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ICT: a sector disconnected from the climate reality?

This report summarizes the results of the campaign to analyze the carbon performance of companies in the Information and Communication Technologies sector, carried out using Carbon4 Finance's methodology, called Carbon Impact Analytics, from June to August 2021.

This document is the report's public version. In order to have access to the whole data, please contact Carbon4 Finance.

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Executive summary

- **The Information and Communication Technology (ICT) sector is experiencing an unsustainable growth dynamic:** over the period 2010-2019**,** there has been an increase in the number of users of connected objects (+130%), in the **number of** available **connected objects (+170%)**, and in the overall mass of these objects (+80%). This increase in terminals and end-users' devices is accompanied by a logical growth in network and data center capacities, to support internet access for this expanding demand. These trends prompted an analysis aimed at estimating the sector's greenhouse gas emissions. The results speak for themselves: the digital sector accounted for around **3.5% of global emissions in 2019 and is growing fast (+8%/year from 2014 to 2019)**, which could lead to over **7% of global emissions by 2025**, in the absence of energy-related sobriety measures.

- **The unsustainable dynamics of the sector and its strong contribution to human activities (work and leisure) led Carbon4 Finance to assess the transition risk of 67 digital companies**, using the bottom-up CIA methodology (attribution of a transition risk rating), to **establish the order of merit of the sector's main players in the face of the low-carbon transition**. Carbon4 Finance has also drawn up recommendations for digital companies, to contribute to a world aligned with the Paris Agreement. This is the **first study of its kind** to date.

- **The emissions attributed to the digital sector are linked to the physical ICT infrastructure**, on which all uses rely on. This can be broken down into 3 groups: **data centers, the network and end-user devices**. Emissions are linked to the energy consumption required to **produce the infrastructure** (extraction of raw materials, industrial processes, and delivery to consumers), and its **use phase** (powering equipment while in use). Thus, **acting on emissions means producing and using this infrastructure in a more reasoned way.**

- **Technical progress and energy efficiency improvements are not sufficient to decouple emissions from the growth in digital infrastructure,** because they are more than offset by a multiplication of uses and an increase in data throughput**. This is known as the rebound effect.** Questioning usage is therefore essential to achieving "digital sobriety" (i.e., using digital technologies in a less excessive and more mindful manner).

- The huge **diversity of products** supplied by the digital industry makes quantifying environmental impacts extremely difficult. In addition, there is the **difficulty of accessing the volumes of products manufactured/developed** by the companies (or the energy consumption of the product), as the latter publish little or nothing, which **prevents a comparison of carbon performance based on physical intensity** (in ton of CO2 equivalent per ton of products manufactured or per hour of use, for example).

- **Players' carbon performance ratings appear to be evenly spread due to the ICT systemic risk[1]. Companies are highly interdependent**. A social network (media sector) is accessed through an application (B2C software sector) that runs on a smartphone (computers and devices sector) and requires an Internet connection available through a subscription to a telecom service company (telecom services sector). Consequently, if one of these players is affected by climate change (transition risk or physical risk), all the other players in the value chain will also be affected. Another way of looking at it is that **all players use the digital infrastructure**, and are therefore highly exposed to any constraints that apply to this particular infrastructure.

[1] The strong interdependence of the sector's players creates a systemic risk, as defined in 3.1.2 and 3.2.1.

- The main transition risks identified for this sector are **regulatory constraints encouraging digital sobriety** (e.g.: extension of the legal warranty period, data flow limitation, tax on online advertising, ...), **supply competition with other sectors on rare metals**, and the risk that the **electricity supply requirement** (mainly renewable to decarbonize sites, networks and data centers) necessary for the sector's expansion may not be achievable. **Most players do not consider the first two risk types**, preferring to focus on the constraints of supplying mainly low-carbon electricity - in practice limited to renewables for the time being - for network and data center owners. **Many mention that their business is not at risk as their products do not emit GHG emissions** during the use phase (but this is not true in the global view, see the point on dependency on physical infrastructure). These strategies often result in **unambitious and sometimes irrelevant low-carbon investments**.

- While the vast majority of the analyzed companies declare scope 1&2 emissions, **scope 3 emissions are often forgotten** or poorly understood (particularly for service companies), even though **it represents on average over 90% of the emissions of ICT players**. As a result, **emissions reduction targets focus on scopes 1&2 alone**. But even here there is a lack of ambition, with **many targets referring to market-based scope 2 emissions (i.e., mostly achieved by purchasing Guarantees of Origin) or relying on carbon offsetting (which has no scientific basis, cf. the Net Zero Initiative reference framework)**, without any real operational measures to reduce emissions dependency.

- **Eventually, it is** important to note that there is a **bias in the CIA rating, as it is based on the data of publicly available reports**. As larger market capitalizations are subject to greater scrutiny and regulatory requirements, they provide more data in their reports than smaller capitalizations (and even more than non-listed companies), and are therefore slightly favored by the CIA methodology, which penalizes lack of transparency.

Introduction

Considering the scientific community's consensus on the anthropogenic origin of climate change[2], reducing global greenhouse gas (GHG) emissions to limit global warming is a necessity. The need for action is even more pressing as effects of climate change are already being felt[3], with temperature projections reaching record levels earlier than expected[4]. It is therefore **urgent to work towards an effective transition to a low-carbon economy**, with emission reduction trajectories in all sectors. **The digital sector, which represents a non-marginal and ever-increasing share of global GHG emissions** (3.5% of global GHG emissions in 2019, i.e., more than air travel worldwide[5], with an increase rate of +8%/year[6]), is becoming a high-stakes sector in this transition, whose place and role must be determined.

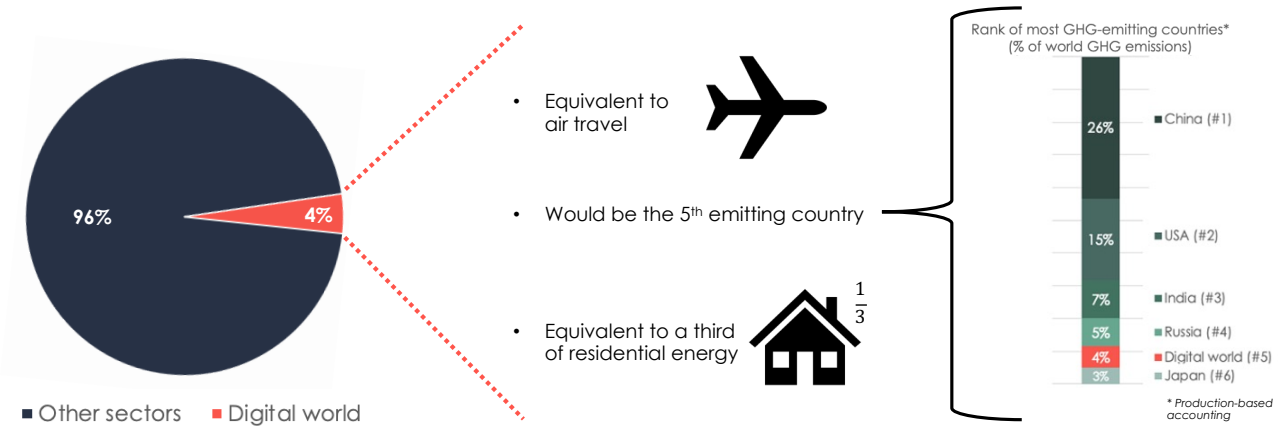

Figure 1 - Order of magnitude of digital emissions[7, 8]

[2] **IPCC, 2021**. Climate change widespread, rapid, and intensifying - IPCC - IPCC.
Available at: <https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/>

[3] **United Nations, 2022**. Causes and Effects of Climate Change | United Nations, United Nations.
Available at: <https://www.un.org/en/climatechange/science/causes-effects-climate-change>

[4] **Nature.com, 2022**. Climate change is hitting the planet faster than scientists originally thought. Nature.com.
Available at:

[5] **Commercial aviation accounted for 2.6% of global greenhouse gas emissions in 2018,** and 5.1% of anthropogenic global warming between 2000 and 2018 when non-CO2 effects (contrails) are included.
Carbone 4, 2022. Preconceived ideas about aviation and the climate.
Available at: <https://www.carbone4.com/analyse-faq-aviation-climat>

[6] **The Shift Project, 2020**. Implementing digital sobriety.
Available at: <https://theshiftproject.org/en/article/implementing-digital-sobriety>

[7] **In 2019, direct and indirect emissions from residential buildings amounted to 5.8 GtCO2** (use of fossil fuels in buildings and production of electricity and heat used in buildings).
IEA, 2022. Buildings.
Available at: <https://www.iea.org/reports/buildings>

[8] **World Resources Institute, 2023.**
Available at: <https://www.wri.org/insights/interactive-chart-shows-changes-worlds-top-10-emitters>

Companies in the Information and Communications Technology (ICT) sector have long been perceived as non-polluting because the apparent digital nature of their products and services dissociated them from the consumption of physical resources required to maintain their activity. In other words, digitization makes it possible to replace physical products - paper - with "immaterial" products (data on a screen), creating the illusion of resource-free production. For example, while it was thought that material savings could be made by replacing paper letters with electronic mail, the reality is more complex[9].

Digital technology is based on a physical system:

- **The raw materials that make up electronic devices, networks and data centers** (the mass of the digital world represented 223 million tons in 2019, or around 5 times the mass of cars in France)[10].
- **The energy consumed by these same entities during their production and use phase** (approximately 4.2% of the world's primary energy consumption)[10].

In this respect, several studies have begun to attempt to quantify digital-related GHG emissions (***Lean-ICT reports*, The Shift Project**; ***The environmental footprint of the digital world*, GreenIT**). The results are unequivocal: the ICT sector emits a large share of the world's GHG emissions and is showing worrying growth, which seems incompatible with the 2015 Paris Agreement (limiting global warming to below +2°C compared with the pre-industrial era).

Furthermore, although certain digital technologies can potentially improve the energy efficiency of some processes, the expected energy savings are rarely observed, or even lead to overconsumption, due to a change in behavior and a multiplication of uses (**rebound effects**). In 2018, **The Shift Project**, (a French think-tank on the low-carbon transition), in its ***Lean-ICT*** report ***(2018)***[11], introduced the notion of **digital sobriety**: "moving from an instinctive, even compulsive digital world, to a controlled digital world, which knows how to choose its directions in view of the opportunities, but also the risks". This concept perfectly illustrates the balance that the digital sector must find to contribute positively to the low-carbon transition.

[9] **Eco2 Greetings. 2022**. The Carbon Footprint of Email vs Postal Mail.
Available at: <https://www.eco2greetings.com/News/The-Carbon-Footprint-of-Email-vs-Postal-Mail.html>

[10] **GreenIT, 2019**. The environmental footprint of the digital world.
Available at: <https://www.greenit.fr/environmental-footprint-of-the-digital-world/>

[11] **The Shift Project, 2018.** Lean ICT.
Available at: <https://theshiftproject.org/en/article/lean-ict-our-new-report/>

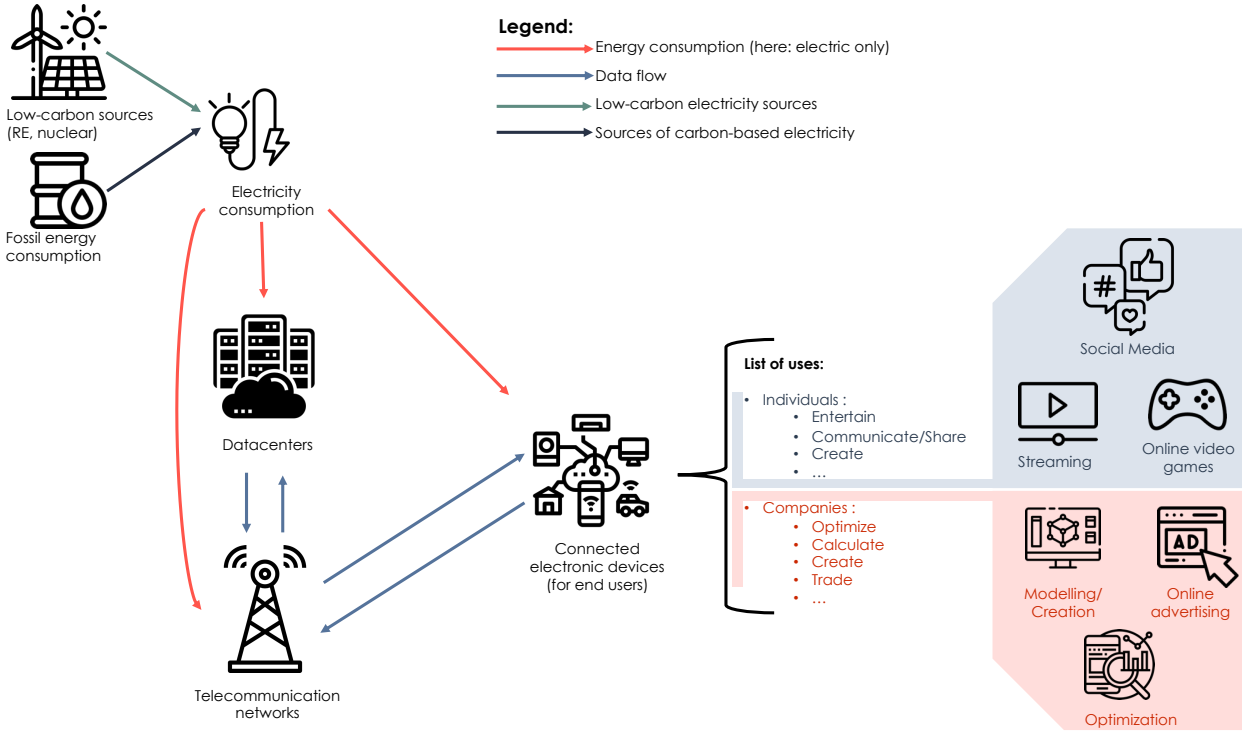

Figure 2 - The digital infrastructure and its various uses (non-exhaustive

We will first present the challenges related to the transition to a low-carbon economy for digital companies. Secondly, we will detail the methodological principles of the **Carbon Impact Analytics** rating used for this sector. We will then review the results of this campaign and the various difficulties encountered. Eventually, we will conclude this report on the overall progress of the sector in its transition.

Sector dynamics and challenges

The role of ICT in the energy and climate transition

Digital technologies, which enable laptops, smartphones, social networks, online payment services, telecommunication services, etc., have become central and essential to the functioning of our society. It is therefore important to bear in mind that they are not virtual tools, as **they rely on physical resources**, although we do not directly perceive their materiality through the actions they enable. Indeed, **all electronic devices** (smartphones, laptops, cables, optical fibers, network antennas, data centers, etc.) require **energy in their production and use phases**. Consequently, **all the software, applications and media that run on these devices also rely on the same physical infrastructure, which consumes energy and emits GHGs**. As a result, the digital world and ICT companies are highly exposed to the constraints that apply to this physical infrastructure.

Nevertheless, **certain digital uses also have the potential to contribute to the transition**, via the optimization/reduction of travel[12], the optimization of energy consumption in buildings/cities[13], and more generally by contributing to energy efficiency. In this way, certain digital applications can offer solutions for reducing emissions, while others (notably video applications) are increasingly contributing to human emissions. We therefore need to consider the place of the ICT sector in a low-carbon economy, as it may represent a potential for optimization, but may also have negative impacts on the environment.

Moreover, **quantifying the reduction in energy consumption enabled by energy efficiency gains thanks to digital technology is complex, as there are often rebound effects**. For example, in the case of digital services that reduce travel (teleworking, teleconferencing), a significant proportion of the savings in business travel is offset by an increase in other journeys (mainly non-business travel) or home heating costs. **Falch (2012)**[14] shows, for example, that Denmark has the highest rebound effect for telecommuting (73%) (105 km/week reduction in business travel, 77 km/week increase in personal travel).

So, in a world of limited resources (energy, raw materials, etc.), the relevance of each digital tool and service must be questioned in terms of its contribution to the low-carbon transition. Current digital developments and uses are uncontrolled, i.e., they do not consider their physical consequences. We need to **move towards more conscious and thoughtful digital practices**, identifying technologies and services that are beneficial to the population, from a social (e.g., communication), cultural (e.g., access to and sharing of knowledge) and environmental (e.g., better resource management) point of view, which need to be preserved and developed, so that available resources can be allocated to them as a priority.

[12] **Dragan, Dejan & Kramberger, Tomaž & Prah, Klemen. 2014.** The reduction of CO2 emissions: Transport optimization approach to decrease the Vehicle Miles Travelled.

[13] **Toma, Ana & Gheorghe, Cristina & Neacșu, Floriana & Dumitrescu, A.M.. 2017**. Conversion of smart meter data in user-intuitive carbon footprint information. 10.1109/ISEEE.2017.8170644.

[14] **Falch, 2012**. Environmental Impact of ICT on the Transport Sector. Telecommunication Economics. A. Hadjiantonis and B. Stiller (Eds.), Springer Berlin Heidelberg. 7216: 126-137.

The main sources of GHG emissions and their trends

GHG emissions from the ICT sector can be divided into three categories, echoing the sector's value chain breakdown:

- Emissions linked to the **production of IT and telecoms infrastructure** (end-user electronic devices, networks, data centers). They include the energy consumed in the extraction of raw materials, industrial processes, and delivery to consumers.
- Emissions linked to **infrastructure use**. These include the energy required - mainly electricity - to power equipment during its use.
- Emissions linked to the end-of-life treatment of infrastructure (recycling or waste that is landfilled or incinerated). This type of emission will not be considered in this study, as it is negligible compared to the first two (but waste treatment has other effects on the environment and society, detailed in **5.2.1**).

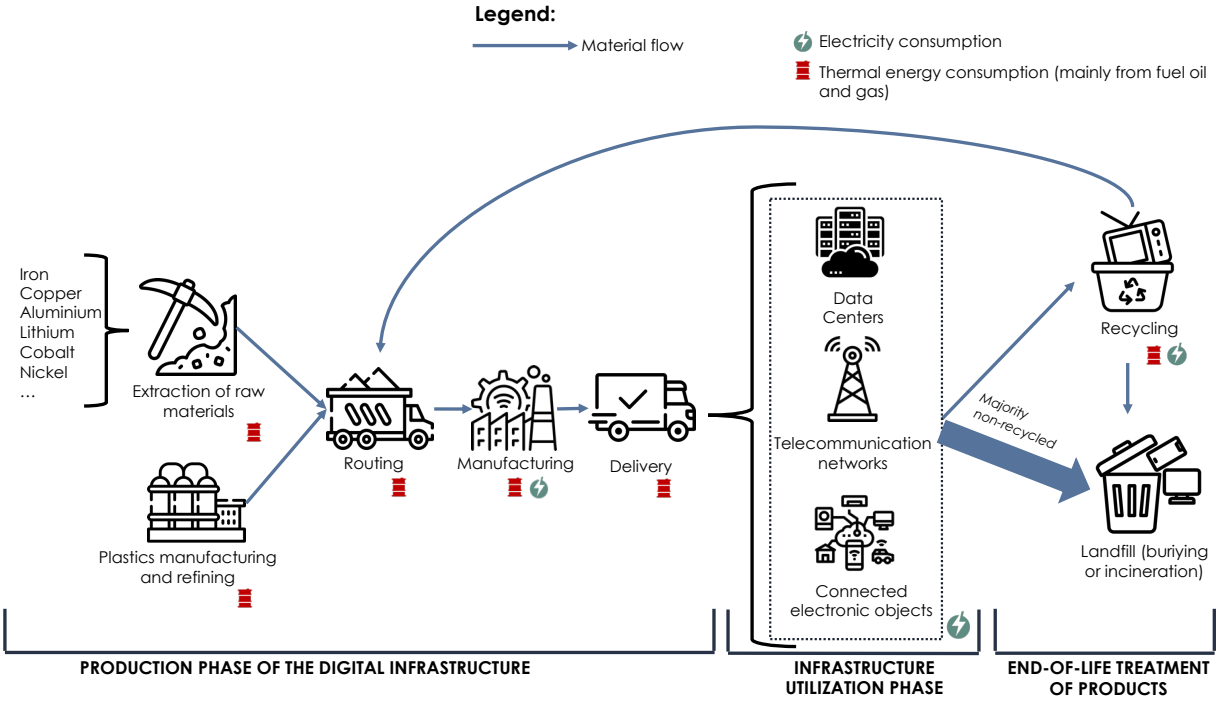

Figure 3 - Digital infrastructure value chain

A few examples to illustrate these two categories:

- Manufacturing a laptop: to produce a 2 kg laptop, thousands of liters of fresh water and 800 kg of resources are needed, including 200 kg of fossil fuels and 600 kg of metals (MIPS method)[15].

[15] **ADEME, 2019**. La Face Cachée du Numérique.
Available at: <https://librairie.ademe.fr/cadic/2351/guide-pratique-face-cachee-numerique.pdf?modal=false>

- Internet box power consumption: on average, an Internet box consumes between 150 and 300 kWh per year[12], about the same as a refrigerator (200 to 500 kWh per year)[16].

The Shift Project (a French think-tank on low-carbon transition), in its ***Lean-ICT*** publication series (started in 2018), drawing on a study **by Andrae & Edler**[17] on digital energy consumption, estimated **total GHG emissions from the ICT sector at 1.84 GtCO2eq in 2019**. Of the final energy consumption generating these emissions, 45% was attributed to the production of infrastructure and 55% to its use.

The GreenIT community, which brings together digital players working for sustainable digital practices, in its **2019 *Global Digital Environmental Footprint*** study, attributed 35% of primary energy consumption to the manufacture of infrastructure and 65% to its use, with the total accounting for **3.8% of global GHG emissions**. These figures confirm those of the Shift Project.

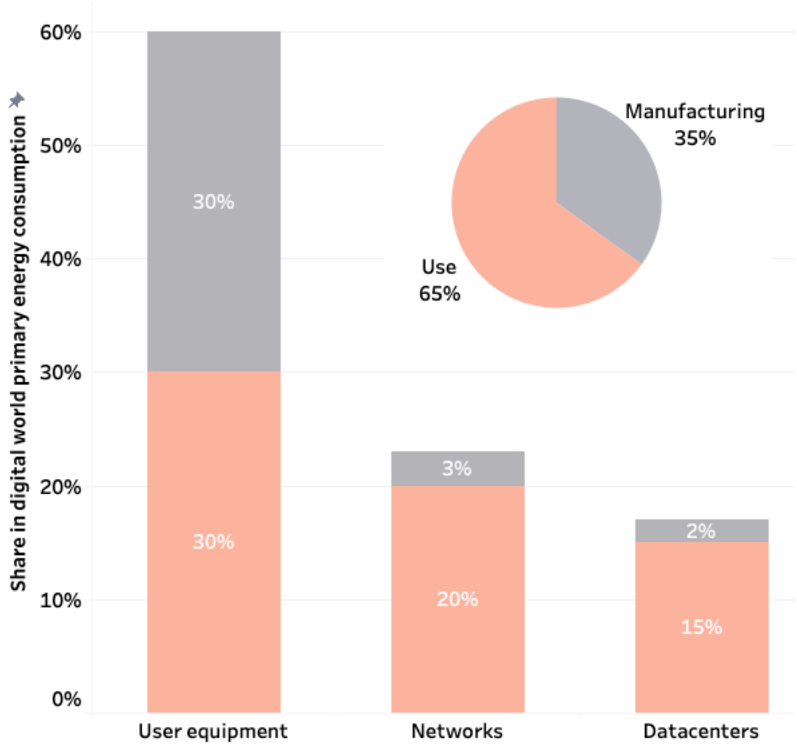

Figure 4 - Breakdown of primary energy consumption in the digital sector (GreenIT, 2019)

Moreover, emissions from the ICT sector are following a **worrying trend**. According to **The Shift Project (2020)**, the growth in global GHG emissions from the digital sector has risen steadily over the Past ten years, averaging **+8% per year between 2014 and 2019**. This trend could lead the sector to account for around **7.5% of global GHG emissions by 2025**. The figure below illustrates

[16] **Engie.co.uk. 2018**. Everything you need to know about your refrigerator consumption. Available at: <https://particuliers.engie.fr/depannages-services/conseils-equipements-chauffage/conseils-equipements/tout-savoir-sur-la-consommation-de-votre-refrigerateur.html>

[17] **Andrae, Anders S. G., and Tomas Edler. 2015**. On Global Electricity Usage of Communication Technology: Trends to 2030. Challenges 6, no. 1: 117-157. <https://doi.org/10.3390/challe6010117>

possible evolutions of GHG emissions from digital technologies worldwide, according to different scenarios (details of the different scenarios[18] can be found in **The Shift Project**, ***Lean-ICT***, **2018**):

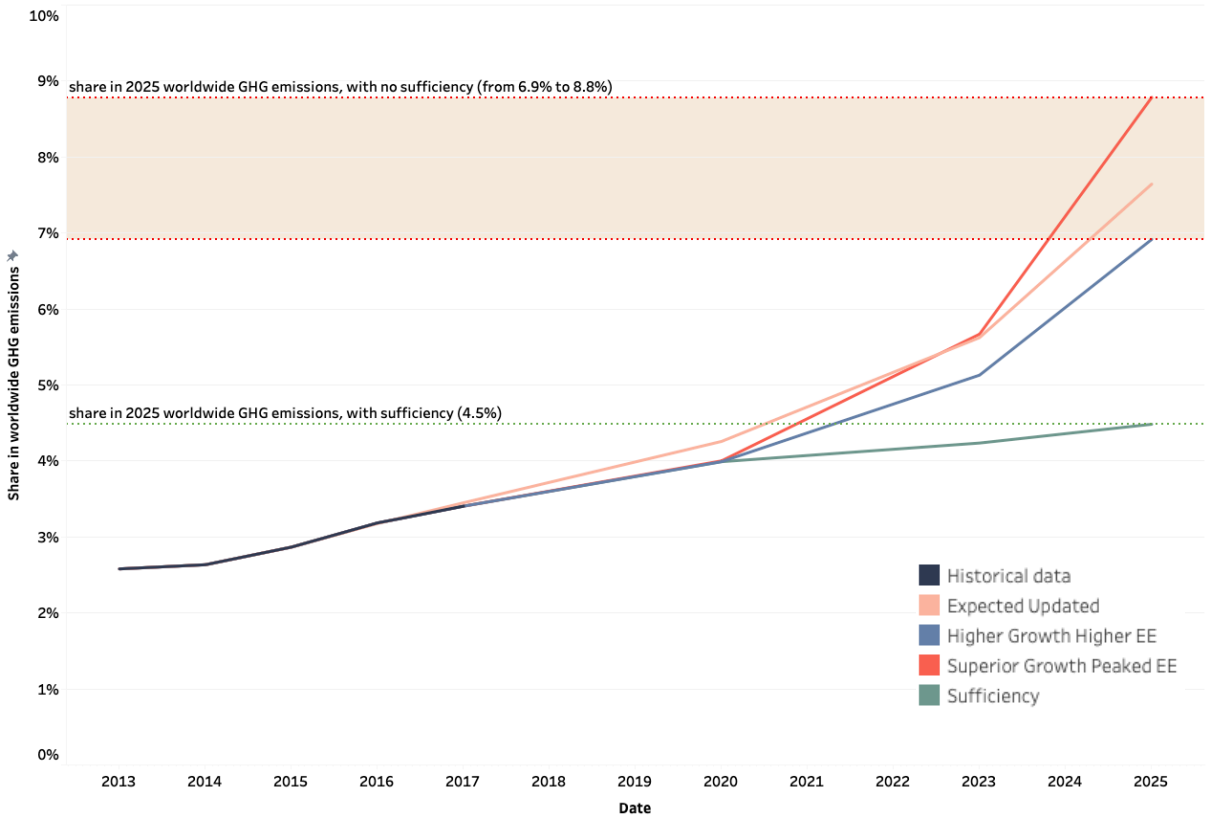

Figure 5: Evolution between 2013 and 2025 of the digital sector's share of global GHG emissions (Lean ICT - The Shift Project, 2018]

This dynamic can be explained by several factors, including (**GreenIT, 2019**):

- **The increase in the number of users** [19] - from 2,023 million in 2010 to 4,700 million in 2020, with a forecast of 5,500 million in 2025.
- **The increase in the number of "standard" connected devices** (computers, tablets, smartphones, video game consoles, etc.) - from 13,531 million in 2010 to 19,041 million in 2020, with a forecast of 20,278 million in 2025 (the increase rate is decreasing because smartphones are the only devices whose number continues to increase while that of other devices decreases).
- **The increase in the number of connected objects** (Internet of Things - IoT - other than standard devices) - from 1,000 million in 2010 to 20,315 million in 2020, with a forecast of 48,272 million in 2025 (the fastest-growing indicator).
- **The increase in the global mass of connected objects** (standard and non-standard) - from 128 million tons in 2010 to 236 million tons in 2020, with a forecast of 317 million tons in 2025.
- **The increase in screen size,** which has doubled between 2010 and 2020.
- **Declining energy efficiency gains**, as technological advances in this area slow down.
- **The increase in equipment in emerging countries** whose energy mix is more carbon-intensive.

[18] The "sufficiency" scenario is called "sobriety" in the work of The Shift Project. We have renamed it for greater clarity. It is the only scenario to include sufficiency measures.

[19] **"Users"** here refers to people who have access to a terminal in the digital world.

The figure below shows the evolution of 4 of these indicators, with a projection to 2025:

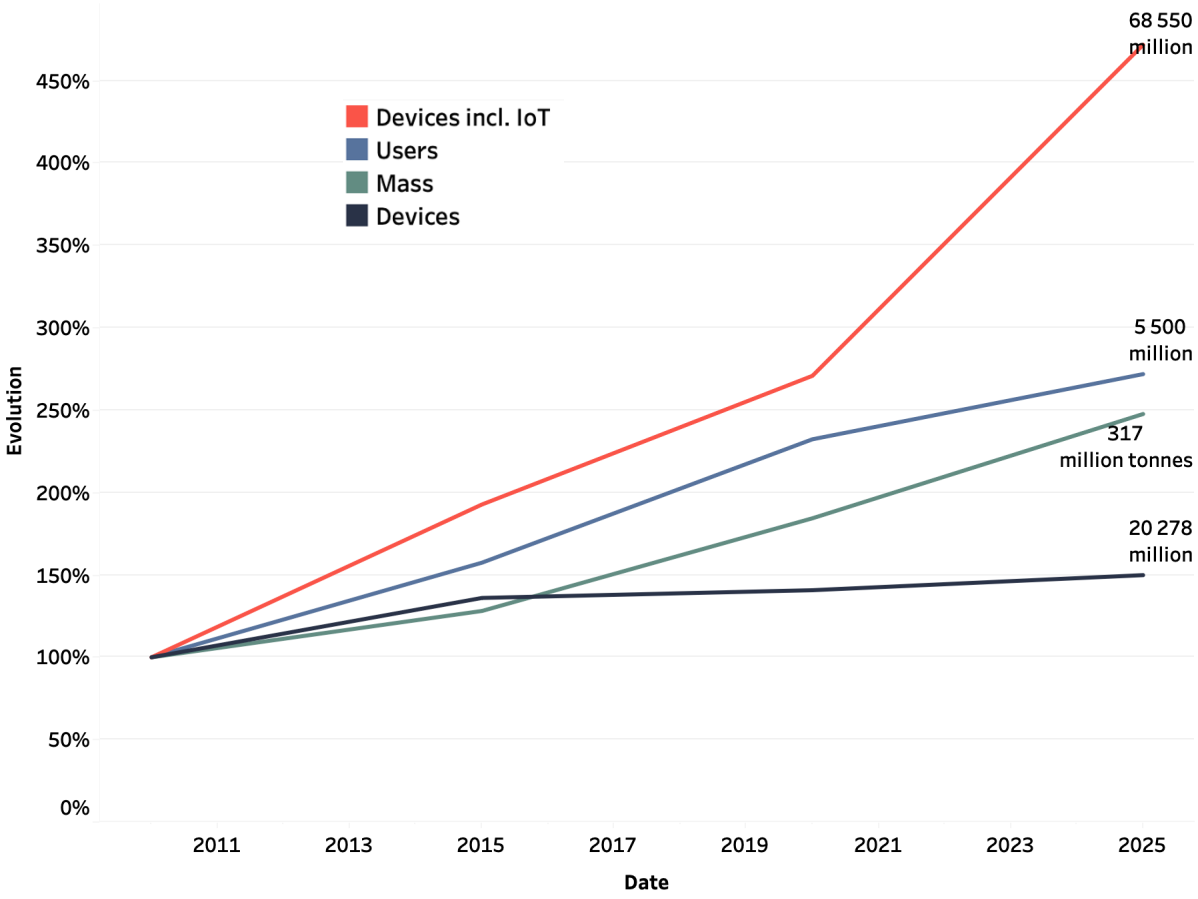

Figure 6 - Changes in selected digital sector indicators compared with the 2010 reference year (GreenIt, 2019)

The fact that the overall ecological footprint of digital technology is constantly increasing may be counter-intuitive, as one might think that improving energy efficiency and reducing the mass of devices (for equivalent services) would limit the increase in energy consumption and the quantity of raw materials extracted. However, studies show that **increases in energy efficiency are counterbalanced by increases in equipment power/capacity**. The rebound effects identified in the existing literature are as follows:

- **The miniaturization effect**. As many devices become smaller and smaller (for example, microprocessors have reduced their size, while increasing their performance), they require fewer raw materials per device. As a result, their cost is falling, driving up demand. The savings in raw materials generated by miniaturization will then be absorbed by the multiplication of the number of small electronic devices. Moreover, new models quickly replace slower and larger ones, which also contributes to accelerating device obsolescence (**Cédric Gossart, 2016**[20]). In addition, miniaturization complicates material recycling (and therefore ultimately increases material consumption).

[20] **Cédric Gossart. 2016**. Rebound effects and ICT: a review of the literature. ICT innovations for sustainability, 310, Springer, pp.435 - 448, 2015, Advances in intelligent systems and computing, 978-3-319-09227-0. ff10.1007/978-3-319-09228-7_26ff. ffhal-01258112f

- **Data virtualization** (integrating data from several disparate sources without the need to copy or store it, retaining only the metadata). This has led to a reduction in the number of servers with constant data storage, and consequently a reduction in the cost per stored byte. As a result, demand for data storage space has increased: between 1986 and 2007, global data processing capacity grew five times faster than economic growth (**Hilbert et al., 2011**).[21]
- **The increasing volume of data** being transferred, transformed, and stored is driving the development of larger IT infrastructures. These new infrastructures enable the emergence of new uses, which themselves require larger volumes of data, thanks to this new availability (**The Shift Project, 2020**).

[21] **Hilbert, M., and P. López. 2011**. The World's Technological Capacity to Store, Communicate, and Compute Information. Science 332(6025): 60-65.

CIA campaign scope and coverage

To assess the digital sector's progress in the transition to a low-carbon economy, **Carbon4 Finance analyzed 67 major ICT companies**, using its Carbon Impact Analytics (CIA) methodology, adapted for this sector.
These 67 companies are classified according to **6 sub-sectors, each with a specific methodological approach**, listed in the table below:

CIA sub-sector	Methodological scope of application	Company examples
B2B software	B2B software is software developed for professional use and sold to companies.	Oracle, Salesforce.
B2C software	B2C software is software sold to individuals.	Microsoft, Adobe.
Consulting services	Consulting services consist, for a company, in soliciting the services of an external professional recognized for his expertise in a particular field.	Accenture, Atos, Capgemini.
Media	Media players include all web content providers and hosting companies (social networks, streaming platforms, cloud hosting, online advertising, ...).	Facebook, Netflix, Alphabet Inc, Criteo SA.
Telecommunications services	Telecommunication services include all actors that provide access to the Internet or a telephone subscription, using a telecommunication network.	AT&T Inc, Orange, Iliad.
Hardware	The "hardware" methodology applies to all manufacturers of connected electronic devices (computers, smartphones, tablets, IoT, etc.) and all their spare parts (processors, semiconductors, etc.).	Apple, HP Inc, Nokia Oyj, Somfy.

Table 1 - Scope of analysis by type of activity

These 67 companies accounted for about **11% of the global market capitalization in 2020**, as well as more than 80% of the overall market capitalization of the ICT sector.

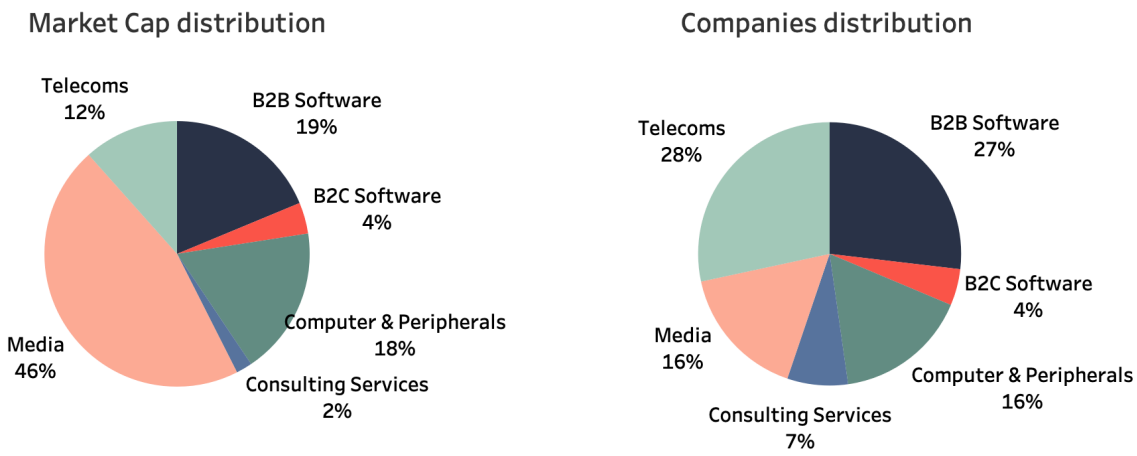

Figure 7 - Distribution of sample companies by sub-sector according to the number of entities (left) and market capitalization (right) (Source: Carbon4 Finance database)

When it comes to the sector's largest market capitalizations, the top 5 are unsurprisingly the GAFAMs (Google - via its parent company Alphabet Inc. -, Apple, Facebook, Amazon, Microsoft), as shown in the chart below. They represent over 50% of the sample in terms of market capitalization.

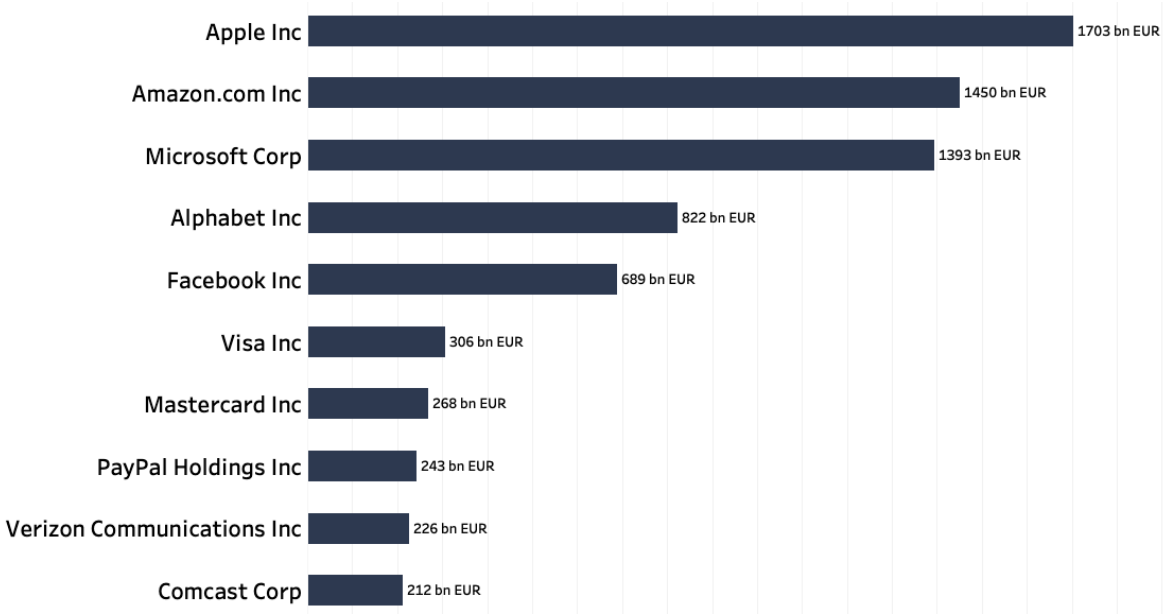

Figure 8 - Top 10 market capitalizations in the ICT sector (2020) (Source: Carbon4 Finance database)

This report presents the results of the first CIA campaign conducted from June to August 2021, on this sample of companies. **The CIA methodology seeks to measure a company's exposure to transition risk, as well as its climate impact (double materiality), through a CIA overall rating (from A+ to E-) and various sector indicators**. Based on our data, we have ranked the companies analyzed according to their contribution to climate transition and their degree of exposure to transition risk. In particular, the methodology takes into account the strategies adopted by companies to align themselves - or not - with the decarbonization objectives of the global economy and reduce their risk exposure. To the best of our knowledge and as of this date, this represents the first study of its kind (**Greenpeace** published a ranking in 2017[22] on the digital players providing the "greenest" internet services, based on the companies' energy mix).

Identified transition risks

The transition risk of a company is the risk associated with the effects of societal and/or economic change linked to the low-carbon transition, which can have an impact on a player's business model throughout its value chain.

Regulatory risk

Regulatory risk can be understood as the risk that a change in climate-related laws and regulations (on the part of a government or regulatory body) will have a significant impact on a company. As far as digital players are concerned, **the main risk lies in the introduction of measures encouraging - or even forcing - digital sobriety**, which would compel players to rethink their business model. Here are just a few examples of measures that have been identified:

- The extension of the **legal warranty period** or the reparability obligation for suppliers of hardware.
- The obligation to inform consumers of the importance of updating, to combat **software obsolescence**.
- **Data throughput limitation** for telecom network operators.
- **Tax on digital advertising,** for media generating revenue from it.

Furthermore, given that ICT players very often rely on "carbon offsetting" to achieve their "neutrality" objectives, a **major risk lies in carbon pricing, as buying credits does not protect against the economic consequences of implementing a tax.** This risk also applies to suppliers. Furthermore, many entities in the sector use **guarantees of origin** (sometimes Power Purchase Agreements or PPAs, which are less methodologically fragile) to ostensibly reduce their Scope 2 emissions. However, **this mechanism is not considered legitimate by the GHG Protocol (nor by Carbone 4)**, which means that there is a risk of reputational damage, or even downgrading, if this practice is banned, or if the conditions for using GOs are tightened.

Digital companies are also subject to a regulatory risk that potentially concerns any business sector: that of finding themselves included in **tradable quota systems**. This happened to AT&T when, in 2013, the State of California adopted a cap-and-trade mechanism to reduce its carbon emissions. Indeed, AT&T was assigned a cap on its maximum allowable emissions[23] taking place

[22] **Greenpeace, 2017**. Clicking Clean: Who is Winning the Race to Build a Green Internet?

[23] It is not specified whether the maximum allowable emissions cover scope 3. In 2013, it is likely to be only on scope 1&2.

in the state, which prompted it to improve the energy efficiency of its network and increase the share of renewable electricity in its mix (to reduce its emissions)[24]. Similarly, Visa Inc. has been encouraged to purchase renewable electricity for its Virginia operations, following the state's accession to the Regional Greenhouse Gas Initiative ("RGGI") in early 2021. Visa Inc. has therefore committed to covering 100% of the electricity demand of its largest data center from solar farms located in the state[25]. Unfortunately, RGGI allows the purchase of guarantees of origin, which is (often) not a relevant way to reduce emissions (see 3.2.3 - reduction targets).

Legal risk

Legal risk is the risk of loss arising from an unintentional or negligent breach of a professional (legal) obligation, related to climate change mitigation, with respect to customers, the working environment, or the nature or design of a product. For players in the ICT sector, this mainly concerns the risk of **litigation arising from incentives to consume carbon-intensive products**. This particularly concerns companies whose revenues depend on online advertising, as it creates artificial needs and encourages consumption, and hardware manufacturers accused of programmed obsolescence. Although not directly linked to GHG emissions, there is also the legal risk of assigning responsibility for immense digital pollution, such as the Agbogbloshie landfill in Ghana.

To date, we have not found any illustrative example of this risk, which is considered low by the study.

Market risk

Market risks at the company level lie mainly in changing customer (end-market) behavior. As the impact of the ICT sector on the climate is increasingly recognized, **customers may adapt and change their behavior to make more conscious use of digital products**. Finally, since data centers and telecom networks consume a great deal of electricity, their operators are subject to the **risks associated with the electricity market, whose prices fluctuate widely**.

Some companies don't hesitate to use their influence to leverage regulations and market prices. For example, in January 2018, the Federal Energy Regulatory Commission (USA) rescinded rules that helped subsidize fossil fuels, in part because players who rely heavily on renewable electricity - mostly through the purchase of Guarantees of Origin, a minority through the purchase of Power Purchase Agreements (including Apple) - filed comments on how these rules would limit the ability of renewables to compete in the electricity market[26].

Technological risk

Technological risk can be defined as the risk of substitution of existing products and services by lower-emission options. It can also be linked to technological deadlocks that prevent emissions reduction targets from being met. As far as the physical infrastructure of the ICT sector is

[24] **CDP 2021**. - Climate Change Disclosure 2021 - AT&T.
Available at: <https://about.att.com/ecms/dam/csr/2019/library/corporate-responsibility/CDP-Climate-Change-Disclosure-2021.pdf.>

[25] **data centerdynamics.com. 2021.** Visa to Power Virginia Data center with 100 Percent Solar Energy.
Available at: <www.data centerdynamics.com/en/news/visa-power-virginia-data-center-100-percent-solar-energy/>

[26] **Apple 2019. -** Environmental Responsibility Report 2018
Available at: <https://www.apple.com/environment/pdf/Apple_Environmental_Responsibility_Report_2018.pdf>

concerned, this risk materializes mainly in **the major investment effort required to decarbonize equipment, notably networks and data centers.**

Besides, as in the previous categories, the **risk also lies in the energy supply**:

- Decarbonizing sites, networks and data centers with renewable electricity require the use of batteries with high storage capacity, the availability and improvement of which are not certain. This could lead to the use of controllable sources of electricity, which are generally fossil fuels (and therefore subject to a high transition risk).
- Dependence on fossil fuels upstream (material extraction and appliance manufacturing) and downstream (end-user electricity) of the value chain suggests a technological risk in terms of the increasing difficulty of extracting fuels (decline in conventional drilling).

Broadly speaking, **the low-carbon transition will be very metal-intensive** (deployment of renewable energies), which **will lead to trade-offs in the allocation of limited resources. There is no guarantee that the ICT sector will be considered a priority** to benefit from the metals needed for the transition.

For semiconductor manufacturing companies, another risk is the need to work in aseptic rooms, with strict temperature and air quality constraints. This means relying on cooling towers or refrigerant coolers, which are subject to HFC regulations. So, if HFCs were banned from the market, players such as STMicroelectronics would have to find new ways of cooling and manufacturing.

Reputation risk

Companies in the ICT sector could find their reputation jeopardized by their lack of interest in climate change. Indeed, the **rise in climate awareness among stakeholders (customers, shareholders, etc.) is making them more demanding of a low-emissions sector**, which is not compatible with the activities of some large companies. Furthermore, large digital companies are compromising their reputations by launching **carbon-intensive business segments** (e.g., the "Metaverse" of Meta, formerly Facebook), sometimes through subsidiaries. In addition, **GAFAM CEOs** have acquired a high profile, which consumers may equate with the company's reputation. As a result, **their emissive activities can affect their company's reputation** (e.g., Jeff Bezos, CEO of Amazon.com Inc., launched a space tourism company, Blue Origin). Overall, over-mediatization generates over-exposure. Ultimately, **companies that fail to meet their emissions reduction targets put themselves at risk**. For example, in 2019, Ohio reduced its target for the share of renewable energy in its portfolio from 12.5% in 2025 to 8.5% in 2026, which interfered with Alphabet's claim to neutrality due to its data center site in Ohio[27].

Human resources risk

Climate awareness is also awakening among the employees and recruitment targets of major digital companies. If companies don't take appropriate action to kick-start their low-carbon transition, they risk encountering **difficulties in employee retention and recruitment.**

[27] **Colorado State University, 2022.** Center for the New Energy Economy. *State Brief: Ohio.* Available at: <https://cnee.colostate.edu/wp-content/uploads/2022/08/State-Brief_OH_July_2022.pdf>

Summary of transition risks

The diagram below summarizes the various transition risks identified (regulatory and legal risks are grouped under "Regulation" and human resources risks are included under "Reputation"):

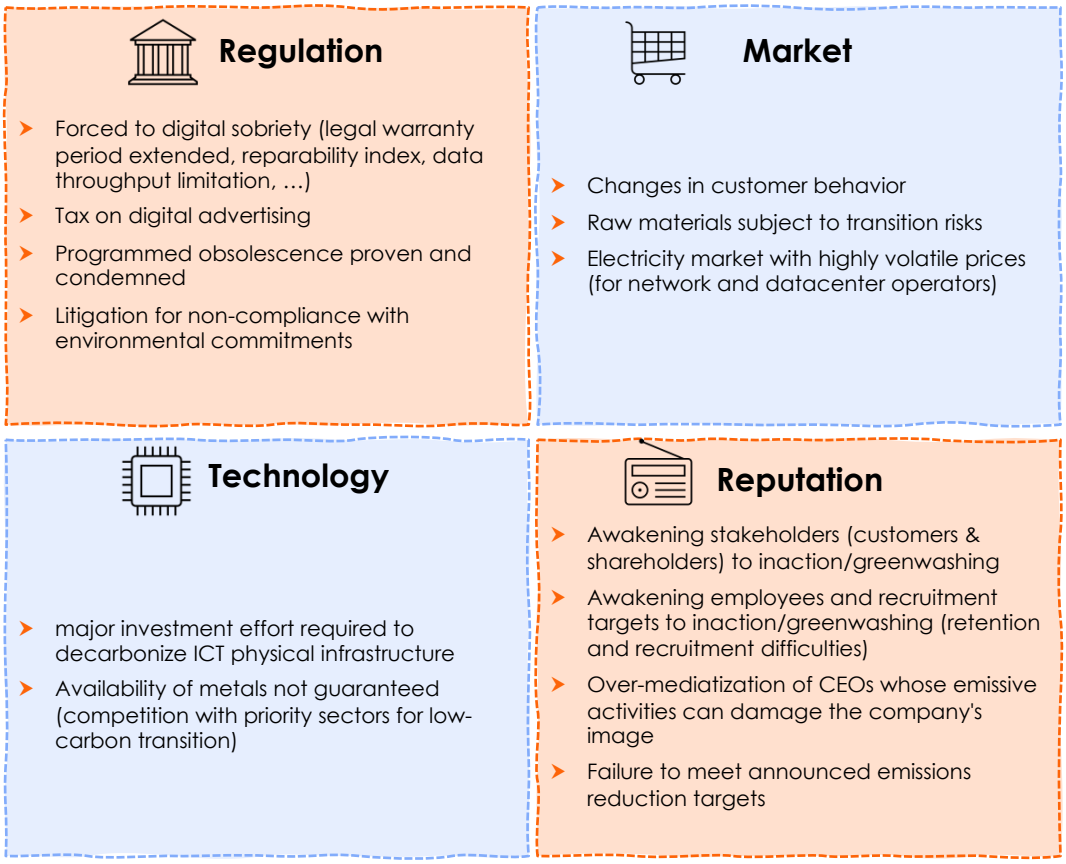

Figure 9 - The various transition risks identified

Carbon Impacts Analytics (CIA) methodology

The CIA methodology calculates (or extracts) scope 1, 2, and 3 emissions, as well as key performance indicators specific to the sector under analysis, enabling the calculation of an overall rating to assess an entity's contribution to a low-carbon transition and its exposure to transition risk.

This section provides a brief overview of how the CIA methodology is applied to the ICT sector. For more details on CIA methodology in general, please refer to our **CIA methodology guide**[28].

Calculating GHG emissions

For the ICT sector, the CIA methodology calculates (or extracts) the emissions (by convention "emissions" without precision means "greenhouse gas emissions") induced in scope 1&2 and 3, as well as the decrease in scope 1&2 emissions if applicable (this decrease reflects the improvement of the scope 1&2 carbon intensity, if any, using a physical denominator).

Scope 1&2 induced emissions

Induced scope 1 and 2 emissions are either published by the company under analysis or calculated using the CIA methodology. We use published emissions when scope 2 emissions are calculated using **location-based emission factors** (the emission factor reflects the electricity mix of the geographical area) and the company discloses **sufficient data to enable a consistency check with our ratios** (energy consumption, office life ratios, etc.). Otherwise, we attribute the emissions calculated for scopes 1 and 2 to the company, based on energy consumption (good accuracy) or financial ratios (average accuracy) and using our own emission factors.

Scope 3 induced emissions

The CIA methodology identifies two main sources of **scope 3** emissions for the ICT sector:

- **Emissions from the sectors that will use the company's digital products and services** (on which the ICT company depends). This approach applies to consulting firms and B2B software development companies.
- **Digital infrastructure usage emissions**. This approach concerns B2B and B2C software development companies (which will inherit terminal and network manufacturing and usage emissions), hardware manufacturing companies (which will inherit hardware usage emissions as well as network manufacturing and usage emissions), and telecoms and media services companies (same logic).

For the first category above, scope 3 is calculated by segmenting the company's sales by end markets, then multiplying, for each market segment, the company's relevant sales by the carbon

[28] Available at: <https://www.carbon4finance.com/our-latest-carbon-impact-analytics-methodological-guide2>

intensity of the market concerned (i.e., scope 1, 2, and 3 emissions per dollar of sales in the sector concerned). These intensities are calculated from our bottom-up CIA database.

For the second category above, we use a top-down methodology, applying the same global monetary emission factor to all companies. This is obtained by dividing global digital emissions (1.84 GtCO2eq - source The Shift Project) by the global added value of the ICT sector (N.B.: scope 1&2 emissions are removed from this result to avoid double counting).

Why focus on these two Scope 3 emissions?

- **End-market emissions**: ICT players whose revenues come from B2B sales may be weakened by the transition to a low-carbon economy if their customers are vulnerable to this transition. Consequently, we attribute part of the emissions from these industries to the ICT player analyzed.
- **Emissions from the physical ICT infrastructure**: we believe that all ICT players have **a part of their transition risk that is systemic**, as all players are interdependent. For example, a social network (media sector) is accessed via an application (B2C software sector) that runs on a smartphone (computers and peripherals sector) and requires an Internet connection available through a subscription to a telecoms services company (telecoms services sector). Consequently, if one of these players is subject to a transition risk, all the other players in the value chain will suffer the consequences. To reflect this dependence of any one player on the emissions of all the other players in the value chain, we take the player's added value in the entire value chain as the basis for allocating emissions.

Main limitations:

To obtain the overall value added of the ICT sector, only listed companies - which provide the bulk of the sector's value added - are taken into account. The overall emissions of the ICT sector are therefore distributed among these listed companies only, but this is sufficient to have a good approximation of reality.

The ideal would be to use a bottom-up approach for each player in the sector. But this would require a broad base of physical emission factors (e.g. kgCO2e/phone_produced for each type of phone sold, or kgCO2e/MO transported according to each type of network) which is currently unavailable, and on the other hand the data needed for such calculations is rarely available (telecom operators don't publish detailed traffic by type of network or number of smartphones sold in the year, let alone by brand and model!).

Overall carbon performance: the CIA rating

GHG emissions alone are insufficient to assess a company's contribution to the low-carbon transition and its exposure to transition risk. To assess this contribution to the transition and this risk exposure, Carbon4 Finance calculates **a rating, ranging from 1 (A+, best) to 15 (E-, worst)**, which results from the aggregation of 3 pillars (themselves rated between 1 and 15):

- **Past performance**: has the company succeeded in improving its carbon intensity over the Past 5 years?
- **Current performance**: how carbon-intensive is the company compared with its peers in the sector?
- **Forward-looking performance**: are the company's carbon reduction strategies and targets ambitious enough to achieve an effective low-carbon transition?

In addition, for each sector we **conventionally set the highest and lowest ratings that can be achieved by a player in that sector**. These maxima and minima reflect the sector's compatibility with a low-carbon transition. For example, in the rail sector, companies' ratings range from 1 to 8 - reflecting a sector that is generally compatible with decarbonization - whereas in the Oil & Gas sector, possible ratings range from 8 to 15 - at best, a company is "neutral" concerning the low-carbon transition. This allows a fairer comparison between companies in different sectors.

For more details on CIA rating, see our methodological guide.

Past performance

Past performance corresponds to **the improvement observed - or not - in the carbon intensity of the player over the last 5 years**. For the ICT sector, this Past rating combines 2 components:

- **A systemic rating** (consulting companies are not included): this results from the strong interdependence of players in the ICT sector, as described above. We calculate the carbon intensity evolution for the sector as a whole, which is then applied to all players. Thus, if we observe a reduction in the sector's carbon intensity, then the Past performance of all players improves.

- **An individual carbon performance rating**:
    - For telecom services, it reflects the evolution over the last 5 years of scope 1&2 emissions per subscriber. The number of subscribers seemed to us to be the best proxy for the physical flows managed by the operator.
    - For consulting services and B2B software developers, the evolution over the last 5 years of their customers' carbon performance (approximated by their CIA rating). This makes it possible to assess whether the customers who support the company are still as dependent (or even more so) on greenhouse gas emissions or not.
    - Players in the media, B2C software and hardware sectors don't have individual ratings. Unfortunately, they don't publish any physical data on which we can rely. For example, data center operators don't publish their installed capacity, or screen manufacturers don't publish the total surface area of screens manufactured in the year. Nor do media companies publish physical metrics (such as data center capacity).

Current performance

Current performance compares the player's current carbon intensity with that of its peers in the sector. The underlying indicators are :

- For telecom services, scope 1&2 emissions per subscriber.
- For players in the B2B consulting and software sectors, the average CIA rating of their customer portfolio. For this calculation, each client is assigned the average CIA rating for its sector. A weighted average is then calculated for each customer's CIA rating (the weight of each customer corresponds to its share of the company's sales). Thus, if a player sells all its products to a customer whose sector is rated C (the average rating of companies belonging to this sector in the CIA database), it will be given a C rating.
- The same actors who don't have an individual Past performance don't have a Current performance, for the same reasons.

<table>
<tr><th></th><th colspan="2">Past performance indicators</th><th>Current performance indicators</th></tr>
<tr><th></th><th>Carbon performance of the ICT sector</th><th colspan="2">Individual carbon performance</th></tr>
<tr><td>Consulting services</td><td>Not applicable</td><td>5-year trend in the sector allocation of the player's revenues</td><td>Carbon performance of the company's customers (end markets)</td></tr>
<tr><td>B2B software</td><td rowspan="5">Systemic rating of the ICT sector (D+), based on the evolution of its intensity in tCO2eq/m€ of revenue.</td><td>5-year trend in the sector allocation of the player's revenues</td><td>Carbon performance of the company's customers (end markets)</td></tr>
<tr><td>B2C software</td><td>Not applicable</td><td>Not applicable</td></tr>
<tr><td>Media</td><td>Not applicable</td><td>Not applicable</td></tr>
<tr><td>Telecommunications services</td><td>Scope 1&2 emissions per customer's evolution over 5 years</td><td>Scope 1&2 emissions per customer</td></tr>
<tr><td>Hardware</td><td>Not applicable</td><td>Not applicable</td></tr>
</table>

Table 2 - Summary of Past and Current performance indicators

Forward-looking performance

The CIA rating's **Forward-looking performance** is based on **an in-depth analysis of qualitative sub-indicators**, in order to assess the entity's efforts to take climate risks into account in its strategy, and to mitigate its impact on climate change. The underlying indicators are as follows:

- The entity's **strategy** for its transition to a low-carbon economy,
- **Investments** and R&D expenditure that will help reduce carbon emissions,
- The entity's **reduction targets** for direct and indirect GHG emissions (scopes 1, 2 & 3),
- The **governance structure** that oversees climate risks within the entity.

The table below shows the criteria considered:

Actor type	Key levers for action to contribute to the low-carbon transition
Software (B2B & B2C)	• **Software that has a positive impact on the climate** (for example, software that helps to reduce a company's carbon footprint). • Software **eco-designed** (for example, software whose functional, graphic, ergonomic and technical design is as energy-efficient as possible).
Hardware	• Working with **low-carbon materials suppliers**. • **Increase products energy efficiency** (in the case of firsthand products). • **Increase the recycling/life span of** electronic equipment.
Telecommunications services	• **Increase network energy efficiency**. • **Increase products energy efficiency** (internet boxes). • **No incentive to change equipment.** • **Pay-per-use tariffs to** encourage data flow limitation[29]. • Implement **low-carbon power purchase agreements (PPAs)** for network energy consumption. • **Increase data centers energy efficiency.**
Media	• Produce **content aimed at mitigating global warming** (awareness-raising, ...). • **Reduce online advertising revenues** which encourage consumption. • **Increase data centers energy efficiency.** • Implement **low-carbon power purchase agreements (PPAs)** for data centers energy consumption.
Consulting services	• Create **relevant tools or services to reduce customers' carbon footprint**. • **Consulting missions to reduce carbon footprint.**

Table 3 - Main levers for action by sub-sector, to contribute to the low-carbon transition

N.B.: to obtain a high rating, the company must **quantify the share of these low-carbon measures** in its overall activity, with **quantified energy or emissions savings**, to understand whether or not these measures are significant.

[29] The study did not identify any players in the sample who used this measure.

Reduction targets: to assess companies' alignment with emissions reduction scenarios, **we compare the emissions trajectory implied by the players' reduction targets (scope 1&2 and 3) with an appropriate sector scenario**. To date, there is no specific scenario available for the ICT sector. We have therefore relied on the global emissions scenarios of the IEA, 2017.

N.B. 1: We consider emissions reductions claimed via green electricity certificates (Guarantees of Origin) to be irrelevant. Indeed, these purchases change neither the physical reality of consumption - the company uses the same electrons from the same grid - nor the physical reality of production: most of these guarantees come from assets that have already been built or that already benefit from public subsidies[30], and in no way contribute to financing new installations. However, if the company mentions traced low-carbon power purchase agreements (PPAs), energy efficiency and reduced energy consumption, it can still perform well in the scope 1&2 reduction target criteria.

N.B. 2: Neutrality statements are considered irrelevant by the CIA methodology, as they are meaningless when defined on a company level (for more information, see Carbone 4's **Net Zero Initiative benchmark**[31], which provides guidance on how to position yourself in relation to neutrality).

Governance structure: we assess the existence of internal structures dedicated to energy-climate issues (usually the CSR department), with their link to the executive committee, as well as the implementation of training and incentives to help and encourage employees to integrate climate-related issues.

Aggregation and calculation of the overall CIA rating

The overall CIA rating is the weighted average of Past, Current and Forward-looking performance. For the ICT sector, **Forward-looking performance is the most heavily weighted**, because :

- Regarding telecommunication services, Past and Current performances, which are based on carbon intensities, only take into account Scope 1 and 2 emissions, whereas Scope 3 is the main source of emissions for digital companies.
- Overall, we lack the physical data to reflect companies' service/production capacity. As a result, it is easier to evaluate entities with a qualitative analysis.
- Past performance is partly systemic and does not allow us to differentiate between the players.

[30] **Carbone 4. 2018.** "Green" electricity: a relevant tool for businesses?
Available at: < https://www.carbone4.com/electricite-verte-outil-pertinent-entreprises>

[31] Available at: <https://www.carbone4.com/publication-referentiel-nzi>

Actor type	Past performance weight	Current performance weight	Forward-looking performance weight
B2B software	15%	15%	70%
B2C software	30%	0%	70%
Hardware	30%	0%	70%
Telecommunications services	30%	20%	50%
Media	30%	0%	70%
Consulting services	20%	30%	50%

Table 4 - Weight of Past, Current and Forward-looking performance in overall CIA rating

Finally, as mentioned in the introduction to point **3.2**, we apply an affine transformation to obtain an overall CIA rating ranging from a theoretical maximum to a theoretical minimum. The thresholds for the ICT sector are specified in the table below:

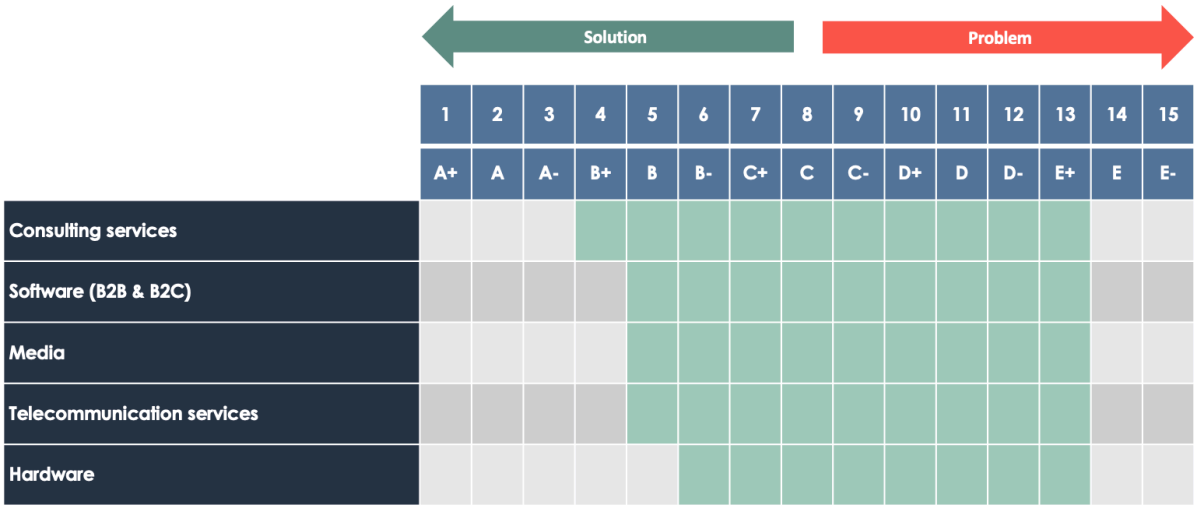

Table 5 - Reachable CIA ratings by sub-sector

Multi-sector companies

Some companies are involved in several ICT sub-sectors. For example, a minority share of telecom service revenues often comes from the sale of digital equipment (internet boxes, etc.), which corresponds to a segment that can be analyzed using the Hardware methodology. **For companies with several business segments, the overall CIA rating corresponds to the weighted average of the CIA ratings for each segment**. The weighting weights are the segment's share of the company's total revenue.

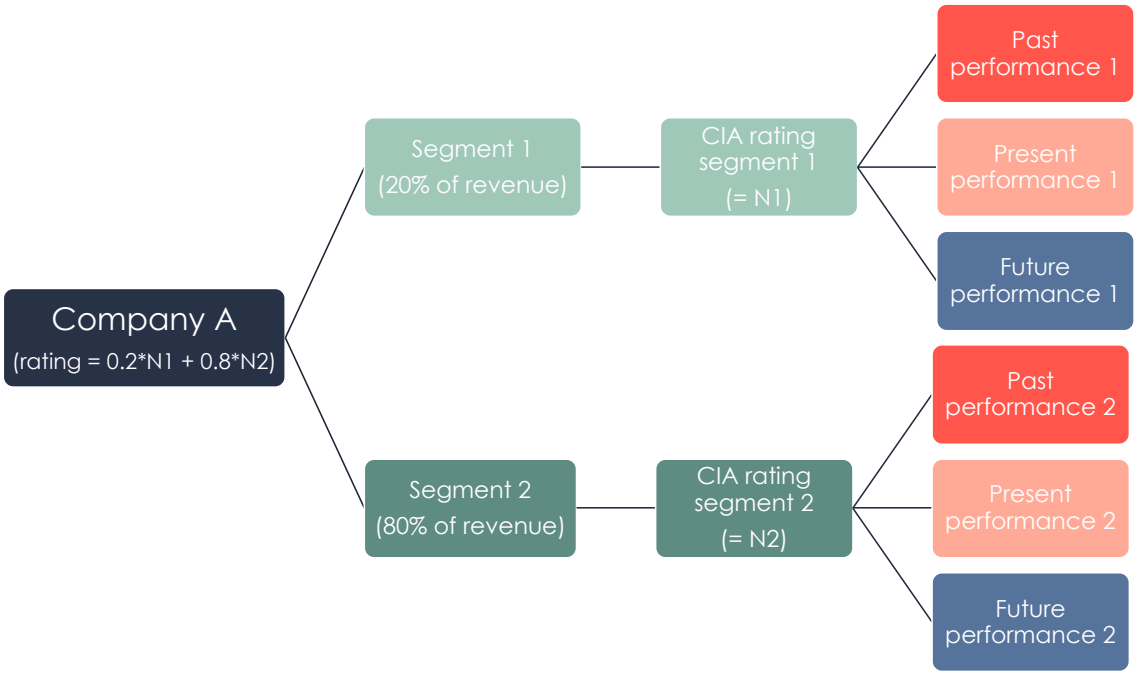

Figure 10 - Example of CIA rating calculation for a multi-sector company

Most of the companies in the sample are single-segment companies (or companies with one main business segment accounting for over 90% of revenues). Among the companies operating in several business segments, we note in particular :

- Microsoft Corp: Media (42%, as the company provides web content through its cloud hosting, LinkedIn, and online advertising), Software (40%, B2B & B2C through its cloud software, Windows, and video games), and Hardware (9%, through sales of PCs, tablets, game consoles). The remaining 9% of revenues are outside the scope of this analysis.
- International Business Machine Corp (IBM): B2B software (42%, including cloud software and cognitive applications), hardware (34%), consulting (21%, helping customers implement digital tools).
- Bollore SE: Media (37%, via its subsidiary Vivendi), Logistics (32%, via its subsidiary Bollore Logistics, which is involved in oil and gas transport, port operations and freight forwarding).

Results

This section presents the overall ranking of CIA ratings for the ICT sector, as well as the distribution of the main indicators that make up Past, Current and Forward-looking performance.

Presentation of results for overall CIA ratings

The **ICT sector CIA ratings range from 6.8 (C+) to 11.9 (D-), with an average of 9.5 (C-)**. Grades are **not widely dispersed**, due to the application to all companies of the systemic risk mentioned above (except for consulting firms[32]**). An average grade of C- for the sector corresponds to a slightly negative contribution to climate change mitigation**.

The overall ranking is presented in the figure below, from lowest (best) to highest (worst) CIA rating.

[32] Consulting companies are dependent on digital infrastructure in the sense that digital tools enable them to optimize their services, but they do not contribute directly to the use or production of digital infrastructure, unlike the other sub-sectors under study.

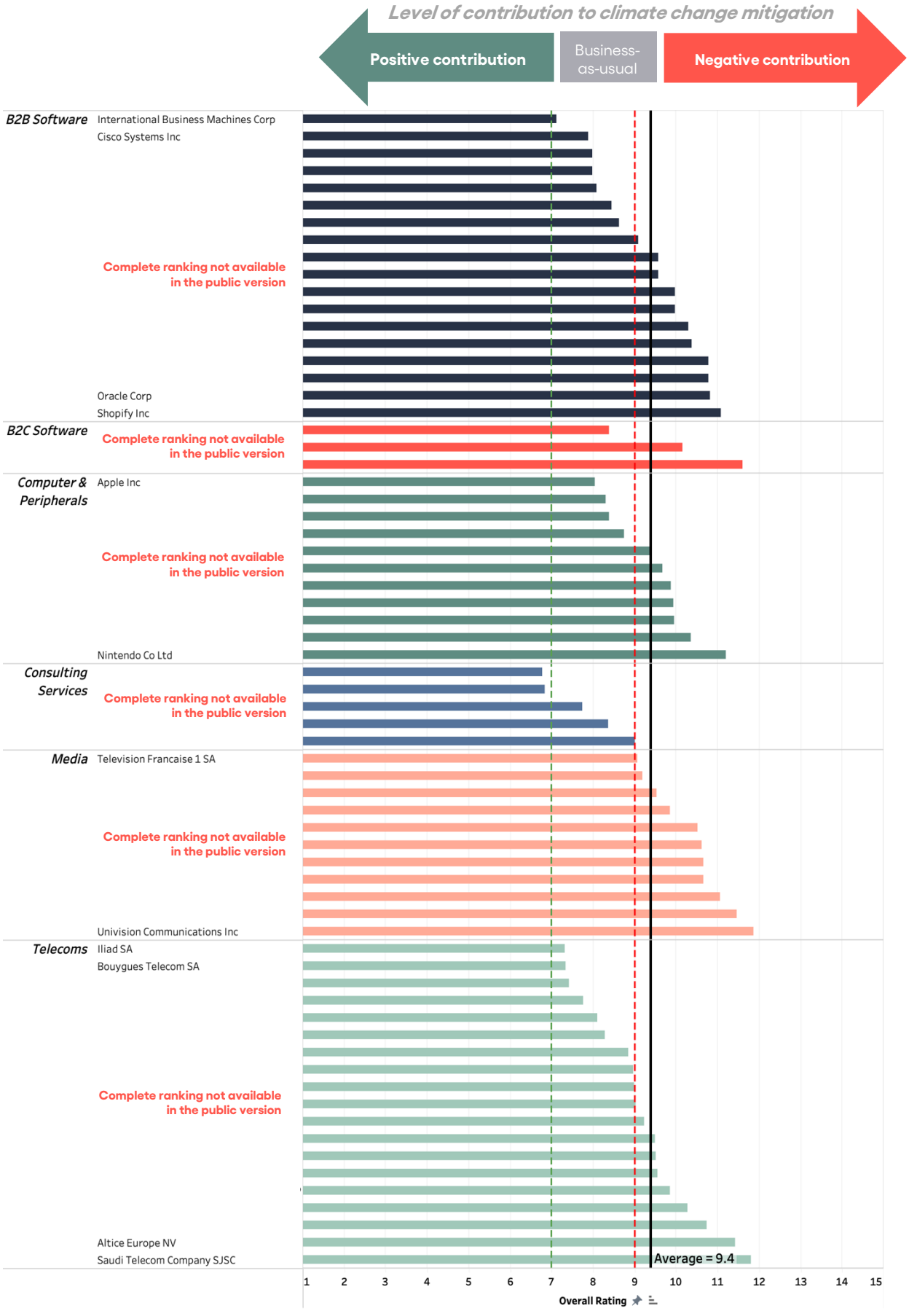

Figure 11 - Overall ranking of CIA ratings by digital subsector[33]

An in-depth analysis of the distribution of ratings within each sub-sector reveals certain trends:

- The **worst-performing** sub-sectors **are media and B2C software**, where many players do not pay particular attention to the climate issue.
- **In the telecoms, hardware and B2B software sectors, ratings are more widely spread**, with some players having a good understanding of their impact on the climate and the levers for mitigating it.
- **Consulting services are rated the best overall**, as many players have set up business units specializing in carbon footprint assessment and supporting their customers in their low-carbon transition.

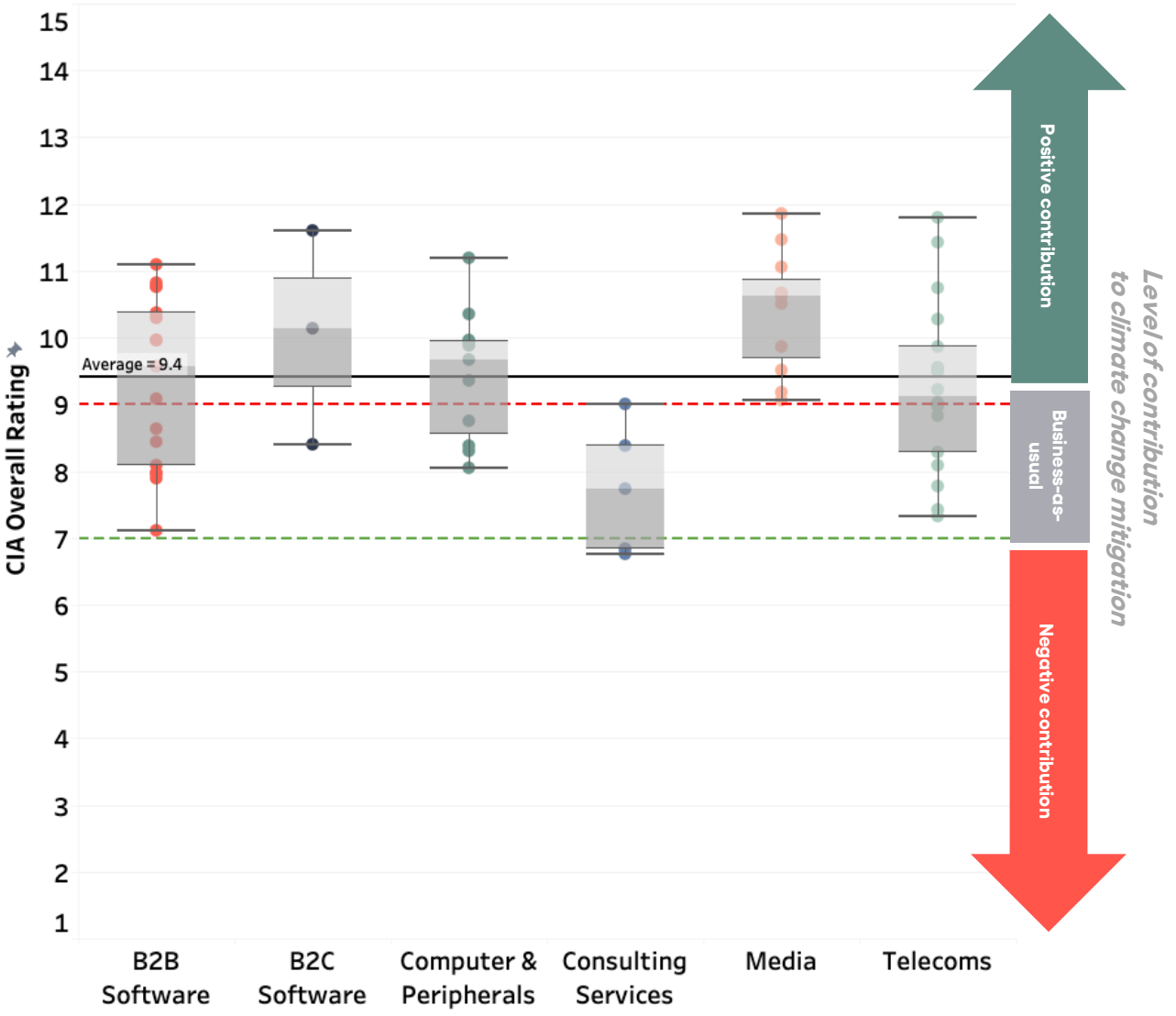

Figure 12 - Breakdown of CIA ratings by sub-sector

[33] Some companies may appear to be categorized in an unexpected sector. In reality, this is the majority sector in terms of revenues, but not necessarily the company's historical sector (see methodological point **3.2.5**).

Past, Current and Forward-looking performance ratings

Past performance ratings

Past performance reflects the evolution of the player's carbon intensity over 5 years. As indicated in section **3.2.1**, Past performance depends on individual performance for telecom services, B2B software and consulting services. For other players in the sector, it only reflects the dynamics of the sector as a whole.

Regarding telecommunication services, the results are widely dispersed: scope 1&2 emissions per subscriber fell by 40% for the best performers and rose by +90% for the worst, with most players fluctuating between +20% and -20%. These **scope 1&2 emissions are mainly linked to the energy consumption of telecoms networks**. Consequently, changes in the intensity of scope 1&2 emissions can result either from an improvement (respectively decrease) in network energy efficiency, or from the sale (respectively acquisition) of networks in countries with a carbon-intensive electricity mix. The use of on-site renewable electricity generation could also be a relevant way of improving carbon intensity, although it is difficult to implement on a large-scale network (more suited to data centers, for example).

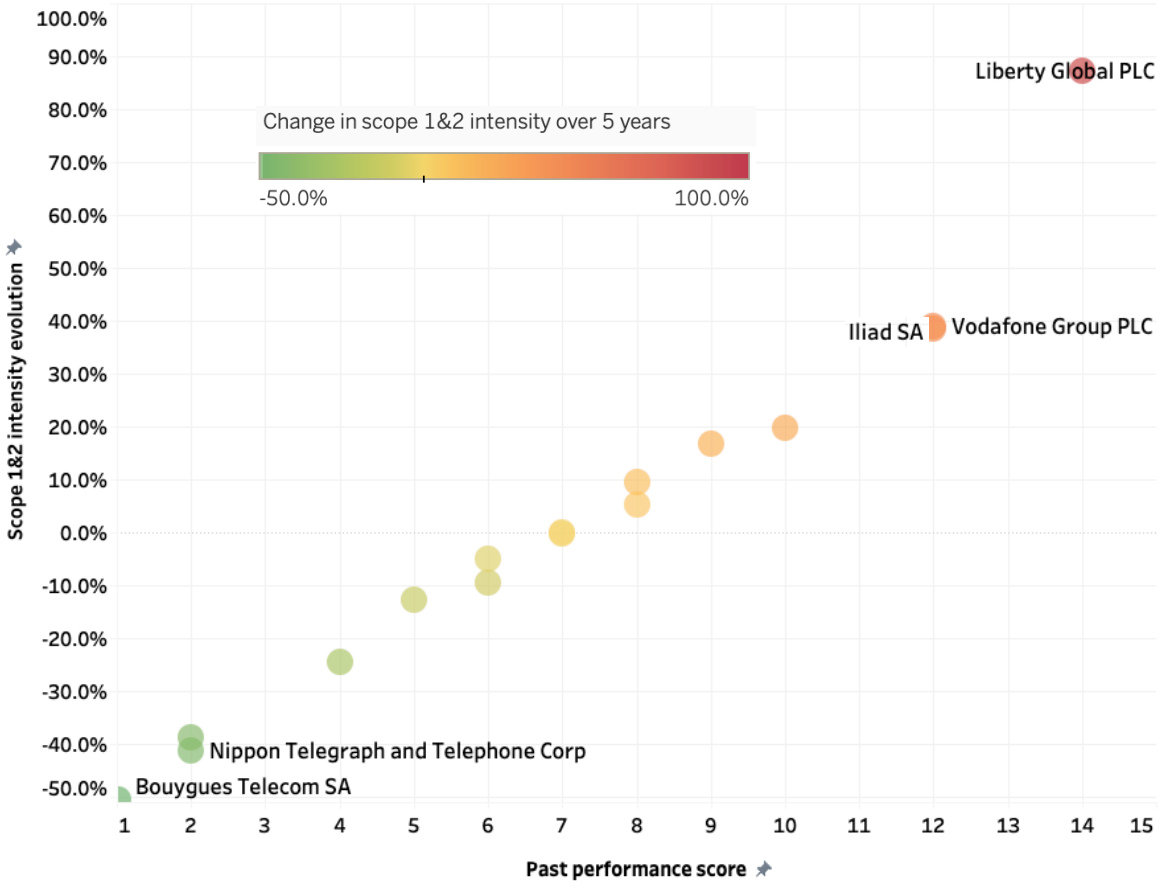

Figure 13 - Past performance for telecoms (indicator: change in scope 1&2 intensity)

For **B2B consulting and software services, the** Past performance is the result of changes in the sector breakdown of the company's customer base. As many players have not changed customer base, the sectoral distribution of their customer portfolio has not changed over a 5-year period, and **evolutions are therefore close to 0%. This results in an average Past performance (8/15), synonymous with the status quo**.

Current performance ratings

The Current performance reflects the player's current position among its peers, in terms of carbon intensity. As with Past performance, the analysis of results will focus on telecommunication services, B2B software and consulting companies, as these are the only sub-sectors with a Current performance indicator (no relevant indicators having been identified for the other sub-sectors).

For **telecommunication services**, scope 1&2 emissions range from 2 to 32 kg CO2eq/subscriber/year, with most players between 15 and 25. These **differences are largely explained by the countries where the player operates its network**. Indeed, players operating in countries with a low-carbon electricity mix (e.g., France) will have a much higher carbon intensity than those operating in countries with a high-carbon electricity mix (e.g., USA).

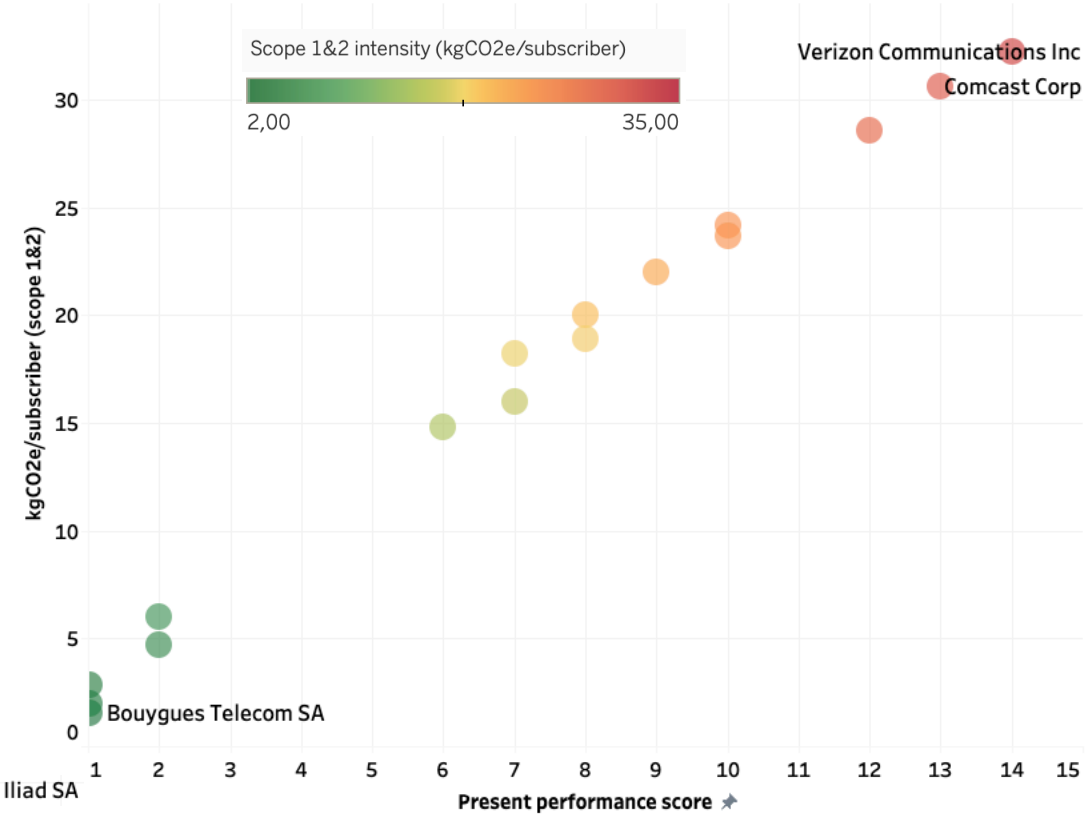

Figure 14 - Current performance for Telecoms (indicator: scope 1&2 intensity)

For **software and B2B consulting services, the results are centered around 8, which is a rating reflecting a "business-as-usual" scenario** (i.e., activity aligned with a +3.5°C increase in global average temperature by 2100, relative to pre-industrial levels), with low variance. This is because **the companies analyzed have clients in all sectors**, as their services are cross-sectoral. It is therefore normal that their Current performance roughly reflects that of the current economy.

Forward-looking performance ratings

The CIA methodology's Forward-looking performance is based on a qualitative analysis, which provides an in-depth assessment of the company's decarbonization strategy.

A first observation is that the **distribution of Forward-looking performance ratings by sub-sector is very heterogeneous**. The **B2C software and media sub-sectors obtain the worst ratings of the sample**, as most players do not communicate their emissions or reduction levers. One reason for this lack of understanding is that **some players consider their activity as non-material and non-emitting, without considering their dependence on the physical ICT infrastructure** (see **2.2**). They see no exposure to climate change risks[34].

B2B software, hardware and telecoms services show **a better average Forward-looking performance overall**, with more scattered ratings, with some players having identified and undertaken key measures supporting a relevant low-carbon transition, and others paying no attention to climate-related risks and opportunities.

Eventually, **consulting services** companies seem to have a better understanding of the low-carbon transition. There is not a single player that does not mention climate change in its sustainability report. In addition, listening to the needs expressed by corporate clients, **many entities have launched business units specializing in impact consulting assignments**, which aim to reduce their clients' emissions.

[34] Here are a few examples:

- **Netflix**, in its 2021 ESG report, after conducting an analysis of its exposure to transitional and physical climate risks, explicitly states, "There were no material climate risks that were identified for Netflix through this analysis." (available at: <https://about.netflix.com/en/sustainability>)
- **Meta**, the company that owns the Facebook social network, in its 2021 sustainability report, places climate change risks (transition and physical) in the "critical" category for stakeholders (shareholders and customers) but "marginal" in terms of potential impacts on its business. (available at: <https://sustainability.fb.com/2021-sustainability-report/>)

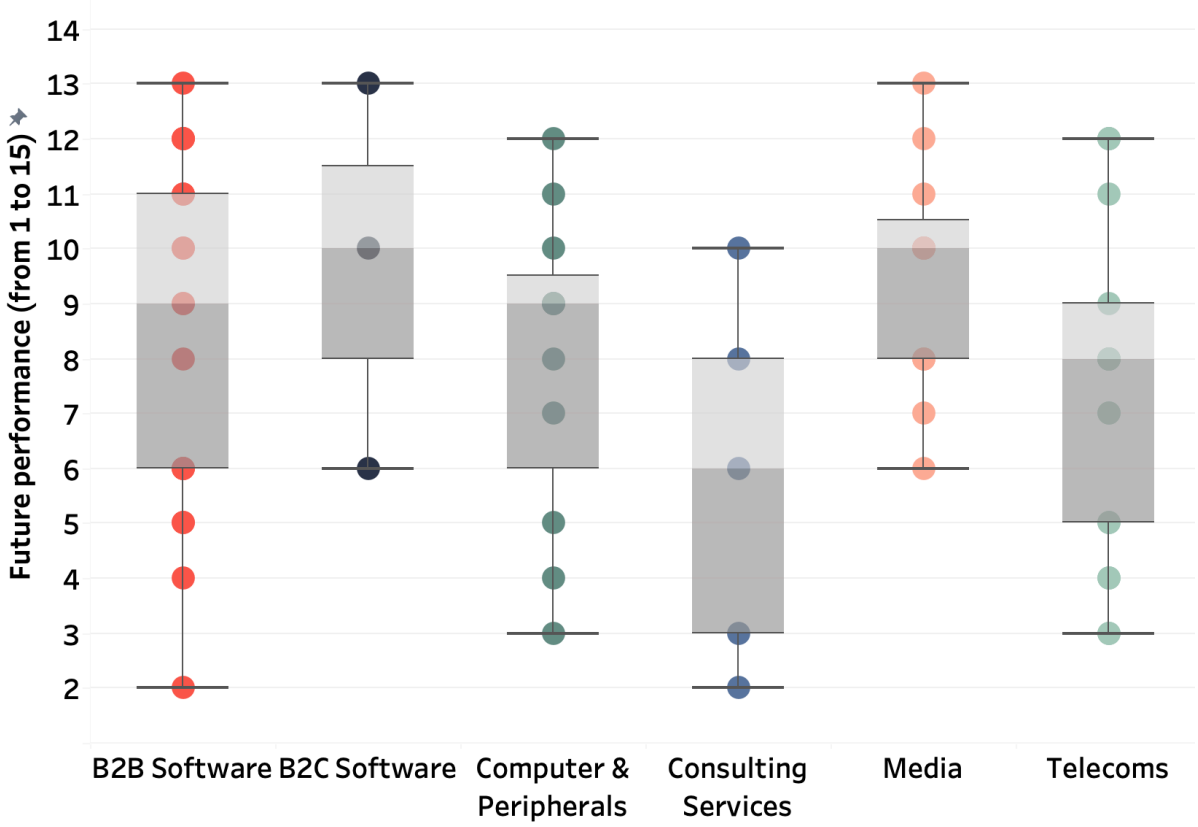

Figure 15 - Distribution of Forward-looking performance ratings by sub-sector

It's also interesting to examine the distribution of Forward-looking performance ratings according to market capitalization. Indeed, while companies with "high" (over €100 billion) and "medium" (between €100 and €10 billion) market capitalizations have a similar average Forward-looking performance**, small-cap and non-listed players have a slightly lower average Forward-looking performance**, and therefore seem to take less account of transition risk in their strategy. This could be explained by the **pressure exerted by stakeholders (customers and shareholders) on large-cap companies to** play a leading role in climate change mitigation. The absence of a low-carbon strategy would entail a significant **reputational** risk for these companies (see **2.4.5**). Furthermore, **unlisted companies do not have the same regulatory constraints or the same transparency requirements** in their annual reports, and this may weaken their capacity for introspection.

Elements of interest identified during the qualitative analysis

Carbon accounting: insufficient understanding of scope 3 emissions

Large digital companies seem to have a fairly good understanding of the emissions linked to their own energy consumption (scopes 1&2). In fact, **80% of the entities in the sample report scope 1&2 emissions**, with 62% relying on location-based emission factors[35] for electricity (at least, as some companies use both location-based and market-based approaches).

On the other hand, **most companies analyzed do not take into account indirect emissions linked to their activities (scope 3)**, which represent over 90% of the emissions on which companies in this sector depend.

This may be due to the following factors:

- **Scope 1&2 emissions are easy to calculate**: all that's required is readily available energy consumption and emission factors. **Scope 3 covers many emission categories**, and for some (notably purchasing) neither the data nor the emission factors are easy to find.
- **Scope 3 is much higher** in terms of volume, and its addition would give players a **worse environmental image**.
- Many companies, particularly those in the **service** sector**, fail to realize the full length of their value chain**. For example, software companies need electronic devices that will use their programs, but they do not include the manufacturing of these devices in their emissions inventory, even though this is the most significant source of emissions in this case. The scope 3 emissions that may be taken into account are those linked to office life (employee travel, business trips, purchases, etc.) and external data centers (which is relevant). As a result, some of their options to act (e.g., pushing for terminals that emit less during manufacture and are renewed less frequently) escapes their vision. The same applies to telecom companies, who do not consider the emissions (manufacturing and operating) of devices connected to their network[36].
- Some **hardware manufacturers are exceptions, publishing relevant scope 3 emissions** because they have a better understanding of where their main emissions come from upstream energy consumption to extract, transport and assemble materials, as well as downstream energy consumption during the use phase of the devices sold. Some players are engaging in discussions with their suppliers to use low-carbon materials, and are working to improve the energy efficiency of appliances.

Strategy: transition risks insufficiently addressed

One of the worst indicators is the assessment of the overall strategy to mitigate climate change and contribute to the transition. **Only 26% of players believe that decarbonization could**

[35] As a reminder, a definition of a location-based factor is given in 3.1.1.

[36] Including emissions from devices used to access services (even if they are not sold by the player itself) is nevertheless recommended by the GHG Protocol (which serves as a reference for most companies), cf. the **Carbon Trust and GeSI (2017)** study *"ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard"*. (Example for the Telecoms sector, table 2.2 p.47 of the study). Available at: <https://ghgprotocol.org/sites/default/files/GHGP-ICTSG%20-%20ALL%20Chapters.pdf>

potentially damage their business and have identified their main climate change mitigation levers (listed in **3.2.3**). **Most players (47%) have undertaken marginal or irrelevant actions**, generally focused on office life and employee emissions, or based on the purchase of renewable electricity certificates (Guarantee of Origin). Many mention that their business is not at risk as their products do not emit GHGs (which is consistent with their minimalist calculation, see **4.3.1**). Finally, **27% of the actors do not disclose any measures to reduce their emissions** or energy consumption.

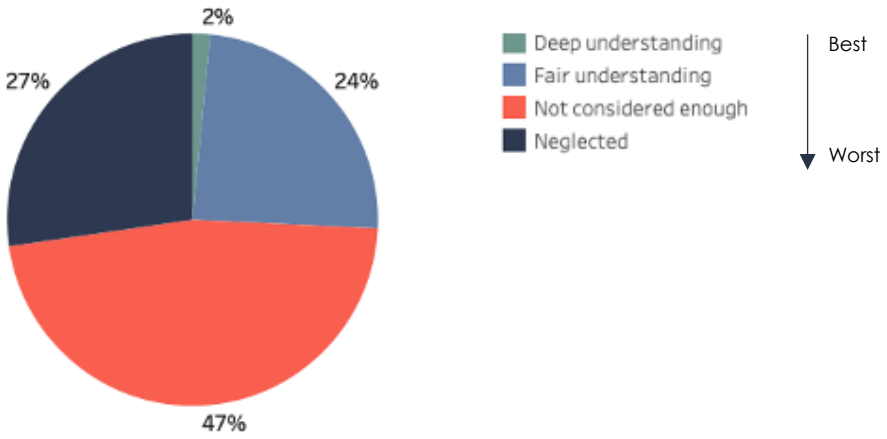

Figure 16 - Companies' understanding of transition risks and their main risk reduction levers (Source: Carbon4 Finance database)

Emissions reduction targets: lack of ambition

A company's greenhouse gas emission reduction targets are an indication of its ambition to align with a low-carbon economy, and of its understanding of its GHG emissions.

Regarding scope 1&2 emissions, **14% have declared no reduction targets**. **36% of the sample only use offsetting** to theoretically reduce their emissions (in practice, the transition risk remains unchanged, as does the impact of their activities) **or purchase green electricity certificates**, without taking any operational measures to reduce emissions, for example through energy efficiency. In such cases, the CIA method does not credit the company with any benefit from this action. **38% of the companies analyzed have a target to align** their scope 1&2 emissions with a scenario below 2 degrees (B2DS) or with a 2-degree scenario (2DS)[37].

[37] This 38% includes players who also use carbon offsetting. We penalize players who **only** use this process, but not those who also have a relevant reduction target (as defined in **3.2.3**).

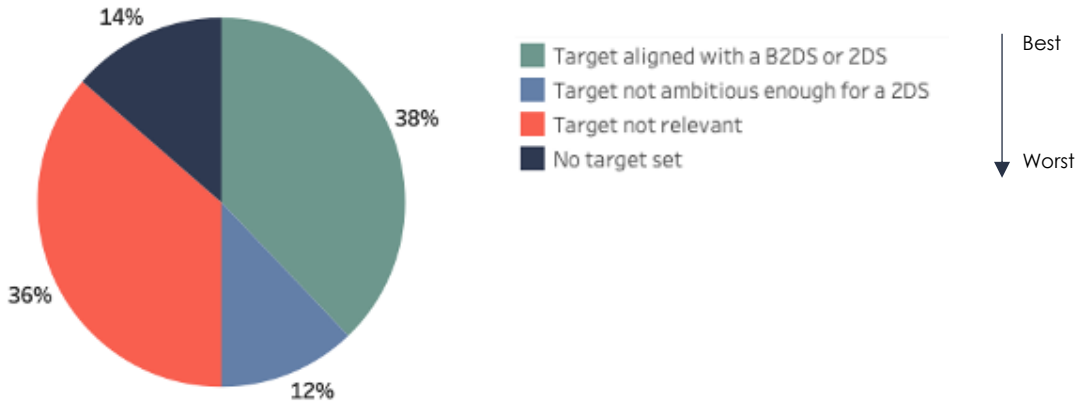

Figure 17 - Assessment of companies' scope 1&2 emissions reduction targets (Source: Carbon4 Finance database)

As for **scope 3** emissions, **42% of players have not set any reduction targets**; **20% have set an irrelevant target,** meaning that it does not cover the most significant scope 3 emission categories, or is based on carbon offsetting. **Only 17% of scope 3 emissions reduction targets are aligned with a scenario** below 2 degrees (B2DS) or with a scenario at 2 degrees (2DS).

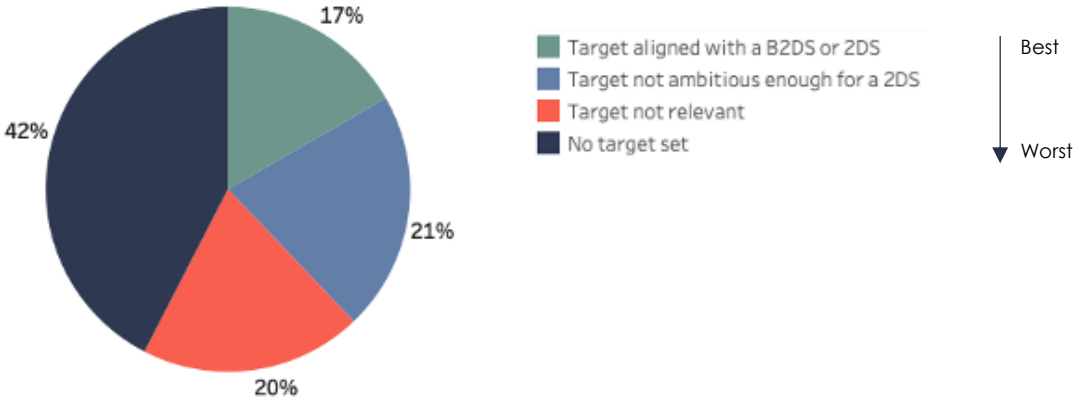

Figure 18 - Assessment of companies' scope 3 emissions reduction targets (Source: Carbon4 Finance database)

Low-carbon investments: still too marginal

Low-carbon investments are part of the efforts companies must make to ensure their transition. The amount of such investments may depend on the following trade-off: if they are aimed at avoiding a transition risk, the upper limit will be the potential loss that will not occur, and if they are aimed at seizing an opportunity, the limit will be the potential gain that will result. Our analyses show that **18% of companies declared no low-carbon investments** (nor low-carbon R&D), **47% declared marginal and irrelevant investments**, which do not contribute to reducing the player's main emissions, and **29% mentioned relevant but partial investments** to reduce their carbon

footprint and that of their customers/suppliers[38]. **Only 6% of the sample show significant investment efforts [28] and consistent with the low-carbon transition**.

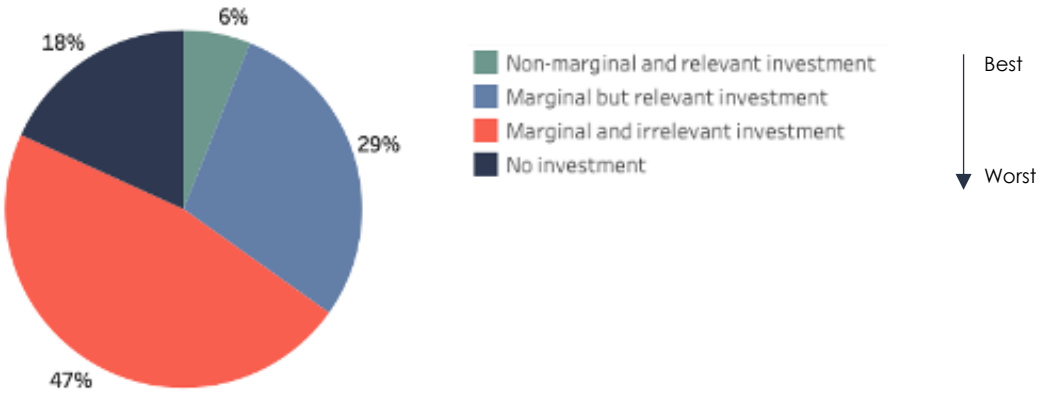

Figure 19 - Share of companies' low-carbon investments
(Source: Carbon4 Finance database)

Involvement of governance and employees: a positive aspect

Evaluating the 'involvement of governance (i.e., the board of directors and executive committee) in the company's low-carbon strategy allows us to measure the integration of the impacts of climate change on the company into the player's strategic orientation choices, with the possibility of in-depth change in the company's overall strategy. It is also important to examine the training and incentives offered to employees to reduce their carbon footprint, as this fosters a low-carbon culture throughout the company. The **results are rather positive, with 45% of the sample having a governance structure relevant for climate transition risks mitigation** and strongly involving their employees in the low-carbon transition. A comparison with previous observations shows, however, that **a strong commitment on the part of senior management is not enough to ensure that there is a relevant low-carbon transition strategy**, and ambitious investment and emissions reduction targets. One explanation for this dissonance could be a **lack of overall understanding of the transition stakes by senior management, or greenwashing**.

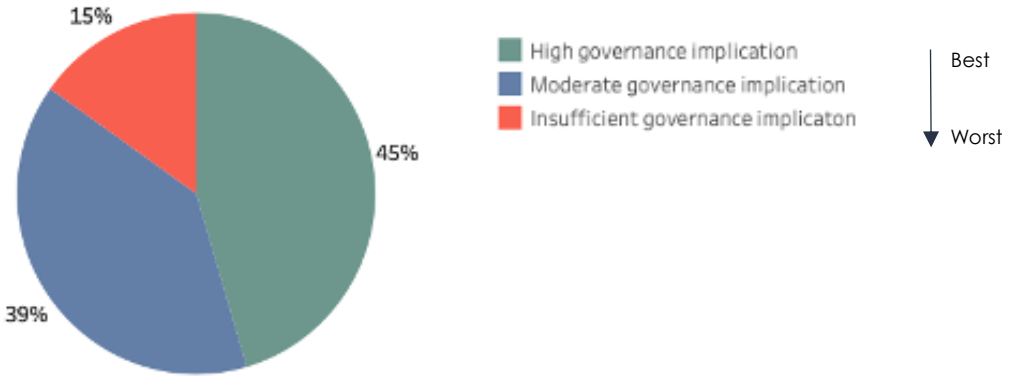

Figure 20 - Governance involvement in companies' low-carbon transition
(Source: Carbon4 Finance database)

[38] As we don't have a scenario of the investments required for the transition in the ICT sector, it was difficult to decide whether an investment was marginal or significant. Significant investments are those whose destination is precisely detailed, whose amount is quantified and which represent a non-negligible share (>5%) of the company's total investments.

Case study: Orange SA VS. AT&T Inc

Activities description

Orange SA and AT&T Inc are two major operators of telecommunications services. Orange SA is the leading French operator (market capitalization of 25.9 billion euros and sales of 42.3 billion euros in 2020), while AT&T Inc is the leading US operator (market capitalization of 181.4 billion euros and sales of 152.1 billion euros in 2020). Orange SA had 259 million subscribers (with operations not only in France but also in Europe, Africa and the Middle East) in 2020, while AT&T Inc had 212 million subscribers. A non-marginal share of AT&T Inc's revenues comes from online media and video, mainly through its subsidiary Warner Media (owner of HBO).

Current performance

Let's remember that Current performance is based on scope 1&2 emissions per subscriber. Orange SA, most of whose network is located in France (less than 100 g of CO2 per kWh of electricity on average), emitted 1.3 mtCO2eq for its scope 1&2 emissions in 2020. Conversely, AT&T Inc. whose network is mainly located in the United States (around 400 g of CO2 per kWh of electricity) emitted 7.1 mtCO2eq scope 1&2 in 2020. As a result, in 2020, Orange SA emitted 4.7 kgCO2e/subscriber versus 28.6 for AT&T (scope 1&2 emissions). However, part of the difference is not due to the carbon content of electricity: half of Orange SA customers access the network via prepaid cards[39], whereas AT&T customers access the network mainly via subscriptions. As a result, AT&T customers will spend more time on average (over a year) using the network than Orange SA customers, potentially generating higher power consumption.

Past performance

Both players have succeeded in reducing their scope 1&2 emissions per subscriber over the last 5 years, thanks mainly to improvements in network energy efficiency. Orange SA reduced this indicator by 13%, compared with 5% for AT&T. In the case of Orange SA, this reduction is partly due to the implementation of a program called Green ITN, which aims to reduce the energy consumption of its networks. However, for both players, Past performance also incorporates that of the ICT sector as a whole (see **3.2.1**), which reduces the difference.

Forward-looking performance

The comparison between Orange SA and AT&T Inc is shown below, with the rating obtained for each criterion.

[39] While in France the majority of Orange SA customers access the network via a subscription, in other regions telecommunication services are mainly accessed through prepaid cards (notably in Africa and the Middle East). In fact, over 52% of network users use prepaid cards.
Orange SA. 2021. 2021 Universal Registration Document.
Available at: <https://newsroom.orange.com/publication-of-the-2021-universal-registration-document/>

	Orange SA		AT&T Inc	
	Rating	**Justification**	**Rating**	**Justification**
Low-carbon transition strategy	**2**	Aware of its impact on climate change, considers it a top priority in its long-term strategy. Rely on energy efficiency, low-carbon Power Purchase Agreements (PPAs) and eco-design.	**3**	Aware of its impact on climate change, considers it a top priority in its long-term strategy. Working on energy efficiency for network emissions. Does not mention the decarbonization of its media business.
Low-carbon investments	**3**	Unquantified investments in energy efficiency (scope 1&2) and circular economy (scope 3) projects.	**2**	AT&T Inc reports quantified low-carbon investments, amounting to 100 million dollars (≈1% of total investments), in energy efficiency projects (infrastructure, network).
Scope 1&2 reduction target	**1**	-30% reduction in absolute emissions by 2025, compared with 2015 levels.	**4**	Emissions reduction target in market-based accounting, without explaining how the player intends to achieve it.
Scope 3 reduction target	**3**	No precise reduction target, but disclosure of relevant scope 3 emissions, which are included in its objective of carbon neutrality (horizon 2040). Orange SA specifies that carbon sequestration (not relevant) is the last step in its strategy, after reducing energy consumption (relevant).	**4**	No target on scope 3, but aims to ensure that suppliers have their own target based on science.
Governance measures[40]	**2**	Several departments (Technology, Purchasing, Sustainable Development) are responsible for dealing with climate change issues, and their heads are members of the Executive Committee. No climate change training for employees. Part of executive salaries is indexed to Orange's carbon performance.	**2**	The CSR manager, in charge of mitigating transition risks, reports regularly to the Board of Directors. AT&T Inc offers training to raise employee awareness of climate change. The salaries of some employees, but not all, are indexed to the carbon performance of AT&T Inc.

Table 6 - Comparison of Orange SA and AT&T Inc Forward-looking performance

[40] Although Orange SA seems to be better than AT&T Inc. on this criterion, the fact that the French player doesn't mention any employee training on climate change puts it on a par with the American.

Overall, Orange SA seems to give greater consideration to the low-carbon transition in its strategy. The difference with AT&T Inc is mainly due to their approach to reducing scope 1&2 emissions, which lacks precision for the American operator.

CIA overall rating

Overall, Orange SA has a better CIA rating than AT&T Inc. It has a neutral contribution to climate change mitigation, while AT&T Inc has a slightly negative contribution.

Limits

As with any evaluation method, the one used for this assessment necessarily has its limitations. First and foremost, **the depth of analysis is limited by the lack of public data** enabling emissions or trajectories to be recalculated. As a result, the various players in the ICT sector are partly treated in an undifferentiated way, even among sub-sectors such as hardware manufacturers (because they include the IoT, which comprises a too wide variety of equipment).

Main methodological limitations

The following is a summary of the areas for improvement:

- **B2C software players, hardware manufacturers and media have no Current performance, and only a systemic Past performance**, due to a lack of relevant physical metrics available to evaluate them. **The ranking is based solely on qualitative analysis of Forward-looking performance**.
- There is a **bias for telecoms services that do not own their network and rely on the infrastructure of other companies**. In fact, their scope 1&2 emissions do not include the energy consumption of the leased network, which greatly underestimates the scope 1&2 emissions per subscriber used in the CIA rating.
- The allocation of **scope 3 emissions** in the ICT sector is not precise, as it is based on a **monetary ratio common to all companies in the sector** ("top-down" approach). It is based on the company's added value (approximated by EBITDA), which does not reflect an entity's physical flows. However, scope 3 emissions are not part of the CIA rating criteria (for the ICT sector) and therefore do **not influence the CIA rating**.
- To calculate scope 3 emissions for consulting and B2B software services, we use sector ratios (tCO2 per M€ of sales) from our database, but these ratios are based on a sample of companies whose average intensity may differ from that of all companies in the sector. Similarly, for some companies, the customer sectors are not exactly consistent with the sector ratios available to us (different perimeters between customer and ratio sectors).
- The CIA ratings obtained are not very widely dispersed, and do not allow us to differentiate strongly between players. **We have chosen to use conservative high and low limits** (the range of achievable ratings is limited and centered on a rather negative rating) **because of the rebound effect generated by all digital activities and the overall unsustainable dynamics of the sector.**
- **Obsolescence and consumer incentive are not captured at the entity level** (although we qualitatively assess whether hardware manufacturers tend to increase the life of their products). We do not have the data to assess this important aspect. **This phenomenon has therefore been included globally in the high and low rating thresholds**.
- For **B2B software and consulting services**, we are not able to properly assess how much the company has or would have helped its customers in their transition, just the extent to which it has shifted its end-customer portfolio to less carbon-intensive sectors. **We therefore assess the extent to which the company has mitigated its risks, but not the extent to which it is contributing to the transition.**
- **Emissions calculations and ratings could have been more accurate if companies had disclosed physical metrics**, such as data flows, weight or screen diagonal of terminals sold by telecom operators, consumption of raw materials, etc., which would have enabled us to calculate and compare emissions and then carbon intensities.

- For Forward-looking performance, the company inherits the lowest rating if it does not communicate its transition strategy. As there is a **general lack of transparency on strategies**, this homogenizes (downwards) the ratings on this criterion.
- **To date, there are no decarbonization scenarios specific to the ICT sector** to serve as a reference. We have therefore compared companies' emission reduction trajectories and targets with global emission trajectories[41].

Important aspects of transition not covered in the study

Impact of recycling and end-of-life treatment of equipment

The CIA methodology does not include recycling and end-of-life treatment of digital equipment (infrastructure, data centers, end-user devices). Indeed, from a carbon accounting point of view, the impact is marginal compared to the emissions induced during the production and use phase of this equipment. However, **electronic waste has other negative impacts on the environment and biodiversity** (air, soil and water pollution due to incineration or landfill), **as well as social consequences** (pollution affecting human health, landfill managed by illegal channels). Only a **very marginal proportion of this waste is recycled**. These aspects should not be neglected by companies, but the CIA methodology focuses on climate transition issues and does not take them into account in the rating.

Cash investments by digital giants: another major source of emissions

The CIA methodology - for companies in the ICT sector as for other non-financial activities - is based on productive activities and organization to assign a rating. It does not take into account the **company's financial investments**. However, when a company has liquid assets, these are invested, and the investments finance activities that will themselves generate GHG emissions[42] (see CIA's sector module for banks[43]**).** As the **largest market capitalizations in the ICT sector have colossal liquid assets, their financed emissions are likely to be significant**.

Consumption linked to online advertising incentives

Companies that derive part of their revenues from online advertising see their CIA rating impacted slightly negatively when assessing Forward-looking performance (qualitative analysis). **The absence of information on the end markets for advertising** and the associated revenues limits the analysis; similarly, the **(potentially non-marginal) emissions linked to the production and use of goods and services sold thanks to this advertising incentive cannot be captured**.

[41] The global scenarios used are those of the IEA (ETP report): Below 2°C ("B2DS") and 2°C (2DS).

[42] Polluting investments include cryptocurrencies (in which major digital companies are investing massively) and major banking institutions, whose portfolios are still highly carbon-intensive.

[43] Available at: < https://www.carbon4finance.com/methodology-note-bank-emissions-calculations>

Consumption linked to online shopping and payment services

Revenues from online shopping services are not analyzed with the CIA methodology, as most of the associated emissions come from energy consumption during the manufacturing and use phase of products sold on the online platform. The data centers and IT infrastructure required to maintain these platforms account for a marginal share of their emissions (≈15%)[44]. Consequently, **a company like Amazon has only been assessed on its Amazon Web Services business segment (24% of its revenues)**. Similarly, although we analyze the digital aspect of **online payment services, we cannot attribute to them the emissions of purchases generated by their services (the necessary data not being available).**

Physical risks

The CIA methodology focuses on transition risk and does not consider the physical risk associated with climate change. As mentioned in chapter **2.2**, the digital world is based on a physical infrastructure that depends on the extraction of raw materials. **Climate hazards can jeopardize the supply of raw materials** for ICT companies and their suppliers.

Digital technology, a catalyst for the consumer society

Digitization has greatly altered the consumer's role in the purchasing process: he or she enjoys greater decision-making power (more choice, more information), can buy anytime and anywhere, can return the product, and communicate with other buyers about product quality. There is **also an impact on the production stages of a product**: increased knowledge of consumer expectations, detection of new market segments (with the help of big data), increased production efficiency, more marketing possibilities, and product personalization. All these factors **tend to increase consumption and production uncontrollably,** which is undesirable in a physically constrained world. Nevertheless, we can also note **potentially more sober consumption practices, notably the shift to a sharing economy** (it is no longer necessary to own a good to be able to use it).

[44] To understand the carbon emissions of e-commerce, see the article "Is e-commerce really a key element in the decarbonization of freight transport?
Available at: < https://www.carbone4.com/decryptage-e-commerce-decarbonation-transport>

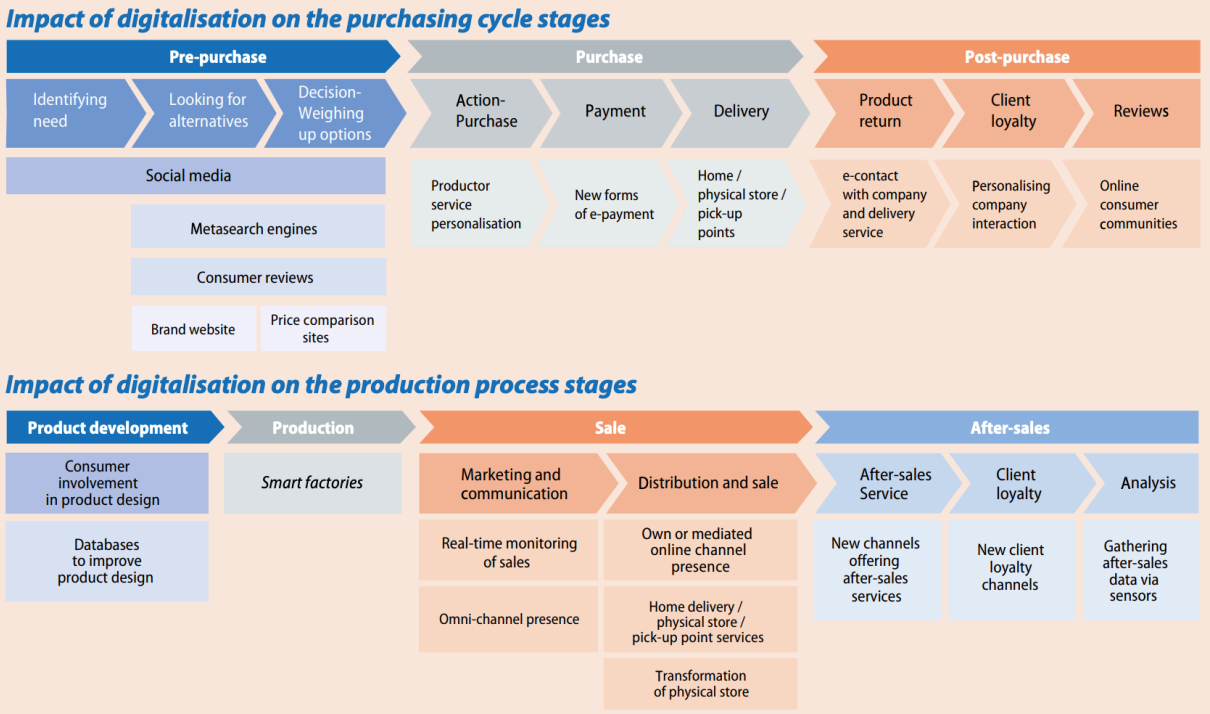

Figure 21 - Impacts of digitalization on purchasing and goods production (CaixaBank Research, 2017)[45]

[45] **CaixaBank Research. 2017.** Consumption in the digital era. Consumption: New Trends pp.36-37, 2017. Available at <https://www.caixabankresearch.com/en/economics-markets/activity-growth/consumption-digital-era>

Conclusions

Analyzing a sample of 67 major digital companies, using a bottom-up approach, has enabled us to identify the main trends, dynamics and decarbonization paths in the ICT sector.

Summary of main results

Although the sector accounts for a significant share of global greenhouse gas emissions, it is **not very mature when it comes to climate issues**: lack of exhaustive analysis of climate-related risks across the entire value chain, communication deliberately focused on a few isolated opportunities, absence of significant low-carbon investments, maintenance of a business-as-usual activity that is both emissive and growing, with significant rebound effects.
A first step has often been taken with the creation of internal committees dedicated to climate change, whose director sits on the executive committee, but there is still significant room for improvement.

Indeed, **most players do not measure their scope 3 emissions** (which represent the most significant emissions) and often aim to reduce only their scope 1&2 emissions through carbon offsetting or the purchase of renewable electricity certificates (Guarantees of Origin, which have no effect on emissions).

Finally, some companies are quick to declare that their activities or products are carbon neutral, which is incorrect and has no scientific basis (carbon neutrality is only valid on a planetary scale, not at the level of a company or product).

Recommendations

To help companies in the ICT sector move towards a low-carbon economy, Carbon4 Finance proposes, for each type of player, **recommendations for reducing their emissions and those of their upstream and downstream value chain** ("Green for IT"), as well as measures for **decarbonizing other sectors** ("Green by IT"). They are presented in the table below:

- In green, recommendations and practices to be encouraged.
- In red, practices that need to be reduced or stopped.

NB: column headings refer, from left to right, to emissions linked to the production of digital infrastructure, those linked to its use, and emissions linked to changes in usage.

	Measures for digital sobriety • In green: practices to be encouraged • In red: practices to be reduced/ceased		
	Production	**Use**	**Usage**
B2B & B2C software	• Software that can be used on a wide range of equipment (the release of new software does not require the purchase of new equipment)	• Software eco-designed	• Software to reduce the user's environmental footprint (optimization or change of use) • Reversibility of updates
Hardware	• Low-carbon suppliers (both in their choice of materials and in their operations) • Increase the lifespan of equipment (recyclability, repairability, reconditioned equipment) • Increase the legal warranty period • Optimizing scarce resources	• Improving the energy efficiency of equipment	• Energy and material efficiency devices (e.g. smart meters, 3D printers, etc.) • **Production of new models with marginal improvements (plays on psychological obsolescence)** • **Marketing of connected objects with no proven social/technical/... utility**
Telecoms	• **Incentive to change equipment**	• Improved energy efficiency of network, equipment and data centers • Electricity supply by renewable PPAs	• Pay-per-use tariffs (data throughput limitation) • **Deploy offers that provide more bandwidth (5G, oversized gigabyte offer, etc.), enabling a multiplication of uses.**
Media		• Improving energy efficiency in data centers • Software eco-designed • Electricity supply by renewable PPAs • For videos, possibility to choose the definition (and set a low resolution by default).	• Content that raises users' awareness of the transition • Pay-per-use (including video streaming) • **Use of online advertising (encourages consumption)**
Consulting services			• Creation of relevant tools or services to reduce customers' carbon footprint • Consulting services to reduce carbon footprint • **Missions aimed at optimizing profitability without taking transition risks into account**

Table 7 - Recommendations identified for the transition of digital players (recommendations in green, actions to stop in red).

Figures and tables

List of Figures:

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carbon4 | finance

Créée en 2016 et basée à Paris, **Carbon4 Finance** apporte au secteur financier l'expertise du cabinet de conseil Carbone 4, qui depuis 2007 propose des services de comptabilité carbone, d'analyse de scénarios et de conseil dans tous les secteurs économiques.

Carbon4 Finance propose un ensemble complet de solutions de données climatiques couvrant à la fois le risque physique (méthodologie CRIS : Climate Risk Impact Screening) et le risque de transition (méthodologie CIA : Carbon Impact Analytics). Ces méthodologies reconnues permettent aux organisations financières de mesurer l'empreinte carbone de leur portefeuille, d'évaluer l'alignement avec un scénario compatible avec 2°C et de mesurer le niveau des risques qui découlent des événements liés au changement climatique.

Carbon4 Finance applique une approche rigoureuse "bottom-up" basée sur la recherche, ce qui signifie que chaque actif est analysé individuellement et de manière discriminatoire.

Pour plus d'informations, veuillez consulter le site www.carbon4finance.com