Bioeconomy Beneath and Beyond: Persisting Challenges from a Philosophical and Ethical Perspective

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Abstract

The concept of bioeconomy is currently discussed worldwide as an attempt to solve global problems relating to climate change, ecological crisis, and global population growth. Bioeconomic applications are of enormous range and affect key sectors of society, such as the food and feed sector, the energy, transportation and construction sector, the chemical sector as well as the textile and clothing industry. Social and environmental justice are meant to be central aims of the concept of bioeconomy just like sustainable economic growth and prosperity. But as promising as the concept of bioeconomy may sound, it still faces various challenges, both from a more theory-driven philosophical perspective and from a rather application-oriented ethical point of view. The present study analyzes persisting philosophical challenges underlying the concept of bioeconomy in view of tensions concerning the relations between economy and man as well as between economy and nature and reveals bioeconomic promises and disillusions. Persisting ethical challenges are scrutinized on the basis of the Precautionary Principle (PP), the principle of Responsible Research and Innovation (RRI) as well as the differentiation of a technological and a behavioral fix. Eventually, it is argued that bioeconomy is no panacea. What is needed rather is a great sustainable transformation to globally address the urgent ecological, social and economic problems of the Anthropocene.

Keywords

Bioeconomy and philosophy · Bioeconomy and ethics · Great sustainable transformation

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1 Introduction

Among the most challenging threats for humanity living in the Anthropocene are climate change, ecological crisis—along with the destruction of nature and biodiversity loss—and food security for a growing human population. At this point in time, the most prominently discussed concept worldwide to address these challenges is the concept of bioeconomy. It is of enormous range and affects key sectors of society, such as the food and feed sector, the energy, transportation and construction sector, the chemical sector as well as the textile and clothing industry. Within the concept of bioeconomy very important issues such as the allocation of renewable, climate-friendly energy- and resource-supplies as well as the rejection of the current dependency on fossil resources like coal, oil, and gas are addressed just as the global food situation. Furthermore, social and environmental justice as well as sustainable economic growth and prosperity are listed as the most prominent aims of the concept of bioeconomy.

However, as promising as the concept of bioeconomy sounds, there are various persisting challenges discernible both from a more theory-driven philosophical perspective and from a rather application-oriented ethical point of view.

In what follows, general philosophical challenges still underlying the concept of bioeconomy shall be examined and major ethical challenges still evoked by it shall be ventilated. For a clearer structure, the philosophical challenges are differentiated under the subtitles "Economy and Nature," "Promises and Disillusions," and "Economy and Man." The first subtitle covers the ongoing debates between neoclassical and ecological economics, the controversy over the interpretation of bioeconomy as economization of nature or ecologization of economics and the dispute over the adequate approach to nature as natural capital or intrinsic value. The second subtitle discusses two main promises of the bioeconomic concept. By means of the ideas of decoupling and a circular bioeconomy their related disillusions are briefly outlined. Under the third subtitle "Economy and Man," the relation between economic growth and human flourishing is scrutinized just as the connection between economic growth and capitalism.

The following part focuses on remaining ethical challenges evoked by the concept of bioeconomy that are mainly tackled by means of two internationally qualified moral principles for the ethical accompaniment and review of modern biotechnologies, especially concerned with their ecological, social, and economic record: the Precautionary Principle (PP) together with the principle of Responsible Research and Innovation (RRI). Last but not least, the ethically relevant question of technical solutions to moral problems is introduced. This question is raised in the juxtaposition of a technological and a behavioral fix as proposed solutions for environmental, social, and economic injustices prevalent in the Anthropocene.

The upshot holds that the concept of bioeconomy is not a panacea for the urgent challenges of our time, but only one piece in the puzzle of possible solutions that needs to be handled with care; especially in view of economic—whatsoever green—growth. Ecological, social, and economic justice on a finite planet may only be

achieved via a *Great Sustainable Transformation* that establishes new ways of human flourishing within ethical and planetary boundaries.

2 Philosophical Challenges Underlying the Concept of Bioeconomy

Denominating an outstanding transdisciplinary project, the term "bioeconomy" lacks conceptual clarity. Oftentimes it remains unclear, who in an interdisciplinary context means what when talking about the concept of bioeconomy. Furthermore, the term has undergone various conceptual changes in the course of its history[1]: Starting off in the 1980s—formulated by the economist Nicholas Georgescu-Roegen (as well as the Club of Rome as an idea of economic modesty located within biophysical limits)[2]—its focus became very much constricted to genetic engineering during the 1990s and was accompanied by high, yet still unfulfilled expectations. At the end of this decade, geneticist Juan Enríquez-Cabot was considered to having delivered the definition of "bioeconomy" as a tool to use new biological knowledge for commercial and industrial purposes.[3] Since 2000 the focus shifted again, this time involving Artificial Intelligence (AI), Big Data and their fusion with biotechnological developments. More recently, the original connotations of modesty and economic limitation sometimes sneak back into the concept of bioeconomy, when economic growth—however green it may be—is not thought of as the highest-ranking goal, but ideas of a—not necessarily growing—circular economy return to mind instead.

A glimpse at the historical variation of meanings shows that bioeconomy is a politically-scientifically informed concept of economic transformation,[4] and it becomes at least more comprehensible why there are so many opposing views and assessments of its concept.

Moreover, there are further semantic uncertainties concerning the delimitation of other concepts such as green economy, green growth, green deal, etc.

2.1 Economy and Nature

The main reason why the concept of bioeconomy causes confusion is the ambiguous relationship between the two terms it is composed of: the term "bio" on the one hand—stemming from the ancient Greek term "βίος (bios)" meaning "life" and relating to nature, the habitat and lifespan of species as well as their livelihood—and the term "economy" on the other hand—etymologically linked to the ancient Greek

[1] Cf. Grefe (2018, 21 f.) and Vogt (2018, p. 32).

[2] Cf. Georgescu-Roegen (1971) and Meadows et al. (1972).

[3] Cf. Enríquez-Cabot (1998, 925 f.) and Birner (2018, p. 19).

[4] Cf. von Braun (2018, p. 11).

terms "οἶκος (oikos)" meaning "household" and "νόμος (nomos)" meaning "law" and "custom" and relating to husbandry and market but also to enterprise, commerce, business, industry and trade.[5] There are various dimensions in which the relation between "bio" and "economy" is assessed differently or even contradictory. Three of these dimensions will be discussed in the next three subsections: neoclassical vs. ecological economics, economization vs. ecologization, and natural capital vs. intrinsic value of nature.

2.1.1 Neoclassical or Ecological Economics?

Between the two main streams of neoclassical and ecological economics, views on the role of nature within economy resp. economy as a part of nature differ widely.

In *neoclassical* economics, nature is seen as an *object* whose value is to be judged exclusively by means of its impact on human well-being. Hence, neoclassical economics may be characterized as an anthropocentric utilitarian approach, according to which human needs can be met by goods derived from nature. Mineral oil is an example for a natural product satisfying the human need for heat energy. Environment in general—such as a relatively pollution-free atmosphere enabling human breathing—as well as plants and animals in particular—such as plant based or animal source foods enabling human nourishment—serves existential human needs. However, from the neoclassical economist's point of view, nature is thought to be subordinated to the economic system and natural goods are considered to be principally substitutable by man-made goods.[6] This assessment of the substitutability of natural by man-made goods is a key aspect that differentiates different positions of sustainability.[7] Economist Volker Radke summarizes the core message of neoclassical economics as follows: if natural assets decline in a period, social welfare can still be maintained if this decline is offset, for example, by sufficient investments in machinery or in people's education. In line with this economic perspective, sustainability is achievable by substituting natural assets with other goods. According to Radke, sustainability in this context is defined as non-declining per capita human well-being over time and the central prerequisite for achieving well-being is seen in the overall stock of capital. In this light, marketable natural resources are valuated monetarily: for instance, mineral oil is quantified in barrel or logging is quantified in solid cubic meter. According to the neoclassical understanding of sustainability—all the different components of the total assets are substitutable against one another without decrease in total prosperity—it thus principally is irrelevant in what kind of assets one invests in.

Inter alia, Radke criticizes the underlying conception of aggregating individual utility on an abstract level by means of a certain social welfare function, as this presupposes the cardinality of individual utility. Only if scores can be assigned to

[5] Cf. for instance Leshem (2016), Müller (2017). Cf. also Lanzerath and Schurr (2022) in this volume.

[6] Cf. Radke (2004, pp. 147–155).

[7] Cf. for instance Schoop (2022) in this volume.

individual utility, the margin between two levels of use may be calculated. In comparison with *ordinal* utility functions, this is a very strong demand on *individual* utility functions in Radke's view.

In *ecological* economics, nature is regarded as a *subject*. The most fundamental critique of neoclassical environment- and resource-economy, as well as its ethical basis, is voiced by advocates of a so-called *ecocentric position*, under the terms of which nature is seen as a natural or legal person provided with inherent rights. Nature in itself is not substitutable and, not least due to their highly complex network of interdependencies, neither are natural goods substitutable by man-made ones. Eventually, every capital good is nothing but natural matter formed by man.[8] Under the ecological economics' term of sustainability, it is then not man, but nature making up for its focal point, and sustainability is equivalent to a long-term preservation of the viability of ecosystems. Ecological economics may be characterized as an ecocentric position as its main focus is not on human or economic good, but on the well-being of ecosystems. With this idea in mind, governmental institutions shall try to influence individual preferences in the best interest of societies and ecosystems as a whole. In particular, individuals shall be induced to foster those kinds of need satisfaction that are not accompanied by materialistic consumption. In this paternalistic manner, environmental pollution shall be prevented without decline in individual well-being. Yet, nature is thought to be superordinated to the economic system, which may not be considered in isolation, but only embedded in the natural environment.[9] Radke's critique of ecological economics refers to its elitist valuation of nature and the associated paternalistic preference order that might impinge on liberal-democratic principles and could lead toward an expertocracy or even an ecological dictatorship.[10]

2.1.2 Economization or Ecologization?

One of the most prominently debated juxtapositions in the bioeconomic context is the understanding of bioeconomy as an *economization of nature,* on the one hand, and as an *ecologization of economy,* on the other hand. One can thus read the meaning of economic transformation ascribed to bioeconomy in two directions: with an accentuation of *economy* in the sense of a program pursuing the goal of further economically exploiting the profitable resource 'nature', or with an accentuation of *bio* in the sense of a program pursuing the goal of further protecting nature and the environment as a value on its own. However, the far more widespread notion and application of bioeconomy leads into the first direction.[11]

In the year 2000, it has been the European Council's announced "way forward" to "*become the most competitive and dynamic, knowledge-based economy in the*

[8] Cf. Bonaiuti (2015).

[9] Cf. Radke (2004, pp. 157–162).

[10] Cf. ibid., 163.

[11] Cf. Gottwald and Krätzer (2014, p. 12) and Vogt (2018, 31 f).

world",[12] especially by means of innovation and a digitalized information society. Adversaries mostly share the view that today's bioeconomy is a worsening program of the most competitive and dynamic, knowledge-based economization of nature in general or of life in particular.[13]

In Germany, a much-noticed critique of the concept of bioeconomy as a wrong track and a totalitarian approach has been put forth by Theo Gottwald and Anita Krätzer in 2014. On the basis of an analysis of the bioeconomy programs of the European Union (EU), publications of the German Bioeconomy Council and different spheres of bioeconomic activity, Gottwald and Krätzer conclude that bioeconomy not only represents a new, but an absolutizing dimension of economic thinking. This thinking is accompanied by a reassessment of every living entity as a discretionary tradable and negotiable commodity of biomass within ever new paths of exploitation.[14] More moderate positions at least agree with regard to the explicit orientation toward growth, which somehow appears to be disguised behind the "bio" of "bioeconomy" in order to promise a win-win business for economy and nature. But as a matter of fact, the focus is almost entirely on "green growth," i.e. an "economization of ecology" rendering the gap between promise and reality concerning climate and environment policies allegeable.[15]

Furthermore, within the concept of bioeconomy, the term "sustainability"[16] is reinterpreted in so far as it is not the precautious conservation of nature and environment but instead its enduring exploitation, which is considered to be sustainable only.[17] Pursuant to the opinion of Gottwald and Krätzer, the leading ethical principle guiding sustainable biotechnological innovation—the Precautionary Principle (PP)—is undermined. According to the PP, ecological damage must be avoided instead of being addressed ex post facto. Thus, in line with PP, a successful reorientation toward an *e*fficient and especially a *su*fficient way of doing business that relies on self-limitation in view of growth and consumption is proposed. In fact, due to rebound effects and distribution mechanisms, bioeconomy's focus on

[12] European Parliament (2000). At the conference "New Perspectives on the Knowledge-Based Bio-Economy" of the European Commission in 2005, the European Commissioner for Science and Research, Janez Potočnik, held a talk entitled "Transforming Life Sciences Knowledge into New, Sustainable, Eco-Efficient and Competitive Products" which is meant to be a definition of the knowledge-based bioeconomy (cf. Birner, 2018, 20).

[13] Cf. Birch (2006), Gottwald and Krätzer (2014), Fatheuer et al. (2015) and Grefe (2018).

[14] Cf. Gottwald and Krätzer (2014, 8 f).

[15] Cf. Fatheuer et al. (2015, pp. 137–167), Vogt (2018, p. 33) and Pies et al. (2018, p. 107).

[16] In its relevant report "Our Common Future" (also known as "Brundtland Report"), the United Nations World Commission on Environment and Development (WCED) (also known as Brundtland Commission) defines "sustainable development" as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, par. 27). Furthermore, at the 1992 United Nations Conference on Environment & Development in Rio de Janeiro the global action program "Agenda 21" has been worked out, which determined three dimensions of sustainable development: environmental, social, and economic (cf. United Nations, 1992).

[17] Cf. Gottwald and Krätzer (2014, p. 19).

efficiency does not seem to qualify for the paramount idea to sustainability and justice if mechanisms of exploitation remain in place. Until now, however, bioeconomy neither fosters sufficiency nor a real alternative policy of sustainability, that is to say, a consistency approach which calls for an adjustment of innovation along the cycles of nature and not vice versa.[18]

This fundamental critique is based on the general opinion that the concept of bioeconomy pushes "a neoliberal regime in which market values are installed as the overriding ethic in society and the market rule is imposed on all aspects of life".[19] Associated with this assessment is the claim that bioeconomic strategies are promoted in the interest of large-scale industries whose utmost goal is the commercialization of innovations in the life sciences for profit, which oftentimes happens at the expense of small scale enterprises and of the majority of citizens who rather reject technological applications such as genetic engineering or synthetic biology.[20]

Besides this main critique, doubts are raised concerning the integrity and execution of the concept of bioeconomy under the accusation of greenwashing. As part of this critique, the general potential of bioeconomy to contribute to a more sustainable way of economic activity is acknowledged, yet the realization of this potential by diverse allegedly sustainable approaches is questioned.[21] Indeed, putting to use biotechnological innovations fed by bio-based, renewable materials and energy is not sustainable per se—not even environmentally benign. This challenge is fueled by the concern that the prefix "bio" is misused and becomes a fraudulent label behind which actually unsustainable practices are hidden and even fostered.[22]

Beyond that, the language-game of bioeconomy itself already unleashes an influence that affects the human-nature-relationship in a potentially worrisome way, as the question of economizing nature or ecologizing economy is also linked to the conception of nature as capital or as a value in itself.

2.1.3 Natural Capital or Intrinsic Value of Nature?

Some criticize the bioeconomic terminology for mechanizing and/or economizing nature. Nature supplies bioeconomy with useful energy and materials and stores or assimilates its waste. As if that was not enough, nature provides a biosphere and an enormous number of further offerings, which are indirectly as well as directly beneficial to humans, let alone their economic activity.[23] These offerings are commonly referred to as *ecosystem services*. Ecosystem services make up the core of the

[18] Cf. ibid., 154. Cf. also Schleissing (2018, p. 72).

[19] Birch (2006, p. 4).

[20] Cf. Birner (2018, p. 24).

[21] Indeed, bioeconomic applications can be energy-intensive, have negative water-footprints and/or negative biodiversity records (cf. for instance Fritsche and Rösch, 2017; Heimann, 2018; Lago et al. 2019).

[22] Cf. Birner (2018, 24 f).

[23] Cf. Victor (2019, p. 49).

German project Naturkapital Deutschland—TEEB DE.[24] Those services of nature consist not only in the most basal processes such as soil formation, photosynthesis or nutrient circulation which build the prerequisite for life on earth (basic services), but also in the production of drinking water, food, feed, and raw materials (providing services) or climate regulation, flood control, pollination and filtration effects (regulating services) or even in the contribution to cultural aspects of human life such as recreation, aesthetics, spirituality, education, and personal identity (cultural services).[25] Therefore, the concept of ecosystem services stretches far beyond that of bioeconomy, yet clearly overlaps with it—especially with regard to the category of providing services. All kinds of ecosystem services are subsumed under the so-called *natural capital.*[26]

Especially the terms "ecosystem services" and "natural capital" are bound to the utility of the biosphere for man.[27] And this is not accidentally or unwittingly so, but on purpose. Firstly, advocates of the ecosystem services approach suppose that the worthiness of nature consists in its usefulness to humans. Secondly and beyond that, they espouse an economic understanding and monetary valuation of nature's utility for man. That is because, according to TEEB DE, it is oftentimes overlooked that unimpaired ecosystems provide important and gratuitous capacities and services, which would otherwise require cost-intensive technical solutions (e.g., concerning climate protection, flood control and the cleaning of air and waters) and cause high social costs (e.g., concerning health and recreation).[28]

Further theses of TEEB DE claim that the worth of nature frequently remains hidden, because its goods and services appear to be at unlimited disposal and free of charge. But, in the economic sense, nature in fact constitutes a *capital* and its performance may be conceived of as a *dividend* accruing to society. Pursuant to TEEB DE, an economic perspective thus helps to uncover nature's worth and its diverse goods and services while providing economic arguments for the preservation of natural capital at once.[29]

Although these arguments are meant to complement ethical and ecological reasons, they assume the ideas of ecosystem services and natural capital to be inevitably given, instead of grasping that those arguments emanate from a thoroughly human-centered, if not utterly capitalistic, mindset.[30] The good being worthy

[24] TEEB DE links to the international study "The Economics of Ecosystems and Biodiversity (TEEB)" and exhibits that through the use of natural resources, valuable biospheres get lost also in Germany (cf. Naturkapital Deutschland – TEEB DE 2012).

[25] Cf. Naturkapital Deutschland – TEEB DE (2012, p. 23).

[26] After a typical definition, natural capital is "the world's stocks of natural assets which include geology, soil, air, water and all living things. It is from this Natural Capital that humans derive a wide range of goods and services, often called ecological goods and services, which make human life possible" (World Forum on Natural Capital, 2017).

[27] Cf. Naturkapital Deutschland – TEEB DE (2012, p. 10).

[28] Cf. ibid., 6.

[29] Cf. ibid., 9, 15.

[30] Cf. Pinsdorf (2020).

of protection here is not nature as such, but only that kind of nature suited for useful capital. Although TEEB DE reaffirms that the motive to preserve nature as a value in itself shall not be neglected, let alone replaced,[31] there is the factual risk of ethical and ecological arguments to become overlaid or even displaced by economic arguments, whose powerfulness seems to be overriding in enduring times of economic supremacy.

For Markus Vogt, catholic theologist and professor for Christian Social Ethics, ethical and economic perspectives are not mutually exclusive, but may complement each other as TEEB DE in his view impressively shows. Here, the protection of nature and biodiversity in particular is motivated by the quantification of its economic worth. Only the numbering of costs caused by climate protection deferral (up to 20% of Gross World Product (GWP) in non-action, approx. 3% of GWP in rapid action) has startled up the world's public.[32] Vogt says, one could now lament on the circumstance that the most sensitive organ of human perception is the modern citizen's wallet, or one can adapt to this actuality and foster an economic valorization (*In-Wert-Setzung*) of nature. As incentives for the protection of nature in market economies only emerge, insofar resource scarcity is prized in resp. insofar external costs are internalized, economization of ecology is for Vogt neither theoretically nor practically unethical, but sometimes just necessary. This is not a seldomly uttered argument of pragmatism. It is considered to be uncontroversial that the internalization of external costs via a systematic juxtaposition of all costs and benefits, i.e. including, e.g., restricted or even lost ecosystem services, gives impetus for the implementation of more sustainability.[33] A prominent example of an economic valorization of nature in the realm of climate change is certificate trading, i.e. carbon trade or carbon tax to reduce CO_2 emissions. This shows that pricing can induce a change of behavior in people and organizations and can thus be supportive to meet environmental objectives.

Pragmatist arguments such as "nature protection is worthwhile because it is less expensive than attempts to restore destroyed ecosystems or to substitute natural resources"[34] are sound from an economic perspective but misleading from an ethical point of view.[35] Although their content is true, they promote a problematic motivation for the protection of nature and, what is more, reduce nature to an object of human disposability. Although in economics the maximum willingness to pay is equivalent to individual utility, hence value of a good,[36] the monetary measurement is not only inappropriate for pivotal interpersonal relations such as love and friendship, but also for primal relations between man and nature. If nature is perceived only in terms of its real or potential market values, it amounts to nothing more than

[31] Cf. Naturkapital Deutschland – TEEB DE (2012, p. 14).

[32] Cf. Vogt (2018, 34 f).

[33] Cf. for instance Naturkapital Deutschland – TEEB DE (2012, 46) and Jackson (2009, p. 174).

[34] Naturkapital Deutschland – TEEB DE (2012, p. 11).

[35] Cf. Pinsdorf (2020).

[36] Cf. ibid., 79.

an exchangeable value without any consideration for its intrinsic value. Analyses of willingness to pay for nature's goods and services or even living beings require, for instance, an inventory of nature, which may seem to be an inadequate as well as impossible endeavor.

Furthermore, the valorization of nature may become subject to a fallacy of composition: Global environmental challenges like climate change, biodiversity loss, or deforestation are phenomena of which critical thresholds—the so-called *tipping points*—have either been crossed already or are likely to be crossed at any time soon. Fueled by financial tradeoffs, one might be fooled into asking "What harm can one more ton of greenhouse gas emissions do? What is the value of losing just one more hectare of old-growth forest?".[37] Since ecological thresholds are inherently uncertain, the mindset of monetary governance becomes more and more hazardous.

A possible commercialization or commodification of nature in terms of its pricing and subsequent marketing is sometimes even feared to lead to a sellout of nature and is oftentimes at least judged to be inadequate from an ethical point of view. The reverse argument, i.e. economic valorization of nature's goods and services is conducive for the development of mindfulness toward and appreciation of nature as well as for exercising one's moral responsibility toward nature,[38] is less than convincing. As soon as something is priced, it is given an exchange value and becomes financially negotiable. In this context, nature as an arbitrary commodity is discretionary tradable. Conceptionalizing nature as capital paves the way forward to an over-exploitative attitude of man toward nature, its ecosystems and living creatures since in this mode of thinking *homo sapiens sapiens* is the only entity of relevance. If, instead, nature and other life forms also matter, and we strive for an attitude of respect for nature and its ecosystems as well as for the recognition of other life forms, it might be more reasonable not to conceive of them as just another form of capital whose purpose is to serve mankind. Mindfulness and appreciation are not achieved via market integration, but rather with reference to a monetary non-negotiable (intrinsic) value, that mirrors the moral status and ethical standing of non-human nature.[39]

All in all, the pragmatist critique of the pragmatist argument contends that it is shortsighted, only works short term and essentially encourages a mindset which has led to and will eventually worsen the ecological crisis altogether. The fundamental critique of the pragmatist argument refers to the epistemological mistake it rests upon—"if [. . .] no commodities available through markets are adequate substitutes for the unpriced ecosystem services, then it makes no sense to estimate a monetary

[37] Victor (2019, p. 89).

[38] Cf. Naturkapital Deutschland – TEEB DE (2012, pp. 12, 21, 47, 62). Peter A. Victor explains: "Commodification [. . .] refers to the conversion of something outside the economy into a commodity for purchase and sale. [. . .] The success of capitalism owes much to this process through which the market takes over aspects of society that were previously outside the economy" (Victor, 2019, 53).

[39] Cf. Pinsdorf (2016, 143 ff.) and Pinsdorf (2020).

value for them"[40]—as well as its ethical inadequacy. Concerning ecosystem services, the fundamental critique accuses the concept by and in itself to put forward an awry understanding of the human-nature-relationship on different levels: for one thing, nature does not produce goods and services in order to place them at the disposal of humans. Nature is an entire and complicated complex, evolved over a period of millions of years, whose center is not mankind and even less mankind's mental constructions of "services," "economics," or "monetary units." In reality, mankind does not know what the focal point of nature is—it might well be that it has none. Be that as it may, for mankind to think and act as if it was the focal point of nature is factually false. For not too few ethicists it is also morally wrong. In economic approaches to nature, such as TEEB DE, it is almost exclusively human well-being what matters. In this perspective nature proves itself to be valuable if and only if it delivers goods and services of direct or indirect utility for human wants and needs.[41] In philosophical ethics such an approach is assigned to normative anthropocentrism, which has been thoroughly criticized for its bias and ethical unjustifiability, i.e. with reference to the discriminatory ideas of *speciesism* or *human chauvinism*.[42]

TEEB DE commendably intends to make people aware of the connection between nature, economic net product, and human well-being. It surely initiates a visualization of the so-called *ecosystem services* and their economic worth and lays the foundations for integrating natural capital in private, entrepreneurial, and political processes of decision-making in order to maintain the basis for human existence. The valorization of natural capital facilitates the incorporation of nature's goods and services as an integral part of commercial calculus from the outset.[43] This, however, rather protects the economy instead of nature. Ecological economist and professor emeritus of Environmental Studies, Peter A. Victor, also comes to a sobering conclusion concerning the monetary valuation of nature and ecosystem services:

> In a culture in which monetary values have such a dominating presence, assigning large monetary values to nature can have considerable rhetorical power, which is important, given the precarious state of nature and the overriding importance of attracting attention to possible solutions [...]. But that does not make it good economics nor does it make it ethically sound.[44]

Summing up, bioeconomy's valorization of nature is at least problematic and only tolerable if it conceptually includes the intrinsic value of nature and the living

[40] Victor (2019, p. 78). For further critique of the conceptual framework underlying the monetarization of ecosystem services or ecological damage, cf. Victor (2019, 77, 80 ff).

[41] Cf. Naturkapital Deutschland—TEEB DE (2012, 10 f). In TEEB DE, for instance, human well-being and usefulness for humans is emphasized throughout (cf. ibid., 9, 10, 15, 18, 23, 49, 80).

[42] Cf. for instance Singer (1977), Bradie (2011, 567 f.), Breitenbach (2009), Sturma (2013), Pinsdorf (2016), Thompson (2017, 85 ff.) and Kopnina et al. (2018).

[43] Cf. Naturkapital Deutschland —TEEB DE (2012, p. 64).

[44] Victor (2019, p. 91).

being's own good and flourishing in equal measure—however, the tension between the two conceptions—natural capital and intrinsic value of nature—might in reality be irreconcilable.

2.2 Promises and Disillusions

2.2.1 The Promise of Decoupling

Societies all over the world are facing a profound dilemma: economic growth (at least in its current form) is unsustainable whereas economic degrowth (at least for capitalistic societies) is unstable.[45] The concept of bioeconomy is meant to induce the solution to this fiddly dilemma inasmuch as it is designed to secure the dynamic of growth that keeps (capitalistic) societies going, but on sustainable, hence ecologically, socially and economically safe grounds.

A feature of bioeconomy to achieve this end is the idea of decoupling: "Decoupling refers to the proposition that economies can grow and yet reduce their use of materials and energy through a combination of technological change and a switch from goods to services."[46] Through increased efficiency and innovation, interlocked cascades of resource utilization as well as the substitution of fossil commodities and energy, bioeconomy is due to separate resp. decouple economic growth from resource usage and environmental impact:

> Production processes are reconfigured. Goods and services are redesigned. Economic output becomes progressively less dependent on material throughput. In this way, it is hoped, the economy can continue to grow without breaching ecological limits – or running out of resources.[47]

Decoupling is about efficiency enhancement, about doing more with less, i.e. more economic activity and productivity with fewer resource inputs, fewer waste outputs, and less environmental damage. A relevant difference is given between relative and absolute decoupling:

> Relative decoupling of materials from GDP [Gross Domestic Product (C.P.)] occurs when, over time, material use per dollar of GDP declines (that is, material intensity) but total material use does not. Absolute decoupling occurs when material intensity declines faster than GDP growth, so that total material use also declines.[48]

Relative decoupling is easier to accomplish than absolute decoupling, but only the latter leads to a potentially significant reduction of environmental burdens.

[45] Cf. Sukhdev (2009, p. xix) and Jackson (2009, p. 65).

[46] Victor (2019, p. 107).

[47] Jackson (2009, p. 67). Cf. also Hamm (2018, p. 138) and Victor (2019, p. xiii).

[48] Victor (2019, p. 108). Cf. also ibid., 38; Jackson (2009, pp. 67–76).

While the German Bioeconomy Council and other proponents of the bioeconomic transformation are enthusiastic in view of the possibilities of decoupling, many critical voices remain. For instance, some already question the possibility to generate steadily increasing incomes for a growing world population without pushing ecological boundaries too far.[49] Others recognize that the concept of decoupling is not unreasonable in itself, as, for instance, energy expenditure per commodity unit has significantly decreased in Germany since 1970. However, despite this development, no ecological release ensued. In fact, energy consumption in total did not drop, but augmented instead.[50] This non-appearance of ecological release is again attributed to the phenomenon of the so-called *rebound effect*: e.g., the costs saved from energy conservation are deployed to expand the production of goods; or, money saved from, e.g., energy efficiency is spent on other goods and services. As the production and consumption of these other goods and services have energy costs on their own, savings achieved through efficiency can either be offset or even be outreached: "In short, *relative* decoupling sometimes has the perverse potential to decrease the chances of *absolute* decoupling."[51]

Next to the rebound effect, there are two further important factors that disrupt the aim of decoupling, namely population growth and augmented per person consumption. Taken together, they may cause an increase of material and energy use in total and over time, even though initially higher efficiencies cause less intense material and energy requirements.[52]

Concluding on the idea of decoupling, ecological economist and professor of Sustainable Development, Tim Jackson, differentiates:

> It's clear [...] that history provides little support for the plausibility of decoupling as a sufficient solution to the dilemma of growth. But neither does it rule out the possibility entirely. A massive technological shift; a significant policy effort; wholesale changes in patterns of consumer demand; a huge international drive for technology transfer to bring about substantial reductions in resource intensity right across the world: these changes are the least that will be needed to have a chance of remaining within environmental limits and avoiding an inevitable collapse in the resource base at some point in the (not too distant) future.[53]

2.2.2 The Promise of a Circular Bioeconomy

In more recent times, a directional change in the configuration of the concept of bioeconomy is observable: away from the growth-minded course for acceleration of

[49] Cf. Jackson (2009, p. 68).

[50] Cf. Herrmann (2015, p. 3), United Nations Environment Programme (2016, p. 16) and Hamm (2018, 138 ff). As Victor notes, "the twenty-first century has witnessed an unprecedented period of relative and absolute *re-coupling* of material extraction and global GDP" (Victor, 2019, p. 109).

[51] Jackson (2009, p. 95).

[52] Cf. Victor (2019, p. 108).

[53] Jackson (2009, p. 75).

(green) growth and toward a renewable resources-based circular flow economy.[54] The Communiqué of the Global Bioeconomy Summit, for instance, considers "it an important task to align the principles of a sustainable bioeconomy with those of a circular economy. This would involve systemic approaches across sectors (i.e., nexus thinking), particularly innovation policy measures that aim at optimizing Bioeconomy value networks and minimizing waste and losses."[55] One of the main drivers of making bioeconomy circular is the so-called *cascade utilization*, a process of using biomass initially materially, then chemically and only last of all energetically. In doing so, as much added value output as possible shall be gained out of as little material input as possible producing as little waste as possible. However, ultimately all materials being used stem from the ecosphere and all of them wind up as waste being disposed back into the ecosphere; this phenomenon applies to all materials being used and is referred to as "materials balance principle".[56] In a similar way, the energy balance principle—which encompasses nothing other than the *first* and *second law of thermodynamics*[57]—applies to all uses of energy. According to the first law of thermodynamics, in any process the quantity of energy is maintained and only its form changes: "An example is the conversion of the chemical energy on gasoline to mechanical energy and heat when used to power an automobile."[58] According to the second law of thermodynamics, energy's capacity to perform necessarily declines each time it is used:

> For example, in a conventional electric power station, energy from coal combustion is used to boil water. The steam drives a turbine that produces electricity. Some energy is released to the environment as waste heat, which is unavailable for further work. Only about 35 percent of the chemical energy in the coal leaves the power station as electricity and then there are further losses during transmission and use.[59]

Sustaining a constant level of any (economic) activity requires a constantly new energy supply.[60] Hence, the theoretical possibility of a circular bioeconomy with 100% of reuse (material recycling and energy efficiency) is precluded by the energy balance principle. Economic activity depending on nature's materials and energy will thus have to keep going back for more and will never produce zero-waste.

But even if an imperfect ecological circular economic system would be possible—and numerous doubts on its feasibility remain—two important questions have

[54] Cf. for instance World Wide Fund for Nature (WWF) (2009, 5 ff). For a further exploration of possible futures of a wood-based circular bioeconomy in Germany, see, for instance, Hagemann et al. (2016).

[55] Global Bioeconomy Summit (2015, p. 5).

[56] Cf. Victor (2019, p. 46). Some, however, still believe a fully closed loop economic system producing no waste to be possible (cf. World Wide Fund for Nature (WWF), 2009, 5, 15 f).

[57] Cf. Georgescu-Roegen (1971, p. 4–7, 17, 129, 197, 280).

[58] Victor (2019, p. 46).

[59] Ibid.

[60] Cf. ibid., 117.

not yet been properly considered: what is the bridge leading from a capitalistic to a post-growth economy and how should the process of transformation look like?[61]

2.3 Economy and Man

2.3.1 Economic Growth and Human Flourishing

Another conceptual lack of clarity applies to the idea of human flourishing or human well-being, which is strongly connected to bioeconomy as a concept for economic growth and prosperity.

In the logic of (at least capitalist) economies, the conventional thesis of economics suggests that economic growth is essential for maintaining economic and social stability, whereas economic degrowth is tantamount to economic collapse and social adversities.[62] In 1987, the Brundtland Report ascertained that global economy and global ecology are intertwined in new ways. Whereas in the past the main concern has been about environmental impacts of economic growth, now the impacts of environmental degradation on future economic prospects come in addition.[63]

Possible biophysical limits to growth can be divided into the four categories: "sources, sinks, services, and synthesis".[64] While "sources" refer to the supply of materials and energy, "sinks" refer to their disposal, and "services" relate to the way nature is anthropogenically transformed with the upshot of decreasing essential ecological functions. Last but not least, "synthesis" refers to the interrelation of the three categories before, thus setting up an even more complex biospherical limit on top.

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[61] Herrmann, for instance, is convinced that due to purely economic reasons, this transition is either impossible or extremely difficult (cf. Herrmann, 2015, p. 3). In the second edition of his forward-thinking book *Managing without Growth*, Victor actually raises related fundamental questions: "How might an advanced economy function in the absence of growth? Would it collapse or is there a configuration of production, consumption, employment and other aspects of importance that is both feasible and attractive without relying on economic growth?" (Victor, 2019, p. 31). And, by the meaningful subtitle of his book, *Slower by Design, not Disaster*, Victor furthermore points to the most probable, if not certain vision that growth is coming to an end and the only freedom of choice left to us is either making it end (sooner) accompanied by well-informed decisions and knowledgeable measures or watching it end (later) disordered and tragically.

[62] Cf. for instance Gordon and Rosenthal (2003), Binswanger (2009b), Jackson (2009, 61 ff.), Smith (2010) and Dörre (2013).

[63] For the added dimension of alarm, see, for instance, the following statement in the Strategy Paper of the German Bioeconomy Council: "Originally, the concept of a bio-based economy was promoted in the light of expected rapidly depleting petrol, gas and coal reserves. However, the move into bioeconomy is no longer driven predominantly by expectations of rising prices of fossil fuels. In view of the exploitation of new fossil reserves and due to energy efficiency improvements, this argument has become less pressing but it nevertheless remains strategically essential. Without major adjustments, the continued emission of greenhouse gases and the related changes in climate conditions will irreversibly damage the global ecosystem and will involve incalculable economic risks" (German Bioeconomy Council, 2014, p. 1). Cf. also Victor (2019, 95 ff., 116, 135).

[64] Victor (2019, p. 100).

What is more, the increasing economic interdependence among nations is accompanied by an accelerating ecological interdependence on local, regional, national, and global scales.[65] Not least in consequence of the links between poverty, inequality and environmental destruction, the Brundtland Report claims: "What is needed now is a new era of economic growth—growth that is forceful and at the same time socially and environmentally sustainable."[66]

But what precisely is that supposed to mean? Or, what exactly is meant to be growing?

As Victor explains,

> economic growth is usually measured by the pace of change of gross domestic product (GDP) after adjustment for inflation also known as real GDP' [...]. This conventional definition of economic growth is not accompanied by a separate explicit definition of the economy, that is, that which grows.[67]

This scanty differentiation is, among other things, insufficient to grasp economy's embeddedness in and dependency on nature, as well as it is insufficient for establishing alternative approaches.[68] Concerning prosperity, GDP—the total value of all goods and services that have been produced by a national economy within one year for the purpose of consumption—has been criticized as an insufficient measure for quite a while. Critics argue that various elements of national wealth and well-being—such as accounting for social costs or unequal distribution of income, qualitative aspects of health and education or depletion of natural resources—cannot be captured on the basis of GDP growth.[69] Under headings

[65] Cf. World Commission on Environment and Development (1987).

[66] Ibid., 7.

[67] Victor (2019, 44 f). Victor ascertains further: "It is also difficult to find official definitions of economic growth even from organizations such as the OECD, the IMF and the World Bank that are dedicated to promoting it. We are simply told that economic growth is measured by changes in real GDP or real GDP per capita. What is being measured has become synonymous with its measurement" (Victor, 2019, 42 f.).

[68] Cf. also the following statement of ecological economist Herman E. Daly: "Exactly what is growing? One thing is GDP, the annual marketed flow of final goods and services. But there is also the *throughput*— the metabolic flow of useful matter and energy from environmental sources, through the economic subsystem (production and consumption), and back to environmental sinks as waste. Economists have focused on GDP and, until recently, neglected throughput. But throughput is the relevant magnitude for answering the question about how big the economy is—namely how big is the economy's metabolic flow relative to the natural cycles that regenerate the economy's resource depletion and absorb its waste emissions, as well as providing countless other natural services? The answer is that the economic subsystem is now very large relative to the ecosystem that sustains it" (Daly, 2009, xi f.).

[69] Cf. Sukhdev (2009, p. xvii) and Jackson (2009, p. 179). Cf. also Jackson (2009), Chap. 4 which analyzes data concerning life expectancy, health and educational participation in relation to GDP collected by the United Nations Development Programme (UNDP) over several decades.

such as "qualitative growth," "eco-social-product," or "beyond GDP," a supplementary measure of the quality of life, well-being and sustainability is claimed.[70]

The term "prosperity" itself seems to be disputable in view of a growing world population confronted with the threats of climate change and resource scarcity. At least it seems to be clear that prosperity under the current prognostic symptoms cannot mean the same as at the time of industrialization. For Mary Robinson, former president of Ireland, former United Nations High Commissioner for Human Rights and founder of the nongovernmental organization *Realizing Rights: The Ethical Globalization Initiative*, these days prosperity "cannot mean business as usual. It cannot mean more of the same".[71] What then can prosperity mean nowadays?

Outstanding ecological economist Herman E. Daly distinguishes between *quantitative* growth and *qualitative* development. Growth in that sense is based on an increased use of materials, whereas development in that sense means an achievement of more desirable goals—such as sustainability—with the same or even less use of materials. Along these lines, economies can simultaneously grow and develop, grow without developing or develop without growing.[72] The crux seems to be that *su*fficiency and ecologically oriented *e*fficiency seem to be complementary concepts consistent with core elements of sustainability, yet incompatible with economic growth. But is this necessarily bad news for prosperity and human well-being? Daly suggests it is not, because sustainable development without growth would lead to an economy that is not bigger, but better.

One key determinant in the semantic field of economic growth, prosperity, and human flourishing is an economic narrowing in the understanding of the term "felicity". In some economic theories, the underlying concept of felicity focuses solely on utility as the consumption of the economy's stock of capital assets, including manufactured goods, services provided by nature, health services, and others. From that economic point of view, felicity is only based on consumption of capital assets derived by diverse sources, such as marketed consumption goods, leisure, various health services, and consumption services supplied by nature. In comparison with former approaches in economics, this might already be judged to be quite a holistic approach. However, it excludes major aspects of felicity that are explicitly independent of the idea of consumption, such as non-material, spiritual or idealistic values, or idle time, which all seem to be unquantifiable in themselves, but are at the same time crucial aspects for the concept of felicity and also decisive for capturing comprehensive wealth.

While financial income provides access to vital as well as comforting goods and so-called *status goods* establishing social standing, some studies have shown that a

[70] Cf. Naturkapital Deutschland – TEEB DE (2012, 46 f.) and Victor (2019, 43 f).

[71] Robinson (2009, p. xvi). Also the OECD itself resumes that positive developments in environmental respect are still only at the margin and far from appropriate (cf. Organisation for Economic Co-operation and Development, 2015, p. 7).

[72] Cf. Daly (1996, 166 f). It is also interesting how Daly translates the meaning of consumption as destruction (cf. ibid., 62) and growth—at least in the global North—as some impediment to sustainable development (cf. ibid., 8, 13 ff.)

growing income beyond a certain threshold does not add or only marginally adds value to the well-being of individuals.[73] In the poorest countries of the Global South, people suffer extraordinary deprivations connected to infant mortality, general life expectancy, nutritional supply, clothing and shelter, or educational participation—here, economic growth and increased financial income are required to achieve urgently needed betterments. But in richer countries of the Global North this is hardly the case.[74] Concerning the global threat of poverty and hunger, customary economic development has not proven to be a solution, but rather to be a reproducer or even reinforcer of problems.[75] Bioeconomy in particular is criticized for globally reinforcing social injustice insofar as it is a capital-intensive endeavor, primarily framed within the industrial paradigm and geared toward international marketing. At least so far, bioeconomy cannot be evaluated as a facilitator of smallholder agriculture and food sovereignty of the poor.[76]

At the same time and at least in ecological respect, it is not feasible to turn the Global South into a Global North. It hence stands to reason that degrowth-strategies and a locally oriented sufficiency economy pave the way for a more socially just future. As the program of sufficiency for all living people may indeed involve further loads for the overburdened planetary ecosystems, there is another argument for the limitation of economic growth and the constant rise of material living standards of the world's most affluent societies. As the overall gain of economic growth is only significant in poor countries, and economic growth found in rich countries is—due to biophysical constraints—not applicable worldwide, it is economic growth in affluent countries that needs to be addressed: "So, in a world where economic growth is constrained by biophysical limits it makes sense for rich countries to manage without growth so as to leave room for growth in poorer economies."[77] This statement retains its validity even more as slow growth or even degrowth should not affect the real prosperity, hence happiness, well-being or felicity of people living in affluent societies, in a negative way. Diverse studies have shown that "higher incomes do make people happier but only up to a point".[78] The realignment of what it means to lead a good life can help people to live more fulfilled and contented lives without continuous raise in consumption necessary for economic growth. Degrowth on the basis of sufficientarianism and a subsistence economy could simultaneously render

[73] Cf. for instance Jackson (2009, p. 52, 59).

[74] "Economic growth has made it possible for people to live longer, healthier lives at a level of comfort that even the wealthy in pre-industrial societies could scarcely imagine. [. . .] But economic growth has its costs. These can be categorized as environmental costs and social costs. [. . .] Social costs include the breakdown of communities, alienation, crowding and crime" (Victor, 2019, p. 241).

[75] Cf. Read and Alexander (2020, p. 52).

[76] Cf. Vogt (2018, p. 39).

[77] Victor (2019, p. 216). Cf. also Jackson (2009, 180 f.) and Grefe (2018, p. 29).

[78] Victor (2019, p. 209). For further arguments on why economic growth does not or is at least not necessary to promote happiness and well-being cf. Victor (2019), Chap. 9.

economies more resilient against catastrophes and people more satisfied, once they have internalized an attitude of contentment.[79]

Swiss economist Mathias Binswanger ascribes the discrepancy between higher incomes and happiness to four so-called *treadmills* guiding people's consumption-related needs modulation[80]:

1. Positional Treadmill: People possess and consume goods and services because of their search for status and standing in society.
2. Hedonic Treadmill: People's aspirations adjust relative to their income, the more they earn, the higher their material living standard.
3. Multi-Option Treadmill: The increasing range of possibilities and choices accompanying higher income lead to overload and frustration.
4. Time-Saving Treadmill: Time-saving devices render leisure time jam-packed and more stressful instead of taking time pressure off.

Especially the status-related positional treadmill frequently undermines people's happiness and well-being, as the most widespread pursuit of status through consumption is all too often self-defeating.[81] This is partly because the extent of happiness someone draws from a certain level of possession and consumption depends on the possession and consumption level of others. As long as the level of possession and consumption increases for everybody under economic growth, nobody is better off at the end of the day. Decisive for the happiness factor resulting from the consumption of positional goods and services is the relative rather than the absolute consumption.[82] Similar considerations also apply to the aspirations-related hedonic treadmill: if someone's happiness hinges on the relationship between demands and their satisfaction, it will not enhance with an increase of demand satisfaction as demands will grow in turn.[83]

2.3.2 Economic Growth and Capitalism

Capitalism requires economic growth—so the widespread belief.[84] Capitalism is not a stable system, prone to balance or to producing reliable income that may well be cut. To the contrary, as soon as growth stops, chaotic shrinkage may impend, and a dwindling production may lead to frenetic attempts of maintaining jobs. The global financial crisis from 2007/2008 and the acute global coronavirus pandemic are instructive examples. Unfortunately, nature and environment are not at all inevitable profiteers of a faltering world economy, but oftentimes its first casualty. According

[79] Cf. Kasser (2002) and Read and Alexander (2020, p. 55).

[80] Cf. Binswanger (2006).

[81] Cf. Sen (1998) and Victor (2019, p. 209).

[82] Cf. Easterlin (1974, 113 ff.) and Victor (2019, 212 f).

[83] Cf. Easterlin (1974, 111 ff).

[84] Cf. for instance Gordon and Rosenthal (2003), Binswanger (2009b), Jackson (2009, 61 ff.), Smith (2010) and Dörre (2013).

to Ulrike Herrmann, an established German economic journalist, no-growth would end capitalism, but the upshot would not be an ecological circular economy—as wished for by many environmentalists—but an economy in free fall, a panic-creating event.[85] Distinctive Swiss economist Hans Christoph Binswanger was driven by the question, whether capitalism could in principle forgo (destructive) economic growth. He concluded that without growth, investment chains would collapse since companies only invest in anticipation of profits, which in turn are macroeconomically identical with growth.[86] No-growth makes companies fear financial losses, absent profits lead to investment freeze and no-investments make the economy collapse. Eventually, an uncontrollable downward spiral of recession is thought to set in: jobs would get lost, demands would decrease, the overall production would shrink, and unemployment would rise.

It thus appears to be imperative to keep the dynamic of growth running. This is normally achieved by at least two interrelated factors that Jackson calls "the 'iron cage' of consumerism"[87]: first, the motive of making (more) profit that provokes continued innovation and the so-called "creative destruction",[88] which in turn causes production and leads to an endless supply and flooding of the market with new products and services; second, the demand of consumers for (more) goods and services which is perpetuated by a complex social logic relating to the aforementioned treadmills.

At the same time, the dynamic of growth imperative has led to and further on leads to ecological crises, climate change, population increase, social injustice, etc. Thus, the world's (especially capitalistic) societies are facing the more than challenging dilemma already mentioned: without economic growth the whole system becomes dysfunctional and collapses, but with ongoing economic growth the whole system inescapably leads into ecological and social catastrophe. Ecological catastrophe in view of anthropogenic climate change, biodiversity loss and nature destruction, social catastrophe in view of the related global imbalance of suffering from ecological catastrophe and the resulting intra- as well as intergenerational injustice. Capitalism, which has brought wealth and technological progress, is now about to bring ruin as it is an oxymoron to have infinite economic growth in a finite world.[89]

As we have seen, however, green growth in the form of bioeconomy is not an overly promising concept, on the basis of which humanity will be able to dissolve the dilemma. It is a concept still implying the economic dynamic that capital is invested to generate added value and more capital, mostly via the production of consumable products and services. Bioeconomy thus banks on *new* raw materials and production

[85] Cf. Herrmann (2015, p. 3).

[86] Cf. Binswanger (2009a). Cf. also Jackson (2009, p. 65), Binswanger (2009b), Herrmann (2015, p. 3) and Binswanger (2019).

[87] Jackson (2009, p. 88).

[88] Cf. Schumpeter (1994 [1942/43], 81 ff.), Jackson (2009, p. 97) and Victor (2019, 50 f).

[89] Cf. Daly (1996, 33 ff.), Herrmann (2015, p. 3), Read and Alexander (2020, p. 33). The according demand for degrowth is not new (cf. Meadows et al., 1972).

mechanisms, but *old* targets for growth and modes of consumption. Hence the question arises whether bioeconomy in fact is no *progress*,[90] but stabilizes established modes of overexploitation and overconsumption as well as unsustainable standards of living and lifestyle by justifying them via reference to only allegedly sustainable modes of production? At least concerning bioeconomic growth, Jackson arrives at the disillusioning view "that there is as yet no credible, socially just, ecologically sustainable scenario of continually growing incomes for a world of 9 billion people" and "it is entirely fanciful to suppose that "deep" emission and resource cuts can be achieved without confronting the structure of market economies".[91] The answer to the former question thus seems to be affirmative, because what is needed to get out of the dilemma of growth is a system change, which the concept of bioeconomy certainly is not.

3 Ethical Challenges Evoked by the Concept of Bioeconomy

A thorough ethical evaluation of a new biotechnology or its application requires to depict as comprehensively as possible, in which respects the said technology or its applications are assessed to be ethically untenable, problematic, acceptable, or required by different ethical theories. An encompassing ethical evaluation of the concept of bioeconomy and its diverse applications cannot be accomplished here. However, two internationally accepted moral principles for the ethical accompaniment and review of modern biotechnologies, especially concerned with their ecological, social, and economic record, shall be presented briefly in the following passages.

3.1 Precautionary Principle (PP)

The EU has taken on the leadership role in fostering the precautionary principle (PP), specifically applied to decision-making processes in the realm of environmental policy.[92] But also the United Nations are pushing the precautionary approach in order to protect the environment.[93] However, in political guidelines and declarations, the understanding of the PP or its methodologies for assessing risks is either

[90] Insofar 'progress' is understood as a normative term which is oriented towards an improved way of life (cf. Schleissing, 2018, p. 75).

[91] Jackson (2009, p. 86).

[92] Cf. e.g. Commission of the European Communities (2000), Sunstein (2005, p. 1), Consolidated Version of the Treaty on the Functioning of the European Union 2016, Art. 191; European Commission Directorate-General for Environment (2018).

[93] Cf. e.g. Principle 15 of the Rio Declaration on Environment and Development (United Nations Conference on Environment and Development, 1992).

controversial or hardly spelled out. This is not the least reason for the existing academic debate on the correct application and interpretation of the principle.[94]

In his most important work, *Das Prinzip Verantwortung. Versuch einer Ethik für die technologische Zivilisation* (*The Imperative of Responsibility. In Search of an Ethics for the Technological Age*), philosopher Hans Jonas develops an ethics for the future of man and nature according to which man—under the conditions of technological progress and the massively extended range of his actions accompanying it—must take on his responsibility for life on planet earth.[95] One key element for the condition of possibility to take on responsibility under the prevailing circumstances is the question whether man is able or unable to generate sufficient foreknowledge to evaluate his new and evermore powerful influence, or whether the increasingly complex, but only to a limited extent foreseeable and controllable side effects of his actions can or cannot be met by his inventing technical solutions. Against this backdrop Jonas formulates his so-called *heuristics of fear* (*Heuristik der Furcht*) as a consequence of which, in case of doubt, the bad prognosis is to be given priority over the good prognosis and the PP must be guiding man's actions.[96]

For the most part however, Jonas' heuristics of fear is nowadays criticized as being too defensive and—given the open dynamics of modern technological research and development—ultimately paralyzing.[97] Contemporary authors like Ortwin Renn, Cass Sunstein, and Ingo Pies et al. have engaged in formulating a more balanced version of the PP by focusing equally on possible risks of action *and* non-action as well as by taking the plurality of risk perceptions into account.[98] The well-established approach of judging innovations on the basis of the PP—the authors claim—should be applied to the principle itself and hence to the evaluation of possible outcomes resulting from the omission of innovative methods, as risks "can arise from action as well as from inaction".[99] Precautionary risk assessment still requires a conservative assessment of risks in the sense of *one should rather err on the side of caution than on the side of daring*. Yet, one of the major challenges for the PP is its referentiality to uncertainty in risk-assessment. Whereas dealing with uncertainties whose probability of occurrence can be mentioned within a certain calculable probability amplitude seems to be feasible, how shall risks be regulated whose probability of occurrence is just unknown? In this context, the determination of reasonable assumptions for cautious procedures is not by itself scientifically predefined, but always requires a value judgment in the sense of balancing against

[94] Cf. for instance Bogner and Torgersen (2018), Boldt (2018, p. 82) and Pies et al. (2018, p. 115).

[95] Cf. Jonas (2017). For an intensive discussion of Jonas' ethics and its implications for the ethical evaluation of the concept of bioeconomy cf. Schoop (2022) in this volume.

[96] Cf. Jonas (2017, 7, 36, 63 ff., 70 ff., 81 ff).

[97] Cf. Sunstein (2005, p. 5).

[98] Cf. Renn (2002), Sunstein (2005, 2 ff.), Renn (2014, 246–285, 533 ff.), Bogner and Torgersen (2018), Pies et al. (2018, p. 115) and Vogt (2018, p. 46).

[99] Sunstein (2005, p. 2).

too much and too little caution.[100] Commonly accepted here is the formula, the more far-reaching and irreversible the consequences of a risky activity are, the more precaution is due.

Concerning the impact area, controllability and irreversibility of bioeconomic applications, disagreement prevails. Unintended side effects are mostly discussed under the keyword "biosafety," potential for misuse under the heading "biosecurity."[101] The assessment of harm an benefit also depends on how much risk—consisting of the probability of occurrence and the magnitude of damage of an adverse event—one is generally willing to take for what advantage.[102] Although one might think that the general willingness to take risks depends first and foremost on a social consensus, in fact the enormous competitive pressure in research and science as well as the forces of the market lead to the acceptance of ever increasing risks in order to remain competitive. In the course of this development, profits including those generated by means of high-risk technologies benefit companies, while systematically co-produced risks oftentimes cannot be limited locally and group-specifically. Thus, profits generated by risk technologies flow into private coffers, whereas society and nature as a whole suffer the consequences of the eventual costs.[103] This privatization of profits coupled with the socialization of costs is called *externalities* and has led to the claim that applying the PP is ever so important for internalizing external effects for the purpose of social and environmental justice.

Opponents of the PP, however, apprehend a status quo bias: "Advocates of the principle might [...] say that *new* risks are unacceptable, but *existing* risks are fine. [...] How does one account for tradeoffs between present and future risks? [...] Does one value a life today more than one tomorrow?"[104] In contrast, proponents of the precautionary approach claim that applying the principle in the first place concedes intrinsic value to all living entities.[105] They consider it to be imperative for man to come to a humbler, more precautionary attitude toward his place in the natural order. Moreover, they argue that man cannot guarantee the availability and applicability of complex technologies with certainty in the long term, so that all things considered, man must learn to be less dependent on complex technologies in order to become more resilient for survival in the long run.[106] Current defenders of the PP consider it to be an ethically broadly legitimized and morally significant action-guiding principle that should be applied whenever there is an uncertain or

[100] Cf. Renn (2002, p. 44) and Rippe and Willemsen (2018).

[101] For an assessment of biosafety and biosecurity in the field of synthetic biology, cf. e.g. Boldt (2018, 79 f.) and Lanzerath et al. (2020).

[102] Cf. Boldt (2018, p. 82).

[103] Cf. Kuttruff and Then (2018, 88 f., 97).

[104] Sunstein (2005, 5 f).

[105] Cf. Kuttruff and Then (2018, p. 98) and Read and Alexander (2020, p. 19).

[106] Cf. Read and Alexander (2020, 24 f).

vague possibility of new technologies causing serious damage to (depending on the underlying ethical theory) humans, animals, plants, and/or the environment.[107]

3.2 Responsible Research Innovation (RRI)

With its emphasis on risk, the PP is frequently criticized to impede technology implementation and innovation.[108] Hence, the European Commission came up with a new, so to say, counterweight principle to focus on the opportunities instead of the risks of a new technology to better promote the implementation of biotechnologies in society. Rather than eliminating risks, the focus of the Responsible Research and Innovation (RRI) principle is to reconcile technological developments with societal values and expectations. The EU has thus developed a value-based understanding of innovation with the aim of orienting technical innovations not only toward commercial interests and profits, but also toward ethical requirements and social needs. The official website of EU's biggest research and innovation program Horizon 2020 lists public engagement, open access, gender, ethics and science education as the thematic elements of RRI.[109] Here, RRI is further classified as key action of the "Science with and for Society"-objective, which is oftentimes accompanied by an RRI-definition of the European Commission's Directorate General for Research, René von Schomberg:

> Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society).[110]

In the wake of RRI, innovations are assessed to be the answer to major challenges of humankind, such as climate change or world nutrition. It postulates a knowledge-based and reflexive technology policy that does not leave innovations solely to the steering power of markets and supposed constraints, but reflects, correlates, and promotes them in relation to the common good.[111] Both principles taken together—the PP as a risk management tool and the RRI as a process shaping tool—are meant to "adequately represent the double face of technological innovation".[112]

However, just as PP generates its specific problems, also RRI faces problems of its own kind. One important part of RRI is the worldwide development paradigm of

[107] Cf. for instance Rippe and Willemsen (2018), Kuttruff and Then (2018, p. 98) and Read and Alexander (2020).

[108] Cf. for instance Sunstein (2005, p. 5) and Bogner and Torgersen (2018).

[109] Cf. European Commission (2014) and European Commission (2020).

[110] Von Schomberg (2013, p. 63).

[111] Cf. Vogt (2018, p. 45).

[112] Bogner and Torgersen (2018, p. 4).

digitalization with its very own (ethical) challenges such as data security, data privacy or knowledge and participation.[113] In the following, only some problematic and general aspects of participation may be discussed.

In the context of bioeconomy, RRI has not yet succeeded to establish a clear ethical definition of objectives, a binding framework or a process-oriented formalization of decision-making procedures and participation rights.[114] Some critics say that even if RRI would have succeeded, it could ever hardly be more than a public awareness tool only.[115] But even its focus on continuous involvement of a heterogeneity of relevant actors, i.e. participation of various stakeholders, policy and administration as well as academia and the broader public, which surely adds value in form of alternative perspectives and rationalities that widen the decision-making horizon, faces some significant challenges. Sociologist Alexander Bogner and biologist Helge Torgersen from the Institute for Technology Assessment (ITA) enumerate among other challenges, social difficulties, issue-framing, and problems of timing and of definition. By social difficulties they refer, for example, to the unskilled trait of tolerating opinion pluralism or the unknown obligation of reasonable argumentation that lead to conflict. With the problem of issue-framing, they point to the fact that leading voices of the participation processes are mostly the same experts and institutions formulating the same standard arguments and questions, thus marginalizing alternative modes of thought from the outset. The problem of timing consists in the circumstance that at an early stage, new technologies or innovations do not interfere with the everyday life of people yet and are not yet broadly discussed in the media and do therefore not yet arouse people's interest. People tend to become motivated to critically engage with new technologies or innovations not before their trajectories have already become quite immutable or at least hardly influenceable by RRI efforts. Last but not least, the definition and deliberation of problems in the participatory, expert-led process runs the risk of remaining either too concrete and narrow, or too abstract and little committed.

In their comparison of PP and RRI Bogner and Torgersen come to the following conclusion:

> Although the PP and RRI have little in common content-wise, [...] they shared a political function, albeit using different strategies: they both should prevent or bring down controversies over particular applications among stakeholders and the public. These controversies were seen as the major obstacles to the implementation of biotechnology. [...] [Yet (C.P.)] both tools with their respective reference to risk or ethical principles and

[113] In the realm of agricultural bioeconomy, it is, for instance applications such as smart farming or precision agriculture that represent the predominant practices of digitalization. In general, the significance of AI for bioeconomic applications and the sustainability context is increasing rapidly. For a general conception of AI *for* sustainability and the sustainability *of* AI see van Wynsberghe (2021).

[114] Cf. Vogt (2018, p. 46).

[115] Cf. Bogner and Torgersen (2018, p. 1).

> societal values could not sustainably cope with the recalcitrant problems of 'making biotechnology happen' [. . .].[116]

Besides the attested failure of RRI to have significantly overcome obstacles of technology implementation, it may further be criticized for its fixation on technical solutions.

3.3 Technological Fix Versus Behavioral Fix

Bioeconomy answers to the global ecological, social, and economic challenges with technological innovations. By some, it is even considered to be a game changer, for instance in its contribution to technologically based defossilization, decarbonization, and climate protection.[117]

Despite all the successes that have already been achieved and all the supplementary hopes and expectations for the future, two profound questions remain to be addressed: (1) Is technology eventually able to solve technologically induced problems, or does it perpetuate a never-ending spiral that creates necessity for new technologies to fix the shortcomings or deficiencies of the old ones? (2) Is it reasonable to deploy technical solutions for in actual fact moral and psychological problems?[118]

Concerning the first question, the insight about the need for developing amendments and alternatives to technological problem-solving strategies is starting to develop in some people's minds. On the one hand, people still seem to press for technological solutions, on the other hand, the message too gladly heard, *Don't you worry, technology will protect us from ourselves*, is questioned more and more.[119]

In spite of its seemingly green and sustainable appearance, the concept of bioeconomy is called into question concerning its inherent potential to prolong an inadequate mindset that has led humanity to the current situation of ecological crisis and global injustice in the first place.[120] Furthermore, it is reflected whether the installation of some bioeconomic applications necessarily always already requires innovative technical compensation for their destructive after-effects hence fostering a vicious cycle of a technological arms race: "What seems to be taking shape is a race between the advancing exhaustion of nature on the one hand and technological innovation on the other."[121] Although, it can never be entirely ruled out that the most

[116] Bogner and Torgersen (2018, p. 2).

[117] Cf. for instance Organisation for Economic Co-operation and Development (2011), Aguilar et al. (2018), von Braun (2018), European Economic and Social Committee (2018). Cf. also bioökonomie.de (2018), an initiative of the German Federal Ministry of Education and Research (BMBF).

[118] Cf. also Beck (2022) in this volume.

[119] Cf. Boldt (2018, p. 83) and Read and Alexander (2020, p. 17, 21).

[120] Cf. World Wide Fund for Nature (WWF) (2009, 2 ff.); Gottwald (2018, 100 f).

[121] Streeck (2016, p. 62).

helpful technological invention might be just within arm's reach, it would still be foolish to rely on that possibility.[122]

Thus, no matter how much a comfortable technological solution that reconciles excessive consumption patterns and business as usual with the Anthropocene's challenges is wished for, the concept of bioeconomy is not able to offer the single solution.[123] On the contrary, what is needed to combat ecological crises and mitigate climate change as well as to rectify the human-nature-relationship is a combination of biotechnological and predominantly socio-economic-ecological solutions, i.e. considerable changes in personal behaviors as well as, e.g., altered value and economic systems, and lifestyle and mobility concepts.

The second question scrutinizes whether technology optimism and faith in progress represent the advisable approach for dealing with nature, and whether it is able to adequately consider human's place in nature, the flourishing of human and non-human lifeforms as well as the planetary boundaries.

Among the reasons why a predominantly technological and bioeconomic way of dealing with living nature is conceptually misleading, Gottwald enumerates its irreducibility (beings are holistic entities which cannot be reduced to mere bricks of life), inalienability (if at all, beings may only be commodifiable and monetizable by strictest rules), unavailability (beings are equipped with intrinsic value), and unconditionality (beings are for their own sake worthy of protection).[124]

Among the steps required to bring about the overdue sustainable transformation, degrowth, post-growth, and voluntary abstinence from consumption are listed. To achieve this, capitalistic growth, materialistic individualism, and the logic of consumption need to be abolished, which of course is anything but easy and would require huge efforts for change in various areas.

One decisive area for inducing change in the logic of consumption is human psychology. The logic of consumption relies to a significant degree on status thinking. Status is a social phenomenon that is determined by and for groups and creates consumption standards and habits for group membership.[125] In this respect, status is a competitive concept that relies on social inequality. For the purpose of keeping the capitalistic economy going, structural incentives for the consumption of ever new goods that promise to further enhance status are marketed. Novelty keeps people buying more goods, which in turn keeps the economy going and the chase for status through consumption running.[126] Next to novelty *per se*, there are two further features impelling a throw-away attitude of consumers, namely creative destruction

[122] Cf. Jackson (2009, p. 83).

[123] Cf. Hagemann et al. (2016, p. 18) and Read and Alexander (2020, p. 9).

[124] Cf. Gottwald (2018, p. 103). I do neither subscribe to Gottwald's further conception of creatures having dignity and a right to freedom, nor to his theological viewpoint that creatures are intended by the Creator as they are. Instead, I argue for asymmetrical relations of recognition within which the morally relevant intrinsic good of all non-human lifeforms may be considered adequately (cf. Pinsdorf, 2016, 233 ff.).

[125] Cf. Victor (2019, p. 237).

[126] Cf. Sen (1998), Jackson (2009, p. 161) and Victor (2019, p. 235).

and planned obsolescence. Already in the early 1940s, influential Austrian national economist and politician Joseph Schumpeter coined the phrase *process of creative destruction* to describe the essence of capitalism, according to which old technologies are replaced by new ones and old companies are driven out of the market by the dominance of new ones in an endless cycle.[127] In combination with the feature of planned obsolescence, contemporary ecological economists observe an increasing intensification and acceleration of these structurally embedded cycles of creative destruction and novelty:

> Product lifetimes plummet as durability is designed out of consumer goods and obsolescence is designed in. Quality is sacrificed relentlessly to volume throughput. The throw-away society is not so much a consequence of consumer greed as a structural prerequisite for survival. Novelty has become a conscript to the drive for economic expansion.[128]

Now, the avoidance of status competition through consumption could already establish new ways to lessen harmful destructive practices toward the environment and the people. The never-ending spiral of producing, distributing, buying, consuming, and disposing of goods not only expands pressure through the increased material throughput and waste on the environment, but it also reinforces social inequality and creates distress, anxiety, and a fear of missing out on the people.[129]

Independently of each other, Jackson and Victor hint at ways out of this moribund vicious cycle. In a first step, structural incentives for consumption-based status competition would have to be revealed and criticized for promoting an unsustainable, sickening, and ethically unjustifiable practice. In a second step, these practices would have to be dismantled and replaced by new structures that foster the people's capabilities to flourish in much less consumptive ways and to fully participate in social life without materialistic status goods.[130] Over the course of the second step, people would have to be willing to change their value orientation and way of life. Because a human attitude of sufficiency and humility appears to be without any alternative in saving life on planet earth.[131] A general rethinking, accompanied by behavioral changes, is necessary, not least to avoid the aforementioned technologically induced rebound effects.

Even if such a development requires colossal changes and efforts on the part of society as a whole, it no longer seems to be pure utopia—for consumer culture spreads some kind of spiritual malaise, e.g. an apathetic sadness of the soul, as more

[127] Cf. Schumpeter (1994 [1942/43], pp. 81–86, 104) and Victor (2019, 50 f).

[128] Jackson (2009, p. 97). On obsolescence cf. also Daly (1996, p. 102).

[129] Cf. Jackson (2009, p. 154) and Victor (2019, p. 236).

[130] Cf. Kasser (2002), Jackson (2009, 153 ff., 180 ff). For the differentiation between status goods, useful goods and public goods cf. Victor (2019, 220 ff).

[131] Cf. Herrmann (2015, p. 3), Vogt (2018, p. 36) and Read and Alexander (2020, p. 19). On the huge impact of changed consumption patterns such as a less meat-based diet see, for instance, the pilot report on the monitoring of German bioeconomy by the Center for Environmental Systems Research (2020).

and more people discover that material things are not able to satisfy the human need for a meaningful life.[132] Moreover, ancient philosophical and social virtues such as temperance, appropriateness, and frugality cease to appear outdated, but are on the rise to be perceived as ever so fashionable.[133] These budding feelings, together with grassroots movements, such as Fridays for Future, claim a system change for environmental and social justice and open the door to a better future on planet earth for at least a little bit more.

To sum up, what is needed is a *Great Sustainable Transformation*[134] that encompasses both a technological *and* a behavioral fix. The first fix connects with socially acceptable technological innovations that support, among others, a new and stable economic framework which is not structurally dependent on ceaseless consumption but operates within ecological limits.[135] The second fix connects with a change of the social logic of consumerism that promotes socially meaningful and ecologically sustainable ways of human flourishing which are not structurally dependent on material accumulation and unproductive status competition, but instead enable people to fully participate in social life on ecologically sound grounds.[136]

4 Conclusion

Bioeconomy is neither a panacea for urgent challenges of the diverse crises in the Anthropocene nor is it sustainable *per se*. Real sustainability on a finite planet can only be achieved via a *Great Sustainable Transformation*. As the threefold understanding of the term sustainability—ecological, social, and economic—elucidates, economies, environments, and the socio-cultural sphere are interdependent. Economic growth effects not only the natural basis it is built upon, but also the social systems in which it is embedded. Today, economic growth runs the risk of undermining and damaging both the ecological and the social sphere. As such, the bioeconomic understanding of human flourishing or human well-being, which is still strongly connected to the concept of economic growth and prosperity, needs to be realigned in a manner that supports humanity to establish ways of flourishing meaningfully and within ethical and ecological boundaries.

[132] Cf. Read and Alexander (2020, 87 f).

[133] There are, for instance, diverse trends countering self-indulgence, such as downshifting, minimalism, vegetarianism and veganism, etc. Besides, there are more and more consumers who want to buy fewer and fewer products from companies "that do not pay attention to ecological and social aspects in their business policy" (Naturkapital Deutschland – TEEB DE, 2012, p. 66).

[134] Here I am borrowing and at the same time sharply distancing from *The Great Transformation* described by Karl Polanyi in 1944 (cf. Polanyi, 1973 [1944]).

[135] Cf. for instance the model of Contraction and Convergence (C&C) promoted by the Global Commons Institute (http://www.gci.org.uk/ [17.03.2021]).

[136] Cf. Jackson (2009, 157 f.); German Advisory Council on Global Change (2011, p. 1).

Solving the profound dilemma of growth requires rectifications on the technological and even more so on the behavioral level. It demands human society to change

> its economics, its accounts, its implicit biases against natural capital (versus man-made capital), against public wealth (versus private wealth) and against logical and less consumption (versus manic and more). And perhaps above all, human society needs to re-examine and change its relationship with nature to one of harmony and co-existence.[137]

Indian environmental economist Pavan Sukhdev, former head of the Green Economy Initiative of the United Nations Environment Programme (UNEP), Study Leader of TEEB and current president of the World Wildlife Fund (WWF), here summarizes the way in which economic reasoning has to change in order to aim for ecological as well as social justice and a sustainable economic system.

Aside from its persisting and problematic orientation toward (albeit green) growth, several semantic ambiguities of the concept of bioeconomy remain: Not least because of the various dimensions in which the relation between "bio" and "economy" is assessed contradictorily—as it is, e.g., the case concerning neoclassical versus ecological economics, the understanding of bioeconomy as economization of nature resp. ecologization of economy, or the conceptualization of nature and living beings as mere capital providing resources and ecosystem services to humans versus the conceptualization of nature and living beings, first and foremost, as entities of intrinsic value in and for themselves.

Over-optimistic promises and expectations concerning phenomena or ideas like decoupling and a zero-waste resp. renewable resources-based circular flow economy are further aspects still in need of being critically evaluated. On that front, PP and RRI are able to facilitate the process of judgment formation and critical public discourse, but are quickly stretched to their limits: for a profound and comprehensive ethical evaluation of the concept of bioeconomy prompts serious questions of relevance for philosophy of nature, anthropology, political philosophy, social philosophy, philosophy of technology, nature and environmental ethics, social ethics, animal ethics, business ethics and others.

Concerning the global questions and problems of environmental, social, and economic justice, there only exist moral guidelines such as the UN Paris Agreement or the UN Sustainable Development Goals (SDGs). There is, however, no political authority to translate those guidelines into binding and enforceable regulations so that perpetrators of globally relevant crimes against nature or mankind are really held accountable. To achieve this, a globally legitimized world government or world court would need to be set up in order to foster humanity's way out of the environmental, social, economic and—once more to our way of dealing with nature related—pandemic crisis via a truly concerted effort.

[137] Sukhdev (2009, p. xix).

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