Digitisation and Low-Carbon Energy Transitions

Katja Müller and Siddharth Sareen

Introduction[1]

As the world faces the urgent challenge of transitioning to low-carbon energy futures, digitisation gains salience: decarbonising energy systems requires the digital process control of energy production, transmission

[1] Note on authorship: The authors are equal contributors to this introductory chapter.

K. Müller
Martin Luther University Halle-Wittenberg, Halle, Germany

University of Technology Sydney, Broadway, NSW, Australia

S. Sareen (✉)
Department of Media and Social Sciences, University of Stavanger, Stavanger, Norway
e-mail: siddharth.sareen@uis.no

Centre for Climate and Energy Transformation & Department of Geography, University of Bergen, Bergen, Norway

S. Sareen and K. Müller (eds.), *Digitisation and Low-Carbon Energy Transitions*,
https://doi.org/10.1007/978-3-031-16708-9_1

and end-use. Decarbonising electricity and electrifying diverse sectors requires real-time digital coordination of increasingly distributed energy production, with growing numbers and variations of power plants and enhanced spatiotemporal complexity. To manage energy demand, raise energy efficiency and enable rapid renewable energy rollout, digital devices can help recursively modulate the rhythms of energy and society. This synchronised shift in energy practices and infrastructures—for whose enablement digitisation is crucial—is essential for the rapid decarbonisation of complex, intertwined systems.

Simultaneously, low-carbon energy transitions premised on electrification and digitisation carry the risk of significant increases in energy demand, systemic and individual vulnerabilities, and further concentration of centralised control, with the benefits of increased energy efficiency accruing to a narrow set of privileged actors who set the pace and scale of low-carbon transitions to maximise their self-interest rather than public gain. This raises questions of political economy about the twin transition of digitisation and low-carbon transitions. Who digitises energy infrastructure, and what drives decision-making? How does governance impact the justice effects of infrastructural change? How does digitisation condition the lived experience of human interactions with evolving energy systems? In sum, what is lost and gained as we transition from fossil fuel-dominated infrastructures to hybrid-digitised energy futures, from coal mining to data mining?

Energy Efficiency and Greenhouse Gas Emission Reduction

In times of climate crisis, digitisation and energy form a coalition not only for economic savings, but for *energy efficiency*, indirectly aimed at reducing greenhouse gas (GHG) emissions. Approaching the twin transition from the energy side, this implies that the climate crisis drives a shift to renewable sources in energy production, and this transition in turn requires a digitisation of the whole energy system. Digitisation is important to ensure grid stability as the variability, scale and distribution of energy sources increase, and the distinction between consumer

and producer becomes less binary and begins to fade. Renewable energy production is concomitant with the decentralisation and fragmentation of power production units, and requires digital coordination of grids that operate across regional and (trans)national scales. In other words, digitisation enables rapid acceleration and widespread adoption of more granular technology (i.e. small-scale, modular, replicable and scalable units) in a low-carbon energy production system (Wilson et al. 2020), and sectoral digitisation can lower transmission losses. Renewable energy systems hence become established as ones where digitisation, decarbonisation and decentralised sources are closely interwoven (Di Silvestre et al. 2018).

The climate aspect has been intensely studied in the field of sustainability transitions, where low-carbon transitions have been conceptualised in depth and at breadth, and scientists envision the current scholarly task as 'discerning the nature of the future "stage" into which we are hurtling and understanding clearly how people are experiencing and understanding this unprecedented energy transition' to low-carbon and lower net energy use systems (Love and Isenhour 2016, p. 15). Yet, conceptions of energy transitions that explicitly include digitisation are still emergent, as are in-depth analyses of the same that take the situatedness of systems and the processual dynamics of changes into view. While Blondeel et al. (2021, p. 11) point out that digitisation, especially through smart grids, is 'radically transforming the interconnectivity, reliability and efficiency of the energy system', an understanding of twin transition dynamics remains in its infancy.

This is surprising given that digitisation in general is hardly new to power plants, these being at the production side of energy systems, where supply-side interactions with wholesale energy markets have long been digitised. Conventional power plant and grid operators may not necessarily be convinced about digitising additional upstream and downstream units, but feel increased pressure to bite the bullet when decentralising energy production aligns with attempts at energy autarky (see St-Pierre in this book). The considerations, implementation and consequences linked to digitising the *electricity sector* (also see IEA 2017, 77f) are

ominously relevant for national governments, as they varyingly emphasise or overlook emergent threats to critical energy infrastructure with changing system and data architectures.

Energy consumption and end-use, too, emphasise digitisation as a means for energy efficiency and GHG emission reduction, most often through the use of smart meters and dynamic electricity tariffs for demand response (Geelen et al. 2019; Hmielowski et al. 2019). However, climate mitigation through energy savings and efficiency can become a sidelined ideal during digital advances (see Ortar and Flipo in this book). Furthermore, efficiency is not only relevant for the electricity sector. It also induces changes in the *building and transport sectors*, where energy efficiency renovation and low-carbon modes of transport either compete to prevail, or struggle to synergise, within locked-in political economies (see Aggeli and Mechlenborg, and Datava et al. in this book).

Data Generation and Rebound Effects

Considering socio-political aspects of technological interlinkages in digitising low-carbon energy systems can also advance an understanding of wider (energy) justice outcomes and human capabilities (Hillerbrand et al. 2021). The twin transition impacts labour, both in terms of evolving work practices and with respect to the global movement of bodies for economic production, as digitisation and robotisation transform the global economy (Stakanov and Ukhova 2020). Furthermore, the digital in the twin transition is not a mere consequence of ideals of decarbonising electricity, but co-constitutes the transition's ontological basis. Analyses of *digital data generation and circulation* provide insights into the need for rapid and deep reductions in GHG emissions as well as countervailing trends (see Lautrup in this book). Data generation and online data circulation likewise precede and enable energy efficiency improvements in the building sector (see, for example, Aggeli and Mechlenborg in this book), and have become prerequisites for various sectors and energy systems in general. Power generation and energy use that enhance efficiency and accelerate low-carbon transitions through digital means are premised on digital data generation and information flow.

However, digital data generation and retrieval come at a cost—an energy cost. The production and circulation of digital data consumes electricity, and as data volumes and server storage and processing capacities burgeon, so do energy demands. By 2019, digital technologies were already responsible for 3.7% of all global GHG emissions (Shift Project 2019: p. 4), twice what civil aviation accounts for, mainly driven by increased video use and short lifespans of digital equipment. However, energy efficiency in data processing has undergone a parallel increase by an order of magnitude; hence, while data processing rose by 500% during 2010–2018, electricity consumption for processing only increased 6% (Masanet et al. 2020). Albeit laudable, this decoupling of the rise of the digital and its energy requirements nonetheless fails to circumvent increasing energy demand, and is undergirded by a logic of growth. As a potentially worrying trend, the expansive development and installation of digital devices in and beyond the energy sector looks set to continue, rather than the *decrease* in overall energy consumption that is required to address the climate crisis. Rather than ignoring these developments in the hope that future energy efficiency enhancement will outpace growing energy demand, some stakeholders—like the visual artists and anthropologists taking to 'glitchy', low-resolution videos (DeAngelo in this book)—are reconfiguring their practices and lenses accordingly, while others—like the German company developing solar energy apps for the Kenyan market (Riedke in this book)—remain largely undiscerning in this respect.

Rebound effects of energy efficiency or GHG emission savings through digitisation are theoretically possible in numerous cases. They are evident when the energy to produce devices such as e-scooters (which can have notably short lifespans) are taken into account (see Datava et al. in this book); when online communication and information searches outpace energy savings in refurbishment (Aggeli and Mechlenborg in this book); or when the energy used to drive to shared working spaces exceeds the savings in energy that arise from the co-occupancy of spatial resources (Ortar and Flipo in this book). Rebound effects—and the impact of digitisation on energy saving—vary severely across technologies and applications as they are specific to technologies and practices; e.g. drone delivery is subject to relatively low potential to lower energy demand,

whereas smart thermostats have high potential to enable virtuous declines in energy demand (IEA 2017, p. 30). Yet again, even if energy use associated with producing and operating a given device is low, rebound effects can lead to increased overall consumption due to lower costs—e.g. setting the temperature for digitally controlled heating higher and thereby diminishing or reversing the energy savings that result from sensorily captured, presence-dependent heating (see Horner et al. 2016 for details). Likewise, automated transport can improve energy efficiency, but reduced costs can also spur a greater tendency for personal car use.

This book centres and problematises these emergent problems of inter-linking digitisation and transitions to low-carbon energy systems. Through an interdisciplinary set of chapters, it transgresses boundaries between energy anthropology (Abram et al. 2019; Smith and High 2017), energy geographies (Huber 2015; Calvert 2016) and longer-running fields such as science and technology studies, political ecology and (digital) media studies. All featured contributions are based on ethnographies of digitisation and low-carbon energy transitions, and thus analyse ideals and processes of the twin transition without constraining focus to energy systems in a technical sense, instead taking on the full import of what 'socio-technical' implies. Rather than remaining on the theoretical level of what digitisation and low-carbon energy transition may encompass, they take to the situatedness of transition processes and their realisation in particular cases, and analyse this based on profound insights. Such a point of departure offers not only case studies of the twin transitions, replete with their challenges and glitches, but enables an inductive approach that allows for theoretical development derived from empirical insights. The authors of these chapters pay attention to the specificities of digitisation, broadly construed and ethnographically explored. In myriad ways, they deal with questions of power, hierarchy and decision-making. Notably, privacy and security emerge as cross-cutting themes that loom large at the intersection of power production and transmission with digital control and regulation, and interpellate the aforementioned core concerns of energy efficiency, GHG emissions, data generation and its rebound effects.

The contributions feature particular attention to the situatedness of transition processes. While digitisation and the climate crisis are by now

global conditions that affect planetary health, their manifestations are strongly dependent on place-based infrastructures and socio-cultural as well as political economic frameworks. By drawing on case studies from Europe and Japan, as well as from Kenya and Australia, the contributions cover a larger spectrum of transitions worldwide, while maintaining a primary focus on the Global North, where these twin transitions have arguably made the most major advances globally thus far.

The contributions were prepared—and then revised both in advance of and subsequent to—the Energy Anthropology Network's biannual workshop, hosted by the University of Stavanger in August 2021. This convened academics conducting research on energy transitions and digitisation from anthropology as well as from a host of disciplinary and interdisciplinary perspectives. The transgression of disciplinary boundaries is symptomatic of both energy studies and digitisation studies, and is richly in evidence here. This book resolutely assembles contributions that take anthropological case studies as their foundation, but allows for diverse methodological approaches (from field research to digital anthropology and from interviews to desk-based analyses),[2] varying writing conventions (e.g. thick description or the use of illustrative examples), and diverse canons that researchers draw upon (i.e. vantage points or theoretical approaches that may be well-established in one discipline, yet novel in another).

The book's chapters are enhanced and completed by a research-based and co-produced art exhibition. The Rjukan Solarpunk Academy, comprising artists Martin Andersen and Margrethe Brekke, exhibited their visions and interpretations of just low-carbon energy transitions at the Norwegian Petroleum Museum during autumn 2021. 'Uro' is a veritable lucid dream or lucid interval-like installation of a broken-down fossil fuel powered car's parts suspended on an oil rig, complemented by the manifesto and technical details of a utopian National Association for Bus Users (rather than the prominent Norwegian Automobile

[2] Pink et al. (2015) address the ontological and phenomenological concern for digital ethnography, reflecting that 'we are often in mediated contact with participants rather than in direct presence'. Introducing an edited collection, Douglas-Jones et al. (2021, p. 9) tackle this head-on by calling for 'an anthropology of data that is ethnographically specific and theoretically ambitious' in its 'engagements with the data moment'.

Federation), artistically rendered and detailed on post-industrial tapestry. Images of the exhibition—stylistically, symbolically and daringly juxtaposed at a museum with a focus on petroleum related national history and culture—are featured after each chapter of this book, replete with a short overview of its research-related development (Chapter "Just Low-Carbon Mobility Transitions: A Research-Based Art Exhibition") following this introduction.

The diversity of disciplines represented in the chapters advances research on the twin transition by contributing to transition studies, energy studies and energy anthropology, and to a lesser extent to media studies and digital anthropology. Importantly, it constitutes a collective response that emerges across the interplay of case studies and conceptual approaches. Reading carefully through the case studies reveals how the study of digitisation and energy transition is enriched by engaging with the actual places in which change happens; by treating change as an intertwined set of infrastructural transformations (including seemingly banal ones); and by mobilising interdisciplinary concepts and methods. The common grounds embodied by these book chapters lead us to mainframe two concepts for ethnographic study of the twin transition: *situating digitisation* and *realising imaginaries*.

Situating digitisation

Digitisation holds transformative potential that can be for the better or worse, depending on how it is shaped through engagement with particular contexts, and how it is translated through regulatory regimes that are themselves evolving to anticipate and grapple with rapid infrastructural change. In an edited collection, Prainsack (2020, p. 444) highlights the need for:

> 'visions and instruments to build new institutions: institutions in and through which human expertise, experience, and interaction are seen as equally important as high-tech precision; where new norms and policy instruments ensure that the benefits of data use accrue for society at large, and in particular for the marginalised and vulnerable; and where

> the datafication of the bodies, lives, and practices of people who have no realistic chance to opt out is recognised and condemned for what it is: robotic brutality', which Chisnall (2020, p. 488) posits as 'a new form of digital enslavement that has the potential to curtail liberty and cause harm'.

Bareis and Katzenbach (2021b, a) argue that national strategies anchored in diverse socio-cultural contexts and political economies performatively lock in a prominent aspect of digitisation, artificial intelligence (AI), as 'inevitable and massively disrupting', and then channel investment to particular technological futures and thus co-produce them. Smith and Fressoli (2021) confront 'future essentialism' by advocates of automation, and argue for a focus on how automating technologies are being hacked, subverted and appropriated to foster conviviality, as a means to inspire a politics of what they call 'post-automation', which is premised on democratic deliberation and the cultivation of social capabilities. Drawing on ethnographic work with firefighters in Denmark, Karsten (2021, p. 92) emphasises the need to guard against the misunderstandings and incorrect applications that tend to accompany digitisation, and correspondingly proposes moving from resistance and apprehension to concern and dialogue (i.e. conviviality) to 'foster more empathetic, productive and understanding collaborations within and across organisations'.

Studying digitisation in Berlin, Quitzow and Rohde (2021) show how techno-optimism on digital solutions at the urban scale presents them as environmental solutions, economically essential, and linked with exciting experimentation and progress, thereby undermining other subtler as well as more radical alternatives. This determinative aspect of digitisation is evident in the rapid current transformation of countless aspects of social organisation, including academic publishing (Fortun and Fortun 2015). Indeed, Karasti et al. (2016) point out that the emergence of new data infrastructures is changing the nature of knowledge production, meaning that digitisation is not only a subject of study, but also an actant on how that study takes place. Knox (2021a, 2021b, p. 178) captures this ubiquitous aspect of digitisation by 'traversing the infrastructures of digital life', elucidating how it encompasses 'the wires and cables that support

mobile and computer communication but also the integration of sensors, databases of measurements, and real-time data analytics into buildings, motorways, ticketing services, fast food delivery, taxi services and more'.

The first three contributions of this book illustrate how energy-related digitisation in its structure and diffusion is heavily dependent on the infrastructures of digital life, comprising both the digitisation segment—transport, energy production or communication—as well as the socio-cultural context and dislocations through which it unfolds. In Chapter "A Solar Off-Grid Software: The Making of Infrastructures, Markets and Consumers 'Beyond Energy'", Riedke offers an analysis of a new software to manage the sales of solar off-grid products. This software is being developed by a German start-up for the Kenyan market. Analysing the different layers of the software, Riedke renders tangible how humanitarian and environmental concerns intertwine with for-profit interests and the overarching aim to establish markets and new consumer subjects among 'off-grid' populations. These ambitions interpellate low-carbon electricity provision in the form of transnational social entrepreneurship, whereby digitised energy users are constructed as new market actors. The attendant advantages and disadvantages of their reconstituted subjecthood range from energy access on the one hand to becoming a market participant subject to neoliberal development agendas on the other hand, rendering people vulnerable to increased monitoring, data generation and control through the ensuing energy consumption and payment practices.

Alongside explicating datafication, marketisation and automation processes, attention to digitisation in specific contexts also foregrounds questions of realigning access and information policies, influencing knowledge economies, and adjusting participation and conventional power dynamics. Control is shifting from conventional process regulation (e.g. by engineers or newspaper offices) to those who programme digital system control with remote access through reading and writing rights (see e.g. Ernst 2009; Müller 2017). As digitisation in a narrow sense refers to transforming analogue data formats into digital formats based on binary codes, software and applications—attuned to pre-existing programmes, needs and desires from a yet-to-be-digitised sector or segment—the software configuration determines future application

options and possibilities to intervene, alter or rewrite programmes. Dominant ways of thinking including hegemonic market logics permeate digitally constituted systems that order and control critical processes, even as forms of counterculture such as open source software development or—with regard to user access—creative commons and open access policies rally against this development (Garcelon 2009; Risam 2019).

In this book, St-Pierre shows how such power mechanisms also figure in the grid protocols and in the realisation of virtual power plants. In Chapter "Contested Energy Futures in Hokkaido: Speculating with European Renewable Energy Models", St-Pierre shows that Japan's low-carbon energy future cannot yet draw on the digitisation required to regulate and control decentralised and diversified energy production, despite enhanced scrutiny of established energy systems and demand for more localised emergency-grid solutions rather than mainland dependency. Even though grid protocols prioritise less centralised renewable energy distribution and the Japanese experience with earthquakes and disasters—which St-Pierre exemplifies with the prefecture of Hokkaido—undergirds the twin transition, the idea of an ever-expanding, digitally regulated grid remains mediated between stakeholders at various governmental and administrative levels as they plan a society where the virtual and the physical increasingly intermesh, as evident in the disaster-proofing of energy production and distribution systems.

Unpacking digitisation in the wider sense of digital technology permeating every aspect of everyday life, a phenomenon commonly signified as *digitalisation*, entails recognising that the internet has profoundly altered information and knowledge systems. Neither the proclaimed internet optimism (Negroponte 1996) that anticipated the break-up of established hierarchies and the democratisation of societies through the internet, nor the internet pessimism that saw it as leading to a surrender of culture to technology (Postman 2011) hold sway; yet, internet communication and social media have reshaped the world (and the world has recursively shaped social media, see Miller et al. 2016) and continue to do so, with prominent, concerning impacts such as election outcomes (Schroeder 2018).

Lautrup's work in Chapter "Overcoming Abstraction: Affectual States in the Efforts to Decarbonize Energy Among Young Climate Activists in Stavanger, Norway", undergirds this by relating internet-based information and digitally based visualisation to energy systems and climate protests. Lautrup demonstrates both how the realisation of a post-fossil resource ideal can be highly problematic and conflictual in a society whose wealth has in large part relied on oil and gas production, and also how the visualisation of the intangible consequences of post-fossil futures depends on digital or digitally based technologies. Numbers, graphs and charts are required to make the climatic consequences of fossil fuel energy systems known and intelligible, making digitisation a prerequisite for future scenarios of altering extractive conventions. As a mode of communication, deliberation and proliferation of competing narratives, digitisation is ontologically baked into energy sector representations, as much as it is also integral to fossil fuel infrastructure such as oil rigs.

The section *Situating digitisation* thus foregrounds a framing of digitisation as context-dependent, with particular attention to its relation to energy production, distribution and consumption. This allows us to draw attention to the socio-cultural contexts of digitising energy systems, and to the intertwined nature of everyday digital practices, energy system configurations and low-carbon energy transition dynamics. Energy-related digitisation in its structure and diffusion is heavily dependent on both the digitisation segment—in transport, energy production or communication—as well as on social norms, hierarchies and expectations.

Realising Imaginaries

It is not only the particular contexts and the situatedness of low-carbon energy transitions and digitisation processes that necessitate (and complicate) adjustments to the pace and mode of twin transitions, but also a variety of other challenges and hindrances related to practical implementation. A focus on realising imaginaries simultaneously envisions and problematises potential futures, foregrounding the conditions and dynamics of their prospective emergence.

As digitisation is ubiquitous, it is simultaneously established and emergent, well entrenched and fluid, established within everyday infrastructures (such as electric grids) and being rolled out in so far socially unfamiliar forms (as with the household electric smart meters required to enable smart grids). Imaginaries are instrumental to and powerful in advancing particular forms of digitisation and determining the terms on which these are institutionalised in wider settings, from ownership to functionality and from the pace of diffusion to the extent of technological proliferation. Jasanoff and Kim (2015) famously discuss how socio-technical imaginaries have been constructed to advance the project of modernity, a project that deeply colours digitisation. Jasanoff (2021) argues for humility rather than the hubris that strives for human control of the earth; the latter tendency contributes to the creation of what Gabrys (2016) calls 'program earth', a world constituted by ubiquitous, hyper-connected digitised technologies.

The realisation of imaginaries, however, usually rests somewhere in between humility and hubris, with good intentions of saving planet earth through digitising energy (related) systems routinely accompanied by severe side effects. DeAngelo in Chapter "A New Reflexive Turn: Glitches, Carbon Footprints, and Streaming Videos in Visual Anthropology", shows the discrepancy between increasing possibilities in digital work and ideals of reducing energy consumptions, but also how people tackle and solve this—at least partially. DeAngelo shows how video artwork—regardless of whether the artists substantively problematise environmental and energy issues in their art—constitutes a mode of dealing with the increasing energy requirements of digital art production and consumption. Some artists and visual anthropologists confront their carbon footprint by limiting resolution and establishing a different style, which simultaneously carries the advantage of partly bridging the digital divide to widen their reach. The resultant 'glitchy' videos in this interpretation reduce energy needs related to their own existence as art that is streamed and consumed, while also benefitting those with limited access to energy and online content. The novel focus on glitchiness underscores the gap between dominant imaginaries of digitisation as a sleek new innovation and its troubled, patchy reality across geographies of socio-material difference.

Ortar and Flipo in Chapter "The Hidden Energies of Work Digitization: A View from France Through the Use of Coworking Spaces", demonstrate how newly established coworking spaces turn imagined futures of digital enablement into reality, with worrying implications for energy consumption even as coworkers imagine these third spaces to be 'sustainable' and inter alia premised on ecological concerns. Ortar and Flipo's examination of practices identifies the silences that surround certain uses of energy either in or associated with these spaces that pervert the promise of decarbonisation commonly linked with shifts to coworking. They challenge the obfuscation that accompanies pro-digital thinking and advances idealised pro-environmental representations of digital technologies. The silences, they argue, suggest the need for a deeper structural transformation of how everyday life is organised to align with logics of digitisation and decarbonisation in such coworking spaces.

The authors in *Realising imaginaries* tie in with other analyses of digital technologies and their energy impact, such as work by Maguire and Winthereik (2021) on the proliferation of data centres. Maguire and Winthereik (2021, p. 530) interpret and conceptualise these emergent digital spaces as frontiers to be negotiated and regulated, arguing that 'as Big-Tech territorialises state land and resources, the state in turn reterritorialises the promising digital futures that come with Big-Tech'. They thus point to tussles over authority and how these are currently playing out over and through artefacts of digitisation. At the urban scale, Iveson and Maalsen (2019) caution that the algorithmic modulation of populations and the disciplining of individualised subjects can magnify forms of social control by authoritative actors in digitally networked cities. Thus, digitisation is inextricably linked with the workings of power on and through the newly introduced and set up infrastructures that penetrate not only energy systems but every aspect of societal activity.

Social control and questions of governing digitally networked cities also loom large in discussions about low-carbon digitised mobility. Electric scooter proponents in Norway, as Datava et al. illustrate in Chapter "Littering the City or Freedom of Mobility? The Case of Electric Scooters", mobilise framings of a low-carbon transport footprint and align this with a particular vision of sustainable urban mobility. The

digitisation of end-users' everyday life becomes essential for booking, tracking and paying for shared devices, and risks becoming a taken-for-granted characteristic of the e-scooter business in urban Norway. This is so much so that digitisation is treated as secondary to prominently contested issues such as the shared usage of streets by multiple stakeholders entitled to public space. Again, digitisation and decarbonisation, when put into effect, display not only a 'natural' diffusion of (end-user) digitisation and allegedly eco-friendly mobility, but face contestation, with competing imaginaries of urban space and flows.

Similarly, end-user digitisation has turned into an infrastructural basis for the very means of decision-making through which people in Australia approach energy-efficient home renovation. In Chapter "Mediatised Practices: Renovating Homes with Media and ICTs in Australia", Aggeli and Mechlenborg analyse how online interactions and digital communication through information and communication technologies (ICTs) have turned into core resources for imagining, choosing, documenting and communicating about low-carbon home renovation. Social media penetrate home renovation to inflect and embed low-carbon renovation practices into households with remarkable success.

These scholarly insights underscore the contingent nature of evolving imaginaries of digitisation even as they have begun to consolidate. The impacts and consequences of installing digital systems are to a great extent determined by the intent and interests of those who transform imaginaries into reality. Through interactions and powerplay within a reconfiguring assemblage of actors and interests, these actors can arguably provide for what Pansera et al. (2019, p. 1) call 'unwise futures' that are marked by the pro-elite allocation of benefits and control through digital technologies, or for 'wise futures' where ordinary people are able to 'freely access digital technologies that are convivial, just, environmentally sustainable, and guided by democratic deliberation'.

Conclusion

In sum, the chapters in this book take on issues of decision-making and power within diverse situated manifestations of the twin transition. This cross-cutting theme has been central in digital media studies (Geismar and Knox 2021; Risam 2019) and in energy studies (Strauss et al. 2013; Boyer and Howe 2019). Digitisation and its most familiar manifestation—the internet—were accompanied by imaginaries of democratising information provision and access, yet the 'information superhighway' is today de facto shaped by a few dominant information technology companies and software developers, who apply ontologies, values and legal frameworks that originate in the Global North, with little scope to deviate from market-dominating applications and programmes (see Risam 2019; but also Anderson and Christen 2013 for an alternative). Authoritative institutions, especially in times of crisis, exercise control over digital infrastructure and connectivity. Likewise, power structures and inequalities related to energy systems routinely manifest as oligopolistic utilities and in neocolonial resource extractivism and trade systems. These perpetuate the fossil fuel-industrial nexus and produce new patterns such as the geopolitical rare-earth extractive race that enables the current rollout of energy storage (e.g. through lithium-ion batteries). Neocolonial and exploitative tendencies can become emergent, reproduced and entrenched when digitisation is combined with energy provision (Riedke in this book), traits that find resonance in geopolitics. Combining attention to digitisation and energy systems, as this book does, generates insights into such dynamics, with power imbalances and dependence on market-driven energy provision and internet companies exacerbating the marginalisation of population sub-groups and indeed entire nations.

Thus, this book demonstrates how the issues of energy efficiency and data generation we have unpacked above abound, unfold and are contested while also being inextricably intertwined with the development of future energy systems and wider societal infrastructure and practices. The grounded approaches on offer here suggest a variety of ways in which research can engage with digitisation and low-carbon transitions even as they unfold, and necessarily so in order to exercise our

agency on societal development. By highlighting two conceptual arenas related to digitisation and energy transitions, this book articulates an agenda for future ethnographic engagement with and ethnographically informed conceptualisation of digitisation and low-carbon transitions as intertwined elements of profound global environmental change.

First, the study of digitisation and low-carbon transitions must be situated within the contexts where digitisation plays out. Given its ubiquitous nature (Sareen and Haarstad 2021), this includes a non-digitisation-centric approach (Pink et al. 2015) as well as explicit acknowledgement of the interpellated nature of digitisation as a phenomenon and scholarship on this phenomenon (Douglas-Jones et al. 2021). Thus, the challenge for scholars is both to understand digitisation within the larger dynamics of its intensification at scales that range from the local to the global, as well as to engage reflexively with it through methods that are themselves conditioned by the digitisation of data, practices of subjects, and the digitised nature of academic practice.

Second, digitisation and low-carbon transitions must be understood as necessarily in the making, contingent and contested, which imbues portrayals with an inherently speculative quality. This does not mean that theories can be dismissed as competing fictions, but rather that analyses of digitisation in the energy sector in general and during low-carbon transitions in particular require explicit attention to power dynamics and the political economic undergirding of socio-technical change. Identifying and foregrounding tacit interests, multiple potential pathways and normative conundrums are all essential elements of engaged ethnography, where grappling with digitisation entails analytical unpacking as well as shaping and realising imaginaries of digitisation in the very process of sense-making.

Thus, we offer a foray into situating digitisation and realising imaginaries, with the hope of advancing engaged ethnographic scholarship on digitisation and low-carbon transitions. Digitisation is inextricably linked with the urgent societal project of low-carbon transitions in a manner that can be generatively approached and conceptualised as an emergent twin transition to a digitised and low-carbon future, a form of hyper-connected climate mitigation. Given the widespread societal

Exhibition Fig. 1 Martin Andersen works on 'Uro' at the Rjukan Solarpunk Academy (*Source* David Odell [used with permission])

implications of this shift, such change has resonance in diverse established scholarly fields, such as socio-technical transitions, media studies, geopolitics, resource governance and not least energy anthropology and energy geographies. The task of generating, cross-fertilising and consolidating conceptual frameworks is essential to ensure critically constructive interdisciplinary discussion and debate. The pressing real-world challenge of digitising energy systems constitutes an exciting opportunity for timely, generative research. Exhibition Fig. 1 follows this chapter.

References

Abram, Simone, Brit Ross Winthereik, and Thomas Yarrow, eds. *Electrifying Anthropology: Exploring Electrical Practices and Infrastructures*. Bloomsbury Academic, 2019.

Anderson, Jane, and Kimberly Christen. "'Chuck a Copyright on It': Dilemmas of Digital Return and the Possibilities for Traditional Knowledge Licenses and Labels." *Museum Anthropology Review* 7.1–2 (2013): 105–126.

Bareis, Jascha, and Christian Katzenbach. "Talking AI into Being: The Narratives and Imaginaries of National AI Strategies and Their Performative Politics." *Science, Technology, & Human Values* (2021a): 01622439211030007.

Blondeel, Mathieu, Michael J. Bradshaw, Gavin Bridge, and Caroline Kuzemko. "The Geopolitics of Energy System Transformation: A Review." *Geography Compass* 15.7 (2021): e12580.

Boyer, Dominic and Cymene Howe. *Wind and Power in the Anthropocene*. Durham, NC: Duke University Press, 2019.

Calvert, Kirby. "From 'Energy Geography'to 'Energy Geographies' Perspectives on a Fertile Academic Borderland." *Progress in Human Geography* 40.1 (2016): 105–125.

Chisnall, Mick. "Digital Slavery, Time for Abolition?." *Policy Studies* 41.5 (2020): 488–506.

Di Silvestre, Maria Luisa, Salvatore Favuzza, Eleonora Riva Sanseverino, and Gaetano Zizzo. "How Decarbonization, Digitalization and Decentralization Are Changing Key Power Infrastructures." *Renewable and Sustainable Energy Reviews* 93 (2018): 483–498.

Douglas-Jones, Rachel, Antonia Walford, and Nick Seaver. "Introduction: Towards an Anthropology of Data." *Journal of the Royal Anthropological Institute* 27.S1 (2021): 9–25.

Ernst, Wolfgang. "Das Archiv als Gedächtnisort." In *Archivologie. Theorien des Archivs in Philosophie, Medien und Künsten*, edited by Markus K. Ebeling and Stephan Günzel. Berlin: Kulturverlag Kadmos Berlin, 2009: 177–200.

Fortun, Kim, and Mike Fortun. "An Infrastructural Moment in the Human Sciences." *Cultural Anthropology* 30.3 (2015): 359–367.

Gabrys, Jennifer. *Program Earth: Environmental Sensing Technology and the Making of a Computational Planet*. Vol. 49. Minneapolis, MN: University of Minnesota Press, 2016.

Garcelon, Marc. "An Information Commons? Creative Commons and Public Access to Cultural Creations." *New Media & Society* 11.8 (2009): 1307–1326.

Geelen, Daphne, Ruth Mugge, Sacha Silvester, and Annemieke Bulters. "The Use of Apps to Promote Energy Saving: A Study of Smart Meter–Related Feedback in the Netherlands." *Energy Efficiency* 12.6 (2019): 1635–1660.

Geismar, Haidy and Hannah Knox, eds. *Digital Anthropology*. Routledge, 2021.

Hillerbrand, Rafaela, Christine Milchram, and Jens Schippl. "Using the Capability Approach as a Normative Perspective on Energy Justice: Insights from Two Case Studies on Digitalisation in the Energy Sector." *Journal of Human Development and Capabilities* 22.2 (2021): 336–359.

Hmielowski, Jay D., Amanda D. Boyd, Genevieve Harvey, and Jinho Joo. "The Social Dimensions of Smart Meters in the United States: Demographics, Privacy, and Technology Readiness." *Energy Research & Social Science* 55 (2019): 189–197.

Horner, Nathaniel C., Arman Shehabi, and Inês L. Azevedo. "Known Unknowns: Indirect Energy Effects of Information and Communication Technology." *Environmental Research Letters* 11.10 (2016): 103001.

Huber, Matthew. "Theorizing Energy Geographies." *Geography Compass* 9.6 (2015): 327–338.

IEA (International Energy Agency). Digitalization and Energy. 2017. https://iea.blob.core.windows.net/assets/b1e6600c-4e40-4d9c-809d-1d1724c763d5/DigitalizationandEnergy3.pdf, accessed on 16 August 2021.

Iveson, Kurt, and Sophia Maalsen. "Social Control in the Networked City: Datafied Dividuals, Disciplined Individuals and Powers of Assembly." *Environment and Planning D: Society and Space* 37.2 (2019): 331–349.

Jasanoff, Sheila, and Sang-Hyun Kim. "Dreamscapes of Modernity." *Sociotechnical Imaginaries and the Fabrication of Power.* Chicago: Chicago University Press, 2015.

Jasanoff, Sheila. "Humility in the Anthropocene." *Globalizations* (2021): 1–15. https://doi.org/10.1080/14747731.2020.1859743.

Karasti, Helena, Florence Millerand, Christine M. Hine, and Geoffrey C. Bowker. "Knowledge infrastructures: Part I." *Science & Technology Studies* 29.1 (2016): 2–12.

Karsten, Mette Marie Vad. "Dislocated Dialogue: An Anthropological Investigation of Digitisation Among Professionals in Fire Safety." *Organization* 28.1 (2021): 92–114.

Knox, Hannah. "Traversing the Infrastructures of Digital Life." In *Digital Anthropology*, edited by Haidy Geismar and Hannah Knox, London: Routledge (2021b): 178–196.

Love, Thomas, and Cindy Isenhour. "Energy and Economy: Recognizing High-Energy Modernity as a Historical Period." *Economic Anthropology* 3.1 (2016): 6–16.

Maguire, James, and Brit Ross Winthereik. "Digitalizing the State: Data Centres and the Power of Exchange." *Ethnos* 86.3 (2021): 530–551.

Masanet, Eric, Arman Shehabi, Nuoa Lei, Sarah Smith, and Jonathan Koomey. "Recalibrating Global Data Center Energy-Use Estimates." *Science* 367.6481 (2020): 984–986.

Miller, Daniel, et al. *How the World Changed Social Media*. London: UCL Press, 2016.

Müller, Katja. "Writing into the Archive: Digitizing Ethnographic Collections." In *Apalai – Tiriyo – Wayana: objects _ collections _ databases*, edited by Beatrix Hoffmann and Karoline Noack. Aachen: Shaker (2017): 269–282.

Negroponte, Nicholas. *Being Digital*. London: Hodder and Stoughton, 1996.

Pansera, Mario, Melf-Hinrich Ehlers, and Christian Kerschner. "Unlocking Wise Digital Techno-Futures: Contributions from the Degrowth Community." *Futures* 114 (2019): 102474.

Pink, Sarah, Heather Horst, John Postill, Larissa Hjorth, Tania Lewis, Jo Tacchi. *Digital Ethnography: Principles and Practice*. Thousand Oaks, CA: Sage Publications, 2015.

Postman, Neil. *Technopoly: The Surrender of Culture to Technology*. New York: Vintage Books, 2011.

Prainsack, Barbara. "The Political Economy of Digital Data: Introduction to the Special Issue." *Policy Studies* 41.5 (2020): 439–446.

Risam, Roopika. *New Digital Worlds: Postcolonial Digital Humanities in Theory, Praxis, and Pedagogy*. Evaston: Northwestern University Press, 2019.

Quitzow, Leslie, and Friederike Rohde. "Imagining the Smart City Through Smart Grids? Urban Energy Futures Between Technological Experimentation and the Imagined Low-Carbon City." *Urban Studies* (2021): 00420980211005946.

Sareen, Siddharth, and Håvard Haarstad. "Digitalization as a Driver of Transformative Environmental Innovation." *Environmental Innovation and Societal Transitions*, 41 (2021): 93–95.

Schroeder, Ralph. *Social Theory After the Internet: Media, Technology and Globalization*. London: UCL Press, 2018.

Shift Project. *Lean ICT: Towards Digital Sobriety*, 2019. https://theshiftproject.org/wp-content/uploads/2019/03/Lean-ICT-Report_The-Shift-Project_2019.pdf, accessed on 16 August 2021.

Smith, Adrian and Mariano Fressoli. "Post-automation." *Futures* 132 (2021): 102778.

Smith, Jessica, and Mette M. High. "Exploring the Anthropology of Energy: Ethnography, Energy and Ethics." *Energy Research & Social Science* 30 (2017): 1–6.

Stakanov, Roman, and Anna Ukhova. "Digitization and Robotization of the World Economy as a Key Determinant of the International Labor Market Transformation." *Torun International Studies* 1.13 (2020): 93–104.

Strauss, Sarah, Stephanie Rupp, and Thomas Love. *Cultures of Energy: Power, Practices, Technologies*. London: Routledge, 2016.

Wilson, Charlie, Arnulf Grubler, Nuno Bento, Stephen Healey, Simon De Stercke, and Caroline Zimm. "Granular technologies to accelerate decarbonization." *Science* 368.6486 (2020): 36–39.