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Can IT Resolve the Climate Crisis? Sketching the Role of an Anthropology of Digital Technology

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Abstract: How can an anthropology of digital technology contribute to our understanding of climate mitigating initiatives? Governments and private sector industries argue that climate mitigation must focus on "decoupling" economic growth from carbon emissions if we are to reduce climate impact while still maintaining a healthy economy. Most proponents of decoupling envisage that digitalization will play a central role in this operation. Critics, however, argue that IT has a large and often unacknowledged climate impact, while IT solutions also frequently bring new and unforeseen problems, particular or systemic. The challenge of decoupling is thus broader than the management of the relationship between the economy and the climate. As much as decoupling is about how we imagine that the climate crisis can be solved with technologies, trusting that they can create the changes we need, it is also about the cultural value of lifestyles that we do not want to change. Seeing the climate crisis from this perspective opens the door for an anthropology of digital technology, which allows us to approach decoupling as a matter of how sociocultural change is imagined in the spaces between IT, climate change and society. The article thus contributes to the qualitative social scientific literature on perceptions of change by focusing on some of the ways that implicit ideas of change are embedded in the promotion of digital technologies as solutions to climate change. In addition, it presents to a wider scientific audience the perspectives that an anthropologically inspired analytic may provide on this topic.

Keywords: anthropology; digital technology; digitalization; carbon emissions; climate change; social change

Citation: Dalsgaard, S. Can IT Resolve the Climate Crisis? Sketching the Role of an Anthropology of Digital Technology. *Sustainability* **2022**, *14*, 6109. https://doi.org/10.3390/su14106109

Academic Editors: Roberto Cerchione and Zubair Baig

Received: 15 March 2022
Accepted: 10 May 2022
Published: 17 May 2022

1. Introduction

The answer to the question of the title—unfortunately—looks to be a no at present. Or at the very least, a moderation with a lot of "ifs" involved. To be fair, the question is too bluntly put. "How can we deploy IT to help resolve the climate crisis?" is a much better formulation.

Human beings equipped with the right technologies can achieve a lot; however, only if a technology is well designed, well implemented and in resonance with the diverse social, political, economic and cultural circumstances that need to be negotiated for it "to work". To achieve this when it comes to large-scale and complicated phenomena such as climate change, is no small accomplishment. IT alone cannot resolve this. No approach, discipline or technology alone can resolve this.

To move just a little bit closer to addressing the role of IT in relation to climate change, my aim is to reformulate the problem and to investigate not an absolute yes/no question but identify some *better* questions. Such questions include finding out how different actors imagine that IT will help mitigate climate change or not (and possible challenges inherent in these imaginations) and how IT may play a constructive role, which not only reduces the emissions generated by IT but also contributes to reducing emissions external to IT.

I assert that one method which can help us in this regard is to subscribe to an anthropologically inspired, but quite general, qualitative social science analytic, which pays attention to practice, to what people do (and not so much what they say they do or what we sometimes think other people do). It is concerned with how individuals and collectivities think about and deploy digital technologies in ways that are meaningful to them—and these are often ways that are surprising to the designers, planners and political–industrial elites who fund, adopt and promote technologies. It is an analytical lens that tries to challenge stereotypes about human beings and their uses of technology and, instead, develops a contribution which stresses how the value of technologies is differentiated depending upon context and how human beings are shaped—or are not shaped—by the technologies deployed. This is not in itself a novel perspective. It has been discussed for decades, for example, by information systems scholars as well as anthropologists working closely with the tech sector, e.g., [1,2]. Yet under the current circumstances of societal change taking place in the nexus of neoliberal capitalism, technoscience and green transition [3], an anthropologically inspired analytic can make a further contribution by addressing the bigger question of how we understand "change" as a cultural category in itself. Not just the change in "climate change" but what kind of change—sociocultural or technical—different actors think is needed in response to the climate crisis. What types of change are regarded as desirable and how are those changes imagined as taking place facilitated by IT? While we all know that it is the "big picture" which matters, the big picture still depends upon multiple individuals and collectivities, and this is where the anthropological analytic in particular may explain why some technologically driven changes unfold as expected, while others do not.

Before I come to the anthropological analytic, I account in more detail for the problem, and especially how different positions imagine IT to be involved—or having potential to become involved—in climate change mitigation. This first part (Section 2) focuses on the technological imaginary—of how technology as an enabler of "decoupling"—is thought to be inserted into the relationship between society and economy on the one hand and the climate on the other. In Section 3, I move on to the climate impacts of IT. I briefly mention the direct energy and material impacts of digital technologies themselves and then exemplify the difficulties of ascertaining how IT impacts human practice by looking at comparisons of the emissions from paper-based and digital communication, respectively. The empirical material here stems from the literature and websites. From there, I return to the anthropological analytic in Section 4 and how it may contribute to asking some relevant questions about the meaning of "change" when we take a starting point in the lived reality of people who adopt new technologies while simultaneously living with a concern for the climate crisis. I conduct this by discussing four challenges that anthropological approaches informed by ethnographic work can help us address when we think about how we imagine change. Finally, I end (Section 5) with an empirical example which questions whether specific digital technologies such as apps and the information that these convey to human actors will stimulate the desired behavioural change. This empirical material stems from ethnographic research carried out by two of my PhD students in the project Sociocultural Carbon (SOCCAR).

2. Background: What Is Technological Decoupling and How Is It Imagined?

Let me begin with what is regarded as one of the main challenges that climate change poses to contemporary capitalism—namely how economic growth can be decoupled from its climate impact.

In the 20th and 21st centuries, economic growth has been accompanied by increases in greenhouse gas emissions. It is the detachment of these two developments which decoupling is meant to achieve. While there are indications that some decoupling today seems to be taking place in specific countries, where the economy grows but national emissions are declining, most experts agree that it is not enough [4,5] (p. 55). Furthermore, decoupling which is territorially fixed to one country may conceal an economic dependency on rising emissions in another country. This is sometimes referred to as "leakage", which I return to below.

As the economist and social scientist Timothy Parrique and his colleagues write in a report for the European Environmental Bureau: There are many kinds of decoupling.

> "It can be global or local, relative or absolute, territorial- or footprint-based, happen over a short or a long period of time, and [. . .] it should be put in perspective with relevant environmental thresholds, political targets and the global socio-economic context, as to assess its adequacy . . . " [6] (p. 1).

The distinction which is most frequently discussed is how to achieve an absolute rather than a relative decoupling. Absolute decoupling means that economic output may grow while the amount of emissions falls both in total and per output, whereas relative decoupling means that it is just the amount of emissions per output which falls but not necessarily the total amount. I exemplify this as I go along, but let me first return to the role of IT in decoupling. Governments and private sector industries increasingly see IT as a central part of the solution to decoupling. Not the only part. Renewable energy, climate engineering technologies and climate finance are given precedence. However, without IT none of these are possible.

The need for technology—digital and otherwise—seems obvious. Partly because industrial production is today highly reliant upon IT for logistics, planning, information management, etc., and partly because it is well documented in social science that citizens and consumers—despite what they may think or claim—find it difficult to change the habits and privileges of their modern lifestyles.

2.1. Technology—A Fix or a Problem for the Climate?

Discussions of the role of technology, however, invite controversies. Current opinions on decoupling as a form of change thus reproduce a long-term and enduring split in our societies between proponents and opponents of the soundness of further technical fixes to the world's problems, e.g., [7,8].

On the one hand, mainstream political, industrial and technoscientific actors display a technological optimism. They argue that IT can play a key role in mitigating climate change due to its potential for automation, advanced computation and optimization. IT allows not only new and more sophisticated ways of knowing climate change; it also facilitates reductions in emissions from industrial and everyday activities, including agricultural production, communication, mobility and so on. Economic growth and progress can in this view continue unabated—or even be strengthened and create a purer and more perfect world for us according to the more utopian fantasies—if only technology is applied in the right way, e.g., [9,10]. Proponents of this view include academics positioned within the so-called ecomodernism school but also business elites and tech gurus such as Microsoft founder Bill Gates. The position is backed up by industry reports such as *#SMARTer2030: ICT Solutions for 21st Century Challenges* authored by the global IT services company Accenture for the Global e-Sustainability Initiative (GeSI), a partnership sponsored by multiple large-scale telecommunication companies. This report promises among other things that

> "ICT can enable a 20% reduction of global [. . .] emissions by 2030." . . . because "ICT emissions as a percentage of global emissions will decrease over time . . . to 1.97% of global emissions by 2030 . . . [and] the emissions avoided through the use of ICT are nearly ten times greater than the emissions generated by deploying it." [11] (p. 3).

On the other hand, and even prior to the surge of COVID-19-related digital needs, critics have pointed out that the emissions as well as the material environmental impacts from the growth in digital technologies have increased rapidly at a time when reductions in emissions are needed the most, e.g., [12,13]. This position draws upon more pessimistic analyses, which argue that due to the expansion in digitalization, including consumer devices, cloud services, streaming, Bitcoin mining and a general proliferation of data centers, the electricity consumption of IT will probably accelerate to the extent that it will constitute a minimum of 8%, and in worst case scenarios—where nothing is done to improve electricity efficiency—up to 51% of global electricity demand in 2030 [14]. Estimates vary widely and require constant updating due to changes in demands and technological capacities [15]. Yet, most of them come out quite differently from the wishful thinking of the GeSI-report, and all require both political and industrial efforts for emission reductions to take place, see [16–18].

On top of this, it is necessary to consider the environmental pollution stemming firstly from the production of IT devices, which comes both from emissions and from the mining of increasingly scarce rare earth metals, cobalt for microchips and lithium for batteries, and secondly, the disposal of IT devices at the end of their lifetimes—the so-called "e-waste" problem [19].

Consequently, the critical position often posits degrowth as the only viable alternative, arguing that the belief in decoupling, as it claims to ensure "green growth", is highly problematic if not already a "debunked" approach, for several reasons, of which I mention two. The first reason is that activities resulting in emissions tend to move elsewhere. This is referred to as "leakage" or sometimes "burden shifting"—when something is simply conducted in another way or in another place where it may still be harmful, or more harmful, and often harmful to those who are more vulnerable and cannot say no, see [12]. An often-used example comes from programs such as the REDD+, where forest areas in the Global South can be put aside for conservation with finance from carbon trading in order to prevent logging companies from devastating the forest. However, such initiatives may just lead the logging companies to take up their activities in neighboring forest areas, making the territorially delimited conservation to little avail. The second reason—which I return to below—is that emission savings tend to be replaced by expanding activities. This is often referred to as "rebound effects" or as "Jevons' Paradox", named after the 19th century economist William Stanley Jevons, see [6,12,20–22]. Very simply put, this means that if an activity becomes cheaper or easier, we engage in it much more. If roads are made wider, they attract more cars, and if our homes become more energy efficient, we may raise the temperature to increase comfort [22] (p. 780) or we may spend the money saved on other forms of consumption that are even less environmentally sustainable. While it is extremely difficult to test Jevons' Paradox empirically [23], it must nonetheless be taken into account when determining the efficiency of a technological intervention.

This points to the challenge of distinguishing between relative decoupling, where each activity or object is more energy efficient, and absolute decoupling, where we keep a focus on reducing the totality of emissions from our activities and objects. While the techno-optimist position tends to argue that IT, and technology more generally, can achieve *both* relative and absolute decoupling, the degrowth position—often merged with a critique of capitalism as a system—tends to argue that absolute decoupling in particular is at best very difficult to determine or predict beforehand and at worst a fantasy, which leads to even heavier emissions from the impact of the newly introduced technologies themselves.

2.2. The Challenges for IT in Achieving Decoupling

Here, it is important to point out how IT may contribute to relative and absolute decoupling, respectively. To be sure, the world has seen an exponential growth in digitalization pursued by an IT industry which, at least for Silicon Valley, is *ideologically* obsessed with rapid growth, see [24]. Just think about Facebook's slogan of "move fast and break things", or Amazon founder Jeff Bezos' message to his company that "every day is day 1", wanting Amazon to stay perpetually in a startup mode [25].

The IT industry has also been *materially* dependent on long-term growth. Here, I am thinking of the steady increase in the capacity of microchips as epitomized in Moore's Law. This "law" affects the planning of innovation because it allows for the projection of a constant growth in processing power [26,27] (pp. 203–204).

Luckily, some of the larger corporations have started to shift to renewable energy. Microchips themselves are becoming more energy efficient, and there is currently some work in programming aimed at improving energy efficiency. This includes changing distributed ledger technologies from proof-of-work to proof-of-stake, making more general "energy aware software engineering" [28] and work with resource-aware data science, which includes how to use and share new hardware more effectively in order to achieve more sustainable growth in computations [29].

These are just examples of the way that IT can be optimized and become more energy efficient to alleviate the impacts generated by the growth of the IT industry more generally. These initiatives—internal to the workings of software and hardware—help achieve a relative decoupling. Such initiatives ensure that energy use is reduced. Although the need for energy will never be zero, such work is really needed, when considering the tremendous growth in IT in recent decades, how much IT is still expected to grow as an industry and how much it will undoubtedly be present in all kinds of social life. While IT services in theory could just run on renewable energy, it is unclear whether the supply of renewable energy will be able keep up with the growth rates of IT as a sector. This has been so steep that commentators every now and then speculate that the revival of an otherwise stagnating coal industry is needed to meet the energy demand, see [30,31]. As with the production and the disposal of devices, the potential emission savings that could be generated by IT also have concrete energy externalities.

The more interesting question for an anthropological approach to technology is how IT can be applied to optimize tasks that are outside IT itself. Even if IT in the form of devices, servers, etc., can never become 100% carbon neutral, the activities covered or affected by IT may still help reduce emissions elsewhere. For example, by replacing something analogue with a digital "equivalent" or by affecting social, organizational or economic practices. This is the bigger and more difficult task because it is a matter of changing human beings. The aforementioned *#SMARTer2030* report estimated that IT will save almost 10 tons of carbon dioxide equivalent (CO_2e) for every 1 ton emitted by IT itself, but this number seems to rely on quite a lot of "ifs", to say the least. Firstly, the report does not tell us how it reaches its conclusion, and for this effect to appear it would require a large number of intermediate factors to fall in place. These factors depend upon human knowledge, values, priorities and social and political relationships, which are difficult to predict and undoubtedly have already changed in the years after the report was written.

The challenge, as mentioned, is that IT is a pervasive, networked and often invisible set of infrastructures in our everyday lives. It may be one of the most complicated sectors for establishing responsibility for emissions [32]. IT is embedded in most forms of capitalist production and circulation of goods, and its share of electricity and emissions is distributed between producers, retailers and consumers. None of those categories are easy to delimit in themselves, and the proportions of energy each of them demand to run IT appliances is constantly changing. Some, such as Bitcoin mining, even consume excessive amounts of energy. Contemporary research into distributed ledger technologies frequently expresses the potential of blockchains based upon proof-of-stake rather than proof-of-work to generally reduce emissions of both blockchain computations themselves as well as the emissions of the socioeconomic relationships that can be managed via this technology. Often-mentioned examples include the gains to be made by optimizing supply chain management (e.g., transparency and traceability) or balancing the distribution of energy across grids of various scales, e.g., [33–35]. While such introductions may have the potential to improve sustainability on specific parameters, it is doubtful that they would amount to more than a relative decoupling when it comes to emission reductions. Because the research in question fails to consider the dynamic effects of introducing such a new technology, blockchain-based "solutions" are as likely as any other technology to be subject to the above-mentioned Jevons' Paradox.

In other words, where digitalization and digital technologies are thought of as lending a helping hand in decoupling, we must, nonetheless, consider that there can be a huge difference between digitalization deployed for the benefit of building smart and distributed energy systems that flexibly match supply and demand and other digital initiatives which pretend to reduce our dependence on material impacts but hardly do so in practice. In the following section, I further problematize this by presenting a longitudinal perspective on an example of technological change.

3. A Historical Example—From Paper to Digital Communication

If we look at some actual examples of how IT has been applied to optimize tasks that are outside IT itself—replacing an analogue thing with a corresponding digital "equivalent" or improving a practice through a digital form of mediation—what does energy efficiency or climate impact reductions then look like? Keep in mind that digitalization processes are not always meant to be a matter of saving greenhouse gas emissions but rather to make social relationships between people operate "more efficiently". The purpose here is to unravel how one can meaningfully interpret what actually changes when communication is digitalized, and that this form of change implies much more than the replacement of one technology (analogue) with another (digital). These changes must fundamentally be understood in relation to broader infrastructures, social and cultural expectations, values and forms of practice.

Let me take an example which I think may be familiar to most readers: how digitally written communication (such as emails) is regarded as being immensely easier—and cheaper and having lower environmental impact—than paper-based communication (such as letters). However, comparing the emission costs of a letter with that of an email is not as easy as it may sound because there is no "standard letter" nor "standard email". We have to construct those first. This involves huge generalizations because the two modes of communication depend on very different infrastructures and sometimes overlapping infrastructures (such as postal services relying upon IT to improve logistics), and their respective efficiency changes with social re-organizations for postal services, or new technologies of distribution such as routers, servers and devices for emailing.

The British scientist Mike Berners-Lee attempted what he has later referred to as a "back-of-the-envelope math" comparison in his book *How Bad Are Bananas* from 2010 [36,37]. He concluded that emissions from sending an average letter in the UK in 2010 were 60 times that of sending an average email—that is, an email of fairly short length and without attachments, illustrations, or colors. We can always weigh this comparison in one way or the other, but the interesting follow-up question is how many more emails are sent today compared with the amount of letters sent prior to digital communication. Berners-Lee estimates that most contemporary office workers exceed the 60/1 ratio. Then, we have not even considered the amount and size of attachments in videos, illustrations and documents that are sent, nor the whole issue of spam. If we start to include the many other forms of digital communication (text messages, chats, tweets and Insta-messages), then it becomes clear that IT has not so much "replaced" letters as it has vastly expanded our communication. Even if these numbers are bound to be different today due to changes in energy efficiency [38], Berners-Lee's general conclusion could still be relevant: "This is a good example of the *rebound effect*—a low carbon technology resulting in higher carbon living simply because we use it much more" [36] (p. 16, *italics* in original). It is easier and it is apparently (almost) free (no need to purchase stamps, no time spent on post office visits, etc.).

Several news reports, researchers and energy companies have presented views on whether emails could be considered free or not, and how much they count in the aforementioned big picture, e.g., [38]. Research commissioned in 2019 by OVO Energy, an independent energy provider in the UK, estimated from a survey that British citizens sent over 64 million "unnecessary" emails every day, and this resulted in emissions of an extra 23,475 tons of CO_2e per year. Just one email less per person per day would save more than 16 thousand tons of CO_2e per year [37].

The response from OVO Energy was to invest in an extension app—Carbon Capper—for the Google Chrome browser, which can alert you when you try to send an "unnecessary email". So, OVO has designed an energy optimization initiative to help us fix the rebound effects of our communication optimization. Their website does not say how much extra energy this extension demands. It might not be a lot, but it seems paradoxical to spend energy on an extra application for "nudging" which we do not even know will work. Personally, I find a simple "thank you" to be absolutely necessary to maintain social relationships, and I can think of many other things which I find more unnecessary, such as the energy-intensive graphics on the OVO website. One might also ask whether 16–23 thousand tons of CO_2e is really a lot. The average for British citizens is maybe 12 tons per year [39], so the unnecessary emails give as much as the total emissions of 1200–1800 average British citizens out of a population of more than 65 million. The paradoxes of the example point to the difficult normative questions of who is to reduce. Responsibility is not a technological question. It is a political and social question of justice and equity, which it sometimes seems as if the techno-optimist position is trying to evade by the introduction of nonsolutions such as the Carbon Capper.

The comparison of paper and the digital can be drawn even further. When email and other forms of electronic communication became the norm in corporate office spaces, proponents of the digitalization of communication expected that we would have less paper around. There were calls for "a paperless office", which Abigail Sellen and Richard Harper in a 2002 book labelled "a myth", which they traced to the 1980s. However, they noted that "the introduction of e-mail into an organization caused, on average, a 40% *increase* in paper consumption" [40] (p. 13, my *italics*).

Thus, in order to understand the impact of the new technology, we cannot assume a one-to-one replacement. It is very difficult to ascertain, for example, what the potential for emission reductions of digital technology "really" is when compared with an analogue (or even another digital) counterpart. It is necessary to look at the affordances of that which is replaced, at that which replaces it and at the entire networks or infrastructures that the given technologies are part of rather than at them in isolation, e.g., [41]. As added by the sociologist Richard York:

> "The reasons that computers led to a rise in paper consumption are not particularly surprising. Although computers allow for the electronic storage of documents, they also allow for ready access to innumerable documents that can be easily printed using increasingly ubiquitous printers, which explains in large part the reason for escalating office paper consumption." [42] (p. 146).

The retainment of printers in office spaces exemplifies the inconsistency of how apparent "solutions" have historically been designed or promoted. The increase in paper consumption is of course in addition to an escalation of electricity consumption. To be fair, things may have changed in the 20 years after [40], but even if there is less paper today, it has taken many more years to arrive there than claimed by the commercial interests behind digitalization. Spurred by the popularity of robotic process automation in administration, there are today still companies promising that they can help us achieve the paperless office, see [43]. The myth still exists as a business product to be sold.

The supposed replacement of paper with digital communication is not the only example of how the optimizing potential of IT has expanded rather than reduced or replaced existing values and practices. When it comes to autonomous and electric vehicles or international shipping [44,45], digital technologies did not eliminate any physical movement or contribute to reductions in emissions (if this had been wished for) within these industries. IT instead helped increase movement and emissions.

This does not mean that all forms of digitalization may lead to expansion of activities and thus emissions. There can also be rebound effects that work productively and sustainably. The Zürich-based computer scientists Coroama and Mattern remind us that "not all products and economic processes are equal." [46] (p. 7). While I am not convinced that all Coroama's and Mattern's examples are exempt from indirect rebound effects, I acknowledge that, for example, initiatives that support circular economy processes (i.e., optimization of resource sharing, circulation and longevity) may be going in the right direction.

The problem, though, remains. It is difficult to compare two technologies because they do different things and are parts of different infrastructures, and indirect and long-term effects are rarely considered. Many predictions thus end up as wishful thinking because technical change also implies or results in social and cultural changes that are difficult to detach from wider contexts.

4. Discussion: Sketching a Role for Anthropology

At this point, I return to how anthropology may contribute with a perspective on the overarching question of how we imagine "change", and the assumptions of what kinds of social or cultural change are brought about through digitalization.

The question of what is considered "change", and what is the agency behind change (what "causes" change), must be addressed if IT is to be used productively to reduce greenhouse gas emissions outside of itself. An anthropological and more general critical social science perspective can help point out what assumptions of change we work with and whether they are realistic or not.

The dispute mentioned in Section 2 over the potential of technology to "fix" our problems indicates how decoupling is intricately entangled with human everyday practices of work and leisure; how we socially and culturally go about our lives and how we value and appreciate the things we have and the things we do. If a comparison of emails and paper—which appears at first sight to be a simple case—turns out to be so complicated, then what are the challenges of "bigger" and more demanding issues of generating change? Thinking about emails and paper should make us realize how the achievement of decoupling is a qualitative question of values and preferences distributed among numerous actors. Including the values of those designing and promoting technology and of those "resisting" it. As such, we should aim at creating a space for the study of practices of decoupling as a way of generating change. Perhaps we cannot approach this directly, but indirectly, we may focus on how and why people, for example, communicate as they do, why and how they travel (or not) and how and why they prefer paper over a screen or vice versa.

In order to study practices of decoupling, one must keep in mind the totality of actors. While it seems obvious that we could study "users" and "consumers" and why they adopt a technology or not, we should also address in what ways climate change is articulated as a problem that demands IT-generated social or cultural change, and how IT is developed and deployed with climate change mitigation in mind. We need to consider research questions that can facilitate an exploration of which kinds of decoupling are thought by funders, planners and developers to be feasible, which kinds are not, and how they become so.

It is likewise necessary to progress from shallow considerations of the potential of singular technologies to instill change to the establishment of a relational but also more holistic view of how different people approach climate change as a broader problem of how we think about change. This perspective could drive a shift in focus of contemporary debates from trying to understand the handling of decoupling by affluent actors in the Global North through approaches that narrowly consider how people "ought to act" (in theory and in policy and as numbers in statistics) to a qualitative view concerned with how people "actually act" in practice and across various countries, domains and relationships [47]. This entails expanding the view of decoupling from being a matter of governance, cost-effectiveness of markets, or elusive visions of nascent technologies to how people individually and collectively attempt to achieve climate change mitigation, and how such attempts are in line with or contrasted to ideals of status, growth or progress but also everyday concerns such as landing a good job or being part of communities of peers, cf. [48,49].

A weak spot in much digital innovation, in many tech development initiatives and also in some social science research, is *how* it is assumed that people change. What generates change and what is it in people, or with people, that changes accordingly? We should be critical of the ways that change is usually taken for granted as a good thing, which we can somehow "engineer" or "control" but which realistically speaking will often come out differently to what we expect, cf. [50].

One challenge is that often at the base of many initiatives aimed at changing someone or something—IT-driven or not—lies a rationalism and a belief in the power of information and knowledge, even if it has been demonstrated that knowledge does not always lead to action or to change, especially not when it comes to changing "business as usual" consumption or lifestyles, e.g., [51,52]. One could easily think of people not quitting cigarettes as an example. Most people are well aware of the problems with smoking. Are they then not rational for keeping it up? Rational decisions are made under specific circumstances, they have their time and place, and many conflicting interests, all seemingly rational on their own, may be at work.

I find it interesting how there is a discrepancy between having information about and acknowledging climate change, yet still relying upon work, lifestyles and ideologies of growth that most likely worsen it. Social scientists have addressed this discrepancy from different vantage points, resulting in contrasting interpretations with varying emphasis on either inaction or misguided actions with inadvertent effects. The interpretations range from seeing inconsistencies or dissonance to outright paradoxes of value which are variably located at different levels of capitalist organization (individual, state and corporate) or between these levels. These inconsistencies are explained with references to elements ranging from the formation of particular calculative, consumptive or ethical subjectivities to the existence of political, societal or technical structures normalizing the status quo and adding to sentiments of denial, estrangement, habit or ignorance, see [53–64]. While none of this social science research addresses the IT sector or the work with IT, it nonetheless addresses a key feature of decoupling, namely how the generation of change imagined under the term decoupling may be seen to take place—or be hindered—in numerous ways and involve multiple potential continuities or discontinuities from slow transitions to radical breaks. Some may, in correspondence with such approaches, regard decoupling as a total transformation, while others see it as the preservation of business as usual; to some it is about changing deeply held norms through technologically induced "persuasion", while others hold that it only superficially motivates change in specific practices and not enduring habits.

In pursuing the question of how IT can address climate change, the anthropologically inspired research into the deployment of digital technologies then brings attention to how decoupling is imagined as a broader, practical concern with sociocultural change. Yet to broaden our perspectives on change in this way, there is a need to address in the social science literature—and in practical approaches to the design of digital solutions aimed at generating change—four challenges in the way we conceptualize and think about change. These challenges have tended to dominate "mainstream" as well as many of the critical approaches to change stemming from social science studies of either IT-generated change or climate change. It must be noted that it is difficult in this endeavor to differentiate between what "belongs" to anthropology and what is more general qualitative social science. The qualitative social sciences have frequently borrowed ideas or taken inspiration from each other, and in going through the four different elements or "challenges" of change that emerge from an engagement with digital technologies, it thus makes sense to pursue a thematic differentiation rather than one based upon strict disciplinary distinctions.

4.1. Challenge 1: Can Digital Technologies and Information Generate Climate Subjectivities?

Common to some influential social science approaches inspired by the French philosopher Michel Foucault is an assumption that "green" behavior, self and subject identities can be "engineered" through the right technologies and techniques (including those of carbon markets and new forms of "green" governance). "Green subjectivities" should be directly achievable with the right informational, technological or socioeconomic incentives, e.g., [65]. This argument relies on the ability of data and technologies to change not only individual actors' behavior but also their sense of self, when data and technologies are used as a mirror for and expression of collectivities and identities. This formation of subjectivities with particular "ethical dispositions", e.g., [57–59], has typically but not exclusively been theoretically driven with a focus on discourse [59,66].

While the analytical consequence has been to develop an intriguing and morally desirable subject category, it remains a largely theoretical and conceptual construct. Instead, we should not assume that "greening" of the self can be achieved directly with single incentives, information, or technology, cf. [67]. It must be seen in relation to difficulties of giving up ecological privilege and livelihoods more broadly [68], and to the fact that environmentally friendly production or consumption may not be undertaken for its own sake but as part of ordinary daily concerns such as cleanliness, comfort and convenience, see [69,70]. For example, some climate scientists, such as the British Kevin Anderson, feel compelled by their privileged understanding of climate data to become activists and actively try to change personal lifestyles as well political agendas. Yet there are also scientists who stress a clear ontological separation between science and politics and who consider the generation of social change to be a moral and societal issue [71]. In other words, it is not clear how intimate engagement with scientific knowledge in itself leads to the creation of green subjects.

In line with the latter, it appears as if some tech traditions think that the construction of a green subject is even unnecessary for decoupling to take place because the change to be made is internal to the technology, programmed to be socially and ethically responsible for us without our knowledge.

An ethnographic approach could here question the assumption that digital technologies and technological innovation act (neutrally or not) as drivers of change or as facilitators of the development of generic "climate conscious subjects". They may, but when identical and generic information is met by diverse, nonidentical and locally specific responses, cf. [72,73], such subject formation also varies.

4.2. Challenge 2: False Consciousness or Reflexivity in Practice?

A related challenge is how to address what one could call the belief in a "false consciousness", which posits the analyst or outside observer as more knowledgeable than the people analyzed or observed. That is, for example, arguing that people only think they follow their own interests by decoupling through technical fixes or carbon trading, but "in reality" they do not. A more nuanced perspective would be to stress how people's reflexivity is practically entangled with or decoupled from IT-based approaches to climate change mitigation. What type of "knowledge problem" is climate change, and what forms of reflexive orientation does engagement with the problem engender? Instead of assuming that people are nonreflexive "dupes" who suffer from false consciousness, we should pursue how people in one way or the other feel and recognize a contradiction between knowledge and practice and between different ways that the impact of IT upon the climate is assessed and acted upon. This reflexivity may be socially differentiated as well as configured in locally specific ways, see [74], and we should pay attention to how actors socially and culturally are engaged with or respond to the question and possible contradictions involved. As argued by the anthropologist Michael Cepek, many Foucauldian-inspired governmentality scholars here "underestimate the degree to which people are capable of forging a critical, self-aware, and culturally framed perspective on collaborative projects for socioecological transformation." [75] (p. 501). The governmentality perspectives, focusing on subjectivities as mentioned before, often fail to reconcile practice with theoretical assumptions about change. Despite, for example, the Swedish researchers Lövbrand and Stripple [76] expressing caution in assuming any centralization of ordering practices, these perspectives still tend to espouse a powerful top-down gaze of the state, the corporation or the organization which constructs legible entities, cf. [77]. We should seek to take individual and collective formations and negotiations of reflexivity seriously along with the conditions and contexts under which they develop. Reflexivity and awareness are not absolute "states of being" but are actions directed towards an object, which is "known" from a social, cultural and infrastructural position, see [78].

4.3. Challenge 3: How to Account for Agency and Responsibility?

Recent developments in IT-based automation and data processing means that IT is now moving into both environmental and human spaces to make them "smarter" [79,80]. To critical scholars and journalists such as Naomi Klein, some of these technologies are assumed to reproduce dominant value structures by individualizing responsibility and drawing attention away from the drastic social, political and infrastructural changes necessary, cf. [81]. The same is said for technologies embedded in specific market designs. These are accused of legitimizing nonaction and the continuation of business as usual, e.g., [82]. These assumptions of the reproduction of dominant value structures of markets and individualization is part of the third challenge. That is, how is this change related to agency and responsibility for emissions (e.g., who is responsible for the emissions from your email?), and how is such agency entangled with or decoupled from IT-based solutions? This challenge concerns debates about the distinction between human and nonhuman agency and its variant impacts upon the climate in different locations, cf. [41,83]; a distinction which is further blurred by the developments in automation and data processing.

The question of how to locate agency and responsibility also implies its distribution across space and time [84], and how to avoid that decoupling becomes a new "digital divide". Recent critical studies have argued that the use of "big data" to solve problems of the governance of emissions may proliferate asymmetries of information access and control [85]. As a consequence, it is difficult to ignore how debates about decoupling are connected to broader "technocolonial" relationships involving dispossession of immaterial or material resources, marginalization, or disempowerment, for example, through datafication, cf. [86]. The rise of urban or "digital elites" blind to their own climate impact as well as their role in generating social inequalities in work and living conditions is also important, cf. [12,49,87]. It is not enough, however, merely to identify how some actors have agency or responsibility while others are deprived of it. It is more promising to ask how responsibility and agency are unequally coconstructed and enacted in different social, cultural and technological configurations, e.g., [41]. This includes questions about how IT as a profession is practiced across different sites—and not assuming that Silicon Valley is the model of and for what happens in the IT industry and with IT more broadly [88]. It also includes questions of how professional practices afford different opportunities for addressing climate change, which professional ethics, codes of conduct or accountability exist beyond the mainstream references to corporate social responsibility and sustainable development goals and what climate justice means to different people.

4.4. Challenge 4: How to Integrate Change and Continuity as a Conceptual Pair?

The three previous challenges all relate to the difficulty of discussing against which background something can be considered "real change". Conceptualizing change is (a) a matter of perspective, (b) embedded in a combination of social, political and economic factors and (c) points to a variety of durations (long and short term). Single surveys or brief studies trying to identify the formation of subjectivities may fail because subject formation can be a long-term process. The example above comparing paper and digital communication is definitely a matter of change, but it is not just the individual technologies of communication that have changed; it is entire infrastructures and societies. When it comes to data about emissions, then technologies such as sensors or carbon footprint calculators are likewise highly contextual. Such sensors and calculators can both inform and generate awareness, but they can also misinform depending on how, when and where they are applied, cf. [72,89]. In terms of emission reductions, some specific everyday practices can be demonstrated to be changing as a result of the introduction of new technologies (e.g., how to reduce energy consumption or offset flights when provided with specific options or "nudging"), but there are many starting assumptions about change that currently fail to explain and understand why awareness of climate change, and the introduction of new technologies that offer data or information about emissions or their impacts, may not profoundly change the practices and values that generate emissions in the long run. Again, this may be related with the entire social, cultural and technical infrastructures that they rely upon.

Another concern is, as argued by key theoretical contributions to anthropology, that new introductions (of technology or valuables) often amplify ("grow") culture in its existing form rather than initiating changes of cultural values. The digital technological office landscape could here be an example of the amplification of the possibilities for using paper, which was the preferred and valued technology. Sociocultural change, therefore, must be recognized as part of a conceptual pair with sociocultural continuity and understood in a broader framework of how everyday lives and practices unfold over time [90,91]. When it comes to identifying sudden or more profound changes in sociocultural values, such identifications have either been made in light of longitudinal developments within a given "community" or network of social relationships, cf. [92], or it has been suggested that it could result from a "cultural debasement" focusing on how events that generate humiliation, inferiority or shamefulness may provoke reflexivity and turn individuals or collectivities towards abandoning existing values [91,93,94].

The four challenges regarding change—with a focus on climate subjectivities, reflexivity in practice, how agency and responsibility is distributed, and what conceptually constitutes change or continuity—are best approached through detailed ethnographic studies. Ethnographic studies of a broad set of everyday practices can teach us how relational configurations of people, data and technology generate specific capacities and dispositions for responding to climate change. Rather than assuming single technologies or sets of data to have the potential to generate reflexivity or mobilize IT for climate change mitigation, or that people merely repeat the social and cultural status quo, the anthropologically inspired contribution that I appeal to can fill an important gap by establishing the relation between IT as key to climate change mitigating practices on the one hand and IT as devices for reflexivity and subject formation on the other. This is, as I see it, an anthropological question of what constitutes continuity or change in the practical enactment of decoupling. The most important starting point for addressing this question is that we need to move away from the assumption that everyone else is "like us" and that change happens because of the reasons that we think it will happen. It is a matter of using an anthropological gaze to foster, in the words of anthropologist Matthew Engelke, "a critical self-awareness that your own terms of analysis, understanding and judgment are not universal and cannot be taken for granted." [95] (pp. 16–17). An example from one of my research projects might explain how some of the challenges can be unfolded empirically.

5. A Contemporary Empirical Example

In the project SOCCAR, funded by the Independent Research Fund Denmark, we try to find out how digital modes of presenting greenhouse gas emissions to individuals and collectivities have impacted the way that these people value and reassess their own lifestyles. What is the value of the things you like to have and to do when you are made aware of the environmental costs, and is that awareness enough to change your practices or your values? In our research group, we expected that the digital uptake and concretization of what counted as emissions in the Danish Lutheran State Church, which my PhD student Katinka Schyberg works with, would be difficult. However, as a contrast, I expected that the young Norwegian climate activists, which my other PhD student Anne-Sofie Lautrup Sørensen works with, would be part of a generation of "digital natives", and therefore find it easier to embrace the use of digital "carbon calculators" [96].

It has probably come to the attention of many readers that smart phones today offer numerous examples of applications that promise us that they can help us account for our everyday emissions as consumers. Some of these apps are international, but the majority are strictly tied to the specific local or national infrastructures of utilities in respective countries.

These calculations are of course somewhat rough. The actual emission of a steak bought in a supermarket is not generated by the customer per se. It was generated—long before the customer put the steak in their shopping basket—by the steak-supplying cow that was slaughtered and by the mechanisms of production which performed the slaughtering, packaging and transporting—to just mention a few of the processes involved. It is the responsibility for this emission which is allocated to the customer via the carbon calculating app. In that way, it is an economic, normative and social question of allocating value rather than an abstract question of what greenhouse gases are. It is generally believed that providing consumers with such information about their responsibility for emissions will result in behavioural and consumptive changes. It will make consumers *feel* responsible, and as such, it is an attempt to govern climate-related consumption.

Yet, these apps rely upon some assumptions that I would like to challenge. Firstly, as I have stressed, information only rarely leads people to change—at least not information on its own. The information has to be delivered in the right way, at the right time and supported by the right infrastructures and opportunities for changing behavior. Secondly, behavioral research has shown that when people do try to pursue proenvironmental behavior they often overemphasize the low hanging fruit and then feel that they have accomplished enough [52]. Good intents but low impacts. The real predictor of climate impact in [52] was people's income. High income equalled high climate impact. The assumption that carbon calculating apps will ever be noticed and used by others than a tiny minority is a third fallacy, which is where Sørensen's research with young activists in the Norwegian oil city of Stavanger comes in.

Very few of the young activists could claim to have an accurate picture of their own responsibility for emissions. In fact, only one tried to calculate it. Keep in mind that if the use of apps does not come naturally to digital natives, and they do not make use of their digital skills and technologies to understand the landscape of consumption-based emissions, then who do the apps appeal to? It is easy for developers and data engineers to believe that scientific data (or just data) are approached in a rational fashion by recipients of their curated data analyses because the data and the analyses in themselves are believed to be exactly that: rational and factual. Yet, this fails to appreciate the contexts where data is put to use and the interests of those putting them to use. Instead, one could think of many people's engagement with climate science and calculations of emissions as a form of "bricolage", to use a concept from an anthropological classic [97]. People deploy *what* they can find, whatever is at hand, to pursue their specific purposes within the social infrastructure, which they are part of. What most people may do—including scientists in fact, when outside their area of expertise—is exactly to operate as bricoleurs or tinkerers—tinkering with modes of understanding that they do not know in detail, picking selectively among models and arguments that fit their agenda rather than testing these rigorously. What this tells us is that conveying information about climate impacts is both highly contingent upon specific local factors, and it warns us that much of the energy and labor, which goes into the making of scientific facts and their communication through digital tools, ends up being wasted unless we invest an equal amount of attention and labor into understanding the "recipients" of data and scientific arguments. This may come across like a banal point, but it is one that often seems forgotten in industrial technological development.

To return to the challenges with our understandings of change, the Stavanger youth could in many ways count as evidence of a more general "climate" or "green subjectivity", but they still do not perform this in ways the theories I have mentioned would expect. They take responsibility for their own individual emissions not based on calculations but largely based on a "feeling" of what is important and what is not. This does not mean that these youth suffer from false consciousness or misassumptions. They are very reflexive about the challenges of integrating the conclusions of climate science with what it means to be a young Norwegian who has grown up with oil-based affluence. There are limits to what they can say and do if they do not want to break with family members who work in the oil industry, and for this reason they are intricately involved in discovering the limits of their own agency, which cannot be easily enhanced by references to science or datafied emission calculations. *Their* struggle is to find out what they can and will do in negotiating the balance between continuation of the reliance on fossil fuels on the one hand, which to them is also about the relationships with their families, and the change which they consider to be necessary on the other.

6. Concluding Thoughts

To conclude, it is important that we realize when our stereotypical ideas of technological adoption are themselves culturally specific and integrated with the concerns and values that we share or promote (of climate change, of digitalization, of scientific knowledge, of improvements and optimizations of value), and that we should not generalize them and think that they apply to other types of subjects or people. An anthropologically inspired analytic can help point out how the changes presumed to be achievable with technological solutions need to be problematized and seen in light of what is interpreted as change in the first place—whether it is about changing subjectivities, reflexivity, forms of agency, distributions of responsibility, or even change at all. For example, comparing the before and after of the digitalization of communication processes reveals a number of complex infrastructural interrelations. If the forms of digitalization sketched in Section 3 had been attempts at decoupling, the rebound effect would have denied their success because the underlying value systems were not being replaced. There are constantly new technologies being proposed as potentially "enabling", but as suggested, for example, by Marilyn Strathern [98], such perspectives often speak more to a positive ontological view of technology in Euro–American culture than to a realistic assessment of what technology "is" and "does". Future research could benefit from taking a realistic approach to the role of technology in mitigating climate change, or in promoting sustainability more generally, such as that of an ethnographically driven "compositionist approach", which takes seriously that technologies may enable some things but simultaneously "disable" others [99–101]. Taking the above-mentioned example of blockchain, its enabling potential is frequently foregrounded, whereas costs are reduced to the anticipated energy bill. Dynamic and infrastructural effects such as leakage and rebounding (to name two that I have brought up above) are ignored, as are the complicated social and political ambiguities [102].

If IT is to contribute to solving the climate crisis, then it is a given that algorithms and software must be more energy efficient, making relative decoupling; however, the decisive factor is to what extent digital technologies can help reduce emissions from activities external to IT itself. That is the harder part. To achieve this, it is necessary to learn from past mistakes, avoid being naively optimistic and be aware of economic and social processes of leakage and rebounding. There are things that IT cannot change, but to better understand how we think about change in people and in technology is a first step.

Funding: The research presented in this article was funded by the Independent Research Fund Denmark under grant number 8047-00010B.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: This article is a revision of the author's inaugural lecture at the IT University of Copenhagen. The author would like to thank Frida Hastrup as well as colleagues and students who have contributed to the work, which this article builds upon.

Conflicts of Interest: The authors declare no conflict of interest, and the funders of this research had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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