

This is an electronic reprint of the original article.

This reprint *may differ* from the original in pagination and typographic detail.

Author(s): Dennis Eversberg, Philip Koch, Rosa Lehmann, Andrea Saltelli, Sabaheta Ramcilovic-Suominen & Zora Kovacic

Title: The more things change, the more they stay the same: promises of bioeconomy and the economy of promises

Year: 2023

Version: Published version

Copyright: The Author(s) 2023

Rights: CC BY 4.0

Rights url: <http://creativecommons.org/licenses/by/4.0/>

Please cite the original version:

Eversberg, D., Koch, P., Lehmann, R. et al. The more things change, the more they stay the same: promises of bioeconomy and the economy of promises. *Sustain Sci* (2023).


<https://doi.org/10.1007/s11625-023-01321-4>

All material supplied via *Jukuri* is protected by copyright and other intellectual property rights. Duplication or sale, in electronic or print form, of any part of the repository collections is prohibited. Making electronic or print copies of the material is permitted only for your own personal use or for educational purposes. For other purposes, this article may be used in accordance with the publisher's terms. There may be differences between this version and the publisher's version. You are advised to cite the publisher's version.



Promises of Bioeconomic Change as a Strategy for Avoiding Socio-ecological Transformation

The more things change, the more they stay the same: promises of bioeconomy and the economy of promises

Dennis Eversberg¹  · Philip Koch¹ · Rosa Lehmann² · Andrea Saltelli^{3,4} · Sabaheta Ramcilovic-Suominen⁵ · Zora Kovacic^{3,6}

Received: 26 January 2023 / Accepted: 13 March 2023
© The Author(s) 2023

Abstract

This editorial lays out the core themes of the special feature and provides an overview of the contributions. It introduces the main argument, namely that the promises of far-reaching change made by recent bioeconomy policies are in fact strategically directed at avoiding transformative change to existing societal arrangements. Bioeconomy discourse showcases technological solutions purported to solve sustainability ‘problems’ while sustaining economic growth, but avoids issues of scalability, integration or negative consequences. Thus, bioeconomy policies, and particularly the latest versions of the predominantly European ‘bio-resource’ variety that have rhetorically integrated a lot of previous sustainability-minded criticism, serve to ward off or delay challenges to an unsustainable status quo, in effect prolongating the escalatory imperatives of capitalist modernity that are at the root of current crises. The editorial’s second part highlights the contributions that the 13 featured articles, based on theoretical considerations as well as policy analyses and empirical case studies from a range of countries, make to this argument.

For more than a decade now, governments predominantly in the Global North have been heralding the bioeconomy as a

core element of solutions to the global ecological crisis, and, increasingly so, as an impending transformation that will entail comprehensive and far-reaching societal change. The EU, as one of the main institutional protagonists of recent bioeconomy policymaking, for instance, opens its current updated bioeconomy strategy as follows:

Handled by Osamu Saito, Institute for Global Environmental Strategies, Japan.

✉ Dennis Eversberg
dennis.eversberg@uni-jena.de

¹ BMBF Junior Research Group “Mentalities in Flux” (Flumen), Institute of Sociology, Friedrich Schiller University, Leutragraben 1, 07743 Jena, Germany

² “Innovation and Sustainability in Ibero-America”, Heidelberg Center for Ibero-American Studies (HCIAS), Heidelberg University, Brunnengasse 1, 69117 Heidelberg, Germany

³ UPF Barcelona School of Management, Carrer de Balma, 132, 08008 Barcelona, Spain

⁴ Centre for the Study of the Sciences and the Humanities (SVT), University of Bergen, Parkveien 9, PB 7805, 5020 Bergen, Norway

⁵ “International Forest Policy and Governance”, Natural Resource Institute Finland (LUKE), Itäinen Pitkätatu 4 A, 20520 Turku, Finland

⁶ Urban Transformation and Global Change (TURBA) Lab, Universitat Oberta de Catalunya, Barcelona, Spain

We live in a world of limited resources. Global challenges like climate change, land and ecosystem degradation, coupled with a growing population force us to seek new ways of producing and consuming that respect the ecological boundaries of our planet. (European Commission 2018, p. 4)

Its 2012 predecessor had promised ‘rapid, concerted and sustained changes in lifestyle and resource use that cut across all levels of society and the economy’ (European Commission 2012, p. 3). Yet, despite such transformative rhetoric, the claimed benefits such as combating climate change, helping restore ecosystems, halting land degradation and reducing food waste while delivering new jobs in a sustainable ‘circular economy’ (European Commission 2018, pp. 5–7) are not to result from some kind of fundamental socio-ecological turnaround that would call into question

established unsustainable modes of production and living. Rather, they are presented as resulting from ‘unprecedented advances in life sciences and biotechnologies, as well as innovations merging the physical, digital and biological worlds’ (p. 6) that will, in the near future, revolutionize the European economy, buttress its globally dominant position, and sustainably re-power the way Europeans live:

[T]he need to achieve sustainability constitutes a strong incentive to modernise our industries and to reinforce Europe’s position in a highly competitive global economy, thus ensuring the prosperity of its citizens. To tackle these challenges, we must improve and innovate the way we produce and consume food, products and materials within healthy ecosystems through a sustainable bioeconomy (p. 4).

This type of vision is not exclusive to the EU, but pervades recent governmental bioeconomy strategies. Another example is Germany’s recent bioeconomy strategy, which portrays the ‘transition to a bioeconomy’ as a process where ‘the way in which we do business will change all around the world and serve to put our economies on a more sustainable footing’. It promises not only a core contribution to achieving the UN’s Sustainable Development Goals, but also ‘a vast array of opportunities’ for domestic firms to be ‘successful in the markets of tomorrow’ and for the country to stay ‘a leader in the development of pioneering approaches’ (BMBF and BMEL 2020, p. 3).

What these proclamations articulate is the *promise*, i.e. the ‘claim to the possibility and desirability of a certain vision’ (Eversberg et al. 2022a, p. 4, in this feature) of bioeconomy in which *more of the same* in technological advance and economic expansion will transform societies toward sustainability without actually transforming anything substantial about them. Following Joly (2013; see also Befort 2021; Giampietro 2019), they can be seen as expressions of an ‘economics of techno-scientific promises’ (ETP): starting from the widely accepted problematization (Joly 2013, p. 206) of ecological crisis, they posit technological ‘innovation’ as the one solution that will solve all problems, de-thematizing any aspect of change in practices, social relations and basic economic institutions, and turning an issue of socio-political conflict into one of solution-seeking by techno-scientific experts (Boyer et al. 2022, in this feature; Lühmann and Vogelpohl 2023). The promise is legitimized by appeal to both the ‘ideology of technological progress’ (Joly 2013, p. 207) and the notion of sustainable development, with the latter as well as the pervasive competitiveness argument serving to back up the claims with a ‘diagnosis of urgency’ (Joly 2013, p. 208). It is provided with credibility through mobilization of the authority of science and its supposed impending breakthroughs (Joly 2013, p. 208), and its reliance on the technologies offered by those breakthroughs

as the principal mode of achieving change amounts to a ‘production of irreversibility’ and ‘lock-ins’ (Joly 2013, p. 209) that renders society dependent and can progressively lock out any other solutions.

The intention of this special feature is to demonstrate that current bioeconomy policies, despite their rhetorical integration of earlier criticisms, are still a prime example of this economics of techno-scientific promises. In this vein, for example, current research has found the German bioeconomy to be successful in ‘stabilizing the existing unsustainable social order’, all the while being a ‘failing political project’ in terms of its stated real-world aims (Lühmann and Vogelpohl 2023). The point we wish to strengthen in relation to this diagnosis is that in effect, and quite possibly contrary to the intentions of some key actors, the stated stabilization is what the project was suited to achieve all along. Building on both theoretical considerations and empirical research on cases of bioeconomy policymaking and implementation from across the globe, including several from the Global South, this special feature aims to provide a nuanced assessment and critical discussion of the promise that the type of bioeconomic ‘transformation’ envisioned by such policy concepts can contribute to more socially and ecologically sustainable societies. It scrutinizes not only the ways in which this promise is legitimized, made credible and turned into a ‘self-fulfilling prophecy’ creating path dependencies and lock-ins (Joly 2013; Befort 2021), but also the increasingly evident globally unequal developments and socio-ecological consequences it triggers.

In the remainder of this editorial, we will first present the core thesis and central diagnoses of our special feature, then situate these by giving a brief account of how the specific type of bioeconomy policy discourse at stake here came about, and finally give an overview of the individual articles and their contributions to the overall argument.

Transformation without transformation: investigating a contradictory promise

The core thesis that the contributions assembled in this special feature investigate from different angles, in different geographic contexts and from diverse methodological approaches is that current bioeconomy policies, despite their rhetoric of transformation, are ultimately directed at the very opposite. Being based on an incomplete and biased acknowledgment of the challenges lying ahead, these policies effectively prevent the radical transformation of modern societies that is urgently needed in light of multiple rapidly escalating crises. The concepts of societal change advanced from within what Joly (2013) terms the ‘ETP regime’, therefore, fall short of envisioning and consciously facing the kind of large-scale societal transformations that will ultimately be

required to deal with the deep contemporary socio-ecological crises. In creating irreversibilities and lock-ins, they also close down, rather than opening up, the scope of possible transformative routes and the diversity of socially available knowledge that could contribute to them (Giampietro and Funtowicz 2020; Saltelli et al. 2023; Stirling 2023). The contributions to the special feature, therefore, also address different aspects and consequences of as well as reasons for this ‘impaired vision’, uncover its omissions and blind spots, and discuss elements of alternatives to the promissory mode of policy discourse that contemporary bioeconomy strategies stand for. Two central diagnoses are at the heart of this Special Feature’s argument:

- (1) Standing in the tradition of earlier visions of ecological modernization (Backhouse 2021; Bastos Lima 2022), the dominant narratives of official bioeconomy strategies present innovation as a means to turn the tensions between environmental concerns and economic priorities into synergies. Rather than aiming at any kind of post-growth strategy, they claim to offer a way to reconcile environmental and economic concerns, by putting bio-based ‘solutions’ at the service of economic growth and constructing the plausible image of a win–win strategy (Kovacic et al. 2019). Such eco-modernist visions have recently made significant gains in political currency far beyond the field of bioeconomy policy, as for example in the EU’s ‘Green Deal’ (Haas et al. 2022) or the Biden administration’s ‘Inflation Reduction Act’ in the US (Schepelmann 2022, p. 283). The concrete ‘solutions’ presented in these visions are mostly technologies promising to boost biomass production by improved control over genetic and environmental factors (GMOs, precision agriculture), and/or substitute fossil-based materials and processes as bio-based drop-in replacements, such as tires made from dandelion or biopolymers produced by genetically modified bacteria (Boyer et al. 2022, in this feature). Even though specific innovations may bring about functional change (such as the example of PLA studied by Befort 2021), within the bioeconomy discourse, the expected role of innovation is that of a “drop-in” that helps maintain the existing paradigm (Befort 2021).

Yet, the feasibility of both upscaling such solutions to the macroeconomic, even global, level and combining them into an overall economic framework to fully substitute for the enormous and still-growing amounts of fossil resources currently used, while avoiding overexploitation of ecosystems, loss of biodiversity, soil degradation and other detrimental effects, remains

largely unaddressed. Instead, governments supply imagery such as that of the “bioeconomy airport” presented at the 2020 Global Bioeconomy Summit¹—a fictional flight transport hub that features plant-based unbreakable window panes and moss walls to filter pollution out of the air, but in effect remains the ground station of the most unsustainable mode of transportation that exists, for which there is no prospect of near-term decarbonization whatsoever.

This, in effect, appears as the real promise. Policy discourse promotes visions of unceasing technological progress and purportedly impending revolutionary breakthroughs as a means to maintain the illusion that economic growth can be reconciled with sustainability (by substituting fossil inputs and increasing efficiency) or even fully decoupled from environmental impact (by establishing a ‘circular economy’ purported to function without any external input)—all while in the real world, emissions targets are missed and fossil fuel use is still on the rise. To remain in the airport imagery: performing highly visible yet comparatively ineffective measures of ‘change’ in the lobby while wide-body planes burning hundreds of tons of fossil kerosene keep taking off from the runway conveys the hypocrisy that rich societies can avoid changes to modes of living that are currently based on unprecedented levels of resource and energy use (Levidow et al. 2012; Kröger and Raitio 2017; Hausknost et al. 2017). As it were, the bioeconomy, and the broader frameworks of ‘green growth’ of which it is a cornerstone, aim at what one might dub *transformation as a way to avoid transformation*. Change in the material-energetic basis of societies is to be the key to avoiding change in the structure and mode of operations of those societies: “a modern, resource-efficient and competitive economy, ensuring: no net emissions of greenhouse gases by 2050; economic growth decoupled from resource use” (European Commission 2019).

- (2) By promising to solve everything by technological and economic means while avoiding changes to prevailing unsustainable modes of living, this type of governmental bioeconomy strategy is poised to prolongate, rather than question, the escalatory societal imperatives that are at the root of these crises (Rosa et al. 2017): the need for perpetual economic growth. The contributors to this Special Feature share the assumption that even though some governments (predominantly in rich Northern countries) now couch them in a rhetoric of thorough transformation, these policies do not represent an answer to the crises wrought by modern capital-

¹ See <https://gbs2020.net/exhibition-airport/>.

ist societies' inherent compulsion to expand economic activity. Albeit from different angles and at varying intensities, all contributions can be seen to reflect upon the fundamental conflict between that expansionist logic and the concrete boundedness of nature, including humans, and on the inability of dominant institutions and forms of knowledge to respond to the challenges. From this point of view, the debates around bioeconomy policies are characterized by the contradictory efforts of governments and industry to both deal with the destructive effects and escalating disasters caused by that expansionism while at the same time attempting to keep it going at all costs.

The promissory nature of bioeconomic policy discourse has often been noted in the scholarly literature (Petersen and Krisjansen 2015; Sanz-Hernández et al. 2019; Giampietro and Funtowicz 2020). And indeed, these promises are far from unchallenged: critics from civil society and agriculture have pushed for stronger sustainability agendas (Lühmann 2020; Riemann et al. 2022), while sustainability scientists have pointed out the lack of viability of growth-oriented bioeconomy concepts in the face of the limited availability of resources and sinks (Giampietro 2019; Bringezu et al. 2021). Efforts at biophysical modeling of feasible bioeconomy trajectories suggest an inevitable necessity for sufficient, much less resource-intensive, trajectories that will require intense societal planning and negotiation processes (Hausknost et al. 2017). No less importantly, research has shown that attempts to reconcile economic imperatives with sustainability criteria end up detrimental to ecological (Kleinschmit et al. 2017) and social concerns. The latter include exploitative working conditions and other forms of domination and injustices in the Global South (Backhouse et al. 2021; Puder 2019; Neimark and Healy 2018), or externalization and low-wage migrant labor in bio-based sectors in the North (Prause 2021; Reid et al. 2021; Bogoeski 2022). Recent research has also increasingly addressed the bioeconomy in light of unequal North–South relations, e.g., by analytically and empirically unpacking its role in perpetuating and/or deepening ecologically unequal exchange and the production of extractive knowledge (Backhouse et al. 2022; Tittor 2021). Challenges have also been mounted in a range of other scholarly and scientific fields, ranging from analyses of their discursive foundations and knowledge bases through economic accounts of jobs and value creation to investigations of the potentials and limits of biophysical expansion of bio-based economies (for an overview, see Eversberg et al. 2022a, in this feature).

The production of such now abundant *uncomfortable knowledge* (Rayner 2012; Giampietro and Funtowicz

2020) about the problems, limitations and even sheer impossibilities of delivering on the promises has led to some degree of discursive re-articulation and a 'greener' rhetoric in new, revised policy strategies (European Commission 2018; BMEL and BMBF 2020). Yet, their overall political and discursive impact has remained unscathed (Lühmann and Vogelpohl 2023; Ramcilovic-Suominen 2022, in this feature), not least due to reductionist approaches to the assessment of policies (Saltelli et al. 2023; Stirling 2023), pointing to precisely the type of lock-in described by Joly (2013).

This special feature addresses this impermeability of the bioeconomy discourse's promises to mounting evidence of their unreality, assembling multi-disciplinary analyses of the structure and evolution of the different promises made, the functions of these promises and their socio-ecological consequences in contexts where bioeconomy strategies are implemented. It highlights the social uses and functions of the promises in maintaining the credible illusion that 'change' is feasible or already taking place, in conveying an image of that change as beneficial to everybody, uncontroversial and ultimately restricted to marginal aspects of people's lives, and carefully avoiding any allusion to the 'tragedy of change' that lies ahead (Giampietro and Funtowicz 2020). Consequently, and as such echoing critical debates on environmental policies and corresponding strategies (Pichler et al. 2020), they expose this promissory face of the bioeconomy as a strategic means for delaying or even circumventing the processes of social conflict and political deliberation that societies will need to embark upon to overcome the dependency on everlasting economic expansion. These narratives thus appear as another strategy to establish a sociotechnical imaginary favorable to the incumbent status quo: another epistemic means aimed at the capture of the collective *zeitgeist* (Saltelli et al. 2022).

Bioeconomy visions and the emergence of a rhetoric of contradictory promises

To some observers, the critical fervor of our argument may seem misplaced: has not bioeconomy policy evolved in recent years, have not policymakers gone to significant lengths to consider critical points raised by scientists and civil society, and have not revised strategies moved sustainability concerns more and more into the center of attention, while toning down the aggressive techno-utopianism that dominated the biotech industry around the turn of the millennium (Eversberg et al. 2022a, in this feature)? Does not all this indicate institutional change pointing in a beneficial,

salutary direction? In other words, is not the successive revision of policies and the broader rhetorical integration of socio-ecological concerns a sign that policymaking itself follows the logic of the ‘promise cycle’ observed in industrial innovation (Befort 2021; July 2013), in which initially exaggerated claims are inevitably disappointed by the limitations of reality, giving way to renewed processes of scientific invention and discovery that lead to new, less hyperbolic and more feasible solutions bound to be further improved in the next round of the cycle? We argue that this salutary view, instructive as it may be with regard to industrial product innovation processes, misses the point when applied to policy formation. Indeed, our critical point is directed precisely against this kind of misplaced optimism: *The more things change, the more they stay the same* in bioeconomy policy. Policymaking is not a ‘clean’ process of invention and discovery in search of optimal solutions, but a messy complex of struggles, competing interests and power strategies, and the claim that these can be overcome in the same cyclical, harmonically solution-oriented way as the challenges of implementing a specific technology is itself a promise that should be viewed with the utmost caution.

The line of inquiry of the present special feature offers important insights on the sociogenic limits and resistances to the deep transformations increasingly recognized as necessary in sustainability science. Taking into account the social frictions and dissenting visions of bio-based transformation neutralized in the vision of a salutary promise cycle, it also aims to counter the ‘production of irreversibility’ by contributing to alternative answers to the challenges addressed. The authors share the view that such alternatives are not to be expected from yet more promises of reconciling growth and sustainability, but from practices based on principles of sufficiency, degrowth and caring relationships with nature. This implies reinstating the term ‘bioeconomy’ itself in the fundamentally antagonistic meaning that it initially bore: it began its career as a highly critical notion that has since been “hijacked” (Vivien et al. 2019) by growth-oriented policy discourse. Originally, the “bioeconomics” proposed by ecological economist Nicholas Georgescu-Roegen (1971, 1975) was no promise at all, but an attack on the abstract formalism of economic thinking with its unfounded promises of everlasting growth. It was a call to suspend the compulsion for destructive expansion built into the mode of operations of the capitalist economy. To Georgescu-Roegen, the composite term was meant to stress the aspect of ‘bio’, indicating the need for any economy to remain within the boundaries of the space accorded to it by the living. In contrast, the current promissory discourse foregrounds ‘economy’, rhyming with and aiming at the economization of life itself and the subjection of the living to precisely that imperative of infinite expansion (Birch 2019; Kaşdoğan 2020; Barla et al. 2022).

When the bioeconomy rose to prominence as a policy notion during the first decade of the present millennium, Georgescu-Roegen’s ideas, and the acute consciousness of ecological crisis of the early 1970s from which he argued, were largely forgotten. As a policy concept initially promoted by the OECD (2009), it was quite clearly the product of an ambition to turn biotechnological innovations into the driver of a new cycle of economic growth as the ‘next big thing’ after the boom of digital technology (Meyer 2017). Seizing on the promises of an industry boosted by the sequencing of the human genome a few years earlier, the ‘biotech vision’ (Bugge et al. 2016; Befort 2020) of bioeconomy was unambiguously set on using technological advances of the life sciences to further the economization and commodification of life, and particularly genetic information, as a means to further expand the capitalist economy. It promoted images of quick and radical change, but that change was to come in the form of a radical Schumpeterian ‘creative destruction’ of established and allegedly outdated modes of bio-based (and other) economic activity that would bring even faster growth and expansion (Saviotti 2017). This policy imaginary suggested that genetically tailor-made biological resources could be made available in unlimited quantity as a result of an innovative dynamic that simply needed to be unleashed. The vision remained wedded to an old-fashioned sci-fi imagery of unfettered technological advance that was as fossil in its inner logic as the post-war era of which it was a legacy. In trying to present as feasible a bio-based economy operating in perfect continuity with the unbridled fossil-driven expansionism of the *Great Acceleration* (Steffen et al. 2015; Görg et al. 2020), it simply doubled down on the process of abstract escalatory societalization that Georgescu-Roegen had exposed as structurally unsustainable.

The ultimate incompatibility between concrete, living nature and that abstract expansionism was always there to haunt these dreams. From the outset, civil society actors and critical scientists contested both the biotech-centered visions and the associated technologies. The hegemonic biotech-centered imaginary was confronted with counter-hegemonic ‘bio-ecology’ visions (Bugge et al. 2016) centered on agro-ecological production and organic agriculture (Levidow et al. 2019). In radical opposition to the dominant vision, these movements are linked to ideas of transforming away from the imperative of growth and maximization of profits in the market. Their visions converge on economies built on principles of diversity, regionality, deceleration, voluntary self-limitation and production according to criteria of use value to serve concrete needs. In the wake of the increasingly acute awareness of escalating ecological crises, Georgescu-Roegen’s thought has been rediscovered and turned into one of the sources of critical positions on the bioeconomy, stressing the biophysical impossibility of

its promises (Vivien et al. 2019; Giampietro 2019). More recently, and in growing recognition of the importance of global injustices as a dimension of socio-ecological crisis, decolonial and degrowth-oriented critiques have also been voiced (Ramcilovic-Suominen et al. 2022).

Due to this double heritage and the deeply entrenched and conflicting power interests associated with it, the meaning of the notion of bioeconomy has always been as contested as it has been ambivalent. One of the products of that contestation is the so-called ‘biomass-bioeconomy’ (Befort 2020) or ‘bio-resource vision’ (Bugge et al. 2016), of which the specific strategy of promising change to avert transformation that is at stake here is arguably a typical characteristic. Focused on substituting fossil inputs to the economy with bio-based materials mass-produced and processed as an abstract, uniform ‘biomass’, this vision was devised early on, most prominently by the EU in its initial concept of ‘knowledge-based bioeconomy’ (Patermann and Aguilar 2018), in an attempt to reconcile the antagonistic visions and competing interests. Reflecting the highly skewed balance of power between those interests, this ‘bio-resource vision’ remains wedded to the growth imperative and the logic of the economization of life and is closer in spirit to the biotech than the bio-ecology vision (Bugge et al. 2016, p. 13). It is also hardly less fossil in its logic, as it ‘aims less at decarbonising society and more at substituting renewable biomass for fossil carbon’ (Levidow et al. 2019, p. 14) in an attempt to ultimately conserve the structures of the fossil era. Still, and even more so in its recently reformulated versions (European Commission 2018; BMEL and BMBF 2020), it has responded to the increasingly pressing need to integrate growing scientific and societal concerns. As such, it has moved somewhat closer rhetorically to the calls for transformation voiced from the ‘bio-ecology’ camp, for instance in adopting the UN’s Sustainable Development Goals as criteria (Eversberg et al. 2022a, in this feature). However, its more specific measures and especially funding priorities have remained essentially unchanged, and continue to favor the biotechnology industry (Lühmann 2020). Therefore, while these processes of reformulation might appear as resulting from an equivalent of the ‘(re-)invention phase’ of the ‘promise cycle’ (Befort 2021) after earlier expectations had been deflated by socio-political challenges and scientific ‘reality checks’ (Eversberg et al. 2022a), this analogy is partly at odds with the actual temporal sequence (concerning the emergence of the ‘bio-resource vision’), and less than half the truth in terms of changes to the actual policies, as the key drivers of the adverse effects that critics had highlighted have remained wholly untouched: rhetorical compromise should not be equated with reinvention.

The promise of ‘transformation without transformation’ thus most closely corresponds to this peculiar hybrid of the ‘bio-resource’ vision, born out of attempts to manage the

escalating crises without questioning the fundamentals of expansionism, ‘competitiveness’ and the prevalence of an obviously unsustainable and unjust ‘imperial mode of living’ (Brand and Wissen 2021). The same may be said for ecological modernization projects more broadly, be it in debates around climate policy and energy transitions or comprehensive initiatives like the EU’s Green Deal (Haas et al. 2022). The more urgent the calls from science and civil society for rapid action, the more transformative the political rhetoric becomes. Yet, effective measures remain out of reach due to the inability, and often unwillingness, of decision-makers to turn their backs on the promises of technological solutionism, to confront the politico-economic power structures and structural lock-ins at the heart of fossil capitalism (Mitchell 2011; Huber 2013; Malm 2016), and to oppose the parties promoting the promise of a green capitalism (Ajl 2022). As a consequence, the political commitments to achieving a sustainable society appear increasingly unrealistic.

The contributions in this special feature move from this diagnosis to provide a critical examination of the dynamics of contestation and realignment playing out around existing bioeconomy policies. They trace these dynamics at various levels and from different perspectives, and face the obvious follow-up question: what would it mean for political projects or initiatives of post-fossil societal change to actually be ‘transformative’ in a substantial, rather than merely rhetorical sense?

Bioeconomic transformation: the making and re-making of a contested policy imaginary

The first, larger part of this special feature assembles those articles whose main contributions lie in tracing the emergence and evolution of the paradox move of promising to transform everything while conserving the status quo, highlighting the contradictions it implies on different scales. They investigate the discursive and ideological strategies employed in bioeconomy policy discourse to establish and lend credibility to the promise of reconciling growth and sustainability, highlight how the promises misrepresent the broader challenges of social-ecological transformation, and illuminate processes of discursive and practical contestation surrounding them.

The overview article by *Dennis Eversberg, Jana Holz and Lilian Pungas (2022a)* introduces the debate around the bioeconomy’s promises by tracing their articulation and re-articulation within the policy discourse since the turn of the millennium. It explains the divergence between rhetoric and priorities of current policies as the result of a series of ‘reality checks’ originating from research on diverse aspects and dimensions of the bioeconomy that,

sometimes unintentionally, have challenged the viability of the promises. On discursive, socio-political, economic and biophysical grounds, these checks have exposed political claims as unwarranted and have prompted policymakers to scale down their rhetoric. The authors suggest that scholarly and political debates should no longer confine critical issues surrounding the bioeconomy to a secluded field of technocratic debate among experts. They call for societal debates addressing it as part of much broader processes of social–ecological transformation that are rightfully the subject of social contestation and struggle, away from an economy of promises.

Yet, as Vogelpohl's (2023) contribution argues, such critical analysis should not legitimize wholesale characterizations of bioeconomy policies as 'neoliberal'. Scrutinizing sustainability standards in the European Union, Brazil and Indonesia from a political ecology and political sociology perspective, he shows that those policies are strongly shaped by the respective countries' or regions' economic situation and the material interests associated with it. Governments tend to use them to pursue the interests they represent. Especially in the Global South, this amounts to the promotion of ongoing spatio-temporal processes of industrialization and modernization, which are at odds with, and thus tend to avoid, any form of sustainability-oriented transformation.

Vogelpohl's focus on efforts to continue 'business-as-usual' on an economic level and his perspective on both the EU and countries of the Global South resonates with the contribution by Kumeh and Ramcilovic-Suominen (2023). In their analysis, they highlight how the European Union's role in tropical deforestation, along with overconsumption, neocolonial domination, and unequal ecological and economic exchange, are left unaddressed in the EU's bioeconomy strategy as well as in policy commitments associated with the EU action to protect and restore the world's forests. These policies contribute little to actual protection of tropical forests, but rather serve as distractions from the underlying problems of overconsumption and asymmetrical power relations between the Global North and South. The authors propose rethinking the EU's approach to addressing tropical deforestation, in order to reduce the pressure and demand for deforestation-causing commodities in the EU, and to tackle the causes of unjust neocolonial relations, including material and immaterial domination. This is to contribute to just and anti-colonial relations between the EU and the former colonies in the Global South.

The contributions of *Janina Puder and Anne Tittor* as well as *Axel Anlauf* add to these findings by investigating other key aspects of the ramifications that high-income countries' bioeconomy policies bear for the low-income countries in the Global South. In the parlance of Eversberg et al., they thus present another 'reality check' to the promises of those strategies. Drawing on the examples of soy in Argentina

and oil palm in Malaysia, Puder and Tittor (2023) confront these policies with the empirical socio-ecological effects of large-scale monocultural biomass production for and in a bioeconomy. They show that the focus of these countries' bioeconomy policies on expanding production for export in these sectors not only fails to deliver their own promises of social and environmental 'upgrading', but also reproduces the dependent positions of these countries in the global division of labor and nature (see, e.g., Alarcón 2022). While attempts to increase the domestic value added of agricultural products do lead to the establishment of new industries in these countries, this has hardly had lasting employment effects. Bioeconomy's promise about 'keeping the wealth in the country' in effect legitimizes increasing inequalities and masks the detrimental effects of industrial agriculture and monocropping on local populations, especially in the long term (see also Tittor 2021). Anlauf's (2022) contribution, while rhyming with these findings, focuses on the oft-neglected role of classical minerals extractivism at the global peripheries for agroindustrial bioeconomy value chains worldwide. He investigates strategies of political and economic actors in Brazil and Germany for securing phosphate fertilizer supply for their countries' industrialized agriculture. This flags a reaction to the material's mutation from a 'low-cost bulk commodity' into a strategic resource in 2007–2013, showing that, through the strategic efforts to gain control of this crucial non-renewable production input, bioeconomy strategies can contribute to the intensification of conflicts as well as the deepening of inequalities and even induce food crises. This analysis demonstrates the dependence of bioeconomy policies' promises on the availability of large quantities of non-renewable resources whose extraction is itself still deeply embedded in the fossil industrial economy. He concludes that the bioeconomy's potential to reduce the extractivist and fossil-dependent character of industrialized agriculture and to alleviate power imbalances is limited at best, due not least to their acquiescence to the agendas of already dominant actors in the respective sectors. This latter aspect is a recurrent theme touched upon in several other contributions of this special feature, including those of Vogelpohl and Boyer et al.

Examining local-scale examples of change in the sectors and practices addressed by the bioeconomy debate, the case reports by *Jana Holz* and *Philip Koch* investigate the effects of promissory bioeconomy policies at the level of concrete, specific bio-based economic practices and the practical rationalities or mentalities characterizing local actors' habitualized social relationships with nature (Eversberg et al. 2021, 2022b). This perspective can illuminate both the ways in which the promises enable the continuation of unsustainable modes of production and living, and the forms of contesting the same promises. Holz (2023) points out that Finnish forestry, while traditionally

a sustainable practice and politically promoted as a prime example of a sustainable and innovative bioeconomy, increasingly exhibits characteristics familiar from the literature on extractivist agriculture. Koch (2022), in his analysis of the olive sector in Jaén, southern Spain, discusses several socio-ecological obstacles or challenges to the modernization plans of the Andalusian regional government's bioeconomy strategy. He identifies these obstacles not only in the spatial limits to the long-practiced extensive expansion of cultivation and the biophysical constraints on its intensification (water scarcity), but also in the deeply engrained mental structures and modes of living of smallholder families and in processes of social contestation and resistance to certain changes.

Rounding off the contributions of this first, empirical-analytical part of the feature, the article by *Miriam Boyer, Franziska Kusche, Sarah Hackfort, Louisa Prause and Friederike Engelbrecht-Bock* (2022) returns to the question of how bioeconomy strategies succeed in making promises that are both unrealistic and widely believed. Deploying methods of ideology critique, they focus on the use and function of the concept of 'biomass' in German bioeconomy policy. The authors examine different forms of biomass-related knowledge and imagery, and distinguish four ideological strategies employed to create and uphold the image of a 'sustainable bioeconomy'. These are redefining conflicts as 'technical problems' to be solved managerially, promoting technological innovation as the rational means to find solutions, postponing action into a supposedly technologically advanced and universally desirable future, and the playing down of the materiality of nature that underlies the presentation of 'biomass' as a homogeneous concept, devoid of issues of scaling, availability and usability, that can be controlled and instrumentalized at will.

Combined with the insights of the first three contributions, this latter article makes a particularly strong point about how the 'policy-based evidence' (Marmot 2004; Strassheim and Kettunen 2014) presented to justify current bioeconomy strategies amounts to tactics of *diversion* and *displacement* (Rayner 2012). These strategies keep the bioeconomy debate separate from questions of broader social-ecological transformation and focus on isolated technological advances (dandelion rubber, maize-based plastics, CO₂-metabolizing microbes). By breaking complex challenges down into small-scale 'solutions' for narrowly defined 'problems', they evade questions concerning the ecological feasibility and systemic integration of these practices, thus contributing to the social construction of ignorance (Rayner 2012). By ending their contribution with a plea for rejecting technocratic abstractions like 'biomass' and practically inventing and exploring alternative, non-instrumental ways of relating to the concrete plants, animals, fungi, microbiota

or landscapes that constitute living, non-identical nature, Boyer et al. move the debate on to the questions addressed in the remainder of the contributions to the present special feature.

The return of the hijacked: preconditions, problems and directions of a paradigm shift

If, as the argument of this special feature implies, an eventual paradigm shift is required, the question of *alternatives to the promises*, rather than of alternative promises, becomes pressing. The final five articles revolve around the preconditions, problems and possible directions of such a paradigm shift. They investigate the reasons for why alternative pathways have so far remained ineffective, and ask how uncomfortable knowledge could feed into different ways of dealing with uncertainty based on principles of sufficiency, precaution, and care. In doing so, they contribute to conceptualizing alternatives to the previously discussed promissory bioeconomy policies by offering perspectives from different schools of thought, political movements and discourses.

These contributions problematize the imperative of growth and expansion, the assumption that 'transformation' requires aiming to overcome that imperative, and proclaim the need for alternative forms of common existence based on principles of self-limitation. All contributors likely agree that the dynamics of abstraction and expansionism cannot be reduced to the capitalist imperative of economic growth, but are inherent to a deeper current of modern societies. There is no agreement, however, on whether and to what degree capitalism must be put front and center analytically, or viewed as merely one more or less subordinate aspect of a larger 'modernity complex' that is colonial, patriarchal and blinded by abstract ontologies no less than it is capitalist. Due to these differences in analysis, they also differ in the imaginaries of alternative modes of being and in their suggestions for transformative strategies.

Pungas (2023) analyzes the bioeconomy strategies of Estonia and the EU to show that they systematically render invisible the majority of the processes and activities that form the foundation of any economy. Drawing on the subsistence approach of the Bielefeld school of feminist economics, she stresses the role of unequal power relations in effecting the capitalist, colonial and patriarchal separations and hierarchizations through which this is achieved, and argues that these effects of social domination currently prevent alternative possibilities from becoming part of real alternatives. Her example are the sustainable practices of food-self-provisioning in the border region between Estonia and Russia, which, although highly important to the region's food supply, is misrepresented as backward, marginal and unproductive by dominant bioeconomic visions

that privilege the formal economy of monetized activities, obscuring how the formal economy itself could never exist without these (re)productive activities.

Ramcilovic-Suominen (2022) picks up on the original bioeconomy vision of Georgescu-Roegen by looking at the European bioeconomy policies through the lens of environmental justice and degrowth, and identifying dominant logics that block actual transformative action. Most importantly, she argues, the EU's policies frame nature as a mere resource at humanity's free disposal, which the bloc actively seizes on in its ambition to be the global leader in bioeconomic transformations. Echoing the findings of a number of other contributions in this special feature (such as Boyer et al., Anlauf, Puder/Tittor, and Schmidlehner), she takes the EU to task for a techno-solutionist policy approach, an insufficient conception of justice, and a geo-economic power politics centered on competitiveness, as well as the persistence of hegemonic politico-economic structures that disproportionately benefit already dominant actors defending business-as-usual. Against these 'barriers' she postulates the need for non-dualist visions and decentralized, bottom-up practices and coalitions of change committed to principles of planetary and epistemic justice as potential catalysts for radical transformative strategies that could overcome the persistence of coloniality and the growth imperative.

Schmidlehner's (2023) contribution identifies the core problem currently obstructing transformation in the inner structure of modern subjectivities. He uses Lacan's psychoanalytical theory to argue that recent contributions analyzing the bioeconomy discourse's core vision of decoupling as a neurotic fantasy analytically fall short. While he does concur, that modern subjectivity is sustained by such a fantasy, this to him is the more fundamental 'fantasy of nature' as something that can be analytically grasped and separated from a human 'cultural' realm at all. However, he argues that the conception of decoupling and green growth is more adequately analyzed as a symptom of a 'psychotic reaction' of 'foreclosure'. A way out of this social pathology for him would require discovering new 'modes of subjectivation' beyond the current mental lock-in to the 'capitalist's discourse' and the fantasy of nature in order to identify and overcome barriers to transformation.

Drawing on the work of political philosophers Ernesto Laclau, Chantal Mouffe and Judith Butler, Hamilton and Ramcilovic-Suominen (2023) develop an analytical lens on the concept of 'transformations', by exploring relations between hegemony and transformative dynamics. Deploying a heuristic that characterizes concepts of change as inclusionary vs. transformational and process- vs. outcome-oriented, they distinguish between hegemony-reinforcing, hegemony-replacing and hegemony-transcending types of transformations. Finally, they situate existing

socio-ecological and environmental political agendas, including those associated with decoloniality, degrowth, eco-modernism, eco-feminism and eco-anarchism, along the lines of the proposed typology of transformations.

The special feature closes with an intervention from the ranks of its editors. Giampietro's (2023) comment takes the popularity of the notion of the circular bioeconomy as an occasion to critically reflect on what he sees as an acute crisis of sustainability science. He charges the majority of the field with clinging to a paradigm of human relations with the 'external world' that has lost its base in reality, as exemplified by the baseless promises of growth, decoupling and circularity discussed throughout this feature. Instead of furthering serious debate on pathways out of escalating global disaster, the abstract ontologies of still-dominant 'normal science' are unfit to understand, much less deal with, the concrete problems and challenges faced today (see also Nightingale et al. 2020). Resonating with the findings of many of our contributions, he attributes this 'ontological crisis' to science's material and epistemological dependency on governance imperatives that are impervious to knowledge about the actual state of affairs, instead demanding 'solutions' and constructive suggestions on the footing of a status quo that is itself at the root of the planetary crisis. As a result, he diagnoses 'a systemic lack of quality control on the science-policy interface' due to structurally inadequate evaluative criteria. Overcoming this ontological crisis would 'require society to rediscuss its identity', as 'Transformation' in this understanding would amount to reinventing what 'society' is or can be.

In conclusion, this may be taken as a crucial hint for further discussion and inquiry: moving toward sustainability in a meaningful sense of the word cannot be achieved by way of technocratic 'solutions' to the escalating problems generated by the current societal mode of operations, but indeed a process of what we might call 're-societalization', to which scientific business-as-usual appears as an obstacle rather than a helpful tool. Therefore, if Giampietro calls for 'a more reflexive science and a more reflexive society', this is not to be confused with the reflexive *modernization* (Beck et al. 1994), in which an expansionist society finds itself forced to constantly go on complexifying by turning back on itself to manage its own unintended consequences. Instead, this would amount to a process of *reflexive societalization*, of creating social worlds capable of adapting and correcting themselves precisely because they are not blindly compelled to expanding and becoming ever more complex.

Notwithstanding this rather fundamental closing note, we hope that the present special feature can contribute some impulses to building sustainability science as a field of inquiry. The authors aimed at shedding light on the causes of the structural injustices and unsuitability of the purported solutions to sustainability problems offered under

the rubrum of bioeconomy, and to show how the promises themselves function as barriers to transformations that would have a potential to deal with the present challenges in non-destructive, just and sustainable ways. This inquiry includes critical examination of the implications of bioeconomy concepts for ecologically unequal exchange and the extractive and unequal relations between the Global North and South, highlighting how the solutions, based on ideologies of ‘competitiveness’ (in the North) or ‘development’ (in the South) and rooted in domination over humans as well as the extra-human, are inherently incapable of being decoupled from unsustainable growth trajectories.

The practical relevance of these findings is in the capacity to inform civil society, social–ecological movements and sustainability-oriented policy actors about the risk of unintentionally endorsing counter-transformative strategies pursued under the heading of sustainable and/or circular bioeconomic change. These contributions may help various actors in bringing forward alternative narratives of transformation (from Indigenous knowledge to Georgescu-Roegen’s original understanding of the term ‘bioeconomy’) that already exist at the margins of the debate, thus moving it to the terrain of transformative visions that, despite all rhetoric, it has so far carefully steered clear of. We hope that this can help overcome the promissory discourse toward a responsible process of social learning about how to transform prevailing social practices toward a sustainable, sufficient and caring economy.

Funding Dennis Eversberg and Philip Koch’s work on this special feature was funded by the German Ministry of Education and Research (BMBF) as part of the work of the Junior Research Group “Mentalities in Flux” (flumen), Grant number 031B0749. Zora Kovacic acknowledges financial support of the Spanish government’s Research Agency (RYC2021-031839-I). Open Access funding enabled and organized by Projekt DEAL.

Data availability No data is associated with this article.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Ajl M (2022) Everything stays the same while everything changes. *Dev Chang* 53:1398–1420. <https://doi.org/10.1111/dech.12732>
- Alarcón P (2022) Dependency revisited: Ecuador’s (re)insertions into the international division of nature. *Lat Am Perspect* 49:207–226. <https://doi.org/10.1177/0094582X211070831>
- Anlauf A (2022) An extractive bioeconomy? Phosphate mining, fertilizer commodity chains, and alternative technologies. *Sustain Sci*. <https://doi.org/10.1007/s11625-022-01234-8>
- Backhouse M (2021) Global inequalities and extractive knowledge production in the bioeconomy. *Bioeconomy and global inequalities: socio-ecological perspectives on biomass sourcing and production*. Springer International Publishing, Cham, pp 25–44
- Backhouse M, Lehmann R, Lorenzen K et al (eds) (2021). Palgrave Macmillan, London
- Backhouse M, Lühmann M, Tittor A (2022) Global inequalities in the bioeconomy: thinking continuity and change in view of the global soy complex. *Sustainability* 14:5481. <https://doi.org/10.3390/su14095481>
- Barla J, Kluzik V, Lemke T (2022) *Biokapital: Beiträge zur Kritik der politischen Ökonomie des Lebens*, 1st edn. Campus Verlag, Frankfurt, New York
- Bastos Lima MG (2022) Just transition towards a bioeconomy: four dimensions in Brazil, India and Indonesia. *Forest Policy Econ* 136:1–9. <https://doi.org/10.1016/j.forpol.2021.102684>
- Beck U, Giddens A, Lash S (1994) *Reflexive modernization: politics, tradition and aesthetics in the modern social order*. Stanford University Press, Stanford
- Befort N (2020) Going beyond definitions to understand tensions within the bioeconomy: the contribution of sociotechnical regimes to contested fields. *Technol Forecast Social Change* 153:119923. <https://doi.org/10.1016/j.techfore.2020.119923>
- Befort N (2021) The promises of drop-in vs. functional innovations: the case of bioplastics. *Ecol Econ* 181:106886. <https://doi.org/10.1016/j.ecolecon.2020.106886>
- Birch K (2019) *Neoliberal bio-economies?: the co-construction of markets and natures*. Palgrave Macmillan, Cham, Switzerland
- BMBF, BMEL (2020) *National bioeconomy strategy*. Federal Government, Berlin
- BMEL, BMBF (2020) *Nationale Bioökonomiestrategie*. Kabinettdokumentation, 15.01.2020. Bundesregierung, Berlin
- Bogoeski V (2022) Continuities of exploitation: seasonal migrant workers in German agriculture during the COVID-19 pandemic. *J Law Soc* 49:681–702. <https://doi.org/10.1111/jols.12389>
- Boyer M, Kusche F, Hackfort S et al (2022) The making of sustainability: ideological strategies, the materiality of nature, and biomass use in the bioeconomy. *Sustain Sci*. <https://doi.org/10.1007/s11625-022-01254-4>
- Brand U, Wissen M (2021) *The imperial mode of living: everyday life and the ecological crisis of capitalism*. Verso Books, New York
- Bringezu S, Distelkamp M, Lutz C et al (2021) Environmental and socioeconomic footprints of the German bioeconomy. *Nat Sustain*. <https://doi.org/10.1038/s41893-021-00725-3>
- Bugge MM, Hansen T, Klitkou A (2016) What is the bioeconomy? A review of the literature. *Sustainability* 8:691. <https://doi.org/10.3390/su8070691>
- European Commission (2012) *Innovating for sustainable growth: a bioeconomy for Europe*. Europäische Union, Brüssel
- European Commission (2018) *A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment*. Updated Bioeconomy Strategy
- European Commission (2019) *The European green deal*. European Commission, Brussels

- Eversberg D, Fritz M, Holz J et al (2021) Mentalities matter: Sozial-ökologische Mentalitäten und ihre Bedeutung in post-fossilen Transformationen. Friedrich-Schiller-Universität, Jena
- Eversberg D, Holz J, Pungas L (2022a) The bioeconomy and its untenable growth promises: reality checks from research. *Sustain Sci*. <https://doi.org/10.1007/s11625-022-01237-5>
- Eversberg D, Koch P, Holz J et al (2022b) Social relationships with nature: elements of a framework for socio-ecological structure analysis. *Innovation Eur J Soc Sci Res* 35:389–419. <https://doi.org/10.1080/13511610.2022.2095989>
- Georgescu-Roegen N (1971) *The entropy law and the economic process*. Harvard University Press, Cambridge, MA
- Georgescu-Roegen N (1975) Energy and economic myths. *South Econ J* 41:347–381
- Giampietro M (2019) On the circular bioeconomy and decoupling: implications for sustainable growth. *Ecol Econ* 162:143–156. <https://doi.org/10.1016/j.ecolecon.2019.05.001>
- Giampietro M (2023) Reflections on the popularity of the circular bioeconomy concept: the ontological crisis of sustainability science. *Sustain Sci*. <https://doi.org/10.1007/s11625-022-01267-z>
- Giampietro M, Funtowicz SO (2020) From elite folk science to the policy legend of the circular economy. *Environ Sci Policy* 109:64–72. <https://doi.org/10.1016/j.envsci.2020.04.012>
- Görg C, Plank C, Wiedenhofer D et al (2020) Scrutinizing the great acceleration: the Anthropocene and its analytic challenges for social-ecological transformations. *Anthropocene Rev* 7:42–61. <https://doi.org/10.1177/2053019619895034>
- Haas T, Syrovatka F, Jürgen I (2022) The European Green Deal and the limits of ecological modernisation. *Cult Practice Europeanization* 7:247–261. <https://doi.org/10.5771/2566-7742-2022-2-247>
- Hamilton RTV, Ramcilovic-Suominen S (2023) From hegemony-reinforcing to hegemony-transcending transformations: horizons of possibility and strategies of escape. *Sustain Sci*. <https://doi.org/10.1007/s11625-022-01257-1>
- Hausknost D, Schrießl E, Lauk C, Kalt G (2017) A transition to which bioeconomy? An exploration of diverging techno-political choices. *Sustainability* 9:669. <https://doi.org/10.3390/su9040669>
- Holz JR (2023) Threatened sustainability: extractivist tendencies in the forest-based bioeconomy in Finland. *Sustain Sci*. <https://doi.org/10.1007/s11625-023-01300-9>
- Huber MT (2013) *Lifeblood: oil, freedom, and the forces of capital*. University of Minnesota Press, Minneapolis
- Joly P-B (2013) On the economics of techno-scientific promises. In: Akrich M, Barthe Y, Muniesa F, Mustar P (eds) *Débordements : Mélanges offerts à Michel Callon*. Presses des Mines, Paris, pp 203–221
- Kaşdoğan D (2020) Designing sustainability in blues: the limits of technospatial growth imaginaries. *Sustain Sci* 15:145–160. <https://doi.org/10.1007/s11625-019-00766-w>
- Kleinschmit D, Arts B, Giurca A et al (2017) Environmental concerns in political bioeconomy discourses. *Int Forest Rev*. <https://doi.org/10.1505/146554817822407420>
- Koch P (2022) Where limits to growth are tangible: the olive sector in Jaén and its bioeconomic future. *Sustain Sci*. <https://doi.org/10.1007/s11625-022-01236-6>
- Kovacic Z, Strand R, Völker T (2019) *The circular economy in Europe: Critical perspectives on policies and imaginaries*. Routledge, London
- Kröger M, Raitio K (2017) Finnish forest policy in the era of bioeconomy: a pathway to sustainability? *Forest Policy Econ* 77:6–15. <https://doi.org/10.1016/j.forpol.2016.12.003>
- Kumeh EM, Ramcilovic-Suominen S (2023) Is the EU shirking responsibility for its deforestation footprint in tropical countries? Power, material, and epistemic inequalities in the EU's global environmental governance. *Sustain Sci*. <https://doi.org/10.1007/s11625-023-01302-7>
- Levidow L, Birch K, Papaioannou T (2012) EU agri-innovation policy: two contending visions of the bio-economy. *Crit Policy Stud* 6:40–65. <https://doi.org/10.1080/19460171.2012.659881>
- Levidow L, Nieddu M, Vivian F-D, Béfort N (2019) Transitions towards a European Bioeconomy: life sciences versus agroecology trajectories. In: Allaire G, Daviron B (eds) *Ecology, capitalism and the new agricultural economy: the second great transformation*. Routledge, London, pp 181–203
- Lühmann M (2020) Whose European bioeconomy? Relations of forces in the shaping of an updated EU bioeconomy strategy. *Environ Dev* 35:100547. <https://doi.org/10.1016/j.envdev.2020.100547>
- Lühmann M, Vogelpohl T (2023) The bioeconomy in Germany: A failing political project? *Ecol Econ* 207:107783. <https://doi.org/10.1016/j.ecolecon.2023.107783>
- Malm A (2016) *Fossil capital: the rise of steam power and the roots of global warming*. Verso, London
- Marmot MG (2004) Evidence based policy or policy based evidence? *BMJ* 328:906–907. <https://doi.org/10.1136/bmj.328.7445.906>
- Meyer R (2017) Bioeconomy strategies: contexts, visions, guiding implementation principles and resulting debates. *Sustainability* 9:1031. <https://doi.org/10.3390/su9061031>
- Mitchell T (2011) *Carbon democracy: political power in the age of oil*. Verso, London
- Neimark BD, Healy TM (2018) Small-scale commodity frontiers: the bioeconomy value chain of castor oil in Madagascar. *J Agrar Chang* 18:632–657. <https://doi.org/10.1111/joac.12231>
- Nightingale AJ, Eriksen S, Taylor M et al (2020) Beyond technical fixes: climate solutions and the great derangement. *Climate Dev* 12:343–352. <https://doi.org/10.1080/17565529.2019.1624495>
- OECD (2009) *The bioeconomy to 2030 designing a policy agenda: designing a policy agenda*. OECD Publishing, Paris
- Paternann C, Aguilar A (2018) The origins of the bioeconomy in the European Union. *New Biotechnol* 40:20–24. <https://doi.org/10.1016/j.nbt.2017.04.002>
- Petersen A, Krisjansen I (2015) Assembling ‘the bioeconomy’: exploiting the power of the promissory life sciences. *J Sociol*. <https://doi.org/10.1177/1440783314562314>
- Pichler M, Brand U, Görg C (2020) The double materiality of democracy in capitalist societies: challenges for social-ecological transformations. *Environ Politics* 29:193–213. <https://doi.org/10.1080/09644016.2018.1547260>
- Prause L (2021) Digital agriculture and labor: a few challenges for social sustainability. *Sustainability* 13:5980. <https://doi.org/10.3390/su13115980>
- Puder J (2019) Excluding migrant labor from the Malaysian bioeconomy: Working and living conditions of migrant workers in the palm oil sector in Sabah. *Austrian J South-East Asian Stud* 12:31–48
- Puder J, Tittor A (2023) Bioeconomy as a promise of development? The cases of Argentina and Malaysia. *Sustain Sci*. <https://doi.org/10.1007/s11625-022-01284-y>
- Pungas L (2023) Invisible (bio)economies: a framework to assess the ‘blind spots’ of dominant bioeconomy models. *Sustain Sci*. <https://doi.org/10.1007/s11625-023-01292-6>
- Ramcilovic-Suominen S (2022) Envisioning just transformations in and beyond the EU bioeconomy: inspirations from decolonial environmental justice and degrowth. *Sustain Sci*. <https://doi.org/10.1007/s11625-022-01091-5>
- Ramcilovic-Suominen S, Kröger M, Dressler W (2022) From pro-growth and planetary limits to degrowth and decoloniality: an emerging bioeconomy policy and research agenda. *Forest Policy Econ* 144:102819. <https://doi.org/10.1016/j.forpol.2022.102819>
- Rayner S (2012) Uncomfortable knowledge: the social construction of ignorance in science and environmental policy discourses. *Econ Soc* 41:107–125. <https://doi.org/10.1080/03085147.2011.637335>

- Reid A, Ronda-Perez E, Schenker MB (2021) Migrant workers, essential work, and COVID-19. *Am J Ind Med* 64:73–77. <https://doi.org/10.1002/ajim.23209>
- Riemann L, Giurca A, Kleinschmit D (2022) Contesting the framing of bioeconomy policy in Germany: the NGO perspective. *J Environ Policy Plan.* <https://doi.org/10.1080/1523908X.2022.2071689>
- Rosa H, Dörre K, Lessenich S (2017) Appropriation, activation and acceleration: the escalatory logics of capitalist modernity and the crises of dynamic stabilization. *Theory Cult Soc* 34:53–73. <https://doi.org/10.1177/0263276416657600>
- Saltelli A, Dankel DJ, Di Fiore M et al (2022) Science, the endless frontier of regulatory capture. *Futures* 135:102860. <https://doi.org/10.1016/j.futures.2021.102860>
- Saltelli A, Kuc-Czarnecka M, Piano SL et al (2023) Impact assessment culture in the European Union. Time for something new? *Environ Sci Policy* 142:99–111. <https://doi.org/10.1016/j.envsci.2023.02.005>
- Sanz-Hernández A, Esteban E, Garrido P (2019) Transition to a bioeconomy: perspectives from social sciences. *J Clean Prod* 224:107–119. <https://doi.org/10.1016/j.jclepro.2019.03.168>
- Saviotti PP (2017) Structural Change, Knowledge and the Bioeconomy. In: Dabbert S, Lewandowski I, Weiss J, Pyka A (eds) *Knowledge-driven developments in the bioeconomy: technological and economic perspectives*. Springer International Publishing, Cham, pp 17–32
- Schepelmann P (2022) Towards a green new deal. Lessons after a lost decade. *Cult Practice Europeanization* 7:275–291. <https://doi.org/10.5771/2566-7742-2022-2-275>
- Schmidlehner MF (2023) The green growth narrative, bioeconomy and the foreclosure of nature. *Sustain Sci.* <https://doi.org/10.1007/s11625-022-01259-z>
- Steffen W, Broadgate W, Deutsch L et al (2015) The trajectory of the Anthropocene: the great acceleration. *Anthropocene Rev* 2:81–98. <https://doi.org/10.1177/2053019614564785>
- Stirling A (2023) Against misleading technocratic precision in research evaluation and wider policy—a response to Franzoni and Stephan (2023), ‘uncertainty and risk-taking in science.’ *Res Policy* 52:104709. <https://doi.org/10.1016/j.respol.2022.104709>
- Strassheim H, Kettunen P (2014) When does evidence-based policy turn into policy-based evidence? Configurations, contexts and mechanisms. *Evid Policy J Res Debate Practice* 10:259–277. <https://doi.org/10.1332/174426514X13990433991320>
- Tittor A (2021) Towards an extractivist bioeconomy? The risk of deepening agrarian extractivism when promoting bioeconomy in Argentina. In: Backhouse M, Lehmann R, Lorenzen K et al (eds) *Bioeconomy and inequalities socio-ecological perspectives on biomass sourcing and production across South America, Asia and Europe*. Palgrave Macmillan, London
- Vivien F-D, Nieddu M, Befort N et al (2019) The hijacking of the bioeconomy. *Ecol Econ* 159:189–197. <https://doi.org/10.1016/j.ecolecon.2019.01.027>
- Vogelpohl T (2023) Understanding the bioeconomy through its instruments: standardizing sustainability, neoliberalizing bioeconomies? *Sustain Sci.* <https://doi.org/10.1007/s11625-022-01256-2>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.