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Digitalization and Sustainability: A Call for a Digital Green Deal

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ABSTRACT

The relation between digitalization and environmental sustainability is ambiguous. There is potential of various digital technologies to slow down the transgression of planetary boundaries. Yet resource and energy demand for digital hardware production and use of data-intensive applications is of substantial size. The world over, there is no comprehensive regulation that addresses opportunities and risks of digital technology for sustainability. In this perspective article, we call for a Digital Green Deal that includes strong, cross-sectoral green digitalization policies on all levels of governance. We argue that a Digital Green Deal should first and foremost aim at greater policy coherence: Current digital policy initiatives should include measures that service environmental goals, and environmental policies must address risks and advance opportunities of digital technologies to spur sustainability transformations.

1. Main text

Digitalization, the restructuring of domains of social life around and with digital communication and media infrastructures (Brennen and Kreiss, 2016), is a double-edged sword with regard to environmental sustainability. Its material and energy needs are exceeding expectations, and the transgression of planetary boundaries (Steffen et al., 2015) may be accelerated by digitalization. Yet there is also hope that digitalization's potential can be harnessed to slow down, if not prevent, further violation of the safe operating space within the thresholds of critical Earth-system processes (Rockström et al., 2009; Fuchs et al., 2021). In this essay, we call for a Digital Green Deal – strong, coherent and cross-sectoral green digitalization policies on all levels of governance.

2. Friend or foe?

To date, academic research on digitalization for environmental sustainability (D4S, or ICT4S) is only conducted in niches. The literature distinguishes between different environmental effects: life-cycle effects resulting from production, operation and disposal of end user devices, data centers and network infrastructure, as well as indirect positive and negative effects resulting from the manifold applications of digital devices and services throughout society (Williams, 2011; Hilty and Aebischer, 2015). For instance, a review of the contributions to the five international scientific 'ICT for Sustainability' conferences since 2013 (e.g., Chitchyan et al., 2020), conducted by some of the authors, reveals a clear dominance of the topics of life-cycle effects and enabling effects

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on the efficiency of production and consumption. Comparatively few publications examine other indirect and structural effects, such as whether digitalization contributes to circular economy goals, to absolute reductions of energy and resource demands, or to whole-systems change in particular sectors (e.g. electrification, vehicle-to-x technologies and digitalized supply chains in motorized transportation).

Life-cycle effects of digital technologies are substantial in terms of their energy and resources demand, and global CO_2-emissions (Freitag et al., 2021). In particular, the environmental impact of data-intensive applications and services such as streaming media, crypto-currencies, machine learning, internet of things (IoT) and data center power consumption is currently the subject of controversy (Krause and Tolaymat, 2018; Masanet et al., 2020; Urquhart and Lucey, 2022). Mining of several crucial resources (e.g., 'conflict minerals') as well as production in hardware facilities usually take place under insufficient environmental standards and labor conditions. Recycling rates of digital devices are miniscule. Hence, digital communication technologies and media infrastructures themselves are far from being organized in a circular economy.

As regards indirect effects from ICT (see Hilty and Aebischer, 2015, S. 25), studies have identified various mechanisms how the application of digital technology may either positively or negatively contribute to environmental sustainability (e.g., Hilty, 2008; Horner et al., 2016). First of all, ICT can greatly improve environmental monitoring and provide real-time data on earth systems as well as socio-economic indicators. Moreover, case studies show that digital applications can increase energy and resource efficiency – for example in smart factories and by the (industrial) IoT. But at the same time, efficiency improvements can generate rebound effects that intensify use patterns and induce new applications of digital technologies and hence, countervail the savings potential (Santarius et al., 2020). Another favorable contribution of digitalization lies in its potential to substitute physical goods and movements with digital services, as tends to occur when workers replace some of their commuting with teleworking. However, substitution seems to be the exception rather than the rule. Oftentimes consumption of digital services complements pre-existing consumption practices, as with e-books vis-à-vis print books or video-streaming compared to conventional DVD watching (Lüders et al., 2021). Although the application of digital technologies facilitates improvements in energy and resource efficiency and can guide consumers in sustainable decision-making, it mainly increases labor productivity and brings about innovations in consumption, which leads to an expansion of production and subsequent additional demand for energy and resources (Lange et al., 2020).

It will probably never be possible to determine whether the net effect of digitalization on environmental indicators in all production and consumption domains is positive or negative. Nonetheless, there is a substantial gap between the 'hype' around the potential contribution of digitalization to environmental sustainability, and the rather sobering effects measured to date. On the whole, the form of digitalization we have witnessed in the past decades has not solved any of the pressing environmental issues of our time: Despite innovative small-scale initiatives, it can be noted that in none of the key sectors – transport, energy, agriculture, housing, consumer goods – did the introduction of digital tools so far spur transformation towards sustainable alternatives (Lange and Santarius, 2020).

Some studies do highlight the potential of digital technologies to increase its sustainability contributions in future years (e.g., Digitalization for Sustainability (D4S), 2022; Muench et al., 2022; WBGU, 2019). For instance, there are promising examples of how artificial intelligence could play a role in climate change mitigation and adaptation, e.g., by better predicting use patterns and flattening energy peaks in urban spaces (Kaack et al., (forthcoming)). While such potentials ought to be explored, the capacity of digital technology approaches alone to prevent further transgressions of planetary boundaries should not be overestimated. Forthcoming innovations will always be sociotechnical and embedded in political, economic and regulatory systems (Geels et al., 2017). Technology adoption, use, and acceptability must be considered, but takes place in pre-existing power structures and will happen unevenly across the world (Ryghaug et al., 2022). Dominant market actors often appropriate innovations to sustain path dependencies and perpetuate locked-in modes of production and consumption (Kleine and Unwin, 2009). The knowledge we gathered in our research suggests that the processes around D4S are too big, too consequential and too relevant for the environment to be left to markets and corporate actors. Rather, there is a need for strong, clear, evidence informed policies to foster the potentials and contain the risks of D4S.

3. Lack of coherent governance

High hopes are pinned on digitalization as an enabler of systemic societal transformation that ensures respecting certain planetary boundaries, most notably climate change. Industry has been overly optimistic, estimating stunning cuts of roughly 9 % of global greenhouse gas emissions due to digital technologies (GeSI and Deloitte, 2019), while multi-national corporations and national trade associations have joined forces to push digitalization as essential to sustainability transformations in key sectors (Digitaleurope, 2021). However, the narrow evidence base on the environmental implications of digitalization suggests a large gap between these hopes and reality. We suggest that one of the reasons why digitalization has not yet been harnessed enough to reach environmental goals is the missing coordination and collaboration between the two policy fields of digitalization on the one hand and environmental sustainability on the other.

Debates on governing environmental sustainability and digitalization are at different stages. Sustainable development policies have been developed for several decades and by numerous actors, ranging from multilateral to (bottom-up) local politics. In contrast, the governance of digitalization is less developed, with many open questions at different policy levels. While environmental science has provided a workable evidence base and risk assessments based on decades of research (compiled by the IPCC, IPBES, and others), digitalization policies are dealing with 'unknown unknowns' (Scholz et al., 2018), grappling with deciding on the policy questions to tackle and trying to keep up with the immense technological advances in the field. In the meantime, significant amounts of lobbying money are spent by the big technology firms to minimize regulation, and narrow the imagination of digital futures down to versions protecting and centering the current oligopolistic dominance of key firms.

The deficiencies in governing digitalization are starting to be addressed. On the global level, the United Nations Secretary General set up a Roadmap for Digital Cooperation in 2020. The World Trade Organization WTO is currently working on an Agreement on E-Commerce. The European Union got several important regulatory initiatives off the ground, including the Digital Services Package, the Data Governance Act, and the Artificial Intelligence Act. In the United States, anti-trust efforts are building around Lina Khan's leadership of the Federal Trade Commission with numerous policies currently under consideration, such as the proposed Platform Competition and Opportunity Act. Other nation-states, such as China, Egypt and South Africa, have developed their own national approach to digital regulation. And in many countries, national digital strategies form at least part of the future narratives of politicians.

However, in all of these initiatives, there is a significant lack of policy coherence between digital policy initiatives and policies targeting sustainable development. For instance, the EU's two major policy packages are the Green Deal and Fit for the Digital Age; yet, the vast majority of regulatory initiatives coming from either package do not address opportunities and risks of digitalization for the environment (as an exception, see Council of the European Union, 2021). Likewise, the UN Roadmap for Digital Cooperation neglected environmental issues upon its establishment in 2020 and has only recently started to consider the topic in its ongoing work. Few initiatives intend to mitigate environmental effects directly related to digital technology hardware, such as regulation to reduce impacts from e-waste. Yet globally, there is no comprehensive regulation that addresses indirect environmental impacts stemming from digital technology use. And far more comprehensive multi-stakeholder collaboration and governance is needed to nurture the potential of digital technologies to serve sustainability goals, e.g., to decarbonize the society or preserve scarce resources and fragile ecosystems.

4. Towards a digital green deal

Transformative governance of digitalization requires more than public authorities offering smart incentives or even a full mix of regulatory, financial or information-based instruments. It requires what we, the authors, call a Digital Green Deal.

Above all, a Digital Green Deal needs to be tied to a broad vision about the role digital technologies are playing in the prospect for people in all places to realize a decent living within humanity's safe operating space (Digitalization for Sustainability (D4S), 2022). This vision needs to recognize environmental challenges as intersectional problems and incorporate questions of equity and justice. Moreover, it needs to be flexible in its local and cultural interpretations, allowing for cultural diversity as well as for variations at multiple geographical scales. For instance, equality of access to digital green solutions must be considered in particular when looking at global implementations of technologies also in low income countries. At the same time, the vision must take into account internationally negotiated policy goals, such as the Sustainable Development Goals, the UN Framework Convention on Climate Change, and other framework conventions. Developing such a vision needs to engage citizens and civil society but also the private sector – in all its diversity (company sizes and business models) – to be a key partner at the table, rather than allowing oligopolistic technology firms to be the dominant framing power and guide to the future.

Based on this vision, a Digital Green Deal would aim to ensure coherence between sustainability policy and digital policy initiatives. This requires addressing and integrating three aims (Fig. 1). First, policies should reduce the environmental footprint stemming from lifecycle effects of digital technologies. For instance, design directives can establish environmental standards for hardware production, require manufactures to increase the share of recycled materials and reused parts, and require devices to be designed modular and repairable. Moreover, hardware companies can be incentivized to change their business models from selling to letting (device-as-a-service). To reduce impacts during the use phase, policies should set clear and ambitious energy standards for devices and data centers, ensuring constant improvement of those standards over time.

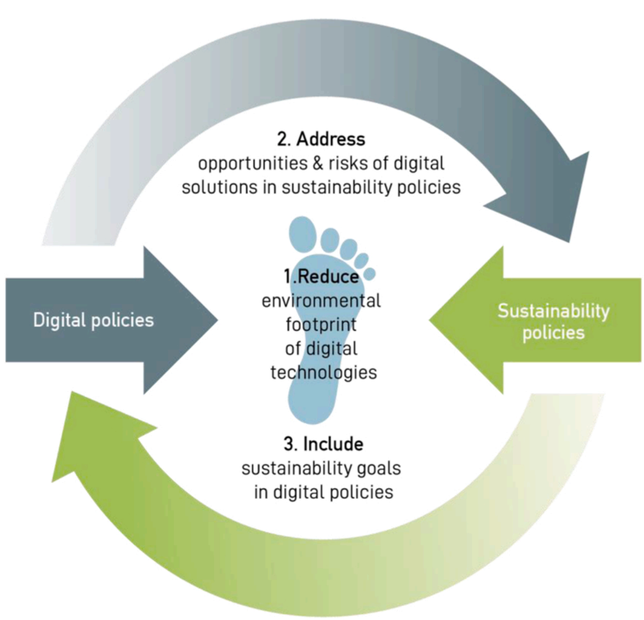

Fig. 1. Three aims to ensure policy coherence between sustainability and digital policies.

Second, sustainability policies should foster the development and application of digital solutions that aim to spur genuine transformations in systems of provision and distribution while simultaneously minimizing usage of digital innovations that are counterproductive from an environmental perspective. Digital opportunities and risks should be addressed in a cross-cutting manner, for instance in legislation on circular economy, governance of value-chains and corporate accountability requirements. Opportunities and risks should also be addressed in sectoral policies, thereby advancing sustainability transformations in energy, mobility, agriculture, building/housing, industry, and consumption of goods and services whilst not setting back social issues. For example, transport policy-making should not leave the governance of vehicle automation to ethics commissions or data governance initiatives alone but proactively develop initiatives to support communal or private mobility providers (e.g., transport associations) in the bundling of vehicle automation and car sharing in a wider Mobility-as-a-Service (MaaS) environment. In general, governance should ensure that a digitalised solution provides an added value compared to a non-digital one. Also, risks of digital failure caused either by unpredictable environmental events or malevolent actors (e.g., cyber-security attacks) must be assessed and countermeasures configurated.

Third, digital policies should include elements that serve sustainability goals. For example, most platform markets lack 'production standards' – there are neither energy standards for video streaming or social media platforms, nor are services on rental or sharing platforms bound to contribute to low-energy housing or reductions in greenhouse gas emissions in transportation. Since even comparatively strong platform legislation such as the Digital Services Package of the European Union do not fill this void, future legislation is needed that includes environmental and social standards for service provision in platform markets. Likewise, policies regarding data governance, artificial intelligence, e-commerce, digital finance, crypto-currencies among others should include legislation that advances sustainability goals.

Decision makers aiming at ambitious policy initiatives regarding the 2nd and 3rd aim of such a Digital Green Deal should be aware that governance towards a progressive role of technologies for a sustainability transformation does not render changes in production and consumption unnecessary. Hence, some policy initiatives may face resistance by certain groups of producers and consumers. Just as the current EU Green Deal, so will a Digital Green Deal have to stand up to pre-existing power structures.

5. Transformative science

Understanding the relationship between digitalization and environmental sustainability requires truly interdisciplinary knowledge – integrating insights from technical, social, and natural sciences. At present, just like policy-makers on digitalization and sustainability appear to be split into separate camps, so are much of the academic communities producing research siloed in their approach. In order to advance a Digital Green Deal, research will need to bring diverse disciplinary and domain expertise together in an interdisciplinary field connecting digital technologies and their governance with sustainability research.

Moreover, interdisciplinary research will need to be combined with diverse approaches including scientific data analysis and synthesis, mediation and diplomacy, policy analysis and standard-setting, design methodologies, participatory approaches and citizen engagement. These should be open, reflexive and learning-based approaches, including open sharing of things that don't work or fail. To better inform policy-makers and contribute to greater policy coherence, research must not only analyze existing challenges but also contribute to goal setting, e.g., by defining indicators for a 'sustainable digital society', and contribute to problem-solving by developing knowledge how to get there. This can also help policy makers deal with potential trade-offs between sectoral optimised policies and overarching coherence-oriented policies. Such integrated research would benefit from approaches for co-creation of knowledge and transdisciplinary research with policy-makers, business representatives, and civil society actors, but should not shy away from squarely addressing vested interests in those groups of actors that intend to impede the sustainability potential of digital technologies.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Tilman Santarius reports financial support was provided by Robert-Bosch Foundation GmbH, Germany.

Data availability

No data was used for the research described in the article.

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