-embracing crisis such as climatic instability is disconnected from a multitude of worldly factors. Technology is not just a collection of tools available for employment by conscious human actors, but appears in the world that it co-constitutes, in which humans are always already intentionally involved as users, innovators and operators.

In the philosophy of technology, such broad understandings of technology have been developing for over a century, starting with the first generation of Ellul, Anders, Heidegger, Benjamin and others (Achterhuis et al., 2001). Later, insights from cybernetics were used in Simondon's conception of technology. Also, influences from biosemiotics such as Uexküll's studies made an early entrance in this tradition. Recently, the term "Technocene" has been coined to describe the novel environment where technology forms the entire habitat, or *oikos*, in which humankind has to live (Cera, 2017). This oikological conception considers how humans have had to adapt historically to their technological surroundings just as animals are evolutionarily shaped by their environment. Cera puts it clearly in the following quote: "In this context the term 'technology' does not indicate the sum or addition of single technologies, rather it outlines the worldview and ideology that has made these possible and that manifests itself as a particular historical circumstance" (Ibid.). As a final example, Stiegler drew from insights in epigenetics to develop his own understanding of technology. Drawing from the tradition of the philosophy of technology, in the following we will explore the idea that technology co-constitutes a meaningful world that humans are involved in intentionally (Blok, 2022).

Whether it is a biorefinery, a nuclear plant, a field of solar panels, a vertical farm or a meadow of windmills, in each case an innovation emerged as central node for

specific economic, social, political and environmental processes. Neglecting the reality of the world in which technology is immersed leads to significant conceptual inconsistencies such as conceiving of a bioeconomy completely in terms of technology. Climatic instability is an all-encompassing dilemma which concerns technological, ecological, natural, economic, social, historical, political and cultural aspects and cannot be pinpointed as an issue repairable by a technologic solution. A habitable biosphere is composed of myriads of ecological processes we only partly understand (Langmuir & Broecker, 2012). The global infrastructure of technological equipment, furthermore, has been built over centuries in narrow reciprocity with the affordances provided by this natural environment and by generations of humans closely manipulating varying aspects of it such as heat, elemental conditions, distance and energy (Clark & Szerszynski, 2022). Overshadowing these worldly complexities by primarily focusing on isolated instances of technological solutions, as ecomodernism tends to do, is effectively designing a technology-based economy, or a biotechnology-based economy, rather than a biobased economy.

The excessive focus on technological innovation in the context of climatic instability can be largely explained from our current economic paradigm, in which technology is consistently understood as a means to realise economic growth. The biorefinery is viewed as sustainable when it reduces the use of fossil energy sources and as a failure when it is still dependent on those resources. The biosphere is, then, always considered first and foremost as a source of energy for economic activity and not as an ecosystem boundary condition that limits economic growth. The analyses above raise legitimate criticisms and are correct in stating that a social element is, among other aspects, lacking from current bioeconomy strategies. However, although it has been scientifically clear since the eighties that our economic processes are unsustainable, the techno-fix solutionism of ecomodernism still remains the dominant paradigm today. Therefore, our question here concerns the self-evident dominance that causes these strategies to be the only ones actually put into practice today: why is the ecomodernist approach the dominant one and what kind of a critique is required to enable a transition into an economic system that actually operates within the limits of the biosphere?

Degrowth theory diametrically opposes the ecomodernist narrative and its emphasis on technological innovation by arguing that if the BBE is to realise its primary ambition of transitioning into a new, sustainable, biobased production paradigm, it should be oriented on fundamentally revised economic structures altogether, i.e. shaping a new "world" of doing economy, instead of relying on the worldview of techno-optimism. Degrowth does not, however, actively question the economic assumptions on which techno-optimism is built or provide any feasible programme explaining how this radical, minimal, plant-based way of doing economy should work. To obtain conceptual consistency regarding the foundation of the BBE it is necessary, rather than asking which of these paradigms suggests the superior strategy, to critically investigate the fundamental premises of techno-optimism at play in the BBE.

By having indicated the ecomodernist worldview to be overly focused on technological innovation and having explained that such a perspective is too narrow to assess the global situation in which any bioeconomic activity is located, it has

become clear that an encompassing worldview is lacking from current conceptualisations. In the following, we will explore the hypothesis that technology itself is not the issue but, rather, the economic exploitation of technologies in the pursuit of profit, making it so that every investment into sustainability continues to be indebted to the paradigm of economic growth.

The current global situation, especially in reference to climate, economics and technological development, has been more and more referred to as "the Anthropocene" (Malhi, 2017). Discussions about the Anthropocene's exact nature are ongoing, but in general, the term designates a new geological time period, characterised by increased human impact on the environment to the extent that human activity has become a geological force, more significantly shaping the Earth than "natural" processes do (Crutzen, 2006). In fact, the term "Anthropocene" also indicates the gradual disappearance of the difference between humanity and nature, as all of "nature" is now touched by humans, calling for a new understanding of *world* (Blok, 2019). Many industrial and chemical processes influence the biosphere's ecosystems at an accelerating pace, increasing the likelihood of hitting ecological tipping points after which global socio-economic catastrophes will be inevitable (Steffen et al, 2015). Economic growth can be seen as a major driver behind the human influences on the planet of climate change, biodiversity loss, resource scarcity, waste and pollution. The strong link between (limitless) economic growth and industrialisation, starting in the Industrial Revolution, results in ecological destruction because costs are externalised onto the environment.

The ideal of the BBE is to establish an "economic metabolism" that operates within the carrying capacity of the biosphere, in which all used materials provide renewed inlet for the following production cycle. The idea is that if human, economic processes were similar to biological processes, such as circular ecosystems and energy cycles, they could operate within the physical limits of the planet instead of exceeding them as we currently do (Asveld et al., 2019; Pfau et al., 2014; Zwier, 2021; Veraart & Blok, 2021a, 2021b). Our hypothesis is that, in order to answer to the new situation of a world that has entered the Anthropocene, a philosophical perspective is needed to make sense of the fundamental relation between economy, technology and the human condition. Here we are inspired by Bernard Stiegler, who developed a theory of the libidinal economy in his more recent writings. In the following, we will present Stiegler's theory and explain how the controlled and therefore exhausted collective libido created and sustained by consumerism on the open market can be seen to be the fundamental reason for the current, excessive trust in technological redemption and the immoderate focus on materialistic gain and economic productivity. Accordingly, we will be able to demonstrate how a theory of corrupted human desire as lying at the root of our failing to 'save the environment' can offer significant explanatory power to the BBE-debate and open up a dimension that still remains unexplored.[1]

[1] Stiegler has, in his later work, written about the environment himself (Stiegler & Ross, 2013). Although informed by this work, it is not within the confines of the current research to elaborate on these theories as well. Rather, we focus on his theory of the libidinal economy only and apply it to the situation of the BBE, which Stiegler did not do himself.

3 The Libidinal Economy

Bernard Stiegler has written substantial works in the philosophy of technology. His major theory on how the human condition is fundamentally technologically constituted was published in the *Technics and Time* series (Stiegler et al., 1998, 2008, 2011). Relevant here is that Stiegler combines the notions of economy, desire, politics and technology in a way that can provide new insights into the concepts of the BBE. Building on the psychoanalytic tradition, principally on Freud (cf. Featherstone, 2020; Ross, 2020), Stiegler finds that beyond political systems and processes of production, consumption and distribution, it is ultimately human desire that shapes an economy. In Stiegler's theory, every economy of production and consumption as we generally understand it is always also a libidinal economy, i.e. an economy of *desire*, desire being the principal driving force of all human endeavours. He argues that economy is always also primarily a technological matter, since economy is always a question of desire and libidinal energy, which, for Stiegler, are technologically constituted from the outset. Later, and most succinctly, in *For a New Critique of Political Economy* (2010), Stiegler coalesces his fundamental philosophical theories of technology, economy and humanity into an essay that provides an analysis of what he calls the toxic, indeed, corrupted state of current capitalist techno-economic systems. In the following, we will explain how a perspective on desire as a principle aspect of economies—including any *bio-based* variant thereof—has significant explanatory power regarding the failure of truly biobased practice.

To understand the function of desire in the libidinal economy as Stiegler conceives it, it must be contrasted to urges, wants or needs which humans share with all other animals. Basic needs such as hunger, warmth, itch, lust and sleep can be satisfied. Such needs are *finite* as they can be solved with a conclusive solution, mostly in the form of a certain object like a bed to sleep or a drink to quench one's thirst. In contrast to such concerns about concrete things, desire is about our relation to ideas and ideals, such as truth, justice and beauty. Objects of desire are things that cannot simply be fulfilled or satisfied by any concrete object. As such, desire concerns those grand, human yearnings that are in a sense *in-finite* (Stiegler et al., 2010, 42). A search for beauty by an artist, for example, is never finished. Rather, the more beauty is discovered, the more possibilities are opened. Ultimately, Stiegler will argue that the problem of political economy today is the systematic substitution of infinite desires by finite, addictive needs and wants. Desire concerns the deep themes of human existence and fuels humans with libidinal energy, i.e. motivation, the will to excel and passion for justice, the will to truth, etc., as such giving shape to societal, political, economic and policy-related structures. To understand how infinite desires focused on long-term goals are systematically exploited today and replaced with finite drives aimed at—or, rather, addictively attached to—short-term satisfactions, causing libidinal toxicity or corruption, we must first explore in more detail the conceptual background on the basis of which Stiegler makes this claim. Subsequently, we will be able to explain how these tendencies are also at play in the BBE.

Desire poses an endless opening in human existence, which is always underway, always becoming, developing, never finished. As such, desire always

concerns a principally infinite temporal extension into the future. Desire is such an important concept in understanding Stiegler's critique of the current global economic system because he understands the concept of economy in general to always designate a system producing *protentions*, existential relations directed towards the future, indeed in the form of desire. Stiegler's understanding of the concept of desire and protention builds on the phenomenological tradition, in which Edmund Husserl introduced the central concept of intentional consciousness (Hansen, 2009; Husserl et al., 2001). That consciousness is intentional, means here that it is always related to something else, some object, thought, memory, perception or symbol. To these principal relations of intentional consciousness always belong the temporal dimensions of retention and protention. Retention is the relation of consciousness to the past, shaping the whole of a conscious moment by involving memories, associations and chronological continuity. Protention is the relation of consciousness to the future, involving our hopes, longings, anticipations, expectations and wishes. In capitalism, for example, the economic relation towards the future is shaped by entrepreneurs producing goods for the consumer market aiming to make a profit, and by consumers anticipating new products for purchase and investors looking for opportunities of return.

Because intentional consciousness, or attention,[2] is always directed-at-something, the wholeness of an individual experience is always determined by the specific retentions (memories, associations, interpretations) and protentions (objectives, expectations, wants) a particular individual has accumulated in their life. Each individual has a specific set of protentions constituting the way in which they conceive of and live towards the future. For example, people will listen differently to the same song or have different thoughts when attending the same talk because from their individual backgrounds—containing different retentional funds—they perceive something different (Stiegler & Ross, 2013: 86). Since the composition of specific re- and protentions that an individual has accumulated in their lifetime differs per person, Stiegler refers to the whole of a consciousness as having been shaped by re- and protentions as a *process of individuation.* An individual is the unique combination of specific re- and protentions, gathered and combined in a unified, indivisible experience (Stiegler et al., 2010, 93).

For Stiegler, an economy is a system that first of all produces protentions. Objects of need and desire are created on the market, determining what can be desired, anticipated upon and longed for. It is the way in which these objects are produced that is crucial here, because technological objects, in Stiegler's words, "materialize experiences" and select and carry over specific knowledge and praxis over the course of human generations (Stiegler et al., 2010, 8). From the very first

[2] In Husserl's phenomenology, on which Stiegler builds, "intentional consciousness" and "attention" do differ significantly in meaning. For the purpose of this paper, however, these terms can be understood in a similar fashion as the main focus is on Stiegler's understanding of it. The main difference between Husserl's and Stiegler's conceptions of attention is that for Husserl the term is more used to describe temporal turning points in the structure of consciousness, whereas for Stiegler attention is more connected to desires and protentions that have a more political meaning, such as a care for the future (Sá Cavalcante Shuback, 2006; De Giovanni, 2018; de Preester, 2021).

flint tools onwards, technological artefacts have formed an inheritance system of materially inscribed experience, conserving the information and applications discovered in each individual's lifetime as a legacy for the future. The point of this technological genealogy is that protentions, retentions and economic processes are *themselves* technologically conditioned structures of existence. Specific practices, skills, habits and behaviours are stored in external artefacts, functioning as intergenerational memory carriers. As time progresses and technological knowledge accumulates and what is remembered through the system of technology becomes more and more particular; certain innovations, once emerged, continue to shape human potential, affordances and behaviour over centuries. These new instruments containing practical knowledge from the past (e.g. combustion engine, internet) never disappear but are updated, improved and recreated constantly. Over time, more and more technology becomes a standard for the techno-economic landscape in which new individuals are born (Lemmens, 2017).

At this point, it is necessary to address the twofold meaning of the concept of "technology" in the context of Stiegler's theory. Because, within Stiegler's theory of technological genealogy, the term "technology" can indicate both the (ontic) level of particular technological artefacts (such as piano's and biorefineries) and the (anthropological) level of "technology" as a way of approaching the world (techno-fix). Building on Simondon's theory of individuation, in which technical artefacts possess a tendency towards organisation, for Stiegler technological artefacts bring about changes in the human condition (Scott, 2014). As processes of individuation proceed through technologically conditioned frameworks of intergenerationally selected knowledge and praxis, human identities (individual, psychic and collective identities) are shaped by the objects conditioning their worldview—one could think of social media as an explicit example (Stiegler & Ross, 2013). This techno-genealogy does not only concern specific objects that individuals interact with but also affects cognition, libido, group forming, polarisation, voting, entertainment and all other kinds of human behaviours. Industrial machinery automates physical labour, for example, and therewith opens up a vast range of possibilities, not only on the individual level. Digitalisation, to take another example, automates cognitive processes—which is having major impact on social, psychic and economic systems. This is why, within an economy, where protentions are produced, Stiegler speaks of individuation processes as shaping *libidinal circuits*. These are circuits in which technological artefacts give rise to new, technologically conditioned, existential, political and economic structures in the world, including consumption patterns, decision making processes, policy, marketing, religious convictions, etc., significantly shaping societies. This means that the human condition is being shaped and co-constituted by technological objects.[3]

New audio-visual technologies such as mass media and marketing are used both to persuade consumers to buy more and to have them introduce these technologies

[3] Although this concise explanation is necessary for the completeness of our argument, the discussion about ontic and ontological technologies is an advanced topic in fundamental philosophy on which entire books are (being) written and as such leads beyond the scope of this paper.

in their daily lives, reinforcing the cycle of being affected by those technologies. Because, according to Stiegler, these technologies condition our re- and protentions and shape the whole of intentional consciousness, i.e. of attention. As objects of desire are constantly mass-produced and marketed in the form of videos, movies, TV series, advertisements, games, apps, etc., but also as material "gadgets", our psychosocial protentions are reduced to becoming functions in the endless cycle of production and consumption. Principally tasked with endlessly promoting and accelerating consumption, modern media technologies become increasingly short-termist, narrowing our attention and feeding it with fabricated fantasies. For Stiegler, this means our very memory and the way it functions is affected by technologies such as photography, film, YouTube videos and other analogue and digital technologies, and our very anticipations, hopes, phantasies and dreams are affected by such technologies employed in advertisements and marketing.

Human psychosocial systems in general constantly have to adapt to novel technical systems, the innovation speed of which constantly accelerates. Technologically conditioned protentions shape libidinal circuits and therewith the identities of both individuals and collectives. There is no longer a central institution, such as a government or a church that interferes in this vicious cycle but the bare ratio of supply and demand, i.e. the market. As such, the influences of technologies on the human psyche (i.e. on intentional consciousness, attention, re- and protentions and on collective identities) accumulate exponentially (Lemmens, 2014; Stiegler et al., 2010). The formation of individual, psychic and collective identities now proceeds via elaborate information networks, imagery and many other innovations (Stiegler et al., 2010, 42–45). This is the *libidinal economy*: the technologically constituted system of (collective) protentions being produced. Looking ahead at our final argument, we can already imagine how biorefineries are just another technology immersed in the macro-process of the techno-economic conditioning of collective structures of desire.

To understand Stiegler's thesis regarding the transformation of desire through libidinal circuits in an economy, we must recall the distinction between needs as aimed at finite objects and desire as aimed at infinite "things" such as beauty, freedom, morality and truth. Circuits of desire can either be *short* and *finite*, for example the instant gratification of drinking a soda, or they can be *long* and in principle *infinite*, for example when practicing the piano for years with the goal of becoming a professional piano player, only ever learning more, never being fully satisfied or finished. In both cases, there is a relation with material objects determining the protentions of the subject's consciousness, but one is short, quick, for instance aimed at a sugar rush, quenching thirst and enjoying bright colours, whereas the latter is, for instance, a lifelong relationship with an instrument that only ever becomes deeper the more one learns, or constantly improving a scientific or philosophical theory. These latter, long circuits of desire are also at stake in matters such as freedom, truth, beauty, morality and the very "meaning of life". Short-circuited desire structures prevent structural investments in the benefit of the long-term community, which is especially problematic in the context of sustainability.

Stiegler's point is that over time, more and more long-term, cognitive, intellectual libidinal circuits aimed at infinite "objects", be they political, scientific, artistic,

erotic or of any other sort, have been replaced more and more with short-term circuits aimed at instant gratification, based on impulsive and finite urges. Every economy is a libidinal economy but in our contemporary, Western economy, something has happened that caused desires to be (dis)organised and degraded into drives. People today buy lots of things, not because they need them, but because they crave them, almost as an addiction. This means that libidinal structures of desire are no longer aimed at long-term, sustainable investments but more and more at instantly gratifying objects. The problem is that these disposable or excessive objects require an infrastructure of industry and commercialism to be produced. Moreover, an economic system that revolves around providing objects of short-term desires is itself ruled by such short-term urges, affecting policies, decision making and production systems alike. In our (current, Western) version of a libidinal economy, libido has become corrupted, exploited and exhausted, altered by techno-economic development and constant, profit-driven innovation and directed at short circuits provided by marketing. The theory of the libidinal economy might explain the fixation on technological innovation of this technofixism. Therefore, the question becomes: if the situation of libidinal short-circuiting applies to our current economic situation, what does that entail for the biobased economy?

4 The Limits of Technology and the Environment—the Libidinal Economy in the BBE

The fundamental connection between technological innovation and economics is, of course, not something first noticed by Stiegler, but has long since been observed by economists such as Karl Marx[4] and Joseph Schumpeter. In the industrial capitalist system, production becomes so efficient that it reaches a limit, which implies a limit to profit.[5] Businesses need to constantly adapt and innovate to be able to compete on the market. If nothing changes, economic growth stagnates. This is why, according to Schumpeter, the "capitalist enterprise" and "technological progress" are "essentially one and the same thing" (Schumpeter, 1943, 110). In order to realise economic growth, new limits of efficiency must be discovered to overcome the previous ceiling. This is what Schumpeter famously calls "creative destruction". Although without involving the libidinal perspective, Schumpeter identifies a cycle in which entrepreneurs explore and exploit innovations to achieve a temporary monopoly. These innovations are then copied by large firms, necessitating new innovations once again by entrepreneurs. This cycle of competitive technological innovation is

[4] The reason we focus here on Stiegler and not (only) on Marx is that Stiegler adds a perspective of original technicity in a non-instrumentalist manner, working further on the development of the philosophy of technology. Additionally, Stiegler's libidinal perspective enables a critique of political economy with an emphasis on its technological condition specifically. Stiegler does not offer a final answer, but his perspective is fruitful in this specific context.

[5] Picking up on analyses developed both by Schumpeter on the law of diminishing return and by Marx on the tendential fall in the rate of profit, Stiegler elaborates on these economic workings significantly. Explaining these in detail, however, fares beyond the scope of the current research.

what essentially drives the economic system: "The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organisation that capitalist enterprise creates" (Schumpeter, 1943, 82).

Another classical observation about the relation between technological innovation and economics that is significant here is the impasse known as Jevons' paradox (Alcott, 2005). Conceived of in 1905, when structural effects of the industrial revolution were becoming noticeable, Jevons noted that when a new technology increases efficiency of production, total consumption *also* grows. This is paradoxical because usually, in economics, supply and demand are supposed to balance each other out; if something is produced more easily, production costs should go down and therewith consumption should increase up until a stable limit. However, in practice, increase in efficiency will lead to *increase of both production and consumption* instead of, for example, using the excess energy for sustainable practices. Moreover, Jevons' paradox is especially problematic in a sustainability context because here, if production processes become more efficient (e.g. biofuel is obtained more easily), demand rises along with supply and net pollution will still go up, making the system de facto less sustainable.

The notion of the libidinal economy can help to makes sense of Jevons' paradox. The continuous chase of novelty is a fundamental driver for businesses competing on the market, which undermines an equilibrium of supply and demand. In a system where people chase their short-term, ever-changing desires to consume, there will always be enough demand and so production processes can never become overly efficient and will keep supplying products aimed at short circuits of desire. As everything can always be sold to anybody in this short-term libidinal economy, the self-reinforcing cycle of economy and technology has no principal limits except for the natural environment because the short-circuit, frantic production system makes use of the biophysical systems of the planet both as resource and as waste depot. As long as environmental problems are in the first instance seen as market failures, the solution to these failures is found within the economic paradigm, in which the environment is seen as a subset of human economy, i.e. as a resource for production (Blok, 2018). So long as the economy is not understood as a subset of the ecosystems of planet Earth, technological innovation in itself can never pose a sufficient answer to the climate crisis.

The examples of Schumpeter's creative destruction and Jevons' paradox show how the technological and environmental limits to economic possibilities have already been clearly indicated in the past. But as it becomes more and more obvious that human efforts to counter climatic instability are having insignificant effects, it should be explained why our species is collectively failing to have any real sustainable impact. Stiegler's theory of the libidinal economy enables us to reflect on these ecological limits from a perspective seldom employed in the context of the BBE. This perspective can help to shift away from the conventional focus on inventing the best innovations to solve environmental problems. Stiegler's perspective enables a reflection on the very mode of human existence, being adapted and modified over generations due to the very systems of economy and technology surrounding and conditioning human beings on an intentional and libidinal level (i.e.

of consciousness, attention, desire). The notion of the libidinal economy allows for biobased practices to be viewed from the existential standpoint of a species that is collectively conditioned to chase short-term desires, paralysing itself to make structural investments for the far future.

As complex as Stiegler's philosophical analyses might appear, seeing how a degraded mode of desire is principally at play in current bioeconomic practice is in fact quite evident. If we return to the case of the biorefinery, we can see that this also is an institution of production, akin to what Schumpeter and Jevons observed. Certain targets must be met for the factory to prove its functionality and for more investments to be obtained to continue its existence. Energy output must hit certain levels for stakeholders to remain interested; the refinery must deliver more resources than it uses each financial quarter, employees must be paid, bio-nutrients must be obtained (while not going at the cost of food nutrients) and so on. A biorefinery that is sustainable but not economically viable goes bankrupt. Without a feasible business case, a BBE cannot come off the ground because BBE frontrunners would have to close down before a sustainable transition can take place (Blok, 2022). Although a biorefinery could, in principle, constitute a meaningful step towards the long-term ambition of sustainable energy supply, it remains another institution of production operating on the free market, having to deliver on short-term goals, to come up with innovative developments and to guarantee financial growth in the foreseeable future in order to keep running at all (cf. Bos et al., 2010; Schieb et al., 2015; Dornau et al., 2020). These short-term economically pragmatic necessities suggest that the economy is not so much *based on* the biosphere but, vice versa, the biosphere continues to be exploited in the service of economy.

In the project of the BBE, the very survival of humanity is, at least implicitly or intuitively, at stake. Currently, the existential dimension of future human existence on Earth is not addressed in either major policies or critical literature. The notion of the libidinal economy can help to clarify this conceptual discrepancy. For example, an encompassing study of biorefining lists the sustainability challenges of the undertaking and concludes: "Ultimately, sustainability can only be achieved on a global scale, across all sectors, over very long time frames. But it is important to recognise progress in the field of sustainable biorefineries towards this ultimate goal" (Holleman et al, 2014: 12). The problem is that sustainability is a normative concept here, describing the world not as it *is*, but as it *should be*; but the BBE does not take on this normative task explicitly, which would mean actually *basing economy on* the biosphere. Instead, the BBE is merely understood as a guideline for resource-optimisation and so, in practice, everyday survival on the open market takes precedence over normative sustainability (Blok, 2020; Veraart & Blok, 2021a, 2021b; Zwier et al., 2015).

Within a short-circuit libidinal economy, it is precisely these normative concepts of "very long time frames" and an "ultimate goal" that will not be accomplished. As long as the BBE essentially remains caught up in traditional economic practices such as constant innovation, meeting targets of energy production and competing with other energy producers, the drive to efficiency and short-term results in a fuel and growth-focussed paradigm of economics still completely determines the workings of the system. Within this configuration, because neither the BBE nor the

biorefinery even discuss such long circuits of desire, it is implausible that long libidinal circuits will emerge from it. Still, the talk of "very long time frames" in the context of "an ultimate goal" might itself be understood as a long-term libidinal circuit. If—hypothetically—an economy could be conceived that is oriented on long circuits and ultimate goals, allowing for long-term investments, a normative version of a bioeconomy could work infinitely towards a more sustainable system. This would require a collective effort of recognising and acting according to long-term desires. Within the current libidinal economy, however, it is questionable whether long-term oriented individuals could unite this orientation into political action.

As a mere example of BBE-practice, the biorefinery is of course not responsible to realise the structural ideal of establishing an actually sustainable bioeconomy. Yet, the very absence of such an ideal is symptomatic of the issues at stake in the encompassing transition of which it is an instance. This is not a problem caused by any individual working in a biorefinery, nor even one of collective decision-making around bioeconomy objectives at large. Such individual and collective identities are all part of the encompassing libidinal economic system that conditions the very modes of desire and consciousness of the subjects partaking in the network. Moreover, techniques of individuation obstruct the organisation of collective, long-term libidinal circuits. Each human identity working at the project of the bioeconomy is individualised through short-term desire-circuits (salary, profit, cost-effectiveness of biorefinery on the open market, etc.) obscuring any joined long-term perspective or action. Whether a biorefinery employs diesel-powered trucks to import waste materials across the continent, spends government grants on short-term finances, is managed by huge companies operating on the profit-driven industrial market, or even resorts to the burning of whole tree trunks or animal parts to reach the desired energy output (cf. Schieb et al., 2015; Dornau et al., 2020), all these unsustainable practices can be better understood with the addition of the notion of a corrupted libidinal economy short circuiting subjects' attention.

Because the theory of the libidinal economy applies to individuals as well as collective organisations, in the context of the BBE, it can help to make visible a lacuna in the dominant way of thinking about the BBE in two major versions, ecomodernism and degrowth (Vivien et al., 2019). The two paradigms are generally posed as being mutually exclusive, but have more in common than appears prima facie. Both ecomodernism and degrowth frame the problem of and the solution to climatic instability in terms of *natural energy*, i.e. fuel, or what Stiegler would refer to as the "energy of subsistence" (Stiegler & Ross, 2013: 91). Ecomodernism argues we should continue using our technologies to obtain plenty of energy so that we might innovate ourselves into a sustainable future one day. Degrowth theory argues we should abandon many energy-consuming processes and focus all resources on long-term survival, meanwhile living less energy-hungry lives. But the framing of the BBE in terms of the binary opposition between degrowth and ecomodernism excludes a third possibility.

On the basis of the theory of the libidinal economy, it can be argued that in addition to the practical problem of replacing fossil fuel-based energy production systems by renewable ones, a renewal of *libidinal energy* is necessary. On the one hand, libidinal, i.e. social, passionate energy is the source of energy for the free market

to thrive, motivating subjects to do business and grow wealthy. On the other hand, these processes are destroyed by the consumption model of marketing, i.e. infinite desires that constitute our relation to long-term goals are disrupted by the short-termism that short-circuits libidinal circuits. Within such a corrupted version of the libidinal economy, replacing fossil fuels with renewables will not lead to sustainability because the economic system at large is still growth-oriented and will always continue to exhaust resources for short-term gain.

Without a critique on the libidinal economy, all conceptualisations concerning the BBE remain caught up in the paradigm of natural energy.[6] Even the fiercest opponent of this paradigm, degrowth theory, can be seen to adhere to it to some extent. By focusing mainly on consuming less, degrowth is caught up in a negative dependency regarding ecomodernism: it is mostly focused, via *negativa*, on what should *not* be done, without offering itself a constructive, alternative paradigm framed beyond natural energy. Accordingly, degrowth theory often seems to tend to an "anti-technology" stance.

By showing how both ideologies share the orientation on consumption and technology within the paradigm of natural energy, a third position regarding technology beyond this dichotomy becomes visible: a libidinal one. The paradigm of control, growth, efficiency and fuel has been hardwired into our collective memory through the economic designs of institutions, laws, production equipment and other infrastructure. Human attention in general has co-evolved with the technologies from the dominant ecomodernist paradigm. This provides an answer as to why it is impossible to suddenly change back or forward to a mode of long-term mode of economy in which radically less technologies are consumed. What this comes down to, then, is that ecomodernism is correct in stating that we need to keep employing technology but incorrect in stating that the current techno-economic, free market orientation is the correct way of achieving sustainable development; accordingly, degrowth theory is correct in stating that we need to drastically alter our modes of living, but requires a focus also on the libidinal dimension to conceptualise a strategy beyond "abandoning" technologies or reverting to a state of minimal, plant-based economic existence.

Currently, as a bioenergy fuel economy, the BBE completely adheres to the problematic libidinal structures at play in the ideal of the techno-fix and ecomodernism, making it unlikely that this system will one day become sustainable. Even if the BBE were to explicitly be a project of first establishing humanity's survival before working on the establishment of long-term libidinal circuits, as ecomodernists might argue here, this cannot be the logical order of transition. Sustainability should from the outset on serve as a normative principle, inspiring long libidinal circuits for a future economic system. Framing today's energy problem in terms of *fuel* is perpetuating the past paradigm of limitless growth (of fuel) in the incommensurable, current situation of the environmental crisis. Surely, natural energy production is important for humanity to subsist, but besides that fact that lots of energy is used to satisfy short-term urges, it might not be the *only* relevant solution. Such seems to

[6] Introducing this demarcation, from here on out we will be distinguishing between "natural energy", as fossil or biobased *fuel*, and "libidinal energy", as social, passionate energy concerning human desires.

be our ironic fate that the most short-term oriented humans that have ever lived are tasked with the most long-term challenge humanity has ever encountered.

We cannot abandon the technical systems that have shaped us overnight, as might seem the wish of degrowth theory, but neither can we keep designing the technical systems in the way of the last century, as this ecomodernist paradigm of overproduction, overconsumption and excessive pressure on both the climate and our own consciousnesses has long since run its course. The short-circuits that run the BBE will, by definition, not survive the wear of time as fossil fuels will drain and chronic innovation will replace them anyways eventually. The question for the BBE is, then: what is the "ultimate goal" of a biobased economy? What is the BBE *for*, what is at stake? Even though BBE policies need not explain how humans have to live or why, it must have an answer here. Currently, the point of installing circular processes everywhere seems to be *for humans not to die*. This is a short-term goal. Of course, we must first eat and breathe and survive (maybe even producing some unsustainable energy in the process) before fulfilling higher life goals, but the objective of vegetative persistence or also includes the existential dimension, always being implicitly at stake: if we remain alive, what is that life worth living for? If it is to pursue short-term urges, not only will we be frustrated, addicted and unhappy, but neither will we survive as we will not have the attention to create sustainable long circuits. The macro-project of transiting into a new era of energy-use of the BBE might require, besides the replacement of linear by renewable fuels, nothing less than a revolution in libidinal energy. In the face of the finitude of our habitat, we might indeed require *limitless*, *infinite economic growth*, but not necessarily in first instance of fuel, but of a different kind of economic energy altogether: libidinal energy aimed at long-term goals, infinitely improving itself.

5 Conclusion

We began by discussing the different conceptualisations of the biobased economy, showing how the ecomodernist version is dominant and concretely put into practice today and how degrowth theory still remains only a concept. We discussed the biorefinery as a prime example of contemporary biobased practice, criticising its techno-industrial—rather than *biobased*—approach to energy. This led us to ask why ecomodernism constitutes the dominant paradigm and what would be needed for a truly sustainable economic system to be created (Sect. 1). Accordingly, we turned to some critical literature to show how the framework of the BBE is overly narrow and insufficiently inclusive. Adding to this, we argued also that an existential dimension of desire escapes the BBE perspective, emphasising the need for an answer to the question as to why humanity is collectively failing to transit into a sustainable economy (Sect. 2). Introducing a philosophical concept useful to analyse this question, we consulted the theory of the libidinal economy by Stiegler. This theory explains how the most fundamental reason for our collective failing is that the human mode of desire has been corrupted through multiple generations of technological structures adapting our very consciousnesses in such a way that long-term circuits, aimed at infinity, are systematically

replaced by short-term circuits, aimed at instant gratification (Sect. 3). Finally, we applied Stiegler's theory of the libidinal economy to the context of the BBE, arguing that a humanity caught up in short-term, drive-based, addiction-like impulses can never produce the long-term, sustainable structures required for the implicit existential goal of the BBE. We stated that both the degrowth and the ecomodernist conceptualisations of the BBE thematise the problem and solution of climatic instability in terms of natural energy, whereas conceiving of the stakes in terms of energy as libidinal, human energy offers a more encompassing and adequate perspective to criticise current practices (Sect. 4). With this, we received an answer to our main research question. The theory of the libidinal economy explains the dominance of ecomodernism, because it is based on short-term, drive-based desires. The alternative of degrowth theory is in need of including the libidinal dimension if its conceptuality is to transcend the framing of the paradigm of economic growth and natural energy. The analysis in general shows that what is needed is a departure away from short-circuit-based natural energy and towards a long-circuit economy of libidinal energy.

The economic system primarily oriented on growth once appeared as an infinite potential where actors on the market were free to chase their desires for profit and the endless accumulation of wealth through increasing production and consumption. Ideally, this system even provided wealth and well-being for society as a whole. But today, more than a century later, as our libidinal systems have taken on the short-circuit properties of this system of permanent innovation, the global situation no longer allows for this type of economics to flourish as it runs up to biophysical limits. The ever accelerating, ever updating and everchanging production of objects and profits depends upon the environment for resources and as a waste depot. In a deteriorating biosphere, the chase of short-term desires poses the exact opposite of what would be needed for sustainable human life or even for healthy libidinal human life at all.

Industrialised humanity has, over generations, become caught up in a self-reinforcing cycle of technologies and economics, completely in the mode of the paradigm of economic growth and natural energy. The idea that a techno-fix could repair the biosphere, stemming from an outdated—yet still currently dominant—paradigm, is a harmful figment of corrupted imagination and structures of desire. Convinced as we are by individualised imagery and personalised advertisements that we are expressing our unique identities through the purchase of the latest shiny objects, the all too human illusion of autonomy and control remains intact while we consume ourselves and the planet towards the end. In fact, it is not even the case that we consume too much but, rather, we are ourselves *being consumed* by our very own subconscious drives, which have been brought to the surface of economic function under the purpose of profit. Remnants of a techno-economic model created more than a century ago are finally catching up to collect a significant debt. At the very least, the current analysis shows that the existential dimension of human consciousness and desire (conditioned by intergenerationally accumulating technological knowledge and infrastructures) is a relevant, yet heavily underarticulated dimension of a project such as the BBE. Whether acknowledged explicitly or not, the BBE is a project in which the survival of humanity is at stake. But merely surviving means, in this context, to continue toxic, short-term libidinal circuits and precisely not to work

collectively towards the infinite goal of establishing a techno-economy within the limits of the biosphere.

What could a bioeconomy embedded within a long-circuit libidinal economy look like? To answer this question following from the analysis, future research is necessary. However, it seems clear that a fundamental role is played here by *technology*. On the one hand, our corrupted desire is technologically constituted and transformed. On the other hand, this does not exclude the possibility of future transformations in the human relation with technology. Technology and long-term circuits do not necessarily exclude each other, as is made clear by the example of the infinity involved in playing an instrument as an alternative to technological consumption and exploitation. The question is then whether it is possible to re-condition libidinal structures via technology. Attempts should be made to conceptualise a biorefinery according to long-term desire-structures aimed at infinity. It should then be explored which long-term structures remain conceivable within our current technological constitution. Regarding Stiegler's theories, in this context his notion of "pharmacology" should be further explored, as this notion means that technological systems, structures and circuits constitutive for identity are always both the toxin and the remedy, offering possibilities both of corruption and of salubrious therapy.

Abbreviation BBE: Bio-based economy

Author Contribution RV carried out the main research, determining the topics and drafting the manuscript and rewriting the text on the basis of feedback received. VB provided detailed feedback on each of the drafts iterations, offered literature recommendations from his expertise and helped shape the general argument. PL is an expert on Stiegler and verified the philosophical analysis dealing with Stiegler's concepts, insuring it was accurate and coherent.

Funding The contribution of Blok is part of the research programme Ethics of Socially Disruptive Technologies, which is funded through the Gravitation programme of the Dutch Ministry of Education, Culture, and Science and the Netherlands Organisation for Scientific Research under Grant number 024.004.031.

Data Availability The data that support the findings of this study are available from the corresponding author (all relevant data are in the manuscript).

Declarations

Ethics Approval Approval was obtained from the local ethics committee.

Consent for Publication All authors provide their consent for publication.

Conflict of Interest The authors declare no competing interests.

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