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A scalar mismatch: the IETF's sustainability approaches in a framework of infinite growth and abundance

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Abstract: Until recently, environmental harms were largely absent from internet governance discussions and their study. This article offers an analyses of how the environmental impact of internet infrastructure is discussed within the Internet Engineering Task Force (IETF) arguing that sustainability becomes a justification regime for the internet's continued existence and growth in a world in crisis. Taking a discard studies approach, I explore what is and what must be discarded for the internet to continue to operate through a thematic analysis of 26 position papers submitted to the Internet Architecture Board (IAB) e-impact workshop. These insights allow me to expand on Liboiron's (2014, 2021) concept of scalar mismatch to illuminate how limits to growth are directly at odds with the values that have shaped the internet. The internet governance community has not come to grips with the idea that the network is an environmental problem in itself; rather, a belief in growth, abundance of natural resources, and sustainability through innovation shapes their understanding of sustainability. This paper straddles infrastructure studies, internet governance studies, and environmental social sciences, showing how an environmental lens on infrastructure studies allows us to connect global governance debates with local conflict over resources.

Introduction

The internet is widely perceived as a critical infrastructure in contemporary society, where the policy and technical decisions shape economic and social activities (Bowker & Star, 2008; Plantin et al., 2016). This prominent position makes its governance regimes an important area of study. Initial academic debates sought to understand how power operates by delineating the roles and responsibilities of the different internet governance spaces and models (DeNardis, 2013), the norms and values underpinning these regimes (ten Oever, 2020), and the cultures that determine whose voices count in the governing of the internet (Cath, 2022). More recently, digital sovereignty has become a framework for understanding states' approaches to regaining power and control over internet infrastructures and their governance regimes (Pohle & Thiel, 2020; Musiani, 2022). In this paper, I contribute to the understanding of power by revisiting internet governance as an object of study and exploring how the emergence of a new issue area, sustainability, sheds light on the ideologies that shape this governance field. This approach is guided by Niklas and Dencik's (2021) observation that, "the formulation of new policy areas, [...], provides a window into what priorities, interests and concerns currently shape" a governance field (p.1). This paper argues that the ways in which sustainability is conceptualised and embedded within internet infrastructures reveal the norms and values that underpin its governance. A discard studies approach (Liboiron & Lepawsky, 2022) provides an analytical lens for examining not only what is said, but also what is omitted and what must be discarded for internet infrastructures to continue operating. Building on these insights, I extend the concept of *scalar mismatch* (Liboiron, 2014; 2021) to internet governance to argue that the dominant understanding of sustainability is socially constructed and offers a narrow definition of the problem. As a result, the proposed solutions are likely to have limited impact and offer a justification regime for the internet industries to continue to grow and externalise its environmental harms.

Although sustainability is often marginalised in policy debate about the internet, AI and cloud computing, emerging protests against data centre expansion demonstrate that internet infrastructures are increasingly becoming sites of political contestation. Research on these conflicts shows that local communities are often excluded from decision-making processes surrounding data centre expansion (Rone, 2024) and that these disputes centre on competing claims over land, water, energy, and carbon emissions (Hogan, 2015; Bejarano & Valdivia, 2026; Pasek, 2019). When the relationship between sustainability and internet infrastructure is discussed, political and industry leaders are quick to emphasise the promise of these

technologies as tools to mitigate climate change. This promise can be understood as the latest incarnation in a long line of tech-solutionism (Jansen & Thorne, 2024; Mollen et al., 2026) and as part of a commercial strategy through which cloud providers market their services as pathways to decarbonisation (Sridharan, 2026). While considerable scholarly attention has been directed at understanding these governance debates and the frictions that emerge when ‘the cloud hit the ground’, much less is known about how internet governance bodies responsible for the technical operations of the internet engage with matters of sustainability. Anastacia’s (2025) work begins to address this gap by examining how these internet governance bodies are addressing the environmental impact of the internet itself. Building on her work, this paper uses sustainability as an analytical lens to examine the norms and values that become embedded in, and enacted through, internet governance.

The technical governance of the internet takes place across a number of international fora, including the Internet Corporation for Assigned Names and Numbers (ICANN), the Internet Engineering Task Force (IETF), the International Telecommunication Union (ITU), and the Institute of Electrical and Electronics Engineers (IEEE). Each of these bodies, with its own governance structure and mandate, has evolved to fulfil specific roles and responsibilities in maintaining the internet’s safety, security, and resilience. The non-profit organisation ICANN manages the internet’s domain name system; the multilateral ITU develops international telecommunications standards and coordinates the allocation of radio spectrum; and the IEEE focuses on standards for electrical engineering, electronics, and computing technologies (ten Oever, 2020; Anastacio, 2025). This paper focuses on the IETF, a private industry-led multistakeholder body that brings together many of the world’s most prominent internet infrastructure companies (Cath, 2021). The IETF’s mission is to develop technical standards and promote voluntary protocols for the internet through a community of more than 7,000 active participants. Unlike multilateral organisations, the IETF makes decisions through rough consensus rather than formal intergovernmental negotiations (IETF, 2025). The IETF is a vital part of internet infrastructure, as its community shapes how the internet operates, including how traffic is routed, how security mechanisms are implemented, and how users access information. The Internet Research Task Force (IRTF) and the Internet Architecture Board (IAB) are two bodies of the IETF that play complementary roles. While the IRTF serves as the IETF’s long-term research arm, the IAB provides architectural oversight of internet protocols and procedures and sets the technical direction needed to ensure that the internet remains a trusted medium with a robust technical foundation. The environmental impact of internet routing only recently

materialized as a topic of interest for the IETF (Anastacia, 2025). This paper traces this shift to the IAB Environmental Impact of Internet Applications and Systems workshop, which marked a key moment in putting sustainability on its standards development agenda.

In this paper, I offer a thematic analysis (Braun & Clarke, 2006) of the written contributions to the IAB workshop on the Environmental Impact of Internet Applications and Systems, from now on referred to as the e-impact workshop. The analysis is further informed by my experience as a participant in the workshop and by discussions on the workshop mailing list. Following the workshop framing, I'll use the term environmental impact to refer to both the climate crisis and broader ecological degradation. The IAB organises workshops to initiate discussion on topics related to internet architecture, emerging industry needs, and future directions. As Dhody (2024) observed in a reflection on a decade of IAB workshops, they have "played a key role in launching new standards work within the IETF, stimulating research initiatives at the IRTF and providing valuable insights and resources for the wider community". Although environmental issues had been discussed previously within the IETF, the IAB e-impact workshop, organised in December 2022, marked a turning point in the institutionalisation of sustainability within the community. It catalysed the development of a sustainability agenda and resulted in an active e-impact mailing list and working group. Anastacia (2025, p. 151) found that "After the IAB workshop, the IETF established the e-impact program and the Getting Ready for Energy-Efficient Networking (GREEN) working group. The IRTF also created the 'Sustainability and the Internet' (SUSTAIN) research group".

This paper adopts an infrastructural approach to examine the seemingly invisible substrates of society (Bowker & Star, 2008; Hesmondhalgh, 2021). In this case, the focus is not on the material infrastructures, but on the norms, values, and governance mechanisms that shape them (DeNardis, 2013; ten Oever, 2020). The IETF e-impact workshop serves as the case study through which to examine how the technical internet community engages with the environmental impact associated with the internet. The aim is not to evaluate the effectiveness of the proposed technical solutions, but to use sustainability as a lens through which to examine what these proposals reveal about the assumptions, priorities, and values embedded within internet governance. To this end, I first review recent debates in internet governance scholarship to discuss how power and governance are conceptualised in the internet age. I then engage with scholarship on the environmental impacts of infrastructures in specific territories, demonstrating that infrastructures are also sites of political contestation (Hogan, 2015; Brodie & Velkova, 2021;

Pasek et al., 2023). Bringing these debates together, I draw on discard studies as the paper's analytical approach to illuminate the politics underpinning internet governance regimes. In the context of waste, Liboiron and Lepawsky (2022, pp. 2-3) argue that discard studies move beyond material waste, trash, and recycling as the primary object of study to focus on "wider systems of waste and wasting". Applied to internet governance, this approach enables this paper to ask not only how sustainability is constructed, but also how environmental problems are defined, how harm is determined, and by whom, and what is missing from these debates? These questions shed light on the belief systems that guide the IETF's approach to sustainability. Rather than treating sustainability as limited to the immediate environmental impacts of internet infrastructures, this paper argues that technical proposals for sustainability reveal what internet governance values, what it renders invisible, and what must be discarded for the internet to remain a critical social and economic infrastructure.

In the findings section, I examine how the IETF community frames environmental problems and sustainability solutions, which shape discussions on *how much* internet we need, how it is organised, and what is considered acceptable environmental harm for the network to function. I find that the community's belief in the exceptionalism of the internet, the idea that it will revolutionise other sectors, and the belief that the network's own growth is decoupled from resource use are driving a narrow sustainability agenda. This siloing of the problem offers solutions that focus on efficiency and optimisation measures, which can be considered techdeterminist, short-term, and reductionist, as they approach the reduction of carbon emission as an engineering rather than a political or economic problem. Applying Liboiron's (2014; 2021) concept of scalar mismatch allows this paper to make sense of the dynamic, as the concept describes the tendency to frame environmental problems and their solutions at a scale that appears to be technically manageable, while obscuring the broader political and economic systems that have created the problems to begin with. This foregrounds a dynamic in which the unwavering belief in the good of the network reduces environmental harms to the minimisation of carbon emissions through technical innovation, while obscuring the extraction, pollution, and violence needed to sustain the operations and expansion of internet infrastructures. This technical framing of sustainability produces a justification regime for the growth of the internet in a world in crisis, by making the case that growth is both necessary and compatible with a just and sustainable society.

Infrastructure, power, and governance

Susan Leigh Star called for the study of infrastructure, *the study of boring things* (Star, 1999), the invisible substrates that allow other aspects of society to function. In line with her argument that we cannot study a city without studying its sewer system, we cannot study information systems without studying their infrastructures, both their material layer - the data centres, cables, routers, and devices - and their immaterial layer - computational processes, policies, and ideologies (ten Oever, 2020). Since this initial call for the study of boring things there has been a rising academic interest in understanding how infrastructures shape economic and social activities and how power gets inscribed and made durable in communication networks (Bowker & Star, 2008; Plantin et al., 2016; Parks et al., 2023). This paper will start by situating its research within internet governance scholarly debates on questions of power and counter-power. While Hesmondhalgh (2021) observed that many scholars follow Star's interest in the immaterial layer of infrastructure, its organisational cultures, norms, and standard-setting processes, the renewed interest in the materiality of media has also created space to theorise about the environmental impact of infrastructural objects, such as data centres or submarine cables (Starosielski, 2015; Edwards et al., 2024; Pasek et al., 2023). Despite these developments, these two strands of scholarship remain largely disconnected. This paper brings them into conversation with each other through Liboiron and Lepawsky's (2022) discard studies approach, to ask not only how sustainability is constructed within internet governance, but also how it is informed by larger social, economic, and political systems that shape the internet governance regimes.

Internet governance organisations, like the IETF, have since their emergence piqued the interest of social science scholars, as their policy and technical coordination shape how information flows across the world (DeNardis, 2013). Initial academic debates sought to delineate the roles and responsibilities of the different governance spaces and models (DeNardis, 2013; Mueller, 2010; Meier-Hahn, 2015). Van Eeten and Mueller (2013) observed that the interest in more formal global governance organisations overlooked how organisations that actually run and maintain code shape the internet. In this research, I build on the scholars who deepened these initial debates by more profoundly engaging with questions of power (ten Oever & Milan, 2022). As mentioned in the introduction, there are a number of interconnected internet governance bodies, each with their own mandate, governance structure, and decision-making processes, that ensure the internet continues to function. The IETF is characterised as a private internet governance regime that rejects government oversight (DeNardis, 2009; ten Oever, 2020).

and promotes the belief that technical governance bodies and the standards and protocols they produce are largely free from political influence (Cath & Floridi, 2017; DeNardis, 2014). The once lauded multi-stakeholder nature of some internet governance bodies, in which technology and policy are developed and governed through debate and dialogue among different stakeholders, has been critiqued for favouring those in power (Scholte, 2020). Specifically, the *who* of internet governance, including the over-representation of industry in internet governance debates, has become a point of contestation (Carr, 2015). The dynamic where industry is overrepresented is what Perarnaud (2025) calls corporate saturation, achieved through the consolidation of power and control in the application layer and, in some cases, across the entire stack by the major industry players. Here, companies have gained structural power over standard-setting processes, as these actors have the time, resources, and the technical expertise to participate in multi-year standardisation processes (Cath, 2022) and, like Google in the case of QUIC, have the capacity to develop the protocol and the network control to push the internet industry to adopt it (ten Oever, 2021). This allows certain companies to unilaterally develop and push certain standards.

The study of counter-power in internet governance bodies explored to what extent efforts to include public interest perspectives in technical and policy debates shifted power dynamics or ended up legitimising the existing order (ten Oever, 2020). Internet scholars have used the concept of public interest as a loosely defined concept that describes a governance approach that goes beyond economic logic (DeNardis, 2010; 2014; Maxigas, 2024). In part, the limited success of counter-power has been attributed to the fact that the institutional mandate of internet governance bodies is in line with private interests (Perarnaud, 2025), their norms form barriers to including public interest perspectives in standardisation processes (Cath, 2021), and, while these bodies are procedurally open, their organisational cultures are exclusionary. As Cath (2022) observes, “Distinct organisational cultures – from confrontational and ‘rough’ models of collaboration to the greater respect afforded to participants who work at large corporations – can impede, undermine, and discourage civil society participation”. Cath primarily looked at civil society exclusion from standard-setting processes, but influence from states or companies believed to be too closely affiliated with state interests is considered undesirable and at odds with the values of the open, interconnected, and free internet (Carr, 2015; Nanni, 2024; Rone, 2024). The study of exclusion illuminates how large corporations shape both the meta-governance of internet governance regimes and the specific standards and protocols according to their own interests. This paper builds on these insights by exploring how a new policy domain, that of

sustainability, is framed in global technical governance debates, by whom, and what this tells us about the role of internet infrastructures in society.

A material approach to the internet

In the cultural imagination, internet infrastructures have long been viewed as immaterial (Frenzel, 2023; Starosielski, 2015; Hu, 2017). To counter the imagination of the ephemeral cloud, scholarly debates on the environmental impact of media have rendered local infrastructural sites visible. Hogan's (2015) turn to a new material line of inquiry allowed her to theorise about the entanglements between natural resources and surveillance systems. Water, she argues, becomes more than a resource to be consumed; it is the non-human entity that unites contestation against surveillance regimes and makes infrastructures visible, material, and contestable. Similarly, other studies that looked at the relationship between non-human elements, water, energy, and land, and infrastructure have made the political entanglements of the data centre industry visible (Lehuedé & Valdivia, 2023; Rone, 2024; Velkova, 2026). Tracing the origins of infrastructural sites shows that they do not materialise out of nowhere; they are part of a long-term and often non-transparent negotiation between states and companies in which favourable tax, development, and political climate should entice companies to build their physical assets on a specific territory (Brodie & Velkova, 2021). In this process, the state actively facilitates infrastructural expansion while limiting democratic participation (Rone, 2024).

Alongside the ongoing governance struggle over environmental impact and resource allocation at infrastructural sites, scholars have examined how technology companies that dominate most layers of the internet position themselves as the solution to climate change while remaining largely silent about their own environmental impact (Mollen et al., 2026). Riemens (2025) called Big Tech's AI for sustainability claims *green platform capitalism*, where companies position themselves as the solution to environmental problems while simultaneously naturalising their own environmental impact. Sridharan (2026) analyses the same phenomenon, emphasising the commodification of climate issues, where Microsoft markets its cloud services as a decarbonisation tool and its AI products as enabling planetary-scale climate governance. This promise of AI for sustainability represents the continuation and acceleration of a longer history of techno-solutionism (Sætra, 2023). To contribute to these debates on the material conditions of internet infrastructures and the roles of the state and Big Tech companies in promoting a normative notion of sustainability, one in which the internet, the cloud, and AI are intrinsically connected to environmental solutions, this paper shifts attention to the technical

governance of the internet, where these claims are operationalised.

Following Liboiron and Lepawsky's (2022) discard studies approach, this paper understands technical internet governance not merely as the production of standards and protocols, but as a mechanism of power situated within a broader context in which ideas about sustainable infrastructures are shaped by dominant social norms and values. A discard studies approach invites researchers "to trouble the assumptions, premises, and popular mythologies of waste so discussions can address wider systems and power dynamics rather than remain mired in technological or moral fixes (Recycle more! Don't use plastic straws!) that deal with symptoms rather than origins of problems (Liboiron & Lepawsky, 2022, p. 6). Applied to internet governance, this approach asks what is not, or must be, discarded for the internet to continue operating and expanding. Juxtaposing the propositions that are deemed valuable with those deemed less valuable provides insight into how particular understandings of internet governance are produced and whose interests they serve. Liboiron and Lepawsky (2022) identify four dimensions of discarding that are particularly relevant to this paper: how a problem is defined, whether the solutions match the scale of the problem, who is held responsible, and where responsibility should ultimately be located. Through a thematic analysis of the written contributions to the e-impact workshop, complemented by observations from the workshop and its mailing list, this paper will tease out what is valued in discussions on sustainability and what is rendered disposable.

Methods

To gain insight into how the internet governance community accounts for the environmental impact of its infrastructure, this paper offers a thematic analysis of the position papers submitted to the IAB e-impact workshop held online in December 2022 (IAB, 2022). The position papers are a material artefact of the workshop, as invitations were only extended to those who submitted one. The sample represents the sustainability framing of a self-selected group of people who are familiar with the IAB and the IETF, and have an interest in and feel an urgency to reduce the environmental impact of the internet. The IETF community consists of 7,000 active participants, of whom only 82 authors submitted 26 position papers to this workshop. While this is not significantly less than the number submitted to most other workshops (IAB 2026), Anastacia (2025) found that sustainability still occupies a marginal position in technical internet governance debates. Still, the workshop signified a transformative moment in discussions on environmental harms as it created momentum for and shaped the IETF sustainability agenda. Furthermore,

the sample is considered representative of the worldviews embedded within the technical internet governance community, as the organisers and participants of the workshop are long-standing members and contributors to the IETF community, and the program committee chairs have served as IETF Chairs and been members of the IAB. After review by the programme committee, invitations were extended to everyone who submitted a position paper. The committee set the workshop agenda and invited those contributors whose topics were in the scope of the IETF mandate to present their papers.

For this paper, I conducted a thematic analysis of the 26 position papers submitted to the workshop. To attend the workshop, I also submitted a position paper, which I have excluded from the analysis. My attendance informed the analysis by allowing me to assess the relative prominence of different proposals by observing which participants were selected to present their ideas, which topics received attention during the workshop and on the e-Impact mailing list, and which concerns were dismissed. The submitted position papers range from comprehensive overview documents on the energy discussion in the IETF to short aspirational pieces on internet sustainability. The authors' affiliation allowed me to group the position papers as contributions from industry (13), academia (8), technical community (2), and an interdisciplinary team (3). The industry was represented by employees from telecom and technology companies, the technical community consisted of people from internet governance bodies, namely the Internet Society Foundation (ISOC) and the Regional Internet Registry for Europe, Middle East and Central Asia (RIPE NCC). ISOC is a global non-profit that advocates for an open and secure internet, and owns the Public Interest Registry (PIR) that manages the .org domain. RIPE NCC registers IP addresses and Autonomous System Number (ASN) for Europe and the Middle East and Central Asia. The interdisciplinary groups consisted of a mix of academic and industry representatives, and one submission was co-authored by a civil society organisation.

The thematic analysis is based on the six steps recommended by Braun and Clarke (2006) using the qualitative open-source data coding software Taguette. This process involves constantly moving back and forth between position papers, codes, and analysis. After an initial familiarisation with my data set, I started generating initial codes by highlighting specific data and leaving comments in the margins. This allowed me to organise my data and start to identify common themes (Boyatzis, 1998; Tuckett, 2005). After I coded all the position papers, I went back and recoded them to include insights and themes that emerged during the coding process across my entire data set. In the third phase, I grouped all codes and un-

derlying data into potential themes (Braun & Clarke, 2006). In a separate document, I clustered, grouped, and regrouped codes into possible themes and further refined the clusters by rereading all of them, assessing whether they formed a coherent pattern, and using observations from the workshop and mailing list to assess their prevalence in relation to my overall research questions. In the coding process, I looked for the affiliation of the authors; discourses around internet infrastructure and sustainability; problem framing; proposed solutions, the underlying assumptions and foreseen implementation challenges; external pressures; economic incentives; and responsibility, specifically how the engineering community defines the scope of their role and the IETF's role on this topic. This approach offered insight into how this group of internet practitioners frames the nexus between the environment and infrastructure, their problem statement and proposed solutions, before discussing what is missing from these technical visions of the internet.

Findings: internet exceptionalism, greening and growth

In this section, I surface the IETF community's normative understanding of sustainability. In particular, I will explore what is valued and devalued, or, said differently, how environmental problems and solutions are defined and which ideas and interventions are discarded for the internet to continue to operate and expand. I foreground the belief in the exceptionalism of the internet, the reduction of environmental impact to carbon emissions, and a focus on measurements, efficiency, and innovation, to show that the community proposes a narrow sustainability agenda that requires technical but not political action.

The participants of the workshop are part of a small and nascent community of internet engineers who are concerned about the environmental impact of the internet. They share an understanding that "climate change is considered the greatest current threat to human health [WHO]" (Arkko et al., 2022) and the "Internet both affects and is affected by the environment and climate change" (Robinson et al., 2022). As such the engineering community has a responsibility to act to ensure a sustainable future. In this section, I will first excavate their understanding of the internet vis-à-vis environmental harm, which informs their propositions on how to act.

In their papers, industry actors emphasise that while the internet has a direct negative impact on the environment, it has and will significantly contribute to the transformation and "greening" of other sectors. "Arguably, networks can already be

considered ‘green’ technology in that networks enable many applications that allow users and whole industries to save energy and become more sustainable in a significant way. For example, it allows (at least to an extent) to replace travel with teleconferencing; it enables many employees to work from home and ‘telecommute,’ thus reducing the need for actual commute; [...]” (Clemm & Westphal, 2022, p.2). The belief in the revolutionary potential of the internet to ‘green’ other sectors is echoed throughout the workshop submissions and forms the ideological starting point for all discussions on sustainability. After the initial caveat of its greening potential, the contributors to the workshop recognise that the promise in itself cannot offset the direct environmental harms of technology and that everyone has a part to play in solving the climate crisis. “Helping the decarbonization of other sectors cannot be an excuse for not addressing the carbon emissions of ICT – for our credibility, we need to master both” (Arkko et al., 2022, p. 3). In this call to action, the authors clearly demarcate the scope of their responsibility and by extension the boundaries of their intervention. Although the broader group acknowledged the wider impacts across the supply chain, an implicit consensus emerged to limit the scope to energy consumption and carbon emissions.

As one member of the technical community observed, “technical communities have been focused on growth, ‘progress’ & innovation since the start of the internet” (Manojlovic, 2022). This observation highlights a historically embedded value within the technical community, the belief that the internet’s continued expansion is both possible and desirable, and that negative externalities can be overcome through permissionless innovation. In line with Cath’s (2021) ethnographic observation that the IETF identifies permissionless innovation as a key principle alongside connectivity, interoperability, and innovation, concerns about the increased energy consumption and carbon emissions associated with network growth were frequently downplayed during heated debates at the workshop and on the mailing list. Participants argued that advances in hardware had historically decoupled network growth from environmental impact. Industry actors emphasised that “there is no correlation between electricity consumption and the exponential growth in the number of bits sent” (Arkko et al., 2022). The authors base this argument on studies that show that in the last 10 years, the energy consumption of mobile networks has increased moderately in comparison to the exponential growth in mobile data transmission. Additionally, it was noted on the mailing list in reflection to day 1 of the workshop that “we are in a much better state today than we were a decade or two decades ago, per bit (not per demand). A router chassis that was designed 2 decades ago and has taken 10KW was replaced a decade later by 1KW 4U box (with extra capacity)” (N. Zilberman, personal communication, June 12, 2022). This

reflects the belief that improvements in hardware efficiency have decoupled network growth from energy consumption. In addition, participants highlight how the network has become more energy efficient and greener with the increased use of clean energy alternatives. According to Arkko, Lövehagen, and Bergmark's paper (2022), greening further decouples carbon emissions from energy use and data growth. Similarly to other research on the ICT sector more broadly (Pasek et al., 2023; Riemens, 2025; Sridharan, 2026), this paper found that by framing the internet as exceptional, such that more internet is believed to make other industries more sustainable and not lead to more environmental impact, participants foreclose discussions on whether network growth in itself is the problem, limiting solutions to technical advancements.

Vanderbauwhede (2022), a professor and lead of the Low Carbon and Sustainable Computing activity at the School of Computing Science, University of Glasgow, challenged the assumption that network growth is inherently benign. Although he was not selected to present his ideas at the workshop, his position paper argues that this assumption is flawed for two reasons. First, it fails to account for the embodied carbon associated with hardware production. Second, he argues that historical improvements in hardware efficiency have provided the internet industry with little economic incentive to reduce energy consumption in networking. However, these efficiency gains are approaching their physical limits, as integrated circuits can no longer be scaled down indefinitely. Consequently, further growth of the network is likely to be accompanied by increased energy consumption. This point of view received little traction during the meeting as questions around hardware and its improvements were considered out of scope for the IETF.

Greening the internet: sustainability or an economic proposition

From the start, the internet was designed from an *always-on* assumption; “energy efficiency was only a secondary objective, if at all” (Jacob, 2022, p. 2). This quote signifies that the emerging interest in accounting for and reducing the energy consumption and carbon emissions of the network comes to fruition in a mature network that was built for resilience and security (Munn, 2022), rather than sustainability. Operating within these constraints, industry actors propose a number of practical ways to *green* the network, ranging from introducing protocols designed to reduce the volume of data to be transmitted, and removing redundant links and network equipment from the network topology, to experimenting with path-aware networking that steers traffic along paths with the smallest carbon footprint (Clemm et al., 2022; Retana et al., 2022). These optimisation efforts should allow the community to do “the same” in terms of the internet, only to ‘do it more ener-

gy efficiently at scale” (Greening of Streaming, 2022). In this section, I will specifically explore three solutions, measurement, carbon-aware networking, and sleep mode, which were presented at the workshop (IAB, 2022) and received attention during the workshop and on the e-Impact mailing list. These solutions foreground how the decarbonisation of the network is presented as a technical rather than a political solution.

Given the IETF's longstanding emphasis on technical solutions, considerable attention was devoted to measurement and standardisation. Carbon emissions measurement is seen as an important step in making the internet more sustainable. It stems from the belief that “you can’t improve what you don’t measure” (Krishnan & Pignataro, 2022). Participants agree that there is a knowledge gap; the size and decentralised nature of the internet, along with its entanglements with society and other industries make it difficult to gather accurate carbon emission information at scale. “The overall impacts of ICT on the environment is complex to derive” (Arkko et al., 2022, p. 2), and “quantifying and managing the emissions related to network transfer has historically been much harder, as so many intermediate actors are involved in supporting connections between two or more parties” (Adams et al., 2022, p.4). This information deficit is attributed to a lack of access to reliable information and the absence of shared agreements or standards within the internet governance community on how and what to measure (Anderson et al., 2022), and is considered a barrier to taking the appropriate measures to combat climate change. By connecting the focus on measurement and standardisation to Andrejevic’s observation that data-driven governance involves “a persistent attempt to collapse the political into the technical, as if the solution to societal and political conflicts were simply a matter of imperfect information” (Andrejevic, 2020, p. 101), it becomes apparent that sustainability can be advanced through the implementation of technical solutions without addressing broader questions concerning values, power, and competing interests.

Two aspirational propositions, path-aware or carbon-aware networking and sleep mode, were presented at the IAB workshop and illustrate the underlying rationalities that are actively being shaped. Carbon-aware networking aims to optimise internet traffic by routing it along *greener nodes*. It envisions a system that has the “ability to adjust its behaviour in response to changes to the carbon intensity of the electricity it consumes” (Adams et al., 2022, p. 1). Its inspiration stems from large data centre operators who employ carbon-aware computing, shifting non-time sensitive computational processes to times or locations where cheap green energy is in abundance (Adams et al., 2022; Schooler et al., 2022). The authors

who proposed the idea justified investment in this type of networking solution in economic terms, drawing a parallel to carbon-aware computing, where larger cloud providers have been able to access cheap renewable energy sources that might otherwise go unused or cause instability in the energy grid (Adams et al., 2022, p. 4). After setting the scene, the papers and discussion quickly focused on the engineering challenges that need to be solved to actualise this solution; it requires freely available and accurate information about the carbon intensity of different nodes in the network (Adams et al., 2022), a standard to include this information in the header of IPv6 packages, and a protocol that privileges routing traffic along greener paths in real-time. As such, investing in solutions such as carbon-aware networking is justified on economic grounds and becomes an interesting engineering problem that allows the community to act sustainably in a global network and connect solutions to existing industry developments like IPv6. However, this approach does not account for the territories, energy politics (Velkova, 2026), or the communities that host these *greener* or *dirtier* nodes.

There is a general understanding that the “largest gains can be made when network resources can effectively be taken off the grid” (Clemm et al., 2022, p. 6) or placed in sleep mode (Jacob, 2022). Theoretically, shutting down idle devices should diminish the total volume of energy consumed by the network, but it is an approach that raises significant concerns. For example, how would the network know which node is in sleep mode without pinging it and *waking it up*, which would be counterproductive as it costs more energy to power a device than to keep it running (Clemm et al., 2022)? While some argue that hardware innovation, such as chip manufacturing that allows for *microsleep modes* (Arkko et al., 2022) and hardware redesign that allows devices to power up faster (Jacob, 2022), might solve some of the challenges, the concept of sleep mode was not uncontested. The pursuit of sustainability through powering down network nodes creates a fundamental tension with the core values of the internet governance community, the desire to have an internet infrastructure that is always-responsive in nature and designed for speed, efficiency, and resilience (Munn, 2022). This points to the reality that internet governance consists of the continuous weighing of different priorities according to the norms and values embedded within its community.

An ideology based on infinite growth and an abundance of resources

The emergence of sustainability discussions in the IAB and IETF is part of a broader trend in which the technology industry is accounting for its environmental im-

pact in a number of ways. This is evident from industry discourse that actively shapes the cloud as a sustainability solution (Sridharan, 2026), sustainability reporting, and the industry's climate pledges (Kazansky & Kekana, 2023; Vrikki, 2024). In analysing the IAB contributions, it is clear that the climate and ecological crises are sparking genuine concerns, and community members want to understand how they can contribute to ensuring sustainable futures. Yet, there are limits to what the solutions can achieve as they frame sustainability as something that is technically manageable. I will use the Liboiron's (2014, 2021) concept of scalar mismatch to argue that 1) the solutions do not engage with the violence and pollution of the network, or the relationships that matter; 2) the scarcity of natural resources required to build and operate the internet is discarded from sustainability debates; and 3) sustainability approaches are actively shaping underlying justification regimes for internet growth in a world in crisis. These insights shed light on the norms and values that underpin the governance regimes of the internet, those of infinite growth and an abundance of resources.

Scalar mismatch describes a process in which interventions do not match the scale at which the problem is produced (Liboiron, 2014; 2021). The term scale is not used by Liboiron (2021, p. 84) in the traditional economic sense but in relation to governance processes, to identify the relationships that matter within a particular context, which will determine the pathways for action. Here, the relationship that matters can be understood as the social, political, and economic processes, as well as the actors and interests, that shape a specific industry or context and therefore constitute the most important site for addressing the larger problem. Instead of focusing on harm reduction, which limits solutions to determining how much pollution is deemed acceptable, scalar mismatch invites us to look at the problem from a different perspective and asks what the origins of potential harms are, how they might be influenced, and who has the power to intervene. Returning to the example of waste, rather than focusing on recycling, an intervention at the end of the supply chain, Liboiron and Lepawsky (2022, p. 41) argue that the relationship that matters is plastic production itself. This shifts responsibility upstream, placing it on the governance of industrial production and not on changing consumer behaviour. From this perspective, sustainability demands must address those spaces and actors that have the power to address the larger problem. In the context of internet governance, I use Liboiron's concept of scale and scalar mismatch to trouble the norms and values that inform the IETF's current sustainability approach. I argue that by framing sustainability as the quantification and optimisation of the network's energy consumption, it reproduces a dominant narrative aligned with the interests of the internet industry. In doing so, it avoids engaging with the more

fundamental problem that the network itself is polluting. Following Liboiron (2014; 2021), identifying the relationships that matter requires understanding sustainability efforts as a technique of power that privileges certain interests at the expense of others.

The emphasis on measurement and optimisation focuses on the technical (Andrejevic, 2020) and hides the economic incentives to grow the network from view. An economic rationale that has shaped the internet is known as Metcalfe's law, which holds that when networks grow, the cost for each new node increases linearly but the value of the network increases exponentially (Swann, 2002). Thus, the value of an infrastructure, and the services that run on top of it are believed to be intrinsically connected to its market share and the volume of users, nodes, and data. Growth as a central value (Cath, 2021; Jansen, 2023) is achieved by developing new internet services, expansion of the network to new geographical areas, and increasing the number of users and connected objects. When the internet grows, it grows in multitudes, designed to be always-on and built for redundancy to prevent the loss of connection and services (Munn, 2022). For example, packets are routed in multitudes across different paths, networking equipment is configured for peak load and with a backup option, and emergency power supplies are designed to keep everything, including non-essential services, running at all times. None of the contributions in the IAB workshop addressed the network or its growth as an issue, or as a relationship that matters. By describing the scale of the problem incorrectly, they unintentionally narrow the scope for meaningful intervention, running the risk of redirecting attention away from the underlying causes of environmental harms, and delaying much-needed climate action while continuing to promote the internet as a sustainability solution.

My findings illustrate that while there was a brief acknowledgement of the various ways pollution and harm manifest throughout the internet supply chain, issues concerning natural resources were considered outside the mandate of the IETF and occupy a marginal position in its debates on sustainability. The representation of internet infrastructure as immaterial in the cultural imagination (Starosielski 2015; Frenzel 2023) can explain why the general public does not connect technology to the environmental harms associated with the mining of critical raw materials, hardware manufacturing, and e-waste (Bridges, 2023; Falk et al., 2024; Gabrys, 2011). It cannot explain why the engineering community, which is deeply connected to the materiality of internet infrastructure, discards supply chain issues. I draw on Hultman et al. (2021) to argue that the discarding of natural resource extraction in sustainability discussion is not a specific feature of internet governance,

rather, it is an expression of a wider dynamic of *resourcification*. Industrial production in a capitalist society revolves around turning things into resources for extraction and accumulation. Resourcification, a term coined by Hultman et al. (2021), refers to the process through which resources do not just come into being; economic value is created through social processes, by actors seeing the potential of a resource and creating demand for it. The process of resourcification can only be achieved by slowly sacrificing certain Lands for the economic and social prosperity of other areas (Juskus, 2023). In sustainability discussions, these social processes are taken as a ground truth, which provides grounds to disengage from the notion of violence and harm caused by extractive processes in the supply chain, or they are justified by the rhetoric of progress. Thus, while internet governance in whatever form is far more intrinsically connected to questions of resources than is often acknowledged, the social process of resourcification detaches sustainability debates from the material reality of routing and perpetuates a worldview in which there are enough resources to power and grow the internet.

In priming the sustainability discussion with the caveat that the internet is crucial for the decarbonisation of other industries, the internet governance community is actively shaping underlying justification regimes for internet growth in a world in crisis. To locate this observation within the underlying structures that shape society, I build on ten Oever and Milan's (2022) approach to the study of internet governance organisations and standards processes as a study of power. The authors built on Weber (1968) and Peet (2007) to argue that internet infrastructures are not merely defined by the power struggles within the market, state, and citizen nexus but are shaped by ideology, that is, the dominant social norms and values that allow power holders to justify their position and actions (Beetham, 1991a: 1991b). As my findings show, the IETF community's construction of the internet as exceptional and indispensable to social progress serves to justify the violence of extraction and pollution. By aligning itself with dominant narratives of progress, it positions the continued expansion of internet infrastructure as a prerequisite for achieving a sustainable future (Jansen & Thorne, 2024; Sridharan, 2026). This positioning is the continuation of a long line of techno-solutionist approaches where the emphasis is on innovation rather than change (Sætra, 2023). Cath (2021) has shown that in internet governance imagination growth and innovation are intrinsically tied to each other. The internet is imagined "as an inherent good whose availability depends on uncurbed growth and a non-prescriptive ethos" (Cath-Speth, 2021, p. 17), a belief that prevents critical engagement with the question *how much internet do we actually need and at what cost?*, and embeds justification regimes for growth in narratives around innovation and progress as central to sus-

tainability approaches.

Conclusion

In this paper, I show how the study of sustainability approaches offers a lens through which to understand the politics of internet governance regimes. In light of geopolitical uncertainty, the climate crisis, and rising energy prices, it is important to understand sustainability efforts as an attempt to create stable conditions for the network to continue to function. The concept of scalar mismatch helps to situate technical internet governance within a wider system of power. In the age of the Anthropocene, where human activity continues to have a devastating impact on our planetary system, the problem definition presented at the IAB workshop suggests that the internet governance community has yet to come to terms with the idea that the network, and its continuous expansion, constitutes part of the problem. As a result, the internet industry's proposed sustainability interventions operate at the wrong scale, they optimise the effects of network growth while leaving its underlying drivers and sources of environmental harm unchallenged. These insights allow me to theorise that the norms and values of infinite growth, an abundance of resources, and sustainability through innovation shape the governance of the internet and justify its existence and growth in a world in crisis. In addition to contributing to discussion of power and governance in internet governance, this paper outlines a future research programme at the intersection of infrastructure studies, environmental social science, and internet governance studies. Such a research programme would examine internet governance as a locus of power that shapes the terms on which environmental harms and sustainability are understood. Further research is needed to identify the relationships that matter and the scales at which they can be governed in order to unsettle the social, political, and economic interests that legitimise the internet's continued growth despite its environmental harms.

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