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Analyzing Infrastructures in the Anthropocene

Philipp Degens, Iris Hilbrich & Sarah Lenz *

Abstract: *»Die Analyse von Infrastrukturen im Anthropozän«.* This contribution takes the multiple ecological crises as the background to connect discourses on sustainability and infrastructures. It discusses the preservation, development, or disorder of infrastructures by different actors and practices in the context of diverse imaginaries of sustainability. When infrastructures are addressed and scrutinized against different visions of the future, their order-forming elements, dysfunctionalities, and transformation potentials come to the fore. The question of which decisions, translations, and norms are inscribed in infrastructures is of particular importance in the discourses on ecology. Moreover, focusing on the planetary dimensions of the ecological crisis adds particular complexity to the infrastructural analysis. An ecological perspective fundamentally challenges the view of infrastructure, as traditional concepts are no longer able to contribute to necessary planetary solutions. Since struggles for the futures of sustainability are struggles for the modernization and transformation of, as well as control over and through (material, immaterial, planetary), infrastructures, we argue that infrastructures will and should receive special attention in the social sciences and humanities in the future.

Keywords: Infrastructural turn, sustainability, modernization, transformation, planetary infrastructures, ecological crises, energy (in)justices.

1. Introduction

Infrastructures are ubiquitous. They are crucial prerequisites for societies to function and at the same time the result of social action, which in turn influence the constitution of social structures. This interdependence becomes increasingly visible in times of ecological crisis, revealing the dysfunctionality of existing infrastructures, such as the consistency of mobility and energy concepts that fail to meet sustainability objectives. At the same time, tangible

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and intangible infrastructures can stabilize and even exacerbate existing inequalities. The Global North, in particular, consumes huge amounts of energy while largely ignoring the consequences. In the spring of 2022, the precarity of energy infrastructures suddenly became visible even to many Western European citizens, politicians, and corporations who had implicitly been relying on the convenient imagination that energy supply could be taken for granted. The Russian invasion of Ukraine has widely been perceived as a fundamental rupture, not least to Europe's supply of oil and gas from Russia. The German Chancellor Olaf Scholz even claimed we are in fact witnessing a historical turning point. Overcoming the geostrategic dependency on Russian energy quickly became a widely shared goal for Western European governments. Within a very short time, the European Union reduced its dependence on Russian energy sources in an unprecedented joint effort. The crisis seemed, to some, to positively demonstrate the potential of a radical transformation that would leave fossil fuels behind. Soon, political discourse intensified on how to rapidly increase the supply of renewable energy or hydrogen. Appeals to households to save energy have since been incorporated into European energy governance. At the same time, however, there are calls for substituting coal with gas, stepping up fracking, and investing more in nuclear energy. It seems that what scientists had warned about for a long time – the need to overcome the dependence on fossil fuels, despite the global economy's reliance on it – makes it nearly impossible to make the most of such a tremendous rupture and to pursue a transformative path. Instead, it seems, path dependencies and continuities are rendering transformation unlikely. While millions of people in the Global South still fundamentally lack energy security or access to electricity altogether, people in the Global North have recently been confronted with the inconvenient fact that energy supplies can falter, and costs can rise significantly. The crisis in 2022 also shows that state institutions in the Global North are very well placed to respond quickly to these infrastructure and policy challenges and disruptions. Yet if the Global North hastily deviates from the path of sustainable energy transition due to the current geostrategic challenges and turbulence, this will have a signal effect for the rest of the world that should not be underestimated. Thus, the disruptions of European sustainability transitions due to the war is met with skepticism from the Global South as could be seen at the COP27 negotiations.[1]

Without diving deeper into the causes and outcomes of the war, we would like to take this global predicament as an illustration for the fundamental relevance of infrastructural regimes. In the different responses to the crisis, questions about sustainability and infrastructures are converging. While some strive for fossil continuities, others see their demands for energy

[1] https://mg.co.za/opinion/2022-10-04-african-leaders-must-stand-together-at-cop27-to-counter-the-global-norths-divide-and-rule-tactics/ (Accessed 01.12.2022).

autonomy confirmed. In their eyes, renewable energy infrastructures are needed to ensure that wars and crises in the future do not force us to choose between security of supply and combating climate change.

These debates are part of a broader shift towards sustainability that has been taking place during the last decades. In light of the multiple ecological crises, as manifested in climate change, along with the loss of biodiversity and further planetary boundaries (Rockström et al. 2009), an imminent turn towards sustainable development seems in fact unavoidable. Sustainability has accordingly become a widespread societal guiding principle; however, there is no single vision of what sustainability is and how to get there. This is reflected in the notion of contested "futures of sustainability," whose diverse, sometimes conflicting tendencies describe different potential trajectories of social change, namely modernization, transformation, and control (Adloff and Neckel 2019). Central to these manifold conceivable futures are different interpretations and imaginaries of sustainability, as well as different structural settings and repertoires of practices that actors draw upon when striving for sustainability (see also Jasanoff 2022; Slota and Hauser 2022, both in this issue). These trajectories do not necessarily complement each other; rather, they often contradict each other. For example, green modernization can be seen to leave capitalist structures untouched, while the vision of transformation refers to a broader, fundamental shift away from existing, growth-oriented institutions. Politics of control invoke an ecological emergency to enforce resilience measures (Aranova 2015), while at the same time suspending civic rights. The notion of multiple futures of sustainability aims to capture this embattled diversity (Adloff and Neckel 2019). Any trajectory towards sustainability rests on particular imaginaries of what sustainability looks like and how to achieve sustainable change. These imaginaries are in turn enmeshed with specific practices and are also linked to specific material and immaterial infrastructures. Imaginaries are often seen as implicit starting points for the consolidation of structural change and for the construction of the future in general (Beckert 2016; see also Suckert and Ergen 2022, in this issue). At the same time, imaginaries are always dependent on the structures already in place, which continue to shape and constrain them (Jasanoff 2015). Thus, imaginaries structure the practices of sustainability that are carried out in social fields such as politics, the economy, and civil society. Yet these practices are interdependent with antecedent structures and the Earth system. Infrastructures and practices "co-evolve" (Shove 2016) and mutually condition each other: Infrastructures enable multiple practices, while at the same time, practices determine the ways in which infrastructures are used, thus shaping imaginaries of future infrastructures.

In this contribution, we take the multiple ecological crises as the backdrop to connect discourses on sustainability and infrastructures. On the one hand, we shed light on how social science discourses on sustainability might profit

from integrating an infrastructural perspective that considers material and immaterial components and their interdependencies with social practices and imaginations of the future. On the other hand, we aim to show how ecological crises irritate conventional thinking about infrastructures; they make visible the fragility and destructiveness of fossil infrastructures, and they demand consideration of the planetary dimensions of infrastructures.

In the following, we will briefly reflect on the infrastructural turn in the social sciences. In particular, we explore what insights can be gained when an infrastructural perspective is adopted to analyze the challenges of ecological crises and responses to sustainability. This allows us to identify key fields of research as well as methodological/conceptual problems that arise when infrastructures are analyzed in the Anthropocene. We do not aim to review the plentiful and growing literature on infrastructures comprehensively (for overviews, see Niewöhner 2014, 2015; Anand, Gupta, and Appel 2018; Appel, Anand, and Gupta 2018; Hetherington 2019). Instead, we would like to highlight key aspects that accompany an analytical focus on infrastructures and ecology.

2. Infrastructures and Ecology: Building on the Infrastructural Turn

When infrastructures are addressed and scrutinized against the backdrop of sustainability, their order-forming elements, dysfunctionalities, and transformation potentials come to the fore. The question of which decisions, translations, and norms are inscribed in infrastructures is of particular importance in the discourses on sustainability. Their reality-shaping role becomes evident especially when infrastructures do not fulfill the demands placed on them or even the hopes associated with them. Deeply enmeshed in all social fabric, the observation of infrastructures enables fundamental analyses of different paths of social-ecological development, allowing, in a strong sense, for a "commentary on modernity" (Howe et al. 2016, 556).

Thus, the diversity of sustainability trajectories in the Anthropocene is also reflected in the diversity of infrastructural theorizations and concepts. Just as we speak of multiple sustainabilities, the multiplicity of infrastructures must be considered in order to grasp their contested efficacy. Ergo, there can be no single concept of infrastructure in the Anthropocene. The "new infrastructural turn" (Amin 2014, 138) of recent decades in the social sciences and humanities illustrates this diversity. As with many of the turns in the social sciences, the infrastructural turn is one in which the diversification of a particular term brings with it a multiplicity of definitions of varying scope. What do rather broad or narrow perspectives bring to the analysis of

infrastructures? What are the conceptual limits of a broad notion of infrastructure? Does the proclamation of the Anthropocene and the accompanying crisis of the relationship between humans and nature change our view of infrastructures? In the following, we will look at conceptions of infrastructures, scrutinizing them for their perspective on the link between infrastructures and ecology.

When we analyze infrastructures in the Anthropocene, we see, on the one hand, that they only become visible when they are not fulfilling their role, mainly in times of crisis (i). Furthermore, by focusing on the processual nature of infrastructuring, we see the interconnectedness of material and immaterial foundations of modern societies, which are essential for a social science analysis in the Anthropocene (ii). Infrastructures are always embedded in and emerge from socio-political negotiation regimes, the analysis of which can shed light on participation opportunities, transformation possibilities, and the solidification of continuities in the center and periphery of a society (iii). Most fundamentally, the ecological crisis broadens our view of the spatial and temporal dimensions of socio-material entities. The focus on planetary dimensions of infrastructures finally dissolves the separation between the natural, social, and material worlds and confronts the historical social sciences with hitherto unprecedented analytical scales (iv).

(i) Infrastructures in Times of Crisis

Pointing to the achievements of traditional infrastructure research, it is important to emphasize how they have sharpened and changed our view of the seemingly invisible basis of our modern societies (Star 1999; Star and Bowker 2006; Niewöhner 2015). The concept of infrastructure initially refers to technical structures such as cables, power lines, or the metro system – in other words, structures without which, upon closer look, modern life would be almost inconceivable. In fact, infrastructures have been "defined negatively, as those systems without which contemporary societies cannot function" (Edwards 2003, 187). Contemporary societies are necessarily dependent on infrastructures since their material as well as immaterial facilities make social integration in modern societies possible in the first place (Calhoun 1992). Infrastructures are mostly invisible in the sense that they and their functioning are taken for granted (Star 1999), and their maintenance is considered a matter for experts or administrations (van Laak 2001). They might even be regarded as almost insignificant in everyday life, especially since the term "infra" itself refers to the subordinate, the underlying supporting the social. It might not be surprising then that even the social sciences and humanities have not dealt with infrastructures in a long time, regarding them largely as lifeless, functional things. Reduced to the material background of the social world, they have even been rendered "boring things" and "unexciting" for social analysis (Star 1999, 377).

Infrastructures become noticeable and visible above all during crises when they do not function (Graham and Thrift 2007; see Suckert and Ergen 2022, in this issue). This holds especially true for those types of infrastructure whose use has become routine. Looking at the ecological crises from the perspective of infrastructures points to the interwoven nature of the material and the immaterial. In order to find answers to ecological questions, it is not enough to merely consider, for example, renewable energies and high-voltage power lines as material infrastructural conditions; it is infrastructure's contribution to creating, maintaining, or altering social order that needs to be analyzed. In turn, ecological crises disrupt how societies think about infrastructures, e.g., when they turn out to be dysfunctional or counterproductive in tackling climate change. Societies then face the double challenge of modifying existing infrastructures to make them ecological and to create resilient future infrastructures that respond to climate change without unintentionally creating new paradoxes and inequalities.

(ii) Processuality and Socio-Material Entanglements

As a promise of progress, material and immaterial infrastructures shape contemporary societies in a variety of ways (Anand, Gupta, and Appel 2018; van Laak 2018). The concept of infrastructuring (Niewöhner 2014, 2015) or infrastructuration (Edwards 2019; Szerszynski 2022, in this issue) opens our view to the processuality, fluidity, precariousness, and normativity of these structures (Appel, Anand, and Gupta 2018, among others) and the "mutually constructive character of agency and structure" (Edwards 2019, 355). This perspective opens the possibility to emphasize connections between structure and practice, instead of antagonizing them (Niewöhner 2015). Infrastructures are by no means mere technical artifacts solely supporting the social. Rather, they are inscribed in social practices and conventions (Star 1999): "Infrastructure in an ecological reading ceases to be a homogeneous technical artifact. Rather it is understood as a fluid technology contributing to practices in multiple ways" (Niewöhner 2015, 8).

As the decisions, stocks of knowledge, and hierarchies embedded in the construction process of a bridge or building, for example, become invisible, they tend to be understood in retrospect as purely technical decisions. However, it is not the technical aspects that constitute the essence of infrastructure but its interrelation with social organization and moral order (Bowker and Star 2000; Star and Ruhleder 1996).

If we understand infrastructures fundamentally as systems of socio-technical (Edwards 2003) or socio-material interaction (Angelo and Hentschel 2015), the innate relatedness of people and material components of infrastructures come into view. Thus, the "new infrastructural turn" sheds light on how the material and the cultural constitute each other (Amin 2014, 138). Infrastructures thus are the outcome of social processes and structures, but at

the same time, they create, shape, and condition social structures (see Wagner 2022, in this issue).

(iii) Infrastructural Regimes

Because infrastructures are each tied to a specific mode of social structuring, it is possible to identify particular "infrastructural regimes" (Barlösius 2019). Many contemporary infrastructures, for example, are closely linked to the territory of a state, and they have helped to establish the corresponding forms of social integration and exclusion (ibid). Furthermore, existing infrastructures, such as transport and energy networks, are strongly bound to national boundaries. As the example of the Russia-Ukraine war painfully illustrates, it is also geopolitical dependencies that, in times of crisis, reveal the dysfunctionality of infrastructures that rely too heavily on nation-state interests.

Infrastructure, like any technology, is never neutral (Latour and Venn 2002; Jasanoff 2022, in this issue), and both form and function are subject to constant social change, which certainly shows the possibility of reinterpreting the balance of power between center and periphery. Regarding infrastructures as socio-material practices rather than mere technical objects makes it possible to question and understand the relationality and implicit hierarchies between the center and periphery of society (Niewöhner 2015). Who participates in the development of infrastructures? Whose everyday lives are even disadvantaged by infrastructures? Here, global inequalities become apparent: While many people in the Global North take fresh water from the tap or electricity supply for granted, improvisation and maintenance or repair of infrastructure seem to be much more necessary in the Global South (McFarlane and Rutherford 2008; Amin 2014). Following this line of infrastructural thinking, "narratives of top-down power and the manifold resistances against it [...] are always also articulated in material, i.e., infrastructural terms" (Niewöhner 2015, 6). Questions about social participation are evident here: The distribution of expertise in technology development is being contested, starting mostly from the center, and having in turn a retroactive effect on the social periphery and its reconfiguration (Weizman 2015).

Thus, more broadly speaking, feminist and postcolonial accounts point to the role of agency and also the distribution of infrastructures (Fox 2017; Howe et al. 2016; van der Straeten and Hasenörl 2016; van der Straeten 2022, in this issue). A situated and performative perspective makes it possible to identify those actors who are constantly engaged in the maintenance and repair of infrastructures (Howe et al. 2016). To turn analytically to infrastructure, then, means at the same time to turn to critique and to turn to the hidden mechanisms of inequality and to issues of (energy) justice (see Symons and Friederich 2022, in this issue). For example, costs and risks in infrastructural projects might be systematically externalized (Lessenich 2019). In the context of sustainability transitions, it may also mean to shed light on how

environmental and conservational knowledge is produced and in what way interdependencies between humans and non-humans are recognized (Jasanoff 2022, in this issue; Schleper 2022; Morita 2016; see Rosengren 2022, in this issue).

(iv) Temporality and Space: Planetary Infrastructures

The ecological crises and corresponding demands for sustainability can be regarded as an irritation for infrastructure research with regard to temporality and space. Historical and geo-logical time overlap (Chakrabarty 2018). More drastically, time to solve the ecological crises becomes shorter and shorter (Intergovernmental Panel on Climate Change [IPCC] 2022). In terms of space, the current situation urges us to reflect on linkages between the local, national, global, and planetary. On a general level, the issue of sustainability demands to understand how and under what conditions infrastructural transformations are possible. Yet even continuities in infrastructural provisions entail specific temporalities. Maintenance and reproduction often defy conventional perceptions of time (see Slota and Hauser 2022; Szerszynski 2022, both in this issue).

So, in addition to material infrastructures of the technosphere and immaterial infrastructures of social institutions, Purdy (2019) identifies a third infrastructural level that encompasses the fundamental areas and cycles of the natural world, such as the atmosphere, water cycle and movements, soil, and fertility. Here the planetary dimensions of infrastructures come to the fore. The notion of planetary infrastructures inevitably rejects any clear-cut distinction between the human or social world and nature since it once again highlights the interdependence of "natural" and "societal" infrastructures (Westerman and Rohr 2015; Bogusz and Holtappels 2021; Niewöhner 2021; Rosengren 2022, in this issue; Szerszynski 2022, in this issue; Slota and Hauser 2022, in this issue). Accordingly, the necessity to develop an analytical perspective on the inter-connections between infrastructures and ecology becomes apparent. Such a perspective highlights the temporal dimensions of ecological crises, especially their implications for the future. Infrastructures are thus important elements for the opening of an ecological future and can at the same time close it (Bowker 1995).

Focusing on the planetary dimensions of the ecological crisis adds particular complexity to the infrastructural analysis: What does it mean for strongly nation-state-based infrastructure concepts that solutions now have to be found on a planetary level? Which institutions and actors are addressed and assigned responsibilities? An ecological perspective fundamentally irritates the view of infrastructure, as traditional concepts no longer manage to contribute to necessary planetary solutions. The multiple crises show that infrastructures will and should receive special attention in the social sciences and humanities in the future. To shed light on these complex entanglements, this

Special Issue puts infrastructures at the center of analyzing the ecological crises and the possible trajectories to sustainability. It specifically examines ruptures, transformations, and continuities to explore the meaning of infrastructures for sustainability and the fruitfulness of an infrastructural perspective. The contributions all explore the question of what it means to analyze infrastructures in the Anthropocene.

3. Between Ruptures, Transformations, and Continuities – Infrastructural Futures in the Anthropocene

Examples of the kinds of material and immaterial infrastructures that seem most relevant to sustainability include energy and non-fossil fuels, water, waste systems, private and public transport, financial infrastructures, legal infrastructures, and global knowledge and communication structures (see Bowker et al. 2010). In particular, as already stated, the ecological crises highlight the dysfunctionality of existing infrastructures, causing ruptures to their functionality (e.g., on the Oil Crisis of the 1970s see Lifset 2014; see Suckert and Ergen 2022, in this issue). For example, energy provision or mobility concepts might be pursued and continued despite their incompatibility with climate protection goals. However, infrastructures are not immutable or timeless but fluid and changeable (Appel, Anand, and Gupta 2018; see Slota and Hauser 2022, in this issue; on historicity see Jasanoff 2022, van der Straeten 2022, Wagner 2022, all three in this issue). Especially in moments of crisis and rupture, they are vulnerable, precarious, and fragile (Appel, Anand, and Gupta 2018; Star 1999; Graham and Thrift 2007; Suckert and Ergen 2022, in this issue). Accordingly, both existing material and immaterial infrastructures are being criticized with regard to inequality-promoting implications (Hetherington 2019; Boyer 2016, 2022, in this issue; Foundational Economy Collective 2018; von Schnitzler 2013; van der Straeten 2022, in this issue), global resource overuse (Thacker et al. 2019), or their underlying anthropocentric guiding principles (Haraway 2016; Szerszynski 2022, in this issue; Rosengren 2022, in this issue).

The modification or redesign of these infrastructures offers the opportunity to respond to the challenges and threats of the Anthropocene (see Jasanoff 2022, in this issue). Moreover, this fragility creates opportunities for change (Cass, Schwanen, and Shove 2018). Boyer (2016) argues that "revolutionary infrastructures" can be built up by moving from "gray" infrastructures like fossil and nuclear energy, which rely on long and inefficient supply chains, to "green" infrastructures (sun, wind, and biomass), which get along without long supply chains. Such a transformation may not only result from large

investments by governments but also through social movements and individual actors (see Boyer 2022; Schiller-Merkens 2022, both in this issue). Such changes of infrastructures thus open up the possibility of responding to the challenges and threats of the Anthropocene.

In this line, the manifold social and transformative movements, engaging in "real utopias" (Wright 2010), "prefigurative organizations" (Reinecke 2018; Schiller-Merkens 2020), or "entry projects" (Brangsch 2014; Brand and Schickert 2019) anticipate a future sustainable world on a small scale and attempt to demonstrate its viability (Monticelli 2021). Debates about the diffusion and growth of prefigurative organizations and alternative economic approaches bear witness to attempts to form new structures that go beyond individual organizations and initiatives (in this issue, see Bazzani 2022 on monetary infrastructures from below and Schiller-Merkens 2022 on scaling up alternative organizations). Prefigurative initiatives do not only question common infrastructures and practices, but their existence in itself manifests a sort of change in attitudes within society toward sustainability and the capitalist economy (see Besio, Arnold, and Ametowobla 2022, in this issue).

Yet, given the scale and complexity of the environmental crises, such an interstitial transformation might be too slow or materialized in niches only, without enabling a timely change of direction in society as a whole. Any imagination of the future and future infrastructures is always based on existing societal structures. Wherever the futures of sustainability are being thought about, disputed, or tested on a small scale, the potentials and limits of their embedding become apparent already today (Mische 2014).

In light of slow or even failing societal change toward more sustainability, infrastructures play an intriguing role in international policy settings as solutions to the climate emergency. For example, so-called geoengineering technologies are being discussed as emergency measures and instruments of control. Geoengineering technologies, especially those related to the manipulation of solar radiation, have planetary dimensions (see also Jasanoff 2022, in this issue). The consequences and potential risks would not remain limited to the places of application but could, in some cases, show hardly foreseeable effects on the global climate. For example, the spatial distribution of precipitation and temperatures, including monsoons, could change. In addition, the earth's temperature would quickly rise again if the use of SRMs were to be abruptly terminated. These measures are therefore often discussed as emergency measures against imminent catastrophic climate impacts (Wiertz 2015). Vulnerable countries in the Global South are exposed to different threats than comparatively stronger industrialized nations due to a lack of infrastructure, among other things (Biermann and Möller 2019).

Just as sustainability is fundamentally oriented toward the future, technologies and innovations always refer to a specific form of the future. This refers to a future that can be "technologically fixed" (Weinberg 1966; Keith 2000).

Prominent representatives gather, for example, under the term "ecomodernism" (Symons 2019). Parts of this current movement, guided by the idea of a "good Anthropocene," see the solution to pressing climate and environmental problems in technological innovation and a gradual decoupling of humans and nature (Asafu-Adjaye et al. 2015; Hamilton 2013; Adloff and Hilbrich 2021). Such technofix imaginaries do not challenge the predominant infrastructural regimes; they rest, despite the notion of technological progress, on the idea of infrastructural continuities instead. Opponents, however, associate technological fixes with a dystopian vision of the future, according to which a small technocratic elite will take control of the world's climate and wage geopolitical hegemonic struggles that degenerate into global war scenarios (Klein 2015).

Here, we also find promises of digital infrastructures or cyber infrastructures (Bowker et al. 2010). For example, the industry expects the growth of digital and networked infrastructures to increase efficiency and to increasingly de-materialize production. Material objects are to be replaced by information and knowledge for better coordination of single processes as well as optimizing machine capacity (Sühlmann-Faul and Rammler 2018, 19). The Internet of Things, 3D printing, sensors, and the overall emergence of a "smart economy" (Industry 4.0) or "smart cities" are expected to fundamentally change how the economy and society are organized and infrastructured. However, this notion of a "good Anthropocene" through digital technologies and digital infrastructures is put into perspective when the initial efficiency gain leads to increasing consumption and growth in production. Such rebound effects are evident in industry as well as in everyday life. The simplified access to online shopping and the resale of clothing and other goods favors increasing consumption; in addition, the cloud is increasingly being used to store the needed data, which requires about as much energy as it was originally intended to save (Andrae and Edler 2015; Lange and Santarius 2018, 33ff.).

4. Transitions Towards a Good Anthropocene?

The image of a good Anthropocene, in which humanity proves capable of overcoming ecological crises, is also reflected in strategies for internalizing sustainability issues into the economy. The newly emerging sustainability markets are intended to structurally integrate sustainability issues into economic decision-making. New forms of organizing that reconfigure institutional logics aim to take on the "grand challenges" like climate change (Gümüsay, Claus, and Amis 2020). At the same time, the relationship between market and state is being restructured through the financialization of sustainability (Chiapello and Knoll 2020; Knoll 2019; Lenz and Neckel 2019). In this

context, ecological modernization includes ideas of green finance or green monetary policy. Political regulations also shape, force, or enable the orientation toward sustainability, as reflected in the European Central Bank's (ECB's) green monetary policy. Accordingly, the European Union's Green Infrastructure Strategy refers to a modernization narrative that locates the solution to the climate crisis in the renewal of infrastructural projects (see Gengnagel and Zimmermann 2022, in this issue). Such attempts open up the future by (aiming at) providing large-scale infrastructural preconditions for decarbonized economies, promising transformational change in energy provision, economic production, and financial investment opportunities. However, they also close the future, e.g., by centralizing infrastructural forms and functions, by further deepening the financialization of the economy with its impacts on social inequality. In any case, the role of states as an important actor for providing much needed infrastructural change seems to be recognized again (Mazzucato 2021; Neckel 2022).

These various empirical examples show how the temporality of the ecological crisis influences the corridor of possible and more or less sustainable futures and the role infrastructures play in imagining, but also implementing, possible futures. Whereas the necessary, protracted transformation processes do not seem to keep pace with rapid climatic changes (IPCC 2022), moments of rupture also repeatedly point to the fundamental possibility of rapid change. The uncomfortable question remains as to which continuities would need to be abandoned for a more sustainable future (see Wagner 2022, in this issue).

5. Contributions to this HSR Special Issue

In all areas we find different persistences and limitations but also new opportunities for the implementation and transformation of infrastructures. The idea of this HSR Special Issue rests on the premise that an infrastructural perspective can sharpen the analysis of ecological crises and sustainability in the social sciences. It sheds light on the social (material and immaterial) preconditions of societies and everyday life and overcomes the limits of approaches that focus on individual decision-making and consumptive behavior as a driver for change. Instead of holding individual consumers responsible for the ecologically destructive consequences of contemporary (Western) life, infrastructural perspectives look at the complex interplay of everyday practices and the material and immaterial conditions they are maintained in. Such a perspective also rejects the idea of isolated technological fixes because both the realization of technological innovation in the first place and its outcome, including intended and unintended effects, rely heavily on the infrastructural regime that they are embedded in.

If every social order and their infrastructural settings are co-dependent, then any transformation toward a post-fossil economy (not to mention post-growth economies) has to be based on holistic assessments of this interplay, constituting a specific infrastructural regime. Finally, an infrastructural lens also urges us to consider the interwoven relations between the material and the immaterial – thus, arguably, it also responds to the demands to question the canonical nature/culture division that Western societies rely on.

The Special Issue focuses on such contested processes, which also include reversals and disruptions. It discusses the preservation, development, or disorder of infrastructures by different actors and practices against the background of specific imaginaries of sustainability. Struggles for the futures of sustainability are always struggles for the modernization and transformation of, as well as control over and through (material, immaterial, planetary) infrastructures. It tracks infrastructural developments of the past and the present as well as those that exist mainly as blueprints that are currently being defined and also contested. If socio-technical ideas have not yet stabilized, science and society alike still have an important role to play in shaping their future development (Jasanoff and Kim 2009).

In this line, this Special Issue seeks to explore several guiding questions: What happens when material or immaterial infrastructures prove to be dysfunctional or unsustainable? What are the responses and efforts to address global inequalities? What are the analytical advantages of looking at infrastructures for sustainability research?

These questions guide the multidisciplinary accounts of this Special Issue. It brings together conceptual and empirical contributions from different disciplinary perspectives. Against the backdrop of the "infrastructural turn," they all deal with ecological crises and their attempts to be overcome by practices of sustainability. In her opening essay, *Sheila Jasanoff* hints at the complex entanglements of materiality and meaning-making in times of ecological emergency. From the perspective of Science and Technology Studies (STS), the normative underpinnings of infrastructures cannot be separated from their design and implementation as these are always subject to a process of "co-production." The analysis of infrastructures thus illustrates nothing less than the question of how we ought to live in the Anthropocene. By comparing receptions of the first images from space, which gave rise to different cultural narratives around the world, Jasanoff recalls how intertwined the cultural and the material are. She shows that spaceship and stewardship are two central yet contradictory imaginaries of sustainability that refer to different notions of responsibilities, affectedness, and temporalities in answering to the ecological crises. Hereby, inequalities between the Global North and South, underlying power structures, and the implications of authoritative epistemological dimensions of knowledge and science can be revealed, opening our

analytical view from the local to the planetary dimensions of infrastructures and back.

A range of contributions to the volume shed light to various fields in which alternative infrastructures emerge, mainly from the local level. These papers range from conceptual accounts of revolutionary (Boyer) or prefigurative infrastructures (Schiller-Merkens) to empirical studies of renewable energy in Germany (Besio, Arnold, and Ametowobla), local monetary infrastructures in Italy (Bazzani), or electronic mobility in Bangladesh (van der Straeten). *Dominic Boyer's* historical account of "Infrastructural Futures in the Ecological Emergency" recalls the role infrastructures have played for the development of exploitative practices and unsustainable societal development in the Global North and the Global South. Boyer identifies three distinct types of infrastructural futures that he labels grey, green, and revolutionary. Focusing on local case studies in the US and Mexico, Boyer shows how grey as well as so-called green infrastructures exacerbate the ecological emergency. His study of failed flood management in Houston, Texas, shows that grey infrastructure projects entail a temporality that aligns with past ideas and ideologies and cannot keep up with the rapid demands of the climate crisis. In contrast to prevailing centralized grey types of infrastructures, Boyer sees the "revolutionary" potential in locally applied, flexible, and experimental forms of infrastructural organization that go far beyond anthropocentric conceptions of the future.

Simone Schiller-Merkens connects Boyer's reflections on revolutionary infrastructures with the discourse on prefigurative politics. Prefiguration means illustrating visions of alternative, non-capitalist futures already here and now through corresponding social practices embedded in real utopias. Schiller-Merkens conceives prefiguration as a multi-political process that both critiques and negates the realities of contemporary capitalist societies. The contribution offers a discussion of the possibility of infrastructural change and directs attention to the requirements for organizing such a change. It focuses on the conditions under which infrastructural change towards an eco-social transformation could succeed.

Cristina Besio, Nadine Arnold, and Dzifa Ametowobla address the organizational dimensions of sustainability infrastructures and illustrate their relevance by the example of German energy cooperatives. They argue that participatory organizational structures like cooperatives are paramount to potential transformations in the Anthropocene because they bring together diverse interests – economic, environmental, and social – and enable the scalability of social phenomena from small to large units. Yet these social imaginaries of sustainability do not have a transformative effect through technical devices alone; instead, this effect depends primarily on how organizations use and share these devices. The contribution asks how energy cooperatives can promote the social and economic impact that their radical

imaginaries envision in order to expand infrastructures of sustainability in the conventional energy sector.

Giacomo Bazzani discusses the Sardex by juxtaposing this local currency of Sardinia with the euro. In doing so, he sheds light on the infrastructural performance of monetary systems and discusses the possibilities of using money as an instrument to create infrastructures of solidarity and cooperation. To this end, he contrasts the Sardex as "situated money" with the euro as "indifferent money." Bazzani sees the infrastructural coordination services of the euro as, among other things, enabling and extending practices of satisfying individual preferences through markets. In contrast, the Sardex enables the creation of bottom-up monetary infrastructure to strengthen local communities and economies.

Broadening the view to energy transitions beyond a eurocentric context, *Jonas Van der Straeten's* empirical case study of electric mobility in Bangladesh is a plea for understanding the complexity and decolonizing sustainability discourses in the Global South. It illustrates the extent to which Western notions of the future influence current debates about sustainability transitions worldwide. The electric rickshaw serves as an example of hegemonic continuities in policies that fail in their attempts to integrate bottom-up practices and "the site-specific socio-material legacies" in the Global South into abstract Western conceptions of sustainability trajectories. This underpins, for example, the claim that actors in the informal economy prove to be important agents of sustainable change. Van der Straeten shows the extent to which local practices are interwoven with supranational discourses and narratives, and the asymmetries that arise when these complex entanglements are dismissed or overlooked.

Against the background of the new materialist turn and the challenge to social theory posed by the intertwining of the "social" and the "natural," some contributors emphasize the need for a systematic assessment of non-human agency and more-than-human infrastructural relations. In the context of these theoretical considerations, the temporal dimension of infrastructures comes to the fore in *Mathilda Rosengren's* account of the willow tree in the creation of green infrastructures in the Malmö region in Sweden. Rosengren delves deep into the history of the relations among human and other-than-human beings, showing how the Willow tree connects infrastructural past, present and future of green infrastructures and urban planning. While ecologizing infrastructures requires the recognition of other-than-human agency, current municipal attempts to create green infrastructures rest on an anthropocentric understanding of these infrastructures. Such strategies, Rosengren argues, fail to offer solutions to humanity's challenges in the Anthropocene.

Bronsilaw Szerszynki's account of "Infrastructuring as a planetary phenomenon" also emphasizes the need to go beyond anthropocentric notions of infrastructure following the tradition of more-than-human accounts of social

theory. He argues that a physical systems theory approach opens the view to the holistic features of planetary organization beyond human agency because it extends the notion of infrastructure to the planetary scale and also takes into account the self-regulating properties of the material foundations of the hydrosphere and biosphere. The contribution draws attention to the different temporalities and referentialities of material entities of the Earth system and those of human organization using the concept of "timescale separation." Understanding these diverging temporalities enriches the debate on infrastructures and ecology by highlighting that traditional Eurocentric accounts of infrastructure and the supposed liberation from natural limits was based on both the infrastructural smoothing of planetary variability and colonial exploitation of people and nature.

Stephen C. Slota and Elliott Hauser offer a historical study of the Chesapeake Bay oyster fishery in the United States, examining infrastructural work and its inevitably changing ways to maintain economic, social, and ecological homeostasis. Using the concept of infrastructural inversion to shed light on how infrastructures are formed and operated over time, Slota and Hauser propose to fruitfully connect infrastructure and sustainability studies. They show how both the separation of the human and the natural and its accompanying temporal dissonance of long-term natural processes as well as short-termed political actions are negotiated in sustainability work. By focusing on work, it becomes possible to elaborate how particular technologies, behaviors, and policies are articulated and negotiated, and how infrastructures shape negotiations, conflicts, and outcomes of struggles over sustainability.

Turning from local and regional spaces to (supra-)state and global levels of politics, the following contributions illuminate on issues of temporality and crisis (Suckert and Ergen), legitimacy (Gengnagel and Zimmermann), and global (in)justices (Symons and Friederich) in continued or transformative provisions of infrastructures. *Lisa Suckert and Timur Ergen* observe that crises can serve as catalysts for infrastructural transformation. From their perspective, however, it is crucial how societies interpret these crises or whether disruptions are constructed as "real" crises. In this regard, references to the future and the notion of alternative futures are central. Taking the first oil crisis of 1973/74 as an example, they reconstruct interpretative struggles over the existence of a contemporary crisis. At the same time, they show that although certain actors admit the presence of a crisis, others are empowered to undermine this urgency. Indeed, reactions to the first oil crisis also show how struggles over needed infrastructural change can eventually be lost.

Vincent Gengagel and Katharina Zimmermann draw on the discursive construction of a new European meta-narrative of ecology as concealed in the European Green Deal (EGD). However, in order to support Europe's position in a global green "race," the EGD requires public accountability and needs to be legitimized widely. Faced with the climate crisis, the EU is confronted with

the need to formulate and implement its agenda in a way that integrates ecological conflicts. Against the backdrop of the 1960s "race for space" in the United States, the authors highlight accompanying facets around legitimizing government "missions." As a result, they show that public acceptance can be established through the imagination of solidarity and care for people and the planet.

Jonathan Symons and Simon Friederich turn to the question of equity in energy systems and make the fundamental claim that global energy justice is far from being achieved. Their argument negotiates the fact that the international community currently simply lacks the physical, conceptual, and political infrastructures necessary to reach energy justice. Moreover, existing energy policy infrastructures often reinforce the influence of powerful actors on energy policy decisions and undermine strategies of less powerful communities. Thus, they even exacerbate existing tensions between democratic sovereignty and conceptions of global energy justice. Drawing on the cases of Germany and Nigeria, which represent very different energy trajectories, Symons and Friederich show that there is currently no single, practically viable and globally applicable path to achieve energy justice.

The volume concludes with an epilogue by *Peter Wagner*, which is not intended to merely conclude the issue, but to offer a nuanced point of departure for further discussions. Based on a reading of the other contributions to the issue, Wagner problematizes the infrastructural turn itself. In his social-theoretical as well as historicizing reflection, Wagner warns against the analytical fuzziness that might come along with the expansive use and broadened conceptual meaning of infrastructures in the social sciences. Focusing on the fields of energy and money, Wagner outlines the contours of the historicity of infrastructures in modernity. He shows that any transformation of existing infrastructures towards sustainability has to be created in and through political struggles.

Special References

Contributions within this HSR Special Issue
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Bazzani, Giacomo. 2022. Money Infrastructure for Solidarity and Sustainability. *Historical Social Research* 47 (4): 114-138. doi: 10.12759/hsr.47.2022.41.

Besio, Cristina, Nadine Arnold, and Dzifa Ametowobla. 2022. Participatory Organizations as Infrastructures of Sustainability? The Case of Energy Cooperatives and Their Ways for Increasing Influence. *Historical Social Research* 47 (4): 91-113. doi: 10.12759/hsr.47.2022.40.

Boyer, Dominic. 2022. Infrastructural Futures in the Ecological Emergency: Gray, Green, and Revolutionary. *Historical Social Research* 47 (4): 48-65. doi: 10.12759/hsr.47.2022.38.

Gengnagel, Vincent, and Katharina Zimmermann. 2022. The European Green Deal as a Moonshot – Caring for a Climate-Neutral Yet Prospering Continent? *Historical Social Research* 47 (4): 267-302. doi: 10.12759/hsr.47.2022.47.
Jasanoff, Sheila. 2022. Spaceship or Stewardship: Imaginaries of Sustainability in the Information Age. *Historical Social Research* 47 (4): 29-47. doi: 10.12759/hsr.47.2022.37.
Rosengren, Mathilda. 2022. When Infrastructures and Ecological Actors Meet: Resituating "Green" Infrastructures through the History of the Willow Tree. *Historical Social Research* 47 (4): 168-192. doi: 10.12759/hsr.47.2022.43.
Schiller-Merkens, Simone. 2022. Social Transformation through Prefiguration? A Multi-Political Approach of Prefiguring Alternative Infrastructures. *Historical Social Research* 47 (4): 66-90. doi: 10.12759/hsr.47.2022.39.
Slota, Stephen C., and Elliott Hauser. 2022. Inverting Ecological Infrastructures: How Temporality Structures the Work of Sustainability. *Historical Social Research* 47 (4): 215-241. doi: 10.12759/hsr.47.2022.45.
Suckert, Lisa, and Timur Ergen. 2022. Contested Futures: Reimagining Energy Infrastructures in the First Oil Crisis. *Historical Social Research* 47 (4): 242-266. doi: 10.12759/hsr.47.2022.46.
Symons, Jonathan, and Simon Friederich. 2022. Tensions Within Energy Justice: When Global Energy Governance Amplifies Inequality. *Historical Social Research* 47 (4): 303-326. doi: 10.12759/hsr.47.2022.48.
Szerszynski, Bronislaw. 2022. Infrastructuring as a Planetary Phenomenon: Timescale Separation and Causal Closure in More-Than-Human Systems. *Historical Social Research* 47 (4): 193-214. doi: 10.12759/hsr.47.2022.44.
van der Straeten, Jonas. 2022. Sustainability's "Other": Coming to Terms with the Electric Rickshaw in Bangladesh. *Historical Social Research* 47 (4): 139-167. doi: 10.12759/hsr.47.2022.42.
Wagner, Peter. 2022. Frontiers of Modernity: Infrastructures and Socio-ecological Transformations. *Historical Social Research* 47 (4): 327-340. doi: 10.12759/hsr.47.2022.49.

References

Adloff, Frank, and Iris Hilbrich. 2021. Practices of sustainability and the enactment of their natures/cultures: Ecosystem services, rights of nature, and geoengineering. *Social Science Information. Special Issue "Contested Futures: A Sociology of Sustainability and Ecological Crisis"* 60 (2): 168-187.
Adloff, Frank, and Sighard Neckel. 2019. Futures of sustainability as modernization, transformation, and control: a conceptual framework. *Sustainability Science* 14 (4): 1015-1025.
Amin, Ash. 2014. Lively Infrastructure. *Theory, Culture & Society* 31 (7-8): 137-161.
Anand, Nikhil, Akhil Gupta, and Hannah Appel, ed. 2018. *The promise of infrastructure*. Durham: Duke University Press.
Andrae, Anders, and Tomas Edler. 2015. On Global Electricity Usage of Communication Technology. Trends to 2030. *Challenges* 6: 117-157.
Angelo, Hillary, and Christine Hentschel. 2015. Interactions with infrastructure as windows into social worlds: A method for critical urban studies: Introduction. *City* 19 (2-3): 306-312.

Appel, Hannah, Nikhil Anand, and Akhil Gupta. 2018. Introduction: Temporality, politics, and the promise of infrastructure. In *The promise of infrastructure*, ed. Nikhil Anand, Akhil Gupta, and Hannah Appel, 1-38. Durham: Duke University Press.

Aronova, Elena. 2015. Environmental monitoring in the making: from surveying nature's resources to monitoring nature's change. *Historical Social Research* 40 (2): 222-245. doi: 10.12759/hsr.40.2015.2.222-245.

Asafu-Adjaye, John, Linus Blomqvist, Stewart Brand, Barry Brook, Ruth Defries, Erle Ellis, Christopher Foreman, et al. 2015. *An Ecomodernist Manifesto*. Oakland, CA: Breakthrough Institute.

Barlösius, Eva. 2019. *Infrastrukturen als soziale Ordnungsdienste: ein Beitrag zur Gesellschaftsdiagnose*. Frankfurt am Main: Campus Verlag.

Beckert, Jens. 2016. *Imagined Futures: Fictional Expectations and Capitalist Dynamics*. Cambridge, Massachusetts: Harvard University Press.

Biermann, Frank, and Ina Möller. 2019. Rich man's solution? Climate engineering discourses and the marginalization of the Global South. *International Environmental Agreements: Politics, Law and Economics* 19 (2): 151-167.

Bogusz, Tanja, and Moritz Holtappels. 2021. Third Knowledge Spaces between Nature and Society: A Dialogue. *Historical Social Research* 46 (2): 264-286. doi: 10.12759/hsr.46.2021.2.264-286.

Bowker, Geoffrey C. 1995. Second nature once removed: Time, space and representations. *Time & Society* 4 (1): 47-66.

Bowker, Geoffrey C., Karen Baker, Florence Millerand, and David Ribes. 2010. Toward Information Infrastructure Studies. Ways of Knowing in a Networked Environment. In *International Handbook of Internet Research*, ed. Jeremy Hunsinger, Lisbeth Klastrup, and Matthew Allen, 97-117. Springer Dordrecht.

Bowker, Geoffrey C., and Susan L. Star. 2000. *Sorting things out. Classifications and its consequences*. Cambridge: MIT Press.

Boyer, Dominic. 2016. Revolutionary infrastructure. In *Infrastructures and social complexity: A companion*, ed. Penelope Harvey, Casper Jensen, and Atsuro Morita, 174-186. Milton Park: Taylor & Francis.

Brand, Ulrich, and Christine Schickert. 2019. Ökosozialistische Strategien für eine sozial-ökologische Transformation. Postkapitalismus als wachstumskritische Praxis. In *Neosozialismus Solidarität, Demokratie und Ökologie vs. Kapitalismus*, ed. Klaus Dörre and Christine Schickert, 165-183. München: oekom.

Brangsch, Lutz. 2014. Transformationsprozesse und ihre Politisierung in Einstiegsprojekten. In *Futuring. Transformation im Kapitalismus über ihn hinaus*, ed. Michael Brie, 368-391. Münster: Westfälisches Dampfboot.

Calhoun, Craig. 1992. The Infrastructure of Modernity: Indirect Social Relationships, Information Technology, and Social Integration. In *Social Change and Modernity*, ed. Hans Haferkamp and Smelser J. Neil, 205-236. Berkeley, CA: University of California Press.

Cass, Noel, Tim Schwanen, and Elizabeth Shove. 2018. Infrastructures, intersections and societal transformations. *Technological Forecasting and Social Change* 137: 160-167.

Chakrabarty, Dipesh. 2018. Anthropocene Time. *History and Theory* 57 (1): 5-32.

Chiapello, Ève, and Lisa Knoll. 2020. Social Finance and Impact Investing. Governing Welfare in the Era of Financialization. *Historical Social Research* 45 (3): 7-30. doi: 10.12759/hsr.45.2020.3.7-30.

Edwards, Paul N. 2003. Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems. In *Modernity and Technology*, ed. Thomas J. Misa, Philip Brey, and Andrew Feenberg, 185-226. Cambridge, Mass: MIT Press.

Edwards, Paul N. 2019. Infrastructuration: On Habits, Norms and Routines as Elements of Infrastructure. In *Thinking Infrastructures*, Research in the Sociology of Organizations vol 62, ed. Martin Kornberger, Geoffrey C. Bowker, Julia Elyachar, Andrea Mennicken, Peter Miller, Joanne Randa Nucho, and Neil Pollock, 355-366. Bingley: Emerald Publishing.

Foundational Economy Collective. 2018. *Foundational economy: the infrastructure of everyday life*. Manchester: Manchester University Press.

Fox, Sarah. 2017. Casting a Feminist Eye on Public Infrastructure. In *Companion of the 2017, ACM Conference on Computer Supported Cooperative Work and Social Computing*, 61-64. New York: Association for Computing Machinery.

Graham, Stephen, and Nigel Thrift. 2007. Out of Order: Understanding Repair and Maintenance. *Theory, Culture & Society* 24 (3): 1-25.

Gümüsay, Ali Aslan, Laura Claus, and John Amis. 2020. Engaging with Grand Challenges: An Institutional Logics Perspective. *Organization Theory* 1 (3): 1-20.

Hamilton, Clive. 2013. *Earthmasters. The Dawn of the Age of Climate Engineering*. New Haven: Yale University Press.

Haraway, Donna J. 2016. *Staying with the trouble: Making kin in the Chthulucene*. Duke University Press.

Hetherington, Kregg. 2019. Introduction. Keywords of the Anthropocene. Infrastructure, environment and life in the Anthropocene. In *Infrastructure, Environment, and Life in the Anthropocene*, ed. Kregg Hetherington, 1-13. Durham: Duke University Press.

Howe, Cymene, Jessica Lockrem, Hannah Appel, Edward Hackett, Dominic Boyer, Randal Hall, Matthew Schneider-Meyerson, et al. 2016. Paradoxical infrastructures: Ruins, retrofit, and risk. *Science, Technology, & Human Values* 41 (3): 547-565.

Intergovernmental Panel on Climate Change (IPCC). 2022. Summary for Policymakers, ed. Hans-O. Pörtner, Debra C. Roberts, Helen Adams. In *Climate Change 2022: Impacts, Adaptation, and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, ed. Hans-O. Pörtner, Debra C. Roberts, and Helen Adams. Cambridge: Cambridge University Press.

Jasanoff, Sheila. 2015. Future imperfect: Science, technology, and the imaginations of modernity. In *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power,* ed. Sheila Jasanoff and Sang-Hyun Kim, 1-33. Chicago: University of Chicago Press.

Jasanoff, Sheila, and Sang-Hyun Kim. 2009. Containing the atom: Sociotechnical imaginaries and nuclear power in the United States and South Korea. *Minerva* 47 (2): 119-146.

Keith, David W. 2000. Geoengineering the climate: History and prospect. *Annual review of energy and the environment* 25 (1): 245-284.

Klein, Naomi. 2015. *This changes everything: Capitalism vs. the climate*. New York: Simon and Schuster.
Knoll, Lisa. 2019. Sustainable Markets and the State: Taxation, Cap-and-Trade, Pay-for-Success, and Nudging. *Historical Social Research* 44 (1): 231-257. doi: 10.12759/hsr.44.2019.1.231-257.
Lange, Steffen, and Tilman Santarius. 2018. *Smarte grüne Welt? Digitalisierung zwischen Überwachung, Konsum und Nachhaltigkeit*. München: Oekom Verlag.
Latour, Bruno, and Couze Venn. 2002. Morality and technology. *Theory, culture & society* 19 (5-6): 247-260.
Lenz, Sarah, and Sighard Neckel. 2019. Ethical banks between moral self-commitment and economic expansion. *Research in the Sociology of Organizations* 63: 127-148.
Lessenich, Stephan. 2019. *Living well at others' expense: the hidden costs of Western prosperity*. Hoboken, New Jersey: John Wiley & Sons.
Lifset, Robert D. 2014. A new understanding of the American energy crisis of the 1970s. *Historical Social Research* 39 (4): 22-42. doi: 10.12759/hsr.39.2014.4.22-42.
Mazzucato, Mariana. 2021. *Mission Economy a Moonshot Guide to Changing Capitalism*. London: Lane Allen – Penguin.
McFarlane, Colin, and Jonathan Rutherford. 2008. Political Infrastructures: Governing and Experiencing the Fabric of the City. *International Journal of Urban and Regional Research* 32 (2): 363-374.
Mische, Ann. 2014. Measuring futures in action: projective grammars in the Rio+20 debates. *Theory and Society* 43 (3/4): 437-464.
Monticelli, Lara. 2021. On the necessity of prefigurative politics. *Thesis Eleven* 167 (1): 99-118.
Morita, Atsuro. 2017. Multispecies Infrastructure: Infrastructural Inversion and Involutionary Entanglements in the Chao Phraya Delta, Thailand. *Ethnos* 82 (4): 738-757.
Neckel, Sighard. 2022. Infrastruktursozialismus. Die Bedeutung der Fundamentalökonomie. In *Kapitalismus und Nachhaltigkeit*, ed. Sighard Neckel, Philipp Degens, and Sarah Lenz, 161-176. Frankfurt am Main: Campus.
Niewöhner, Jörg. 2014. Perspektiven der Infrastrukturforschung: careful, relational, kolaborativ. In *Schlüsselwerke der Science & Technology Studies*, ed. Diana Lengersdorf and Matthias Wieser, 341-352. Wiesbaden: Springer VS.
Niewöhner, Jörg. 2015. Infrastructures of Society, Anthropology of. In *International Encyclopedia of the Social & Behavioral Sciences*, ed. James D. Wright, 119-125. Oxford: Elsevier.
Niewöhner, Jörg. 2021. Making Evidence in the Future Perfect: Provincialising Climate Impact Science in the Quest for More-Than-Human Liveability. *Historical Social Research* 46 (2): 35-58. doi: 10.12759/hsr.46.2021.2.35-58.
Purdy, Jedediah. 2019. *This Land is Our Land. The Struggle for a new Commonwealth*. Princeton University Press.
Reinecke, Juliane. 2018. Social Movements and Prefigurative Organizing: Confronting Entrenched Inequalities in Occupy London. *Organization Studies* 39 (9): 1299-1321.
Rockström, Johan, Will Steffen, Kevin Noone, Åsa Persson, F. Stuart Chapin, Eric F. Lambin, Timothy M. Lenton, et al. 2009. A Safe Operating Space for Humanity. *Nature* 461 (7263): 472-475.

Schleper, Simone. 2022. Caribou Crossings: The Trans-Alaska Pipeline System, Conservation, and Stakeholdership in the Anthropocene. *The British Journal for the History of Science* 55 (2): 127-143.
Schiller-Merkens, Simone. 2020. Scaling up alternatives to capitalism: A social movement approach to alternative organizing (in) the economy. MPIfG Discussion Paper 20/11.
Shove, Elizabeth. 2016. Infrastructures and Practices: Networks Beyond the City. In *Beyond the Networked City: Infrastructure Reconfigurations and Urban Change in North and South,* ed. Olivier Coutard and Jonathan Rutherford, 242-258. London: Routledge.
Star, Susan L. 1999. The Ethnography of Infrastructure. *American Behavioral Scientist* 43: 377-391.
Star, Susan L., and Geoffrey C. Bowker. 2006. How to infrastructure. In *Handbook of new media: Social shaping and social consequences of ICTs*, ed. Leah A. Lievrouw and Sonia Livingstone, 230-245. London: SAGE.
Star, Susan L., and Karen Ruhleder. 1996. Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. *Information Systems Research* 7 (1): 111-134.
Sühlmann-Faul, Felix, and Stephan Rammler. 2018. *Der blinde Fleck der Digitalisierung*: *Wie sich Nachhaltigkeit und digitale Transformation in Einklang bringen lassen*. München: Oekom Verlag.
Symons, Jonathan. 2019. *Ecomodernism: Technology, Politics and the Climate Crisis*. Hoboken: John Wiley & Sons.
Thacker, Scott, Daniel Adshead, Marianne Fay, Stephane Hallegatte, Mark Harvey, Hendrik Meller, Nicholas O'Regan, Julie Rozenberg, Graham Watkins, and Jim W. Hall. 2019. Infrastructure for sustainable development. *Nature Sustainability* 2 (4): 324-331.
Van der Straeten, Jonas, and Ute Hasenöhrl. 2016. Connecting the Empire: New research perspectives on infrastructures and the environment in the (post) colonial world. *NTM Zeitschrift für Geschichte der Wissenschaften, Technik und Medizin* 24 (4): 355-391.
van Laak, Dirk. 2001. Infra-Strukturgeschichte. G*eschichte und Gesellschaft. Zeitschrift für Historische Sozialwissenschaft* 27 (3): 367-393.
van Laak, Dirk. 2018. *Alles im Fluss: die Lebensadern unserer Gesellschaft- Geschichte und Zukunft der Infrastruktur.* Frankfurt am Main: S. Fischer.
von Schnitzler, Antina. 2013. Traveling technologies: Infrastructure, ethical regimes, and the materiality of politics in South Africa. *Cultural Anthropology* 28: 670-693.
Weinberg, Alvin M. 1966. Can technology replace social engineering? *Bulletin of the Atomic Scientists* 22 (10): 4-8.
Weitzmann, Eyal. 2015. *The Roundabout Revolutions*. London: Sternberg Press.
Westermann, Andrea, and Christian Rohr. 2015. Climate and beyond: the production of knowledge about the earth as a signpost of social change; an introduction. *Historical Social Research* 40 (2): 7-21. doi: 10.12759/hsr.40.2015.2.7-21.
Wiertz, Thilo. 2015. Technische Ansätze zur Steuerung des Weltklimas. In *Wörterbuch Klimadebatte*, ed. Sybille Bauriedl, 87-94. Bielefeld: transcript.
Wright, Erik O. 2010. *Envisioning real utopias*. London, New York: Verso.

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