Article

Measuring Up? The Illusion of Sustainability and the Limits of Big Tech Self-Regulation

Photini Vrikki

Department of Information Studies, Faculty of Arts and Humanities, University College London, London WC1E 6BT, UK; p.vrikki@ucl.ac.uk

Abstract: This paper offers a critical analysis of the 2023 sustainability reports of five major ICT corporations: Amazon, Apple, Google, Meta, and Microsoft. It scrutinises how these organisations use sustainability data, particularly within the context of their actions, their planned initiatives, and visions for the future to report on three overarching sustainability narratives: 1. Reducing the climate footprint of their own operations; 2. Influencing and reducing the climate footprint of their supply chain and consumers; and 3. Financing innovation for climate change. Despite all five corporations expressing a commitment to sustainability and confronting climate change, their specific actions and planned initiatives differ, influenced by their core businesses and existing sustainability practices. This becomes more apparent in their choice to use their own intricate measuring infrastructures for self-tracking and self-reporting environmental data. Such infrastructures, although purportedly aimed at showcasing progress towards sustainability goals, face scrutiny due to their lack of transparency and the potential for manipulation and greenwashing, especially given the lack of standardised reporting protocols within the sector. This analysis highlights that, despite these companies' claims of commitment to carbon neutrality, their climate pledges and sustainability goals are rarely achieved. In this framework, this paper suggests that a critical approach is essential when evaluating Big Tech's often deceptive sustainability narratives and underscores the need for more rigorous regulatory frameworks and independent third-party audits to ensure genuine progress towards a sustainable future and true accountability.

Keywords: climate change; measuring infrastructures; sustainability; sustainability narratives; greenwashing

1. Introduction

Climate change is considered one of the key current challenges faced by humanity. Global warming will result in a sharp reduction in farmland, climate migration, more frequent and severe natural disasters, and biodiversity losses; it threatens the existence of small island nations and questions the liveability of future Earth. Based on UN estimates, the pace of sea level rise has doubled over the past decade, and the world is likely to surpass the critical level of 1.5 C temperature rise by 2035 [1]. By setting Sustainable Development Goals (SDGs), the international community has broadly recognised the challenge of climate change, with the UN proclaiming urgent action to combat climate change and its impacts. Beyond global and national efforts, whole industries are called upon to commit to the SDGs and the fight for a better future for the planet. One of those industries, Information and Communications Technology (ICT), has become one of the industries attracting attention due to the high electricity consumption of data centres. ICT contributes about 3% of global GHG emissions, comparable to those produced by the aviation sector, and in this context, large ICT companies like Amazon, Apple, Google, Meta, and Microsoft have promoted the idea of transforming the sector from a net source of climate change to a net source of solutions for other industries and households through climate

pledges, the development of measurement infrastructures, and annual sustainability reporting [2]. However, recent analysis indicates that, from 2020 to 2022, the actual emissions from Google's, Microsoft's, Meta's, and Apple's data centres are estimated to be approximately 662%—or 7.62 times—higher than the emissions reported in their official disclosures [3].

Self-regulated sustainability reporting has historically allowed big corporations such as Amazon, Apple, Google, Meta, and Microsoft to deploy creative accounting through their own measuring infrastructures, to develop and promote their environmental, social, and governance (ESG) plans. Having control of these infrastructures translates into having control of the metrics they produce and ultimately the narratives these data convey. Wrapped within greenwashing, Big Tech's sustainability tactics unveil how self-regulated measuring infrastructures go beyond the pervasiveness of greenwashing practices, to also support the control of the systemic process of auditing and reporting. By evaluating Big Tech's climate pledges, actions taken, actions planned, and their vision for the future, this paper questions the measurement apparatuses created by these companies and unpacks the deceptive narratives they relay. Examining how the context-specific development of sustainability reports might influence broader sustainability practices and outcomes, this paper asks: can we distinguish between sustainability narratives (deceptive or not) and genuine commitment to sustainability?

2. Beyond Greenwashing: Sustainability Reporting, Financial Performance, and Corporate Responsibility

Before evaluating whether Big Tech's sustainability is an illusion, we need to first outline the circumstances that have allowed this shift of reporting power to Big Tech companies. This unpacking begins from the growing prevalence of greenwashing, a marketing tactic used by corporations to create an appearance of environmental responsibility without substantive evidence to support their claims, and which tends to cultivate a false sense of ecological commitment [4]. This tactic often involves making unverified or exaggerated claims about the environmental benefits of products and companies, prioritising a "green" image over actual attempts to reduce environmental impact, driven by factors such as market competition, regulatory pressures, organisational incentives, and individual choices [5]. Greenwashing frequently hides behind claims of corporate responsibility and sustainability, allowing companies to appear environmentally conscious without making meaningful changes. Indeed, corporate responsibility and sustainability have become critical pillars in modern business practices, as companies increasingly recognise the need to balance profitability with ethical and environmentally conscious actions [6].

Corporate Social Responsibility (CSR) has seen substantial evolution since its early discussions in the 1950s [7], gradually broadening to include environmental sustainability as a core objective [8,9]. However, as Bansal and Song [10] argue, while CSR and sustainability are interconnected, they are distinct concepts that necessitate separate approaches. Both frameworks reflect societal shifts and influence the strategic direction of corporations [11,12], but CSR primarily addresses the ethical and moral responsibilities of businesses to society, while sustainability focuses on mitigating corporate impacts on ecological systems. This has led to a surge in research related to both concepts. More specifically, the analysis of sustainability report content and the development of methodologies to automate such analysis [13] has been gaining ground recently. Studies vary in their scope, ranging from in-depth case studies of individual company reporting [14] and investigations into single environmental metrics [15] to broader analyses aggregating reporting data across sectors [15], company sizes, and countries [9]. Work by Strielkowski et al. [16] for example, assessed sustainability reports based on "(i) the extent of reporting, (ii) quality of reporting, (iii) achieved results and (iv) envisaged actions". Comparative studies, such as Tešovičová's and Krchová's [17], examine the alignment between corporate environmental goals and global targets, as well as preferences for actions prioritised at different geographical scales. Along the same lines, Ramya et al. [18] determined that there is

limited acknowledgment of climate change within these reports, while Machado and Carvalho [19] found significant alignment between the companies' stated goals and the internationally recognised sustainability targets, with "seven of the nine companies" explicitly incorporating the SDGs into their strategies.

A review of the extant literature on sustainability reporting reveals a predominant scholarly focus on the presumed correlation between sustainability reporting and financial performance. Existing research tends to centre on sustainability reporting practices in both developed economies—such as the United States [20], the United Kingdom [21], and various European Union member states [17,22–24]—as well as in emerging economies, including India [14–16], Indonesia [24], and Vietnam [25]. These regional and national perspectives commonly address questions regarding how leading corporations implement green initiatives, assess the financial implications of such actions [20,22–28], and the extent to which these initiatives contribute to corporate growth or create value for firms [27,29]. The emphasis on the financial impact of environmentalism has inadvertently led to a neglect of critical aspects, particularly the content of sustainability reports themselves and the actual progress made by companies in achieving their declared sustainability goals. Frameworks such as Environmental, Social, and Governance (ESG) and Global Reporting Initiative (GRI) have majorly contributed to this repositioning of the field.

On the one hand, recent research highlights the growing importance of Environmental, Social, and Governance (ESG) practices in business, which are increasingly adopted to generate value for stakeholders and achieve SDGs and protect industrial operations while keeping carbon emissions low [30]. Governments in Europe have identified social innovation, circularity, and energy transition as key components of ESG practices [31], while in China ESG tactics have grown substantially under a top-down framework, with research focusing on corporate disclosure, performance, and investing [32]. ESG practices create value for businesses through risk management, information dissemination, and strategic approaches, with macro, meso, and micro factors moderating their impact [33]. On the other hand, the GRI framework offers a wide array of indicators, allowing companies to select from numerous metrics to represent their environmental impact. While the flexibility of choice provides companies with a toolkit to address varied sustainability aspects, it also masks the criteria and rationale guiding these choices. This lack of transparency raises important questions about the consistency and comparability of sustainability data and reports across companies, suggesting that what appears as standardised reporting may reflect divergent priorities and an illusion of sustainability. The variability in metric selection and disclosure practices complicates efforts to accurately assess corporate environmental accountability across different organisational contexts. This reporting flexibility comes in stark contrast to the more stringent and standardised protocols governing other data-dependent industries.

More specifically, scholars who advocate for more rigorous environmental standards are requesting a closer alignment of sustainability reporting with the established paradigms of traditional and massively regulated industries such as financial auditing. A key concern of that alignment is that increased sustainability regulation could inadvertently detract focus from corporations' efforts to address environmental issues directly or worsen the problem of underreporting carbon emissions, particularly in developing nations [34]. In this light, proposed alternative strategies suggest the enhancement of accountability for sustainability targets, including integrating sustainability considerations directly into strategic corporate planning [22,35], with some researchers weighing the potential of stakeholder activism to pressure companies into honouring their sustainability commitments [20,36]. By holding corporations accountable through public scrutiny and engagement, scholars suggest that stakeholders can contribute to ensuring that reported sustainability attempts translate into tangible actions.

Despite various studies demonstrating contrasting results in terms of the association between corporate sustainability reporting and financial performance or market value, recent studies suggest that companies' significant investments in sustainability initiatives

are primarily motivated to improve financial performance and increasing corporate value, rather than purely environmental or social impact [26]. When comparing between responsibilities and societal expectations, a clear division of roles emerges, whereas companies are primarily expected to focus on profitability, while sustainability experts are tasked with demonstrating and enabling the economic viability of sustainable practices. Simultaneously, consumers and individuals are expected to support these practices through conscientious purchasing decisions. This market-oriented perspective suggests that, when each group fulfils its designated role, the market will naturally align economic interests with sustainable outcomes.

Weighing the current scholarship, sustainability research often falls into the trap of the ideological superiority of metrics, neglecting to critically reflect on how this implementation of self-regulated measuring infrastructures in decision-making processes has subtle yet significant implications. Conversely, this paper offers a critical evaluation, calling attention to the need for future research to move beyond financial performance and sustainability metrics to delve deeper into the specific content of sustainability reports and unpack the sustainability narratives they perpetuate, as a practice that benefits corporations' interests to the detriment of climate change. Closer examination of actual progress towards achieving stated goals, particularly regarding climate change, is crucial. The reliance on developing and deploying measuring infrastructures raises important questions about the nature of expertise, the politics of knowledge production, and the power dynamics inherent in data-driven sustainability decision-making processes. The current state of research underscores the need for a more nuanced understanding of how these infrastructures are developed, interpreted, and deployed in various contexts, and the potential consequences of their uncritical acceptance. By reviewing the climate pledges made by some of the largest ICT companies in the world, including a review of current achievements, and identifying priority areas for further actions aimed at making the ICT sector greener, this paper attempts to provide an understanding of the deceptive sustainability narratives purported by Big Tech.

3. Exploring the 2023 Sustainability Reports

This study is based on qualitative content analysis of the 2023 sustainability reports issued by five of the largest ICT corporations founded in the US (but with global impact): Amazon, Apple, Meta, Google, and Microsoft (Microsoft's 2023 Impact Summary [37], Apple's Environmental Progress Report [38], Google's Environmental Report 2023 [39], Amazon's Sustainability Report 2022 [40], Meta's 2023 Sustainability Report [41]). While reports from 2023 are available for Apple, Meta, Google, and Microsoft, Amazon's different reporting cycle means only their 2022 report is accessible at the time of this study. This single-year snapshot was chosen to provide the most current view of these companies' sustainability discourses and practices and reports were selected for their comprehensive coverage of each company's climate-related strategies and their comparability across the tech industry. This analysis acknowledges the potential limitations of not examining longitudinal trends, but the comparability is enhanced by the companies' adoption of standardised frameworks for sustainability reporting which ensure that the reports address similar areas including energy consumption, waste management, resource use, and greenhouse gas emissions.

The analysis focuses on identifying and interpreting key discursive patterns and framing techniques used by these companies in discussing their climate commitments. This method allows for an exploration of how these influential tech giants construct and communicate their climate responsibilities, revealing underlying assumptions, priorities, and potentially deceptive data narratives. Three steps were taken for this method. The first step begun with a preliminary reading of the companies' reports to establish an initial set of coding categories that help organise the analysis. This first reading was broad and exploratory, aiming to identify the main themes present in the reports. Through this process, three initial coding categories were identified: "actions taken", which includes

specific, concrete steps the company has already implemented (such as reducing emissions or investing in renewable energy); "planned initiatives", which outlines the upcoming strategies or commitments the company intends to undertake in the near future; and "future visions", encompassing aspirational goals and long-term visions, often speculative, about the company's ideal climate impact.

The second step involved an iterative process of re-reading the reports with increasing attention to detail, refining these initial categories, and deepening the analysis. This phase focused on closely examining the language used to communicate climate commitments, as well as the narrative structures and framing techniques employed. Specifically, attention was paid to the tone and specificity of the language, looking at whether the companies use assertive, confident statements (e.g., "we will achieve") or more cautious, conditional phrasing (e.g., "we aim to achieve"). The analysis also examined how issues were framed—whether companies foreground certain metrics like carbon reduction percentages or renewable energy usage while downplaying other less favourable metrics. Additionally, the narrative structure is scrutinised, assessing how climate responsibility is positioned within the broader company mission and whether the reports suggest a holistic approach or isolated initiatives.

This iterative process enabled a refined understanding of each company's climate discourse, revealing three overarching sustainability narratives: 1. Reducing the climate footprint of their own operations; 2. Influencing and reducing the climate footprint of their supply chain and consumers; and 3. Financing innovation for climate change. These narratives showcase underlying assumptions, priorities, and potential gaps or inconsistencies in these companies' climate pledges, providing insights into how they portray uniform or different approaches to a sustainable future. These narratives present how corporate engagement with sustainability metrics extends beyond the development and deployment of measuring infrastructure, to companies trying to influence and shape the choice of metrics to align with their specific business models and public image [42]. By evaluating these strategic approaches, this paper explores the evolving nature of such flexible metrics, where sustainability metrics are not neutral processes but subject to corporate interests and influence. By identifying Big Tech's increasing reliance on illusive sustainability, the following sections reveal how these influential companies frame their past and future contributions to solving the global issue of climate change and their varied actions to attain measurable objectives related to climate change.

4. Big Tech Climate Pledges: Vision of the Future and Sustainability Narratives

4.1. Vision of the Future in Sustainability Reports of Big Technology Companies

The analysis of corporate reports reveals a common emphasis on climate change within the future visions articulated by all five companies examined. Corporate narratives frequently centre on the notion that implementing sustainability pledges will contribute to a "solution"-oriented future (Apple), for a "healthier" (Meta, Amazon) and "more sustainable" (Microsoft, Google) planet. All five companies acknowledge the significance of the climate challenge, with Microsoft explicitly referring to it as a "defining issue of our generation", expressing confidence that "meaningful climate progress is possible" without sacrificing prosperity and growth [37]. This shared focus underscores a strategic alignment among these tech giants, highlighting how addressing climate change has at least entered long-term corporate visions and sustainable growth strategies.

Beyond identifying the problem, Google plays up the technical challenges involved in making reliable information accessible to address climate change and at the same time stresses the importance of innovation in overcoming these obstacles [38]. Amazon too positions innovation as a catalyst for climate solutions, envisioning technologies that can "scale fast to help set our planet back on the right track" [39] and underlines the long-term health and sustainability of future communities. Meta's vision underscores the need for an inclusive and equitable approach to climate mitigation, advocating for "a just and

equitable transition to a zero-carbon economy" and collaborative attempts that ensure the benefits of climate solutions reach all communities [40]. To realise their respective visions for the future, the companies leverage unique strengths: Amazon spotlights its vast scale, while Google, Meta, and Amazon focus on their culture of innovation. Specifically, Google and Microsoft cite the potential of artificial intelligence (AI) and other cutting-edge technologies in reducing emissions and carbon removal. As seen in Table 1 below, corporate objectives related to climate change demonstrate a synthesis of future aspirations and past progress.

Table 1. Corporate objectives related to confronting climate change.

Company	Objective
Amazon	"Achieve net-zero carbon emissions by 2040—10 years ahead of the Paris Agreement" [40]
Apple	"We're already carbon neutral for our corporate operations, and we've set a goal to become carbon neutral for our entire product footprint by 2030. We plan to get there by reducing our emissions by 75 percent compared with 2015, then investing in high quality carbon removal solutions for the remaining emissions" [38]
Google	"We're helping to lead the transition to a more sustainable future by making information accessible and by driving innovation forward" [39]
Meta	"Take bold climate action by minimising our footprint, championing renewable energy, restoring water resources, engaging our suppliers and supporting climate justice" [41]
Microsoft	The overall objective is to become carbon negative. "Addressing [climate change] requires swift, collective action and technological innovation. We are committed to meeting our own goals while enabling others to do the same. That means taking responsibility for our operational footprint and accelerating progress through technology" [37]

4.2. Reducing, Influencing, and Financing Climate Solutions Through Sustainability Narratives

The analysis of corporate sustainability reports published by Amazon, Apple, Meta, Google, and Microsoft also helped identify the actions taken and planned by these companies to confront climate change. Overall, such actions may be divided into three broad narratives that are quantified through in-house measuring infrastructures: 1. Reducing the climate footprint of their own operations; 2. Influencing and reducing the climate footprint of the supply chain and consumers; 3. Financing innovation for climate change (Table 2).

Table 2. Actions and sustainability narratives by Amazon, Apple, Google, Meta, and Microsoft. *** action highlighted as a priority, ** action that received significant attention, * action mentioned in the report.

Action	Amazon	Apple	Google	Meta	Microsoft
Reducing climate footprint of own operations					
Implementing energy efficiency measures in the offices and at production sites	***	***	*	*	**
Measuring carbon footprint	*	***	***	*	***
Using low carbon raw materials		***		***	
Producing energy-efficient products	***	***			
Increasing the life cycle of products and promoting circularity				***	

Providing cloud solutions that help save energy and hardware for data storage and processing	***				
Influencing and reducing the climate footprint of the supply chain and consumers					
Engaging with suppliers to reduce carbon emissions	***	***		**	***
Providing tools supporting more sustainable choices by business and individuals			***	***	
Providing tools for managing climate-related risks and strengthening resilience			***		
Financing innovation for climate change					
Contracting renewable energy	***	***	***	***	***
Investing in innovative technologies and solutions aimed at reducing carbon emissions and carbon removal	***	**	***	*	***
Using low carbon fuel and low carbon transport modes	***		*	***	
Ensuring residual carbon removal		**		**	
Supporting communities vulnerable to climate change			***		

This analysis demonstrates that, while all five companies pledged to contribute to sustainability and confront climate change, the set of specific actions taken and planned by them still varies and depends on the impact to their core businesses. To support the narrative of *reducing the climate footprint of their own operations*, all companies report on energy efficiency measures and the measurement of their carbon footprint. Not surprisingly, all companies studied mention the need for better measurement of carbon emissions and help developing measurement infrastructure. As noted by Amazon:

> "to reduce indirect emissions, it's important to be able to measure them accurately. We support and fund industry partnerships to gather more accurate data, including the Embodied Carbon in Construction Calculator (EC3), which helps measure embodied carbon in buildings, and the Smart Freight Centre's Global Logistics Emissions Council (GLEC) Framework, a globally recognised methodology for measuring freight transportation emissions" [40].

In pursuit of the Sustainable Development Goals (SDGs), these major technology companies have developed a wide range of measurement tools and frameworks. In 2022, Google introduced the Carbon Sense Suite, which includes products such as Carbon Footprint and Active Assist and enables users to accurately measure, report, and reduce their cloud-related carbon emissions. Microsoft is actively using lifecycle assessments and environmental product declarations to monitor carbon emissions of its suppliers and Microsoft reports on advancing AI solutions for greater positive climate impact and support by creating tools for more precise emissions measurement and compliance.

Beyond the measuring apparatuses, Apple, Amazon, and Meta list some actions related to using sustainable materials in products and packaging, reducing the materials in construction and hardware as well as using innovative low carbon materials, extending the product lifetime, and promoting product circularity. Apple also highlights the practice of using low carbon raw materials for production, including recycled materials (aluminium, steel, and gold). On top of this, Amazon Web Services offers cloud solutions, estimating that their use can reduce consumer workload carbon footprints by nearly 80% compared to on-premises computing. At the same time, Apple and Amazon tend to play up actions related to the increased energy efficiency of their products. For instance, "Apple TV 4K is designed to use nearly 30 percent less power than the previous generation while

achieving more powerful performance" while "iPhone 14 uses 57 percent less energy than the U.S. Department of Energy's requirements for battery charger systems" [38]. Amazon products and services also claim to help reduce GHG emissions from users. For example, in 2022, Amazon launched AWS Trainium, a high-performance machine learning chip designed to reduce the time and cost of training generative AI models—cutting training time for some models from months to hours. This, according to them, means building new models requires less money and power, with potential cost savings of up to 62% and energy-consumption reductions of up to 29%, versus comparable products [40].

With the narrative of *influencing and reducing the climate footprint of the supply chain and consumers*, Big Tech attempts and engages suppliers in climate change initiatives and actions. For instance, Microsoft purports that, in 2022, 94% of Microsoft's in-scope suppliers provided their reports, where 40 new suppliers transitioned to using renewable energy, with 12 of those transitioning to 100% renewable energy, avoiding 113,000 metric tons of carbon emissions. Microsoft has also updated its Supplier Code of Conduct sustainability requirements to include independent third-party assurance of emissions data and to deliver a minimum of 55% GHG emissions reduction by 2030. To achieve this target, Microsoft works with its suppliers using lifecycle assessments and environmental product declarations to assess carbon hotspots and carbon in the equipment purchased [37]. In similar practice, Apple argues that "$8.9 millions of investments have been made in supplier efficiency projects using the Asia Green Fund" [38] and the participation of over 100 supplier facilities in the energy efficiency programme helped avoid 1.3 million metric tons of carbon dioxide equivalent (tCO2e). According to Apple, their engagement with suppliers on climate issues has led to impressive results, with carbon emissions across Apple's value chain reduced by over 45% since 2015 [38]. These assessment infrastructures imposed on their suppliers' and value chains stresses how sustainability narratives may also be a conduit to overstate engagement with GHGs by extending the responsibilities beyond the corporation itself and onto third parties.

While reducing their own carbon footprint is seen as important, large tech corporations report that their role is also leveraging their technology and knowledge for enabling businesses and individuals to contribute to reducing carbon emissions. Akin to the strive to involve the value chain, Google spotlights that a substantial portion of its carbon footprint originates from user activity. Consequently, their sustainability initiatives also focus on using technology and experience to enable businesses and individuals to conserve energy and adopt environmentally friendly solutions, e.g., offering the Google Cloud platform, which assists in optimising hardware and energy consumption or Google Nest that uses machine learning (ML) for collective savings of energy and for stimulating the consumption of cleaner energy to "help customers save more than 26 billion kWh of energy [39]—more energy than Google used in the same year" [39].

And finally, the narrative of *financing innovation for climate change* heavily relies on contracting renewable energy, funding investment in technologies, and supporting global and local initiatives. Apple claims to currently source 100% renewable electricity for its facilities, relying on carbon offsets for any remaining emissions [38], and Google reports that 64% of its energy use is currently carbon-free, with an ambitious goal of reaching 100% renewable energy across all operational grids by 2030 [39]. Likewise, Amazon calls attention to the fact that 90% of its electricity consumption in 2022 originated from renewable sources, with ongoing involvement in 401 renewable energy projects across 22 countries [40]. Meta also underlines its commitment to 100% renewable energy for its data centres and offices [41], while Microsoft reports significant investments in renewable energy, exceeding 135 projects across 16 countries [37]. However, as it will be discussed later, this argument raises the question of whether the carbon offsets and renewable energy they rely on are truly effective in mitigating emissions, or if they merely serve as a symbolic gesture without delivering genuine environmental impact.

Amazon's, Microsoft's, and Google's report company investments in breakthrough technologies and solutions aimed at reducing carbon emissions and carbon removal. For

instance, Google provides USD 25 million in funding to the programme AI for the Global Goals, supporting the development of new AI-driven approaches that accelerate progress on the UN SDGs. In 2021, Google also launched a Startups Accelerator on climate change. The first three cohorts included 33 North American startups which raised over USD 650 million in funding. The programme has since been expanded to Europe. Microsoft is also investing in supporting innovations in climate change through its USD 1 billion Climate Innovation Fund, including technologies and business models that have the potential for meaningful, measurable climate impact by 2030. Since 2020, the corporation allocated more than USD 700 million into a global portfolio of more than 50 investments, including sustainable solutions in energy, industrial, and natural systems. One of the current focal points for Microsoft's investments includes reduction in carbon in key materials, such as cement and steel.

Amazon and Meta feature actions related to using low carbon fuel and low carbon transport modes. Amazon indeed significantly invests in low-carbon transport, including electric delivery vehicles (ranging from e-cargo bikes to heavy goods vehicles), hydrogen-powered forklifts, and biofuels for long-distance transportation. The company also prioritises lower-carbon transportation modes such as ocean and rail freight, identifying the expansion of its zero-carbon fleet as a key mid-term objective [40]. By the same token, Meta points to the use of ocean freight for its reduced carbon footprint (97% fewer emissions compared to aviation) as a key component of its sustainability efforts [41]. These attempts illustrate the growing emphasis on both actions and narratives of decarbonising transportation within the technology sector. By adopting low-carbon fuel sources and focusing on less carbon-intensive transportation modes, these companies seek to show an effort to reduce their greenhouse gas emissions and shape a narrative of compliance to the GHG emission goals.

Notably, Apple and Microsoft also invest in projects on carbon removal. For instance, Microsoft contracted over 1.4 million tons of carbon removal in FY22 and made a multi-year forward offtake commitment to carbon removal, which the company views as the model for scaling the industry [37]. Alike, Apple has committed up to USD 200 million to support high-quality nature-based projects that scale up carbon removal, seeking to achieve a financial return on this investment [38]. Amazon reports a 7% decrease in the carbon intensity of its business (the ratio of emissions to sales) [40] while Microsoft accentuates its investment in carbon removal, having contracted 1.4 million tCO_2e of removal capacity. The company further expresses an ambitious goal to remove from the atmosphere all CO_2 emitted since its founding in 1975 [37]. Likewise, Meta acknowledges the necessity of carbon removal projects for achieving its net-zero goal, stating that residual emissions will require active removal efforts [41].

In its sustainability report, Meta underlines the need for greater global awareness about climate change. To support that, the company launched a number of initiatives, including (i) introducing the Climate Science Literacy Initiative aiming at pre-bunking climate misinformation by running ads across Meta's apps and services featuring five most common techniques used to misrepresent climate change; (ii) supporting fact-checking, reviewing, and rating climate-related content and combatting false and misleading information about climate change; (iii) launching Climate Info Finder (This initiative does not seem to be live anymore), which is a tool enabling people to search for trusted information about climate change; and (iv) completing a global survey analysing public views towards climate change [41].

Correspondingly, Amazon is supporting innovation projects advancing cleaner energy storage, green hydrogen production and storage methods, and decarbonisation of materials. To this end, Amazon, jointly with other partners, provides financing to the Climate Pledge Fund (a USD 2 billion venture investment programme supporting the development of sustainable technologies and services). Google also claims to provide grant financing for strengthening the resilience of the communities most vulnerable to climate change. Google's commitments in these areas include: (i) a USD 10 million grant to

supporting cities in their sustainable transition through data-driven environmental and climate action; (ii) the Environmental Justice Data Fund (grants totalling nearly USD 9 million) that aim to help frontline communities that have been historically underserved and disproportionately impacted by climate change and environmental injustice; and (iii) AVPN's APAC Sustainability Seed Fund (USD 3 million in grant funding) for sustainability solutions for vulnerable and underserved communities in Asia Pacific.

Overall, the reviewed reports reveal that large technology corporations engage in reproducing a range of narratives aimed at promoting their wrestling with reducing carbon emissions and contributing to a more sustainable future. While all companies focus on the ways in which they try to reduce their carbon footprints, they also actively promote climate action among their suppliers and within broader society. Despite shared priorities, such as procuring renewable energy, investing in renewable energy projects, and measuring carbon footprints, there is significant variation in the specific actions taken by each company. This divergence may be attributed to factors including differences in the companies' current sustainability accounting infrastructures and achievements (e.g., Microsoft's carbon neutrality vs. Google and Amazon's ongoing progress towards zero emissions) and each company's assessment of its unique potential for impact, leading some (like Google and Meta) to focus on enabling sustainable decision-making for businesses and individuals globally, while others adopt a narrower approach centred on their own processes and products across the value chain.

4.3. Comparing Climate Pledges of Global Technology Companies with Policy Targets

Achieving the objectives of the Paris Agreement calls for achieving carbon neutrality by 2050 with similar pledges adopted by the EU and the US. To attain carbon neutrality, the US also committed to reducing greenhouse gas emissions by 50–52% in 2030 as compared to 2005 levels and achieving 100% carbon pollution-free electricity by 2035. Equivalently, the EU is committed to cutting GHG emissions in the EU by at least 55% below 1990 levels by 2030. The recent UN sustainability report highlighted that, overall, the world is off-track in terms of reducing greenhouse gas emissions: the total amount of emissions should be already decreasing; however, the emissions continue to grow. From the carbon neutrality perspective, on paper the reports of all five companies exceed the objective set by international and national regulators. These technology companies either claim they already have achieved 100% carbon-free electricity consumption for their operations or have set targets that exceed the policy target, i.e., aim to achieve the 100% level earlier than it is envisaged by the national policy in the US (Table 3).

Table 3. Comparing corporate climate pledges with international and national policy targets / Source: compiled by the author based on corporate sustainability reports.

Policy Target	Amazon	Apple	Google	Meta	Microsoft
Achieving carbon neutrality by 2050	Achieve net-zero carbon emissions by 2040 (exceeds policy target)	Create all products with net-zero carbon impact by 2030 (exceeds policy targets)	Achieve net-zero emissions across all of Google operations and value chain by 2030 (exceeds policy target)	Achieve net zero emissions over the value chain by 2030 (exceeds the policy target)	Zero carbon level achieved (exceeds policy target)
Achieving 100% carbon pollution-free electricity by 2035	Power Amazon's operations with 100% renewable energy by 2030 (exceeds policy targets)	Apple uses 100% carbon-free electricity for its operations (target achieved)	Run on 24/7 carbon-free energy on every grid Google operates by 2030 (exceeds policy target)	Target achieved	Microsoft uses 100% carbon pollution-free electricity (target achieved).

Reducing GHG emissions in the US by 50–52% in 2030 as compared to 2005 levels Reducing GHG emissions in the EU by at least 55% below 1990 levels by 2030	No target for reducing GHG emissions in absolute terms set	Reduce GHG emissions by 75% compared with 2015 by 2030 and reduce emissions by 90% by 2050	Reduce 50% of combined absolute emissions (versus our 2019 baseline) before 2030	Reducing Meta's operational emissions by 42% in 2031 from a 2021 baseline; not exceeding 2021 baseline GHG emissions in the value chain by the end of 2031	Revised Code of Conduct for suppliers includes commitment to reduce GHG emissions by 55% by 2030

Still, updated information and the analysis of corporate climate pledges in terms of expected absolute reductions in GHG emissions leads to more ambiguous results. Amazon has not set any specific target of absolute GHG emissions while the other four companies have established targets; yet, neither of them have used 2005 or 1990 as a baseline year. As a result, these targets cannot be directly compared to those established within national policy targets. The analysis of the actual dynamics of GHG emissions by the companies in question leads to unexpected results with the most impressive results demonstrated by Apple: its actual GHG emissions decreased by 45 percent from 586.2 thousand tCO2e in 2018 to 324.1 thousand tCO2e in 2022 (Hereinafter total GHG emissions that include the value chain are presented). Google also reported positive dynamics: its actual GHG emissions in 2022 compared to 2019 decreased from 12.5 to 10.2 million tCO2e. Amazon's total GHG emissions in 2022 were cut by 0.4% compared to 2021 but remained 41% higher than in 2019. However, both Meta and Microsoft reported an increase in absolute GHG emissions: Microsoft's actual total GHG emissions increased from 11.8 to 16.8 million tCO2e in FY22 as compared to FY20 [37] and Meta demonstrated the worst dynamics in absolute terms, with the company's absolute GHG emissions (including value chain) increased from 1.1 to 8.5 million tCO2e in 2022 as compared to 2018 [41]. Noteworthy, both Microsoft and Meta published the dynamics of their total GHG emissions in other documents and did not include these data in their main sustainability reports.

5. Measuring Up Big Tech's Sustainability Reporting

The analysis of recent reports indicates that Big Tech often adopts a stance of cautious optimism when addressing the future of efforts to mitigate climate change. Their vision for a more sustainable future is grounded in enhancing resilience capacities and reducing carbon emissions. However, achieving this vision necessitates actions that go well beyond merely minimising their carbon footprints. It requires comprehensive measures such as promoting sustainable practices throughout entire supply chains, influencing consumer behaviour towards eco-friendly choices, and investing in innovative technologies aimed at reducing environmental impact. Despite these expressed commitments, the actual progress made by tech companies remains inconsistent. Notably, only two out of the five companies analysed—Apple and Google—show substantial reductions in greenhouse gas (GHG) emissions when accounting for pollution generated throughout their entire value chains, including both direct and indirect emissions. This discrepancy underscores a significant gap between corporate pledges and their real-world impact. Even with various climate strategies in place, global GHG emissions continue to rise rather than decline.

This trend highlights the ongoing challenges faced by the technology sector in translating climate ambitions into tangible outcomes, as well as the broader systemic issues in achieving global emission reductions. In the case of Big Tech, "Amazon is a heavy polluter, emitting much more climate-warming greenhouse gases through its electricity usage than cloud computing rivals" [43], and despite Meta's insistence on hitting "net zero" emissions in its energy usage, estimates show that its real-world CO2 emissions from power consumption the prior year were 3.9mn tonnes, compared to the 273 net tonnes cited in

the report [41]. Similarly, due to the big drive to develop data centres to power AI tools in the past decade, Google's emissions are up 48% since 2018 and Microsoft's are up 30% since 2019. In fact, Google, in its 2024 Environmental Report, points out that it produced 13% more carbon emissions in 2023 compared to the prior year, attributing the rise in emissions to its supply chain operations and higher energy consumption of its data centres and AI. In the 2024 data published by Meta and Microsoft, separately from the main sustainability report, it is suggested that the GHG emissions of their value chains will keep growing, putting climate targets at risk.

In 2024, following Amazon's announcement of achieving 100% clean energy, the advocacy group Amazon 5es for Climate Justice raised concerns, arguing that this claim presented an inaccurate portrayal of the company's energy practices [44]. Their report indicates that, after excluding the impact of RECs, Amazon's actual direct investment in clean energy fell short of what had been publicly promoted. The analysis, which evaluated the geographic location of Amazon's data centres and the specific energy sources on regional grids—including the proportions derived from coal, natural gas, oil, versus solar and wind—concluded that only 22% of Amazon's U.S.-based data centres were powered by clean energy. Furthermore, the report highlighted that approximately 68% of Amazon's RECs were "unbundled", meaning they did not contribute to new renewable infrastructure but rather represented credits from pre-existing or planned renewable projects.

Big Tech's insistence on presenting such deceptive sustainability narratives can be described through the concept of "carbonwashing", a subset of greenwashing focused on carbon emissions that has emerged as a significant concern in corporate sustainability reporting. Such deceptive narratives involve companies misrepresenting or selectively communicating information about their carbon performance [45], with research showing a positive correlation between carbon emissions and corporate greenwashing behaviour [46]. In a corresponding fashion, all five companies this paper focuses on have engaged with carbonwashing and can be tracked in the formation of the sustainability narratives explored earlier. This trend also explains why these companies accentuate the need for collective actions, (controlled) regulatory involvement, and inclusivity in their reports and why Microsoft (and to some extent Meta) invest significant resources in engaging with their suppliers and making them commit to reducing their carbon footprint.

In the same vein, some of the analysed reports underline that, while absolute emissions may increase, carbon intensity (i.e., the ratio of carbon emissions to sales) may go down—an argument put forward by Amazon and Microsoft. However, from a policy perspective, such comparisons do not hold, as both international and national policies call for reducing the absolute level of GHG emissions, regardless of the economic growth.

While the objectives formulated by the large technology companies to confront climate change are quite similar, the sets of actions taken and planned by them vary. Overall, all corporations undertake actions related to reducing the climate footprint of their own operations and in supply chain as well as leveraging technology and knowledge for enabling businesses and individuals to contribute to reducing carbon emissions. In this framework, however, it is essential to critically examine the allocation of responsibility for carbon footprint production, as the burden of addressing climate change cannot be disproportionately shifted onto the supply chain or individual consumers. This redirection of responsibility represents a form of neoliberal environmentalism, in which systemic issues are reframed as problems best solved by personal lifestyle changes. By focusing on individual consumption patterns, larger corporations such as Big Tech, who are big contributors to environmental degradation, evade accountability. This narrative is not only misleading but also strategically and deceptively constructed, as it masks the structural and corporate dimensions of ecological destruction and perpetuates a false dichotomy between personal responsibility and collective, institutional action.

Other challenges on the way to zero neutral status include the growing energy needs, insufficient availability of carbon-free energy, high cost, and limited volumes of carbon removals. Google and other companies underline that, in some cases, there are no

adequate technical solutions making it possible to reduce GHG emissions or removing the residual carbon. This challenge forms the investment agenda narrative for the big technology companies in question. Their shared vision centres on a more sustainable and healthier world; however, instead of proposing solutions that focus on descaling and cutting down production (and hence emissions), they instead underscore the role of innovative technology and scaling up [47]. But innovation cannot singlehandedly prevent the outcomes of climate change if corporations do not recognise the role of constant growth and tech development in global greenhouse gas emissions [3].

What becomes increasingly evident through these reports is that Big Tech corporations are fundamentally obligated to pursue profitability, as this is central to their survival and growth in a competitive market. Their measuring infrastructures for sustainability, on the other hand, have the critical responsibility of not only demonstrating the economic viability of sustainable practices but also actively facilitating the integration of their metrics into business strategies. Meanwhile, partners and consumers hold the responsibility of supporting and reinforcing these business cases by making informed and responsible decisions that prioritise sustainable products and practices. Collectively, these roles exemplify the market operating according to its intended principles, where each actor contributes to the balancing of economic and environmental objectives and sustains the way the market functions.

6. Environmental Futures and the Illusion of Sustainability

The illusion of sustainability presented by Big Tech underscores the limitations of relying solely on corporate self-regulation. Without standardised, enforceable frameworks and greater transparency, these companies risk perpetuating a narrative of "greenwashing", where their actual contributions to reducing global greenhouse gas emissions are minimal compared to the scale of the problem. To truly "measure up" to the challenge of climate change, it is crucial for the tech industry to move beyond incremental, voluntary actions and engage in more comprehensive, accountable, and externally verified strategies. Only through systemic change and regulatory oversight can the sector begin to align its sustainability aspirations with tangible, meaningful outcomes in the global effort to combat climate change [48].

Though the ICT sector is not the largest source of carbon pollution, its contribution to combating climate change is hard to underestimate. Large technology companies which have global presence and billions of worldwide users present an important role model for others and influence sustainable goals and targets through lobbying at a great scale. Their high innovation potential, influence on local and global politics, and ability to successfully operate in ever-changing agile environments makes them the best candidates for leading the global response to the biggest global challenge. The analysis of sustainability reports published by Amazon, Apple, Google, Microsoft, and Meta demonstrates that, overall, there is consensus about the need to take bold actions to make our planet healthier, more sustainable, and liveable in the future. According to these corporations, achieving this future vision would call for a collective strive to employ innovative technologies. This prioritises market-driven approaches and, in doing so, conceals the underlying power dynamics and privileges afforded to large corporations and their investors.

Findings show that, while large technology companies share the common objective of reaching and sustaining carbon neutrality, the specific sets of actions taken and planned to achieve this objective vary depending on the company's core business, and produce three overarching deceptive sustainability narratives: 1. Reducing climate footprint of their own operations; 2. Influencing and reducing the climate footprint of their supply chain and consumers; and 3. Financing innovation for climate change. The convergence on renewable energy investments demonstrates a collective effort within the technology sector to promote a narrative against climate change and for renewable energy. Using measuring infrastructures, they develop in-house (and which are not audited by any regulator), Big Tech companies are able to put forward narratives where they significantly

aim to reduce their carbon footprint, by investing in sustainable infrastructure. Yet, the exclusion of specifics related to these projects and the ways they are measured and benchmarked calls for questioning their real-life impact and integrity.

Big Tech's illusion of sustainability leads to bureaucratic obfuscation, often misrepresenting the contributions of the tech sector in the fight against climate change. For companies operating on public electric grids, achieving a completely clean energy profile is challenging, as they cannot definitively confirm that their electricity comes solely from renewable sources. To address this, many firms purchase renewable energy certificates (RECs) from renewable energy providers, allowing them to offset their consumption with credits representing renewable energy. By purchasing enough RECs to cover or surpass their energy use, companies can assert that their operations are powered entirely by renewable energy sources.

Clearly, large technology companies cannot meet these challenges without a stricter sustainability regulation framework. Their contribution to enabling other businesses and individuals to make more sustainable choices based on specific data on energy consumptions and general awareness about the need to combat climate change is welcome but not enough [48,49]. The emphasis on individual responsibility aligns with the broader neoliberal ethos that weighs market-based solutions and individual action more over collective, state-led interventions. It frames climate action as a matter of ethical consumption and personal morality, subtly implying that those who fail to live up to these standards—such as by driving cars, using plastic, or flying—are complicit in environmental harm. These narratives neglect the fact that a small number of corporations are responsible for the majority of global emissions—just 100 companies have been responsible for 71% of global industrial emissions since 1988 [50,51].

Financial support to various types of innovations made and planned by Amazon, Apple, Google, and Microsoft is also an important contribution to global sustainability, with its impact going far beyond the ICT sector. While technological innovation and resilience-building are frequently touted as essential components of climate adaptation and mitigation, they are insufficient in isolation, because they do not directly target the root causes of global emissions: fossil fuel dependency, extractive economies, and the political and economic systems that perpetuate these practices. Energy-efficient technologies may lower the cost of energy or carbon reduction, but this can paradoxically lead to greater energy demand and increased emissions. For example, improvements in vehicle fuel efficiency may encourage longer driving distances, theoretically offsetting the emissions reductions gained from the initial innovation. Likewise, resilience community-focused strategies focus primarily on adapting to the effects of climate change, rather than preventing or mitigating the causes of climate change itself—namely, greenhouse gas emissions. This approach often assumes that certain levels of climate disruption are inevitable and shifts attention away from the urgent need to reduce emissions at the source. As such, it can only manage rather than resolve the climate crisis.

The use of monetised sustainability indicators, such as net-zero and carbon percentages, has profound implications for the governance of our sustainable futures. Maintaining transparency about sustainability metrics in combatting climate change is one of them. This paper demonstrates that companies are reluctant to publish the data on dynamics of GHG emissions in the sustainability report if the pollution is growing. Also, instead of reporting on the objective of decreasing the absolute emissions, companies sometimes try to highlight carbon intensity. Sustaining growth and reducing GHG emissions at the same time is a challenging task. It would be more constructive to address this task openly and transparently and, while acknowledging the potential of market forces, a multi-pronged approach is critical. This involves stricter government regulations, shifts in consumer behaviour, and collaborative initiatives between the private sector, civil society, and policymakers to promote system-wide transformations. It should also be acknowledged that Big Tech's influence on consumer awareness represents a positive movement towards a more sustainable future, and while this step alone is not enough to fully address climate change,

it may be instrumental in driving broader behavioural shifts and fostering public demand for systemic changes.

Countries such as China have developed regulatory strategies for managing the rapidly expanding technology sector and the implications that source for the economic governance and policymaking of the country [52]. To ensure accountability in Big Tech's sustainability endeavours, future work while learning from these strategies should also focus on how stricter regulatory standards along with independent third-party audits could verify the accuracy of reported data and of their measuring infrastructures, minimising deceptive data narratives, corruption, and fraud. Mandating detailed public disclosures of emissions and sustainability metrics would enable broader scrutiny from stakeholders and aligning executive compensation with environmental targets could further embed sustainability in decision-making beyond financial benefits [53]. Encouraging these companies to commit to substantial and verifiable environmental progress can lead us into a future of sustainability claims that are both credible and impactful.

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