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Theme issue contribution

Bio-Efficiency: On the valorisation of innovation in the bioeconomy

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Abstract
This article discusses a concept that institutions from the OECD to the EU increasingly employ in their response to the ecological crisis: The bioeconomy, wherein materials for economic activity would be bio-based and renewable. As a present-day project, the bioeconomy translates the critique of (fossil) carbon into patterns of (material) resource use and (economic) resource allocation, not least through a new valorisation of *innovation* in the form of public–private partnerships. Yet where literature on the bioeconomy scrutinizes innovation, the concrete link between funders and funded has seldom been subject to focused analytical inquiry. This link is essential to the structure of the bioeconomy project. To broach the arrangements by which efforts to conjure a (bio-)economy underwrite specific patterns of value distribution, this article asks: Which discursive and conceptual resources are deployed to define the worth by which projects are construed as worthy of funding? Drawing on online ethnographic observation at funding events as well as on document analysis, we show how these arrangements are structured by a valorisation of *efficiency*. We propose to call this bio-efficiency, and relate it to a construal of the world as scarce.

Keywords: efficiency; bio economy; innovation; valuation

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Introduction

An ethnographic scene to evoke the concerns of this article appears, as the familiar PowerPoint layout fills the screen that we are observing. A collection of words already on display: Mission, aim, pillar, cluster. Some 90 persons in attendance. Remotely, just as we are, and none with a camera switched on. Then, next to the presentation, a face comes into view. Long, light hair hovers in front of a white curtain and a woman, with an air of professionalism about her, begins to explain: What we have in front of us is '… the green growth strategy called the European Green Deal'. Today, we are here to learn about the new programme for Research and Innovation, which – the audience hears – 'is extremely important and timely … for the sake of new innovations, for a sustainable future'. That way, we are going to 'manage in a sustainable way'. A brief pause, then: '… and profitable! This should not be forgotten. So, there needs to be a balance!'

In that spirit, the floor soon cedes to the next step in the event: Presenters, telling stories of success from projects that the persons in attendance are meant to emulate: One woman – white shirt against a painted wall, appearing on one side of the screen as her PowerPoint presentation covers the other – speaks about thermal depolymerization processes; one man speaks about fungi and how these illustrate 'how smartly integrated products can solve parts of the challenges facing mankind and the Earth'; a man with short hair and round glasses tells of how the plastic deployed for artificial sports turf can be replaced by non-plastic alternatives capable of providing the qualities of conventional turf; another presenter speaks of the 'fully bio-based materials that can replace metal'; yet another celebrates the 'bio-based diesel', which would 'help us reduce emissions from transport'. And so the afternoon continues, at this event on innovation for the sake of a coming bioeconomy.

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Carbon is no longer the future, and if there is to be a future for our species it will be carbon-free. The most striking thing about this statement is the extent to which it is no longer striking at all: The critique of carbon is now ubiquitous across the mainstream political spectrum, and underpins a wide array of discourse, positions, innovation, and struggles. The old way of doing things – constructing houses, providing energy, transporting goods and people, playing sports – will no longer do, and a new way of life must emerge. In the introductory vignette, we encounter one social product of this consensus: The project, as pursued by actors from the OECD to the EU, to bring a bioeconomy into being.

In Europe, this bioeconomy project – the specific focus for this article – is not a straightforward object of inquiry. Institutions and

actors are manifold, making attempts at coordination difficult in networks now branched out in various states (Vogelpohl et al. 2022; see also Lühmann 2020). The very concept of a bioeconomy is descendent from a considerably more radical pedigree than found in its present-day deployment, remains far from unitary, and is used by conflicting categories of stakeholders (Levidow et al. 2013; Paterman and Aguilar 2018; Vogelpohl and Töller 2021) to frame efforts where the 'bio' carries connotations of bio-tech, bio-mass, or agroecology (Hausknost et al. 2017). However, while European bioeconomy strategies thus suffer 'conceptual ambiguity', which can 'lead to a certain vagueness and arbitrariness' (Vogelpohl and Töller 2021: 143), it remains the case that the rise of the bioeconomy is coupled with the promulgation of certain overarching conceptions of our present predicament and the appropriate ways in which to face it.

At stake in these overarching conceptions is a new reckoning with the material underpinnings for the economic generation of value (Birch 2017). Underpinning the bioeconomy project is a framework for which the contemporary economy is 'bad' by virtue of its reliance on fossils at each stage from production to consumption. Thus innovation is required for the sake of provisioning the means for shifting the entire economy – including the chemical industry, fuel industry, and traditional construction materials – to (non-fossil) biological materials. In short, the bioeconomy project is about supporting a shift where value (in the narrow sense) would henceforth be linked to material processes of a more worthy kind – a 'bad' economy finally made 'good' by virtue of a new alignment with a 'bio' (Asdal et al. 2023). There is ample literature on how such bio-economic innovation would break down existing natural impediments to the economic utilization of nature, particularly the barrier of the cell wall (Waldby 2002; Rose 2007a; Schmidt et al. 2012). Our concern in this article, however, lies much closer with what we actually put on display in the opening vignette above: not cell-walls being broken down, but an occasion where prospective applicants for R&D funding are presented with one framework for resource allocation, as well as examples of successful projects for them to emulate.

Innovation processes are costly (O'Sullivan 2005). Yet where '[i]nnovation has become a leitmotif of policy making and institutional design' (Pfotenhauer et al. 2019: 895), substantial sums are now expended through public investment into private initiatives for green innovation (see Goldstein and Eldield 2018). Thus, in Europe, funding for bioeconomic projects has been channelled through frameworks such as Horizon 2020 and Horizon Europe. While it is difficult to get precise numbers on the funding allocated, funding for 'Circular economy and bioeconomy sectors' amounts to €326 million only in 2023 and 2024 (European Liaison Office of the German Research Organisations 2023). In Sweden, several authorities finance R&D and

research in the 'bioeconomy', including Vinnova (Innovation Agency), Formas (Research Council for Sustainable Development), and the Swedish Energy Agency, along with foundations such as Wallenberg and Mistra. Vinnova also manage the governmental innovation programme 'BioInnovation', which has received SEK50–60 million per year since 2015. When asking one of the managers at Vinnova how many competitive R&D projects this has made possible over the years, he guessed somewhere between '250 and 300' (pers. comm.).

With a focus on its expression in the Swedish context, our aim is to depict and interpret valuation processes operating in this specific domain of the bioeconomy. Thus our concern is not with value where nature has been taken into the economy in the form of novel commodities or procedures of production (e.g. Asdal and Huse 2023). Nor is it value as the patents through which such novelty is turned into propertied assets valorised irrespective of deployment (Kang 2020). Instead, we address the allocation of economic resources within arrangements for funding innovation. These are three distinct moments, where the dynamics of value – as Birch (2017: 483) argues – must be analysed in the modulation specific to each step. In particular, there is a marked disconnect between potential devices that innovators promise and the deployment of actual innovations, and yet this 'failure to deliver on the promise of bountiful new products and services' coexists with 'high and rising financial valuations' (Birch 2017: 461).[1] The bioeconomy project thus operates as a 'new machinery of anticipation' (Hilgartner 2007: 382; see also Petersen and Krisjansen 2015), in which value allocation hinges more on future promise than present deployment. But what promises do innovators actually make in order to attract bioeconomic funding for their projects?

Crucial to this dynamic is the fact that funding, no matter how ample at any given time, will always be scarce in relation to the myriad of possible innovation projects. Funders must thus decide which projects are worthy recipients, and prospective innovators must frame their contribution as significant, viable, and worthy. But this raises a fundamental question: in what does 'the worth of the worthy [consist]' (Boltanski and Thévenot 2006: 14)? Fortunately for our inquiries, this same question is asked – albeit perhaps not in these words – by actors within the bioeconomic machinery itself. Worth, as Boltanski and Thévenot (2006: 132) suggest 'is the way in which one expresses,

[1] When approaching the bioeconomy, the 'bio' poses a magnetizing force and is often theorized in relation to Foucault and his concept of biopolitics. Birch and Tyfield (2013), however, believe that this amounts to a fetishization of the 'bio', which could obscure relationships that are contained in the emerging bio-based economies. Instead, the dynamics and the struggles shaping these relationships could be explored, they argue. Interestingly, however, formal politics is surprisingly absent from many discussions about the bioeconomy, although much resource allocation and many funding schemes are decided and administrated by formal political institutions (e.g. Asdal and Hobæk 2020).

embodies, understands, or represents other people'; this is precisely what the event depicted in the vignette above pivots around, where representatives of a funding institution face an audience of prospective 'innovators' in order to explain what they themselves can offer and what they would expect for doing so. The privileged means for representing worth at this event, as it was systematically during the course of our inquiries, was the example. Indeed, whether presenting fungi or sports turf, the examples on display served to express and represent success of a kind the audience might emulate. In the first instance, success is about the fact of being funded and bringing a project towards a conclusion. Yet beyond recounting the mere facts of projects, the point of doing so is to display what made the project worthy of funding to begin with. Thus, in this article, we understand such examples – examples first selected by interlocutors in the field rather than ourselves as researchers – as means by which bioeconomic actors themselves put the logic of their social field on display for themselves (see Graeber 2001). Events at which examples are presented, thus take on the character of 'grammatical enterprises intended to clarify and fix rules for reaching agreement' (Boltanski and Thévenot 2006: 66). In this manner, they serve our entry point for analysing a social order they both represent and construe (Boltanski and Thévenot 2006: 17; see also Patriotta et al. 2011; Gond et al. 2016).

We build our exploration on Asdal et al.'s (2023) demonstration that bioeconomic discourse promises an economy made 'good' by virtue of a new alignment with a 'bio'. But while we show similar discourse of alignment, we argue that the virtue of the 'bio' is, in turn, construed through promises to render industrial and economic activity more efficient. The economic dynamics by which the capitalist economy subjects actors to imperatives of efficiency has been a topic for the social sciences avant la lettre (see Marx 1990: chs 12–14). In the bioeconomy machinery, by contrast, efficiency interacts with value only as also construed as a normative criterion for defining a good economy (Asdal et al. 2023). We argue that it is imperative to distinguish between these ways in which value and efficiency interlock. Thus, we develop an analytical lens for scrutinizing and criticizing what we term bio-efficiency. This is our contribution and our take on what a proxy of 'the good' is in this particular context.

Our article is organized as follows. After an outline of the methods by which we inquired into bioeconomic innovation funding, we provide a minute depiction of one event. Written in a mode which 'remains a matter of evocation rather than of analysis' (Herzfeld 1987: 23), our intention is to display the lived context in which social actors express and reproduce the notions of worth for which we seek. We supplement the ethnographic depiction by attending to project reports from concluded bioeconomic innovation projects, which brings us to

an ensuing analytic discussion on how to construe the significance of efficiency to bioeconomic innovation processes. Noting that efficiency is already the organizing value of the industrial world whose problems the bioeconomy project seeks to redress (Boltanski and Thévenot 2006), we conclude by suggesting that the primacy of efficiency reflects a construal of the world as scarce rather than abundant, which can contribute to reducing innovation into the activity of finding new efficient means for pursuing old ends (see Goldstein 2018).

Zoom-ethnography, observing the field through a digital prism

During 2020, we began exploring the European bioeconomy by following the networks that make up this economy and how these networks are branched-out into various member states. Many of these networks are the result of innovation and research-funding from the EU Horizon 2020 programme, which has targeted calls for applications on bioeconomy projects. In individual member states, national research funding schemes have also propelled research on the bioeconomy. In 2017, an 'Expert Group' assessed the European bioeconomic strategy and stated that they had observed 'significant reinforcement of policy interaction and stakeholder engagement, for example the stakeholder panel and the stakeholder conferences' (Expert Group Report 2017) The significance of the conferences should not be underestimated (see Brosius and Campbell 2010; Nyqvist et al. 2017). These are events where networks are built, and conflicts contained in the bioeconomy are addressed (e.g. Lühmann 2020). And they are also occasions where expectations and norms are explicated and reproduced, not least by means of the 'exemplary' projects that the organizers elect to present.

From the outset, our research design placed these events at the centre. While not quite the public investment pitches studied in much of the literature (e.g. Lounsbury and Glynn 2001; Chapple et al. 2021), they provide a stage for highly performative presentations where especially presenters of successful innovation projects 'must concisely yet charismatically convey the value of their innovation' (Fairbairn et al. 2022). The COVID-19 pandemic jeopardized our strategy of focusing on such events, as they were cancelled. However, many soon turned into virtual conferences, which provided ample opportunities for our ethnographic work, only now in digital form. Whereas much digital research is concerned with researching 'the digital', as in digital social media, the digitized self, or digital politics (see e.g. Lupton 2015; Ash et al. 2018), we were not primarily interested in the digital practices of online networking. The digital ethnography we adhered to merely meant, following Pink et al. (2016: 21), that we were 'in mediated contact with participants rather than in direct presence'.

Indeed, the virtual conferences we attended amounted to a field of exploration. So, rather than meeting people face-to-face, we listened to and observed what happened in scripted presentations, Q&As and break-out rooms on Zoom.[2]

That the bioeconomy conferences and much of the networking within this industry-science community occurred online meant that we were able to participate in more events, hear more people talking, and learn about the many research projects that were tapping into the bioeconomy policy discourse. Because of the easy access, digital ethnography often leads to, as it did in our case, an overwhelming amount of empirical material, gathered while taking notes, collecting PowerPoints, downloading screenshots, and saving and storing hyperlinks. While our fieldwork spanned a period of 10–12 months, our participant observations were confined to shorter events. We observed around ten events, the shortest being around two hours and the longest two full days. This echoes Góralska's (2020: 50) reflection that digital ethnography tends 'to be shorter than the non-digital ones, as there is more data that can be collected in less time'. We also conducted an analysis of documents relating to the bioeconomy (Asdal and Reinertsen 2022) both upstream (e.g. overarching EU policy documents) and downstream (e.g. reports from concluded innovation projects) in order to attend to how notions of worth may carry through such instantiations. Finally, we interviewed civil servants who, while working with the European bioeconomy in Sweden, were mostly developing research and innovation funding schemes.

"The good economy" at the Bioeconomy Parliament

As discussed above, a critical component of the bioeconomy machinery are events that aim to cultivate the role of 'the innovator'. But what actually takes place at these events? In order to situate our analysis, we begin with a protractive description from one event. We then turn to reports from concluded innovation projects, thus creating a resonance that forefronts the theme for our ensuing analytic discussion.

'The Bioeconomy Parliament': this is the name of an annual event that attracts the big corporations in forestry and chemical industries in Sweden. This time, on a cold winter day, a diverse group of researchers, corporate representatives, and government officials would gather in a virtual room to watch and listen to presentations by start-ups, R&D projects, and researchers. The facilitating presenters are gathered together in what appears to be a small studio. Then, it begins. First, the usual presentation round by the organizers (a city in Sweden together with the Regional Authority) and the agenda and purpose of

[2] All personal names used in this article are pseudonyms.

the parliament is conveyed. Subsequently, to properly open the event, the first keynote speaker: the star-architect Will Gertsson, articulates his thoughts about the housing of the future. Gesturing, leaning forwards, and speaking in the animated manner which has made him a household name in the country, Gertsson enthusiastically voices his thoughts on moving away from using building materials excavated from below ground. As he is very much involved in creating the future of housing, with many prestigious building projects throughout Sweden and Scandinavia, his idea of a 'sustainable' future could be realized – Gertsson explains to his audience – if he only managed to convince his clients. Confessing that he does not care much for today's waste and high-tech solutions in housing construction, Gertsson expounds, instead, on his vision for a dense future city shaped by multifunctional housing, where cement as well as other carbon-intensive materials would be replaced by timber.

Gertsson's presentation is unmistakably both sweeping and visionary in its views for the future, which sets a tone that endures as the floor is ceded to actors of the kind Gertsson would need to convince to realize his envisioned future: Representatives from industrial trade associations. The next speaker, who represents the Swedish chemical industry, pursues his arguments through a series of PowerPoint slides composed, not predominantly by words, but as a series of graphs and images. Concerned with conveying how his industry could switch to circular and bio-based production, and under which conditions this could be done, one slide appears particularly central to the argument. This time, a slide with a figure displays a scenario of embedded carbon in different types of materials up to 2050. While fossil-derived materials constitute 84% of all chemical products as of today, this is supposed to be zero in 30 years. Recycling, he explains over the slide, is forecasted to move from constituting only 5% to 55% over the same time period. And the use of bio-based materials will double.

Against this background, the presentations move on to representatives from the industry which more than most others, at least in the local context, will be tasked with providing those bio-based materials: the large-scale forestry and logging industry.[3] Discussions are once more wide-ranging, but one presenter would take particular care to emphasize a crucial point: that the production of pulp, paper, and timber generates many different by-products, such as bark and chips. Historically, we learn, these by-products have not added any value to production and therefore been treated as waste to dispose of. Now, with efforts to launch the European bioeconomy, the ambition is to integrate the earlier by-products as valorised biomass to be included

[3] In Sweden, the bioeconomy has been characterized as shaped by a 'closed network structure' between research and regional councils and forestry industries in particular (Holmgren et al. 2022: 44).

as inputs in other production processes. Subsequent presentations deliberate the same issue, making this ambition – to turn waste into value – more concrete. Biofuels are a particularly prominent topic of concern, and we listen to technical presentations about how biomass from forestry and logging could be processed in biorefineries and then used as biofuel. Seemingly to round off this part of the discussion about the bioeconomy, the final slot is awarded to Börje Pålsson (professor of Energy Systems at Northern University) to give a broad picture of the availability of biomass globally and nationally, and he points out that in the long term, demand will exceed supply, which could lead to a critical point in the transition to a bio-based economy.

After over 1.5 hours of presentations, we are told that there will be a short break before a new round of presentations will follow. Soon, however, we assume that the invisible audience of listeners returns to their screens, much as we do ourselves, as it is now time for politicians and policy-advocacy representatives from large industries.

One after the other, for just over an hour, four persons speak under the telling heading: 'What political decisions and instruments of governance are needed to transform to a circular and bio-based economy?' Again, the event turns into a series of PowerPoint-presentations. First comes Lars Ekman, Chair of the board of the forestry and logging company Northern; then Sandy Norup, head of economic policy at Sweden's agribusiness association; then Nora Ylvasson from a public agency tasked with developing policy and evaluating regional economic performance; finally, Göte Jylland, member of the European Parliament and the committee for the environment, public health, and food safety. Each in turn gives their view on how transition could come about, based on their respective areas of expertise in forestry, agriculture, the circular economy, and the nitty-gritty of advocacy work in the EU Parliament. As we listen, what strikes us is the overall consensus: where each presenter emphasized the importance of harmonizing political decisions and policy instruments at different scales – the regional, the national, and the European level. Unless there is such a politics of alignment across scales, there is an overhanging risk, those of us in the audience are informed, that policy instruments that promote a transition to a bio-based economy will be hampered. The hosts then end the event by summarizing their main reflections and by thanking all participants, wishing everyone a nice evening. We finished our notes and then shut down our laptops.

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The depiction above, which we have subsequently written on those same laptops, may appear bewildering in an article ostensibly about efficiency – a word which is yet to appear. At this point, however, our

intention has been to portray the bioeconomic field as depicted by certain actors themselves within it. Having already presented innovation projects in the introduction, we here show problem formulations and precepts operating within the institutional framework whence this prospective funding is channelled. Our contention, then, is that this activity is also shaped by a certain valorisation of efficiency. This becomes even more clear if we briefly turn to excerpts from bioeconomic self-description at yet another stage in the innovation process: that where innovators present the results from a concluded project. First, the case of a consortium of government research institutes and energy and fuel companies who, as part of the Bio-innovation research program, received around SEK6 million to explore hydrothermal liquefaction. In their project summary, they write:

> To increase the profitability of lignocellulosic processing, it is necessary to maximize the value of the co-products from the process. In various processes based on wood, side streams are produced, such as sawdust, lignin and bark. As a rule, these are combusted to generate heat and power. There are also forestry residues, most often left in the forest or collected for heat and power generation (BioInnovation 2022a).

Second, the case of a bio-innovation R&D project intended to 'develop technologies for integrating mushroom and biofuel production' to be scalable and potentially profitable (BioInnovation 2022b). After describing the chemical processes, this project reports that more can be produced with less energy. Indeed, they explain that '[t]he studies succeeded in determining key parameters for hot-air pasteurisation of mushroom substrates that can reduce 60 percentage energy use and 65 percentage CO_2 emission than conventional steam autoclavation' and how they have now developed 'new devices and processes […] which may save >30% labour costs and 25% cultivation time' (BioInnovation 2022b).

In sum, our inquiries show how the Swedish bioeconomic innovation field operates much as it does elsewhere. Already Gertsson adopts its anticipatory framing turning his listeners towards a future where the 'bad' present construction has been made 'good' partly by virtue of a shift in the materiality of its composition. His keynote was followed by industry representatives, showing both the kind of private market-oriented economic actors involved in this field, as well as how their involvement remains underwritten by the belief that a bioeconomic transition will let us 'manage in a sustainable way' – to recall words from the introductory vignette – in a manner that is nonetheless aligned with the 'profitable'. Other actors concerned themselves with obstacles to this envisioned future. Yet when it comes to the desirability of that future itself, there is unanimity. Thus, we

contend, the social field we depict here is defined not by brute force but rather by competition shaped by invocations of a notion of common good (Boltanski and Thévenot 2006). So what does that notion amount to?

On the one hand, there is the turn to innovation – not at all a foregone conclusion even as such.[4] The prospective point of innovation, moreover, is on display with all the proposed novelties above. From football turfs to biodiesel, each would turn the old 'bad' economy 'good' by aligning it with 'the bio'. Such alignment is itself a measure of success (Asdal et al. 2023). Yet neither the prospective profitability nor the significance of these innovations for sustainability is about such alignment alone. There is another dimension, particularly explicit where our last example relates the relative savings of labour costs and time expenditure their contraptions enable. These innovators have succeeded in connecting an economic process with 'the bio' – but doing so is a success also because it allows that process to become more efficient in several respects. Similar notions everywhere permeate the vignettes above and our empirical materials as a whole: Energy use is to be reduced so as to render production more efficient; new ways of harnessing living matter will enable more efficient use of biological materials already available; procedures for turning industrial waste into new material input will make production evermore resource efficient. The significance of precisely such claims has – perhaps because they are so omnipresent so as to almost fall out of view – scarcely been touched upon in literature on the bioeconomy. For the remainder of this article, we show why analysing this efficiency of the 'bio' is significant for understanding the 'good' it postulates.

Critiquing carbon by making "bio" efficient?

In the preceding sections, we discussed innovation processes, and specifically such processes where those involved – from funders to researchers – frame their activity as oriented towards a bioeconomy. Once it has paid its due attention, concerns with efficiency appear ubiquitous in this context. For instance, the EU's ambition is to create 'a modern, *resource-efficient* and competitive economy […] where economic growth is decoupled from resource use' (European Commission 2019, emphasis added). This partly builds on the 2012 Bioeconomy Strategy and Action Plan, where the very point of constructing a bioeconomy is underwritten by the alleged need to build 'a more innovative, *resource efficient* and competitive society' (European

[4] The predisposition towards innovation as a panacea for social and ecological ills is itself historically specific. As 'formerly principally an analytic category used to explain technological change and economic growth', innovation is only recently 'a framing device […] through which we tend to frame policy problems as problems of innovation' (Pfotenhauer et al. 2019: 896).

Commission, Directorate-General for Research and Innovation 2013, emphasis added).

One reason that the worth of efficiency is often overlooked in the literature on green innovation, despite its prominence, may lie with how uncontroversial its worth is, among actors in the field as among those tasked to analyse it likewise. In a succinct definition, efficiency amounts to '[g]etting the most output for a given input' (Stone 2012: 67). Whether pertaining to resources or energy or labour, it is a 'technological orthodoxy [that] all things *ought* to act efficiently' (Dunlop 2019: 101216), and efficiency amounts to a 'positively ambiguous euphemism for "good" [whose] seemingly uncontroversial nature makes it difficult to criticize' (Dunlop 2022: 726). In the context of ecological issues specifically, furthermore, contemporary society is shaped by 'a widespread sensibility that efficiency is tantamount to environmental benevolence [and] that using less and producing more is a recipe for sustainability' (Guthman 2022: 77).[5] Precisely by being so uncontroversial, however, it is not clear that an analysis of efficiency contributes towards an understanding of the particular nature of bioeconomic innovation processes. Social worlds coalesce around notions of the substantive worth of the worthy. Efficiency, instead, brackets the worthiness of any worth, and simply compares input-output ratios between means for attaining an end, irrespective of how worthy that end may be. The bioeconomic concern with efficiency, thus, may simply explicate a value that transcends the values of *any* social world. We do not believe that this is the case. Yet, appreciating how the bioeconomic project connects value and efficiency requires distinguishing between two ways in which value and efficiency are connected, as well as two analogous strategies for critically scrutinizing this connection.

The first manner in which to broach the connection between value and efficiency is to approach it as a property of productive processes that generate valued output. Such efficiency is intrinsic to the dynamics of capital itself: Firms are involved in intense competition, meaning that producers are pressured to cut production costs – maximize output for given input – in order to gain competitive advantage on markets structured by price-based comparisons made by consumers (Shaikh 2016). While such augmentation of efficiency can be pursued by different means, it is also the case that '[r]aw-materials-saving processes' – thus akin to the concerns prominent in the bioeconomy – 'are older than the Industrial Revolution [and] have been dynamic

[5] Resource efficiency underpins not only much of the discourse on sustainability, but also the original conservationist discourse built on an imperative of efficiency (Hays 1959). Rather than endorsing a morality of protection or preservation, conservationist efforts are aimed at safeguarding the efficient use of resources for a growing nation.

through the history of capital' (Bunker 1996: 421; see also Martinez-Alier 2011).[6]

Efficiency of this first kind has long been subject to environmentalist scrutiny voiced in what is also the first mode of critique. Some invoke the 'paperless office paradox' in order to question the extent to which we should expect one resource substituting for another to lead to decreased pressure on the resource displaced (York 2006). Others invoke Jevons's paradox to point out that augmentation of the relative efficiency of resource use tends to increase rather than decrease use of the resource in question (Alcott 2005; Herring 2006).[7] The imperative of efficiency would then be paradoxical in the sense of generating some of the very problems that it portrays to solve. Similarly, European efforts to dematerialize the economy by means of technological effectivization may be but a concealed form of environmental load displacement (Hornborg 2009).

These critiques hold significant implications for how we ought to regard efforts to supervene the ecological crisis by means of stimulating innovation. Such implications, however, are wholly internal to a contestation that plays out within an already established regime of worth. The very effort to demonstrate that *apparent* efficiency is *actually* concealed inefficiency draws the force of its claim on one assumption that remains unquestioned: That it is better to be efficient than to be inefficient, and that efficiency amounts to a privileged variable for comparing different options. Thus, this manner of engaging efficiency is wholly different from what is required to answer the questions we pose in this article.

The *second* mode of critical scrutiny hinges on a shift in focus, which moves attention from efficiency as a property that facilitates the generation of value within a productive process, to ways in which social actors construe efficiency *as* the valued property. In the ethnographic scenes portrayed above, a worth is postulated, assessed, and connected with resource allocation – but it is not the case that innovators gain competitive advantage by being efficient themselves. Novel devices, procedures and materials developed within such innovation processes might certainly augment the production of

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[6] See also Boyd et al. (2001) for how bio-based production often struggles with efficiency. Biological growth cycles in both plants and animals are understood by agri-businesses as limits that must be overcome in order to produce the highest level of outputs with as few inputs as possible.

[7] The bioeconomic project of substitution can be read as an effort to reverse a yet earlier substitution: That where biomass was replaced by fossil fuel as the dominant source of human energy. Yet whereas this was a dramatic shift away from biomass in relative terms, absolute energy consumption increased sufficiently to also increase the absolute consumption of biomass (Smil 1994). There is as yet little evidence that a relative shift back to biomass will not have the same (absence of) effect on the absolute consumption of fossil fuel.

valuable output once deployed; in the context of the innovation process itself, however, worth is assessed (and value allocated) on basis of *promises* of efficiency. Efficiency is not a property of their own process of (intellectual) production, but rather the commodity that they produce. There is nothing efficient in these promises in and of themselves, and critical analysis thus requires a different strategy for engaging their concealment and consequences.

In the bioeconomy project, the adjustment of beings to this 'principle of equivalence' (Boltanski and Thévenot 2006) means that efficiency becomes an object, around which everything else is orbiting and is tested against. Then, instead of addressing how apparent gains in efficiency are unavailing (or consist in dissembled exploitation), an analysis of efficiency valued-as-such would challenge naturalizations of efficiency, which construe its beneficence as a universally revered value. This is a task primarily for historical genealogy of the kind that aims at unsettling our own taken-for-granted assumptions.[8] To then understand the consequences of the historically contingent valorisation of efficiency requires addressing specific qualities of the concept, chief among which are its apparent *lack* of qualities. Efficiency simply compares the input-output ratios associated with the processual means for attaining *any* specific good; as a value pursued as such, then, efficiency primarily underwrites efforts to attain 'mastery of the process itself' (Alexander 2009: 1011).

To see how, note above how the overbearing way to represent the inefficient vice of the old relative to the benevolently efficient (bio-)new is numerical quantification – a mode of representation long favoured precisely for its purported detachment from specific perceptions of values (Porter 1995). Accordingly, all the 'exemplary' bioeconomic achievements above amount to augmentation of productive processes, detached from considerations of the worth of specific productive output, let it be either turf on football fields or biofuels. This is particularly clear in the emphasis on substitution, where the good is equated with producing and consuming the same products as before, only aligning production with 'the bio' by replacing the material substance with biological and more efficient alternatives. Likewise with the worth of projects that focus on waste, which aim to more fully master productive processes by reducing or valorising unintended pollution that eludes control (see Klitkou et al. 2019; Böcher et al. 2020).

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[8] Dunlop (2019) concludes that 'investigations into the historical and cultural underpinnings of energy efficiency remain scarce', and the same holds for efficiency more broadly. Yet see Alexander (2008) and Cobley (2009) for how efficiency migrated from a concern for theologians (engaged in efforts to make sense of the properties of God) to its place as a defining 'good' (Asdal et al. 2023) of a cultural ethos in wake of the Industrial Revolution (see also Boltanski and Thévenot 2006).

Directed towards the bioeconomy project we have explored here, this second mode of critical analysis furnishes verdicts that do not rely on challenging (or espousing) claims to efficiency. Instead, two issues come to the fore: First, the ostensible disfiguration produced through 'adjustments' to the criterion of efficiency, readily seen in the 'molecularizing' (Rose 2007b) comportment to living entities, which decontextualize life from its embedded contexts and turn it into matter malleable for a 'real subsumption of nature' (Boyd et al. 2001). Second, in respect of how the bioeconomy project challenges the ecological crisis in a manner that reproduces its underlying drivers. Even the European Union now invokes the once-radical precepts that we live in 'a world of limited resources' where there are 'ecological boundaries of our planet' (European Commission, Directorate-General for Research and Innovation 2018: n.p.). Yet as policymakers fulfil the obligations that follow this conundrum by funding innovation oriented towards efficiency, they also direct public concern down a path where the substantive *ends* of life – against whose horizon the socio-material world of humans takes form – remain in brackets.

Conclusion

Decades ago, radical environmentalists used a variety of concepts – planetary boundaries, limits to growth – to challenge the logic of an economy premised on endless growth. Once deeply controversial, such concepts now find their place in the policies of established institutions, ranging from the Bioeconomy Parliament to the European Union. To insist on the scarcity of both resources and time for action has come to mark the conventional political standpoint, and the rejection thereof amounts to the standpoint that is beyond the pale for many. In this context, conventional economic activity – ways of producing, transporting, consuming – is perceived as fundamentally problematic. Such problematization, in turn, generates a novel moral field, where efforts are marked 'good' by virtue of their trajectory away from the conventional way of life (Asdal et al. 2023).

The prospect of natural scarcity and limits to growth now underwrites abundant resource streams and growth for some. Not least among the beneficiaries of this structure are certain innovators. In the European context, such innovators are presently at work to bring a host of new entities into being, from bioplastics to biofuel and bioenergy. In order to expand the present understanding of bioeconomic innovation, this article has addressed the innovation context found in Sweden. From the observation that *potential* innovation projects tend to become *actual* projects at the point of receiving funding, there is an indispensable link between funders and funded. In what terms is the worthiness of projects construed at this juncture? The answer to this question, we have proposed, reveals

dimensions of the bioeconomy overlooked even as they are hidden in plain sight.

Our ethnographic observations and analysis confirm many observations already made about the bioeconomy project: First, how its public private partnerships operate within a specific future-oriented 'machinery of anticipation' (Hilgartner 2007: 382); second, that the overall 'ethos' of the bioeconomy identifies 'alignment with the bio' as a good in itself (Asdal et al. 2023); third, how many efforts focus on turning what is now regarded as waste into a source of value (Klitkou et al. 2019). Our analysis, however, shows how these characteristics are bound together by a concept often left aside from critical scrutiny: *efficiency.*

In the context of 'green' innovation, efficiency is one of the words most prominently deployed to articulate the worth of an innovation. More fundamentally, however, efficiency underpins the bioeconomic logic of innovation also where the word is not in overt use. Take the three points immediately above: Policymakers' novel apprehension of natural limits underpins their turn to public-private partnerships for innovation. This follows a pattern hearkening back to those responding to Malthus, who alleged that the latter's prospect of a scarce world of inevitable famine was mistaken insofar as it overlooked how *technological innovation* can perpetually push the boundaries of natural scarcity. By means of technology, such detractors assert, the finite nature available for human use can be made to deliver (infinitely) more. And that – to grow not by expanding the resource base, but by making an available resource yield more – is the task of efficiency. Innovators respond to the request for efficiency when, for instance, developing procedures to turn the waste-part of a productive process into a new source of value. What furthermore reveals the logic of efficiency at work is the aim of substitution (of 'aligning with the bio') itself. Where such substitution *is* the criterion of success, there worth is an issue entirely of means – the relative value of *what* a process can produce is bracketed, in favour of a focus on measurable and quantitatively comparable properties of the process itself (from energy to time to money).

We propose to call this the logic of *bio-efficiency.* In addition to encapsulating the observations made above, this term aims to add something further: An emphasis that what bioeconomic innovation aims to make effective is human use of 'the bio', and that it is such *promises* that attract funding, primarily the promise of resource efficiency (rather than from any efficiency in the proposed novelty itself). Beyond situating the bioeconomic innovation field squarely within the industrial world where efficiency serves the cardinal principle invoked in tests of worth (as delineated in Boltanski and Thévenot 2006), the latter is a crucial distinction to enable an analysis of contemporary modes of concrete resource allocation. Where there is

a vast literature on how and why producers who adopt an innovation can increase profits by cutting resource use and so the costs of production, the function of efficiency in the context of bioeconomic innovation is significantly different. Instead of being a characteristic of a process that produces commodities valued by consumers, efficiency (in this latter context) is the property that *is valued.* The promise of efficiency is, in a sense, the 'commodity' that innovators actually sell.

By proposing the concept of bio-efficiency, our article calls for further critical scrutiny of an overlooked dimension of the bioeconomy. Such critical scrutiny does not amount to a denigration of the innovation presented above, nor of the bioeconomic project as a whole. Our point, instead, is to emphasize that a burgeoning socio-economic field – bio-economic innovation – must be analysed with due consideration of efficiency as a core structuring value. If there is a political critique that follows from this, it would focus on the effects of a proliferating cultural preoccupation with efficiency. And that brings us back to the radical environmentalists and their politics of limits. There *is* a limit, these pioneers claimed, to what resources the planetary system can make available for human purposes. Hence, limits must also be put on production and consumption. Those who trust effectivization take the opposing position. Yet the difference between these political camps is, in one way, structured by disagreement simply as to whether effectivization is sufficient for aligning growth and sustainability. Insofar as the widespread sense that we now need to turn our 'bad' industrial economy 'good' is channelled into innovation, and innovations are tested in respect of the criterion of efficiency, such deliberations reproduce the normative values of the very industrial world whose legitimacy is now in question. Neither side asks whether (or how) efficiency is desirable to begin with, nor if the postulate of scarcity is the appropriate point of reference for environmental politics (D'alisa et al. 2014; Krüger 2019).[9] To scrutinize bio-efficiency means to adopt a standpoint cognizant of how contingent the valorisation of efficiency really is, which – we hope – might facilitate a shift to where innovation would innovate more on new *ends* of human life, rather than on ways to pursue old ends by new (more efficient) means.

[9] Guthman (2022: 72) writes that 'there are many reasons to disrupt and probably eradicate industrialized livestock production [but] lack of efficiency is arguably not one of them. Indeed […] industrialized livestock (and crop) production has long been underpinned by a logic of efficiency'. Our article contends that the same holds for the world of industry generally.

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References

Alcott, Blake. 2005. "Jevons' Paradox." *Ecological Economics* 54(1): 9–21.

Alexander, Jennifer K. 2009. The concept of efficiency: An historical analysis. In *Philosophy of Technology and Engineering Sciences*, edited by Anthonie Meijers, 1007–1030. Amsterdam: North Holland.

Alexander, Jennifer K. 2008. *The Mantra of Efficiency: From Waterwheel to Social Control*. Baltimore, MD: Johns Hopkins University Press.

Asdal, Kristin, and Bård Hobæk. 2020. "The Modified Issue: Turning Around Parliaments, Politics as Usual and How to Extend Issue – Politics with a Little Help from Max Weber." *Social Studies of Science* 50(2): 252–270.

Asdal, Kristin, and Hilde Reinertsen. 2022. D*oing Document Analysis: A Practice-Oriented Method*. Thousand Oaks, Los Angeles: SAGE.

Asdal, Kristin, and Tone Huse. 2023. *Nature-Made Economy: Cod, Capital, and the Great Economization of the Ocean*. Cambridge, MA: MIT Press.

Asdal, Kristin, Béatrice Cointe, Bård Hobæk, Hilde Reinertsen, Tone Huse, Silje R Morsman & Tommas Måløy. 2023. "'The Good Economy': A Conceptual and Empirical Move for Investigating How Economies and Versions of the Good Are Entangled." *BioSocieties* 18(1): 1–24.

Ash, James, Rob Kitchin, and Agnieszka Leszczynski. 2018. "Digital Turn, Digital Geographies?" *Progress in Human Geography* 42(1): 25–43.

BioInnovation 2022a. "HTL – Hydrothermal Liquefaction of Forestry and Agricultural Residues." Accessed 30 April 2024. https://www.bioinnovation.se/en/projekt/htl-hydrothermal-liquefaction-of-forestry-and-agricultural-residues-bioeconomy-2-0/.

BioInnovation 2022b. "CoMush: Forest Residues for Combined Edible Mushroom and Biofuel Production." Accessed 30 April 2024. https://www.bioinnovation.se/en/projekt/comush-forest-residues-for-combined-edible-mushroom-and-biofuel-production-bioek-2-0/.

Birch, Kean. 2017. "Rethinking Value in the Bio-economy: Finance, Assetization, and the Management of Value." *Science, Technology, & Human Values* 42(3): 460–490.

Birch, Kean, and Tyfield, David. 2013. "Theorizing the Bioeconomy: Biovalue, Biocapital, Bioeconomics or . . . What?" *Science, Technology, & Human Values* 38(3): 299-327.

Böcher, Michael, Annette Elisabeth Töller, Daniela Perbandt, Katrin Beer, & Thomas Vogelpohl. 2020. "Research Trends: Bioeconomy Politics and Governance." *Forest Policy and Economics* 118: 102219.

Boltanski, Luc, and Laurent Thévenot. 2006. *On Justification: Economies of Worth*. *Princeton*, NJ: Princeton University Press.

Boyd, William, William Scott Prudham, and Rachel A. Schurman. 2001. "Industrial Dynamics and the Problem of Nature." *Society & Natural Resources* 14(7): 555–570.

Brosius, J. Peter, and Lisa M. Campbell. 2010. "Collaborative Event Ethnography: Conservation and Development Trade-offs at the Fourth World Conservation Congress." *Conservation and Society* 8(4): 245–255.

Bunker, Stephen G. 1996. "Raw Material and the Global Economy: Oversights and Distortions in Industrial Ecology. *Society & Natural Resources* 9(4): 419–429.

Chapple, David, Neil Pollock, and Luciana D'Adderio. 2021. "From Pitching to Briefing: Extending Entrepreneurial Storytelling to New Audiences." *Organization Studies* 43(5): 773–795.

Cobley, Evelyn. 2009. *Modernism and the Culture of Efficiency: Ideology and Fiction*. Toronto, ON: University of Toronto Press.

D'Alisa, Giacomo, Federico Demaria, and Giorgos Kallis. 2014. "From Austerity to Dépense." In *Degrowth: A Vocabulary for a New Era*, edited by Giacomo D'Alisa, Federico Demaria, and Giorgos Kallis, 215–220. London: Routledge.

Dunlop, Tessa. 2019. "Mind the Gap: A Social Sciences Review of Energy Efficiency." *Energy Research & Social Science* 56: 101216.

Dunlop, Tessa. 2022. "Energy Efficiency: The Evolution of a Motherhood Concept." *Social Studies of Science* 52(5): 710–732.

European Commission. 2019. The European Green Deal. COM(2019) 640 final. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0640.

European Commission, Directorate-General for Research and Innovation. 2013. *A Bioeconomy Strategy for Europe: Working with Nature for a More Sustainable Way of Living*. Publications Office. https://data.europa.eu/doi/10.2777/17708.

European Commission, Directorate-General for Research and Innovation. 2018. A *Sustainable Bioeconomy for Europe: Strengthening the Connection between Economy, Society and the Environment: Updated Bioeconomy Strategy*. Publications Office. https://data.europa.eu/doi/10.2777/792130.

European Liaison Office of the German Research Organisations. 2023. *Cluster "Food, Bioeconomy, Natural Resources, Agriculture and Environment" 2023–2024*. https://www.kowi.de/en/kowi/Horizon-Europe/2324/cluster-food-bioeconomy-natural-resources-agriculture-and-environment-2023-2024.aspx.

Expert Group Report. 2017. *Review of the EU Bioeconomy Strategy and its Action Plan*. https://ec.europa.eu/research/bioeconomy/pdf/publications/bioeconomy_expert_group_report.pdf.

Fairbairn, Madeleine, Zenia Kish, and Julie Guthman. 2022. "Pitching Agri-food Tech: Performativity and Non-disruptive Disruption in Silicon Valley." *Journal of Cultural Economy* 15(5): 652–670.

Goldstein, Jesse. 2018. *Planetary Improvement: Cleantech Entrepreneurship and the Contradictions of Green Capitalism*. Cambridge, MA: MIT Press.

Goldstein, Jesse, and David Tyfield. 2018. "Green Keynesianism: Bringing the Entrepreneurial State Back in (to Question)?" *Science as Culture* 27(1): 74–97.

Gond, Jean-Pascal, Luciano Barin Cruz, Emmanuel Raufflet, and Mathieu Charron. 2016. "To Frack or Not to Frack? The Interaction of Justification and Power in a Sustainability Controversy." *Journal of Management Studies* 53(3): 330–363.

Góralska, Magdalena. 2020. "Anthropology from Home." *Anthropology in Action: Journal for Applied Anthropology in Policy and Practice* 27(1): 46–52.

Graeber, David. 2001. *Toward an Anthropological Theory of Value: The False Coin of Our Own Dreams*. Basingstoke: Palgrave.

Guthman, Julie. 2022. "The CAFO in the Bioreactor: Reflections on Efficiency Logics in Bio-industrialization Present and Future." *Environmental Humanities* 14(1): 71–88.

Hausknost, Daniel, Ernst Schriefl, Christian Lauk, and Gerald Kalt. 2017. "A Transition to Which Bioeconomy? An Exploration of Diverging Techno-political Choices." *Sustainability* 9(4): 669.

Hays, Samuel P. 1959. *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890-1920*. Cambridge, MA: Harvard University Press.

Herring, Horace. 2006. "Energy Efficiency—A Critical View." *Energy* 31(1): 10–20.

Herzfeld, Michael. 1987. *Anthropology through the Looking-Glass: Critical Ethnography in the Margins of Europe*. Cambridge: Cambridge University Press.

Hilgartner, Stephen. 2007. "Making the Bioeconomy Measurable: Politics of an Emerging Anticipatory Machinery." *BioSocieties* 2(3): 382–386.

Holmgren, Sara, Alexandru Giurca, Johanna Johansson, Christoffer Söderlund Kanarp, Tove Stenius, Klara Fischer, 2022. "Whose Transformation Is This? Unpacking the 'Apparatus of Capture' in Sweden's Bioeconomy." E*nvironmental Innovation and Societal Transitions* 42: 44–57.

Hornborg, Alf. 2009. "Zero-sum World: Challenges in Conceptualizing Environmental Load Displacement and Ecologically Unequal Exchange in the World-system." *International Journal of Comparative Sociology* 50(3–4): 237–262.

Kang, Hyo Yoon. Y. 2020. "Patents as Assets: Intellectual Property Rights as Market Subjects and Objects." In *Assetization: Turning Things into Assets in Technoscientific Capitalism*, edited by Kean Birch and Fabian Muniesa, 45–74. Cambridge, MA. MIT Press.

Klitkou, Antje, Arne M. Fevolden, and Marco Capasso (eds.). 2019. *From Waste to Value: Valorisation Pathways for Organic Waste Streams in Circular Bioeconomies*. Oxford: Routledge.

Krüger, Oscar. 2019. "The Paradox of Sustainable Degrowth and a Convivial Alternative." *Environmental Values* 28(2): 233–251.

Levidow, Les, Kean Birch, and Theo Papaioannou. 2013. "Divergent Paradigms of European Agro-food Innovation: The Knowledge-based Bio-economy (KBBE) as an R&D Agenda." *Science, Technology, & Human Values* 38(1): 94–125.

Lounsbury, Michael, and Mary Ann Glynn. 2001. "Cultural Entrepreneurship: Stories, Legitimacy, and the Acquisition of Resources." *Strategic Management Journal* 22(6–7): 545–564.

Lühmann, Malte. 2020. "Whose European Bioeconomy? Relations of Forces in the Shaping of an Updated EU Bioeconomy Strategy." *Environmental Development* 35: 1–10. .

Lupton, Deborah. 2015. *Digital Sociology.* Oxford: Routledge.

Martinez-Alier, Joan. 2011. "The EROI of Agriculture and Its Use by the Via Campesina." *Peasant Studies* 38(1): 145–160.

Marx, Karl. 1990. *Das Capital, Volume 1: A Critique of Political Economy*. London: Penguin Classics.

Nyqvist, Annette, Hege Høyer Leivestad, and Hans Tunestad. 2017. "Individuals and Industries: Large-scale Professional Gatherings as Ethnographic Fields." In *Ethnographies of Conferences and Trade Fairs: Shaping Industries, Creating Professionals,* edited by Hege Høyer Leivestad and Annette Nyqvist, 1–21. Cham, Switzerland: Springer.

O'Sullivan, Mary. 2005. "Finance and Innovation." In *The Oxford Handbook of Innovation*, edited by Jan Fagerberg, David Mowery, and Richard Nelson, 240–265. Oxford: Oxford University Press.

Patermann, Christian, and Alfredo Aguilar. 2018. "The Origins of the Bioeconomy in the European Union." *New Biotechnology* 40: 20–24.

Patriotta, Gerardo, Jean-Pascal Gond, and Friederike Schultz. 2011. "Maintaining Legitimacy: Controversies, Orders of Worth, and Public Justifications." *Journal of Management Studies* 48(8): 1804–1836.

Petersen, Alan, and Ivan Krisjansen. 2015. "Assembling 'the Bioeconomy': Exploiting the Power of the Promissory Life Sciences." J*ournal of Sociology* 51(1): 28–46.

Pfotenhauer, Sebastian M., Joakim Juhl, and Erik Aarden. 2019. "Challenging the 'Deficit Model' of Innovation: Framing Policy Issues under the Innovation Imperative." *Research Policy* 48(4): 895–904.

Pink, Sarah, Heather Horst, John Postill, Larissa Hjorth, Tania Lewis, and Jo Tacchi (2016). *Digital Ethnography. Principles and Practice*. Thousand Oaks, Los Angeles: Sage

Porter, Theodore M. 1995. *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*. Princeton, NJ: Princeton University Press.

Rose, Nikolas. 2007a. "Molecular Biopolitics, Somatic Ethics and the Spirit of Biocapital." *Social Theory and Health* 5(1): 3–29.

Rose, Nikolas. 2007b. T*he Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century*. Princeton, NJ: Princeton University Press.

Schmidt, Otto, Susanne Padel, and Les Levidow. 2012. "The Bio-economy Concept and Knowledge Base in a Public Goods and Farmer Perspective." *Bio-based and Applied Economics* 1(1): 47–63.

Shaikh, Anwar. 2016. *Capitalism: Competition, Conflict, Crises*. Oxford: Oxford University Press.

Smil, Vaclav. 1994. *Energy in World History*. Boulder, CO: Westview.

Stone, Deborah. 2012. *Policy Paradox: The Art of Political Decision Making*, 3rd edn. New York: W.W. Norton & Co.

Vogelpohl, Thomas, and Annette Elisabeth Töller. 2021. "Perspectives on the Bioeconomy as an Emerging Policy Field." *Journal of Environmental Policy & Planning* 23(2): 143–151.

Vogelpohl, Thomas, Katrin Beer, Benjamin Ewert, Daniela Perbandt, Annette E. Töller, and Michael Böcher. 2022. "Patterns of European Bioeconomy Policy: Insights from a Cross-case Study of Three Policy Areas." *Environmental Politics* 31(3): 386–406.

Waldby, Catherine. 2002. "Stem Cells, Tissue Cultures and the Production of Biovalue." *Health: An Interdisciplinary Journal* 6(3): 305–323.

York, Richard. 2006. "Ecological Paradoxes: William Stanley Jevons and the Paperless Office." *Human Ecology Review* 13(2) 143–147.

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