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The challenges and actions of Big Tech companies to reach environmental sustainability while staying competitive

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ABSTRACT

Digital transformation has, in the past decades, led to a lively debate about its impact on the environmental. Big Tech companies, also called the GAFAM, are part of the Information and Communication Technology sector which, today, accounts for 2.1%-3.9% of global GHG emissions. These companies have been highly controverted for the past few years due to their significant environmental footprint, opposing the debates between their accountability in the increasing emissions of GHG over the years and their significant role in addressing climate change and leading the economy into the transformation towards decarbonization. The purpose of this study was thus to determine the actions taken by the Big Tech companies to respond to climate change, but also their challenges to stay competitive in such context. Through a two-step methodology research, based on an in-depth analysis of sustainability reports and on interviews of energy experts, we were able to draw the extent role of Big Tech companies in paving the way to decarbonization and net zero for the entire economy. The results of our study indicate the focus of Big Tech companies on their data centers and their commitments to cutting CO2 emissions, improving energy efficiency and source energy only from renewable energy before 2050 as well as their genuine engagement in creating ecosystems to allow companies to benefit from their technological, financial and governance capabilities. Even though they have shown concrete achievements, the research has proven that some companies in the sample are still in the process to address all key pillars of their sustainable strategy, and tackle all their value chain, hopefully by 2050. The research method can be applied to other GAFAM as well as to smaller technological companies who need to address the same challenges.

CHAPTER 1 – INTRODUCTION

"Since 1850, human activities have released around 2,400 billion of tons, we are emitting 40 billion of tons per year, still more or less than twenty years and our carbon budget will be emptied", explains Jean-Marc Jancovici, the owner of Carbon 4, the independent consultancy company specialized in low-carbon strategy. To avoid such a disaster, the Paris Agreement states in 2015 the goal to reduce emissions by 5% per year by 2050 to avoid global warming to exceed 2°C. In the same year, the United Nations members signed the 2030 Agenda for Sustainable Development which establishes the 17 Sustainable Development Goals (SDGs) to create a global partnering of all countries to act for health, education, poverty, inequality, geopolitical instability, economic growth, to preserve biodiversity, oceans, and ecosystems by 2030. The agenda was established for all actors involved in inclusion and economic growth, i.e., companies, non-profit organisations, and academia across the globe. Beforehand, The United Nations Environmental Protection Agency (2014) states the idea that "[pursuing] sustainability is to create and maintain the conditions under which humans and nature can exist in productive harmony to support present and future generations". Since then, as the main pollutants, companies from all industries started to address SDGs in their strategy in the matter of driving growth - by expanding to new markets, attract talent and investing in operations - of addressing risks - related to climate change, depletion of resources, geopolitical instability, etc. - of attracting investment and in building strong values to in fine, drive growth. Thus, companies have a corporate responsibility along with a humanitarian responsibility to address the SDGs.

In this paper, we chose to tackle the specific case of Big Tech companies, which since their apparition, have been the target of all critics about sustainability. Indeed, the global share of greenhouse gas emissions of the information and communication technology (ICT) sector is estimated to 1.8%-2.8% and is expected to keep growing over the years. In the first part of the paper, we tackle the lively debate of digital sustainability, which is used to define the need for ICT to consider their competitive advantage in sustainable development as a priority to maintain their competitivity within the industry. This concept is defended by the part of the authors who consider that Big Tech companies have a significant role to play in the climate change by driving positive social and environmental change through their financials and technological assets and contribute to a more sustainable world. Indeed, some research raise the idea that "ICT-enabled solutions could reduce emissions up to 12.08 gt CO_{2e} by 2030 across many industries globally, which is 9.7 times higher than the ICT sector's own direct emissions, thus reducing the global environmental footprint" (GeSi - Global e-Sustainability initiative, 2022). Authors such as Ojala, Mettälä, Heinonen, & Oksanen (2020) support the idea that ICT solutions are enabling reductions in carbon footprint of these sectors as well as reduction in energy consumption such as optimization of industrial processes, replacement of physical products or by facilitating the creation of urban infrastructure which includes resource efficiency. Yet, on the contrary, some authors insist on the major responsibility of the tech industry in destroying the planet as it would be the least sustainable sector with ICT's share of greenhouse gas emissions estimated to 1.8%-2.8% and should keep increasing with

trends such as AI, big data and IoT (Lancaster University, 2021). Thus, this paper aims at addressing the contrast between the very broad research that authors, institutions and governments led on Big Tech companies' environmental footprint and the means and actions by which these companies are tackling climate change. Hence, we developed a research approach, both quantitative – by the sustainability and annual report analysis – and qualitative – by the carried-out interview – through which we attempted to answer to two research questions (RQs):

RQ 1: What are the actions taken by the Big Tech companies to respond to climate change while staying competitive?

RQ 2: How does this inform the debate on the role of Big Tech companies in the quest of the entire economy to environmental sustainability?

With this context, this paper aims at providing some answers and at drawing conclusions on the main challenges that Big Tech companies are facing regarding climate change and how they intend to address them. The topic has been carefully chosen for many reasons. First, the topic is highly related to the cursus of the author, which focus on International Business and digital technologies applied to the corporate environment. During the two-year Master's program of this cursus, the author was able to tackle many topic related to digital transformation and technologies such as Blockchain, Information Systems, Digital Marketing etc. but also to address them in the scope of corporate strategy applied to the international environment. In addition, the authors have been working at Engie, a leader in energy supply and services, for a full year, working in close collaboration with the three interviewees mentioned in the qualitative results (see chapter 4 and 5). The combination of these elements coupled to the very lively debate on climate change and the actions that should be taken at corporate level led the author to add some research to the extant literature review. Also, the readers should note that we have deliberately chosen to focus this paper on the environmental aspect of sustainability. First, in reason to the urgency of the subject of tackling environmental negative effects of the economy, second because we wanted to align the paper's topics to the author's job position, which is in the energy sector and third because covering all aspects of sustainability, such as inclusion for instance, would necessitate much further investigation and time. Besides, this paper aims at informing the debate on the very debated role of these Big Tech companies in driving towards genuine change and leading the sustainability efforts of the entire economy.

The paper is structured into 4 core chapters. Following this brief introduction, Chapter 2 provides a consolidation of academic research on the topics of sustainable development, digital transformation, environmental sustainability, ecosystems, sustainable business model innovation and gives definitions of key topics that are tackled in this paper. It puts into parallel the very diverse publications and discussions on the matter with an objective to set the context of the challenges and actions taken by Big Tech companies to become environmentally sustainable. Then, chapter 3 is dedicated to the explanation of the two-step

methodology used for this research paper. The first step consists in three business cases analyzing and inducting the published reports of three tech giants: Microsoft Corporation, Amazon.com and Google. They mainly focus on understanding the main goals and initiatives led by the companies in terms of sustainability, and specifically regarding the reduction of their emissions and the improvement of their energy efficiency. The second step of the research led includes the in-depth analysis of the three carry out face-to-face interviews of Global Account Managers (GAM) from the energy provider ENGIE. Anne Cateaux, in charge of the Microsoft account, Tom Van den Bussche, in charge of the Amazon account and Ivan Bel, in charge of the Google account, all accepted to respond our questions and give us some insights on their client's sustainability strategy as well as their collaborative partnerships. The following section, Chapter 4 reports on the results of the research, both for the business cases and the interviews. Finally, Chapter 5 reports on the discussions and limitations noted as the outcome of our research.

CHAPTER 2 – LITERATURE REVIEW

I. Digital sustainability: a complex relationship between digital transformation and environmental sustainability

Section 1 – State of research and definition of digital sustainability

a – Digital transformation

The last decade has seen a remarkable series of advances in digital technologies. The rise of tech giants such as Facebook, Google, Twitter, Wikipedia, and many other social networks whose content is generated by users, shows that the edge of technology is accelerating fast, and that companies need to constantly adapt to keep up with them and remain in the competition. There has been a major disruption in both the database and desktop domains in recent years. Thanks to the rapid growth of the Cloud, the standard assumption that one must own servers, operating systems and applications is being challenges. Using this new technology has become simple and inexpensive. For companies, the essence of this new deal is data, to which they now have access through the various contacts it generates as social networks, smartphones, and other digital tools. However, the biggest challenge has been for many years to understand how to manage it. These innovations such as sharing economy, artificial intelligence, autonomous vehicles, and virtual reality are fundamentally challenging our thinking about how to adapt the structure, labour costs and the relationship between people and machines, but also raise ethical questions. Nowadays, companies evolve in a digital environment wherein, to drive operational performance, they are required to develop and adopt new technologies (IA, IoT, machine learning...) as well as to implement digital strategies (Hess, Benlian, & Wiesböck, 2016) alongside with organizational and cultural change.

Existing literature allows us to increase our understanding of the concept and characteristics of digital transformation for companies. Costa et al. (2022) define digital transformation as the "DT refers to the idea of new products or services driven by the increasing number of innovations and use of digital technologies" (Costa, et al., 2022). Other scholars such as Gregory Vial (2019) from the Department of Information Technology of HEC Montréal, drew a more conceptual definition and explains that digital transformation consists in leveraging combination of information, computing, communication, and connectivity technologies to improve a department or a company to bring about significant changes to its assets. From their analysis of 282 works about digital transformation literature, the authors were able to create a framework of digital transformation organized around eight building blocks all intertwined at the organizational level. Figure 1 shows the framework Vial et al. constructed which depicts the underlying concept where the use of digital technologies fuel disruptions, which in turn provoke the need for strategic responses such as digital business

and transformation strategies enabling value creation by the company. However, both external and internal phenomena can occur such as structural changes and organizational barriers leading to outcomes either positive or negative.



Figure 1 - Building Blocks of the Digital Transformation Process (Vial, 2019)

The large number of definitions of the concept of digital transformation has led many authors to draw limitations to these definitions and to deconstruct some general thoughts about digital technologies and their involvement in firms' strategy. Furr and Shipilov (2019), two professors at INSEAD, come back, in their Harvard Business Review article, to the meaning of a digital transformation and wish to undo the myth surrounding this term. The much-used term of digital transformation means changing the structure and strategy of one's organization by seizing the opportunities offered by the digital.

However, nowadays a digital transformation is much more complex as it affects all the value chain of a company. This could explain why managers are struggling to understand what a digital transformation means for a company and how to deal with it. The authors explains that, contrary to popular belief, a digital transformation does not always mean a radical change in corporate strategy. It can only be an adaptation to better deliver the core value proposition. One myth the article aims to destroy tackles the idea that digital requires radical disruption of the value proposition. Furr and Shipilov (2019) claim that a digital transformation is primarily to look for a better way to serve the needs of consumers through digital tools. Digital allows companies to go beyond the new constraints they encounter. In the end, rather than trying to completely transform their business, companies must use digital as a lever to improve their core value proposition. According to the authors, digital transformation is all about seizing the opportunities offered by digital better than its competitors. The paper illustrates this point with the arrival of Uber as disrupters pushing Taxi G7 to totally improve its services. Today G7 is back with a better proposition than Uber. Thus, disrupters do not necessarily put old companies out of the market, they just need to catch the digital wave in time to better

deliver their core business and keep their customers. In this article, Furr and Shipilov (2019) want to convey the idea that even if disruption is a threat, this does not mean that companies should blindly embark on a total digital transformation of the company. Companies should only seek to better serve the needs of their consumers by taking advantage of the opportunities offered by the digital.

b – Sustainable development and environmental sustainability in the digital corporate environment

The term of sustainable development appeared for the first time in the 1980s, before being generalized by the Brundtland report and the Rio Conference in 1992. In the mid-1980s, Peter Bartelmus (1986) denounced the lack of establishment of a universal model of the relationship between environment and development despite the efforts of international organisations to promote environmental challenges. Among the many definitions of sustainable development that exist, the most cited is the one is from the Brundtland report 'Our Common Future' (World Commission on Environment, 1987), which warrants that "the quest for meeting the needs of the present should not compromise the ability of future generations to meet their own needs". Likewise, the United Nations Environmental Protection Agency (2014) supports the idea that "[pursuing] sustainability is to create and maintain the conditions under which humans and nature can exist in productive harmony to support present and future generations". In 2015, the 2030 Agenda for Sustainable Development introduced the Sustainable Development Goals (SDGs) which were adopted by all United Nations Member States and marked the commitment from Big Tech companies to engage in the 17 SDGs which fall withing the approach of supporting a more sustainable path towards inclusive and equitable growth (ElMassah & Mohieldin, 2020). Also, the 2030 Agenda insisted on the importance to apply this initiative to both global and local communities, marking the universal essence of the ambition.

Environmental sustainability is one of the three principals of sustainable development. Numerous authors mention sustainable development in their writings, such as Goodland in 1995 who defines environmental sustainability as "the maintenance of natural capital" or Porritt (2007) defining "ecological sustainability" as "the capacity for continuance into the long-term future, living within the constraints and limits of the biophysical world". Literature has tackled the approach of Big Tech companies to sustainable development.

c – The complex interrelation of digital transformation and sustainability

From the interrelated concepts of digitalization and sustainable development mentioned in the previous parts of the literature review, emerges the concept of digital sustainability. In the recent years, the increasing interest and interrogations on how digital technology deployment and sustainability development are interrelated, has become a topic of lively debate, especially when questioning the straightforwardness of the relationship between both wide concepts. Flyborg, Karlsson and Pamlin (2017) defined digital sustainability

as the role of technologies such as connectivity or the Internet of Things (IoT) and digitalization as a whole in ensuring sustainability. Elmassah and Mohieldin (2020) see digital transformation as a significant role player in supporting SDGs as its allows to a certain extant to capture and analyze information through the use of computational techniques leading to unveil trends and patterns that can be leveraged and transformed as actionable dynamic information on the environment. In the same way, the topic has been tackled with a scientific approach by the Institute for Computational Sustainability (2021) as "an interdisciplinary field that aims to apply techniques from computer science, information science, operations research, applied mathematics and statistics for balancing environmental, economic and societal needs for sustainable development". The extant literature on digital transformation and sustainable development states that to maintain a certain level of competitivity in the digital industry, companies need to see their competitive advantage in sustainable development as a priority. This happens increasingly using Information and Communication Technologies (ICT), which - besides of generating new products and service through innovation – can affect positive social and environmental change by implementing sustainability strategies. Indeed, in addition to minimizing their environmental footprint, ICT can participate in increasing business opportunities and benefits. Hsu, Tsaih, & Yen (2018) state that, today, organizations are more and more able to recognize the potential of ICT in facilitating and supporting sustainability practices.

Extensive research was carried out by authors to address the complexity of the relationship between digital transformation and the environment.



Figure 2- ICT sector global CO2e emissions abatement (GT CO2e) (GeSi - Global e-Sustainability initiative, 2022)

On the one hand, many authors argue that digital transformation can boost sustainability in many ways as digital technologies offer companies a large panel of opportunities to decarbonize. Indeed, the Global e-Sustainability Initiative (2022), the ICT industry's association for sustainability, states that ICT-enabled solutions could reduce emissions up to 12.08 gt CO_{2e} by 2030 across many industries globally, which is 9.7 times higher than the ICT sector's own direct emissions, thus reducing the global environmental footprint (Figure 2). Hence, global adoption of ICT could lead to reduce the gap between economic growth and CO2e

emissions, where "each 1% of growth in GDP equated to a 0.5% increase in CO2e emissions" (GeSi - Global e-Sustainability initiative, 2022).

Other thoughts raise the idea that sustainability can "serve as a catalyst" (Opportune LLP, 2022) for many business leaders to incorporate digital technology into all entities of their business. Authors write that ICTs such as Artificial intelligence, predictive analytics, the IoT or Machine Learning can help organizations effectively achieve sustainability goals. Beside the central issue of the ICT sector to address its own carbon footprint, a second main issue would be the impact of ICT sector on the global economy. In fact, estimations point to ICT sector's potential to decarbonize other sectors, such as shown in figure 3, where it is expected to have a greater impact across 8 sectors, with smart manufacturing, agriculture, buildings, and mobility contribute representing more than 70% of the total abatement (GeSi - Global e-Sustainability initiative, 2022). Indeed, ICT solutions enable reductions in carbon footprint of these sectors as well as reduction in energy consumption such as optimization of industrial processes, replacement of physical products or by facilitating the creation of urban infrastructure which includes resource efficiency (Ojala, Mettälä, Heinonen, & Oksanen, 2020). Therefore, the explored review on the topic largely demonstrates the role of ICT solutions to "help set the world's economy on a sustainable footing" (World Economic Forum, 2022).



Figure 3 - ICT enabled CO2e emissions abatement per sector in gt CO2e (GeSi - Global e-Sustainability initiative, 2022)

On the other hand, literature challenges the idea that the interrelation between the two widely debate concepts is straightforward and state that challenges should be addressed to exploit the entire potential of digital transformation. Indeed, they address the impact of digital on the environment by underlining that digitalization is not inherently sustainable. Furthermore, digital services rely on the ICT infrastructure, whose construction and use can burden the climate and the environment (Ojala, Mettälä, Heinonen, & Oksanen, 2020) and thus participate to accentuate unsustainable systems. Hence, there is a need to organize the use of ICTs in corporate strategies aimed at achieving SDGs (Flyborg, K., Karlsson, & Pamlin, 2017). According to studies prior to 2015, ICT's carbon footprint (40% increase 2002–2012) was estimated to have increased almost twice

faster than global GHG emissions (20% increase per decade) on a 15-years period between 2000 and 2015 (Freitag, et al., 2021).

Linked to the need to understand how digital transformation impacts the environment and particularly climate change, Bieser and Hilty (2018) carried out a systemic literature review recounting the impact of the ICT sector on the environment. In their findings, the authors identify two types of environmental effects of ICTs: direct and indirect effects. While direct effects include resources and emissions resulting from the production, use, and disposal of ICT hardware, indirect effects do not only refer to ICT domains but mainly to changes in patterns of consumption and production alongside with the environmental implications of these changes. Among the most cited ICT's direct impacts on the environment, we can identify two main concerns: the carbon footprint and the electrical demand. First, according to a team of researchers from Lancaster University and sustainability consultancy Small World Consulting Ltd, ICT's share of greenhouse gas emissions is estimated to 1.8%-2.8%¹ and should keep increasing with trends such as AI, big data and IoT (Lancaster University, 2021). Second, electrical demand for digital technology use was estimated, depending on scope, to 7% of the total global electricity use in 2020 and is predicted to rise to 14% in 2030 or 5700 TWh (Andrae, 2020). This increasing demand for electricity comes from both direct and indirect uses, such as powering servers, equipment and charging mobile devices but also as the air-conditioning required to reduce the temperature of data storage or management facilities such as data centers (Lange, Pohl, & Santarius, 2020). Figure 2 shows how the three digital megatrends of data applications & Artificial Intelligence, blockchain and IoT, could lead to substantial growth in ICT's footprint through their use for data centers, networks, and user devices. Finally, another impact identified in peer-reviewed studies is the decommissioned electronic equipment, which represents the world's fastest growing waste type, growing by nearly 7 per cent year-on-year (YoY) (Ojala, Mettälä, Heinonen, & Oksanen, 2020). Globally, the waste related to electronics, or e-waste, generated an estimated 57.4 million tonnes in 2021 (Lai, 2021). In the following section, we will conduct a more in-depth analysis of the existing literature which tackles the impact of ICTs on emissions and energy consumption through ICT infrastructure and especially through data centers.



Figure 4 - The impacts that trends in ICT have on growth in emissions from data centers, networks, and devices (Freitag et al., 2021)

¹ Researchers argue that the true proportion of global GHG emissions includes full life cycle and supply chain of ICT products and infrastructure and would be 2.1%-3.9%.

As we have explored in this chapter, digital transformation and its impact on the environment has garner wider attention in the recent years among authors, researchers, and tech enterprises managers. Many studies have been conducted to understand, calculate, and address the direct and indirect impact of ICT sector, both on emissions and energy consumption. From this chapter, two central challenges have been identified: the ICT sector impact on its own and the ICT sector impact on the global economy. Although the literature highlights the development of digital solutions offer a wide range of opportunities to reduce GHG emissions of other sectors and to optimize energy consumption of digital solutions and services, a main limitation has been found in the rebound effect. It is key that the ICT sector understands the need to address its own emissions as evidence support the low probability that it achieves the significant carbon reduction required by 2050 (Freitag, et al., 2021).

Section 2 – Academic theories applied to digital sustainability

We have outlined the most recent definitions of digital transformation, environmental sustainability and how these concepts are interrelated, creating the lively debate around digital sustainability. This brings us to understand the theoretical foundations of this subject and the existing academic theories which have been tackled by the existing literature so far. Therefore, this section will partly be dedicated to the concept of Net Positive. Then we will explain the Sustainable Business Model Innovation (SBM-I), which will lead us to the concept of business ecosystems and to identify their role in answering to sustainability challenges, in particular environmental challenges.

a – The Net-Positive Initiative: "put back more into the global system than they take out"

First, the literature on corporate sustainability drew our attention to the Net Positive approach and how authors confront it to the traditional sustainability approach of companies. The concept was born with the Net Positive Project aiming at creating an ambitious alliance of partners from different industries to develop a positive, robust, and coherent approach, underpinned by a common set of principles and good practice (BSR, Future, & Norris, 2019). In their article entitled The Net Positive Manifesto, Polman and Winston (2021) define a net positive company as one that "improves well-being for everyone it impacts and at all scales and for every stakeholder and the planet itself". The authors explain that being net positive requires to draw awareness on all the ways businesses affect the environment, which means going beyond carbon-reduction goals and seek to give back what they took. Another definition is given by Flyborg, K., Karlsson, & Pamlin (2017) who introduce the net-positive approach as the focus on how organizations can provide sustainable solutions required by society outside beyond the borders of their own operations. Behind the approach of a Net Positive company lies the idea that companies should take full ownership of their impacts by committing to "put back more into the global system than they take out" (BSR, Future, & Norris, 2019). An accurate example of this approach applied to the environmental impacts would be the Greenhouse Gas Protocol providing standards for taking responsibility for carbon emissions across the 3 scopes² rather than only scope 1.

Moreover, both publications bring this approach into opposition to traditional corporate social responsibility and philanthropy, as they argue that both are defective and inappropriate in the current context as they focus on the organizations' negative impacts over its own life cycle only. In fact, the net-positive approach emerged in part from the shift from a problem focus to a solution focus. In other words, companies started to focus on their core business and on how their activities, products and services could participate to answer to sustainability demand. Flyborg, K., Karlsson, & Pamlin (2017) mention the ICT sector as the

² Scope 1 emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of purchased energy. Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions **Invalid source specified.**

industry being the early pioneer of this shift towards a solution focus as innovation and rapid change led Big Tech companies to see problems as opportunities. The WWF project called "Sustainability at the speed of light" (2002), was one of the first attempt to draw a roadmap for reducing CO_2 emissions in the EU and beyond. It proves the early work of organisations to leverage ICT capabilities and knowledge to both understand and act on the consequences of the human actions on the planet, meaning the induction of a solution rather than a problem perspective.

	Mindset shifts	Behavior shifts	Outcome shifts		
Material	Prioritize impact and potential Net positive is a journey, starting with an organization's most material issues. A company reaches the final milestone once all material issues generate positive benefits overall.	Include partners At every opportunity, organizations adopt an inclusive approach to strategy development and execution and define material areas through consultation with stakeholders.	Integrate strategy Focusing on areas of biggest impact and opportunity, a company inevitably must consider shifts to its core business or operating model.		
Systemic	Recognize interdependence Organizations recognize their place within broader systems and that they cannot achieve net positive on their own.	Collaborate widely Organizations enter into transformative partnerships with stakeholders in their value chain, community and wider system.	Create an enabling context Organizations influence the system around them – including changing policy, business standards, consumer behaviors, community norms, etc. No lobbying contradicts net positive goals		
Transparent	Embrace open communication Organizations are honest about the journey they are on. They continue to innovate and experiment, documenting the progress and the lessons learned.	Ensure true and balanced reporting Reporting on progress is honest, consistent, authentic, transparent, balanced and independently verified where possible. Boundaries and scope are clearly defined across the value chain.	Demonstrate progress and absolute impact Progress and absolute impacts on material issues is clearly demonstrable if not measurable via open communication. This includes reporting on both negative and positive impacts.		
Regenerative Encourage experimentation Net positive strategies need to foster a culture of taking risks, incubating new ideas, and scaling niche solutions.		Ground evidence in science Organizations use evidence-based methodologies to improve conditions in the natural world and society.	Create long-term, positive impact No aspect of a NP approach mistreats individuals, degr society, or harms the environment, however, efforts to long term positive outcomes are approached with the rigor as efforts to minimize footprint. This requires environmentally restorative, socially inclusive and local empowering approaches that can be sustained beyond work of any one company.		



It is noteworthy that an important aspect of this approach lies in the methodologies to measure netpositive impact. Most of the reports mentioning net-positive concept point at the identification of positive and negative impact in society as the first step required for measurement. In the scope of their Net-Positive Project, BSR, Forum for the Future and Norris (2019) developed an assessment and measurement model called the "Maturity Model". This model allows to identify and recognize a Net Positive strategy by addressing four key principles: material (focusing on what matters most), systemic (influencing change across entire systems), regenerative (creating long-term, sustained, and absolute impact) and transparent (sharing progress openly and honestly) (Figure 5). When a strategy responds to all principles, according to the Maturity Model, it can be recognized as a Net-Positive strategy. The Maturity Model (BSR, Future, & Norris, 2019) share the idea of Flyborg, K., Karlsson, and Pamlin (2017) regarding the necessary clarification of system boundaries, which give to net positive measurement contexts within which you take out and put back. For instance, in our case of digital innovative solutions, which are considered as transformative solutions – in opposition to solutions that allow only incremental improvements in existing systems (Flyborg, K., Karlsson, & Pamlin, 2017) - the entire life-cycle impact from the product or service need to be included in the assessment. In addition, Polman and Winston, (2021), Flyborg, K., Karlsson, and Pamlin (2017) as well as BSR, Future, & Norris, (2019) all share the principle according to which companies need to take full ownership of their impacts including suppliers, employees and consumers. Nevertheless, Polman and Winston (2021) added to their research on the net-positive strategy assessment methods, a whole other approach that companies should apply to reach a net-positive strategy. Their findings mention 3 additional core principles: drive shareholder value as a result rather than a goal, embrace deep partnerships and rethink advocacy and the relationship with governments to tackle systemic problems. This last principle refers to what Polman and Winston (2021) call the net-positive advocacy, which refers to a new form of systemic collaboration between companies and governments to improve the policy systems and to address challenges for the benefit of all. These two principles of partnerships and net-positive advocacy fall into the approach of business ecosystems and whether they constitute an answer to sustainability challenges.

b – The concept of Sustainable Business Model Innovation (SBM-I) as a driver of competitive advantage

Sustainable Business Model Innovation (SMB-I) concept arose with the increasing interest on sustainability topics in the recent years and the need for executives to both address these sustainability initiatives and to integrate them in their core business strategy. The SBM-I definition originates from the definition of a sustainable business model, which refers to "the transformation/creation process that balances economic, social, and environmental aspects, mitigating possible tensions between these aspect". (Boons & Lüdeke-Freundb, 2013). In the following years, many definitions of the model were given defining SBM-I as "a change in how a firm operates to reduce adverse external effects and create new positive external effects for the environment and society" (Presenza, 2019) or as "the core activity [...] transforming the value proposition toward a sustainable value proposition that allows value creation by considering the needs of customers, shareholders, suppliers, partners, community, society and environment (Baldassarre, 2017). This definition implies the 4 main characteristics of the traditional SBM-I framework: the consideration of sustainable principles and objectives in the value proposition, the shift from an economic to a shared value creation, the integration of non-financial interests in the decision-making process and the promotion of a new sustainability mindset across the organisation (Ferlito & Faraci, 2022). SMB-I literature insists on the importance for companies to demonstrate their commitment to achieve environmental and social initiatives, without losing their competitive advance that the mainstream business paradigms impose (Minatogawa, et al., 2022). In response to this challenge, the SMB-I enables the intertwining of the need for companies to accomplish economic aspects and market disruptions while developing a sustainable business model (Figure 5).



Figure 5 - The two engines of Sustainable Business Model Innovation (Young, Reeves, & Gerard, The Secrets of Sustainability Front-Runners, 2021)

To be able to understand the impact, for a company, of implementing SBM-I, we investigated what scholars and corporate organisations could observe and depict when analyzing companies in which this type of business model was followed. The BCG series published in 2021 describes the concept of SBM-I and how companies are putting it to use. The specific article on Sustainability Front-Runners aimed at analyzing three core dimensions to understand the state of SBM-I in the corporate environment: expanding the scale and scope of innovation, gaining business advantage and create environmental and social benefits. Their findings are illustrated in figure 8, where there 102 SBM-I initiatives were placed according to these three dimensions. They show how 45% of their scope were (in 2021) "initiative leaders" and initiated the transformation of their model by improving their products and/or services in response to sustainable challenges, hence creating positive outcomes for stakeholders. Then, they identified 25% as "ecosystems leaders", which in turn seek to reshape the dynamics of their stakeholders or create partnerships. Finally, 30% are front runners aiming to "pave the way forward for their industries and markets, and they provide insight into what advanced SBM-I could look like" (Young, Reeves, & Gerard, 2021).



Figure 6 - Cases of Sustainable Business Model Innovation (SBM-I) (Young, Reeves, & Gerard, The Secrets of Sustainability Front-Runners, 2021)

Nevertheless, the past and ongoing research on the topic have shown very little application of SMB-I in the corporate environment (on a scope of 500 sustainable initiatives, BCG research showed that only 102 of them where companies that actually changed either one, a few aspects or all of their core business model to generate environmental and societal benefits as well as business value (Young, Reeves, & Gerard, 2021). Further, SMB-I scholars argue on the outcomes of the model on both business and environment. Minatigawa, et al. (2022) explain in their review that "the majority of SBMI examples usually show modest economic results". It seems that the reasons of the inefficacity of the model have been tackled by few scholars. Young, Reeves & Gerard (2021) give two reasons for the low capture of the model's potential: the very early development of the SBM-I and the lack of a structured approach for designing the model. Likewise, Asswad, Hake and Gómez (2016) found five barriers to SBM-I, which are documented in table 2, and include high costs of R&D countering the use of more efficient technologies and the use of clean energy sources; drawback of long-term investments such as use of renewables or the adjustment of processes to reduce environmental footprint; reluctancy to be precursors in developing and relying on new technologies; or lack of frameworks to measure and communicate sustainability.

SBM Archetypes	Barriers preventing SBMs	Effects of the Barrier		
Maximize material and energy efficiency	Adds no visible value in the eye of the customer	Substitute efficiency for cheap materials/energy		
Create value from waste	See waste as worthless/problem	Dismiss waste and loose valuable resources		
Substitute sources with renewables	Changes are expensive and not visible	See environmental damages as cost factor		
Functionality instead ownership	Path dependency	Ignore changing consumption patterns		
Adopt a stewardship role	Missing foresight of what will be a future standard	Comply only to current standards		
Encourage sufficiency	Lack of framework to communicate changes	Positioning only by directly visible attributes		
Repurpose for society/environment	Problem in determining stakeholder demands	Focus solely on economic profit		
Develop scale up solutions	Collaboration takes effort and requires openness	Find solutions isolated and miss synergy effects		

Table 2 - The Barriers of Sustainable Business Models (Asswad, Hake, & Gómez, 2016)

c-The concept of business ecosystems, partnerships, and alliances as an answer to sustainable challenges

In the definition of digital transformation given by Vial et al. (2019), digital technologies enable new forms of collaboration between the actors as they increase information, computing, communication, and connectivity. From this idea arises the concept of ecosystems, which is widely applied to the digital transformation by the literature. Indeed, the emergence of ecosystems brings out opportunities for Big Tech companies to explore and leverage their dependencies and to innovate as well as sustain their competitive advantage in an environment where interest may not be aligned.

Young, Pidun, Zoletnik, & Beck (2021) have addressed the imperative faced by companies for sustainability and tried to understand the role of ecosystems in providing them the right environment to develop sustainability and drive business advantage. The authors give the very interesting example of virgin polyethylene terephthalate (PET) to illustrate the reason why companies need to establish business ecosystems and collective actions. In fact, the reduction of such material will induce brands to switch to recycled polyethylene terephthalate (rPET), which, in turn, to be produced in sufficient quantities to meet the needs on the long-term, requires to be supported by a strong recycling infrastructure. However, this can happen only if business and organisations take collective action and establish themselves into a business ecosystem driving R&D and the emergence of new solutions such as biodegradables. In the same way, the Business Ecosystem Alliance did a business case on the chemical company BASF to understand how the creation of a business ecosystem could be a strategic initiative to accompany their journey towards a more respectful farming. Appendix 1 shows the BASF business ecosystem canvas designed by Gabriele Rosani and Elisa Farri (2021) showing the creation of environmental, economic, and social positive outcomes of the different partnering models (commercial agreements with local digital providers, product co-development and distribution partners). Both these examples describe how companies with great environmental ambitions usually face constraints when being on their own within the system and how business ecosystems can be help companies to engage in sustainability initiatives.

Business ecosystems are defined in the literature as the gathering of independent companies combining their assets and capabilities to meet one a several specific market needs, carefully coordinated by a central company and creating value as well as yield economic benefits for each stakeholder (Young, Pidun, Zoletnik, & Beck, 2021). In the case of companies building their SBM-I (cf. previous section), business ecosystems often appear as the alternative to a lacking universal standards framework. Thus, these businesses often create cross-industry or cross-sector partnerships to respond to the increasing sustainability challenges that they are not able to address on their own (Young, Reeves, & Gerard, The Secrets of Sustainability Front-Runners, 2021). Authors agree that digitalization comes along with the ecosystem-as-a-structure approach in order to address the sustainability imperative. In present, initiatives to act for the planet are not concentrated in governments' hands; they are initiated and led by start-ups, ventures or NGOs, hence the lack of a central

actors to pilot these activities. Ecosystems are a way to identify all decentralized actors committed in achieving shared sustainability objectives and to enable coordination among these disparate players.

Aside from business ecosystems, Young, Pidun, Zoletnik, & Beck (2021) mention two other types of collective action that companies can undertake to embed sustainability in their strategy. The first one relates to sustainability partnerships or joint ventures, which involve formal commercial contracts between companies and organizations to promote a specific sustainability-related product, service, or project and are often organized around a unique core business and its value chain to develop SBM-I. The second type of collective action enabling sustainability initiative are broad-based, corporate-led sustainability alliances. This action finds its relevancy when used by industries with deeper rooted and more complex sustainability challenges and for which business ecosystems and partnerships have a limited scope. Young, Beck, and von Szczepanski (2022) give as example the mining industry, which requires combining the assets and capabilities of mining companies, steel producers, technology providers, suppliers of new raw materials (such as hydrogen), research institutes, and end users to decarbonize the whole steel making value chain. Figure 8 summarizes the benefits of alliances for some industries.



Source: BHI analysis. Note: N = 50.

Figure 7 - Three motivations for collection action through alliances (Young, Beck, & von Szczepanski, 2022)

II. Implication of digital sustainability for Big Tech companies in the tech industry

Section 1 – The implementation of efficiency strategies to reach sustainability and competitivity

In the recent years, a growing body of evidence indicates that the rising concerns about sustainability has not only reached business executives but every stakeholder within the scope of a company. Indeed, the society's expectations towards sustainability have significantly changed in the past few years, emphasised by the very recent events of the COVID-19 pandemic, the Ukrainian war and the increase in gas prices, and many natural disasters. Nowadays, investors are pushing for actions, B2B customers are setting climate and diversity targets for suppliers, governments and regulators are asking for transparency and disclosure, employees are seeking for companies which share their values and finally consumers and media are asking for more transparency about the companies' commitments towards the impact of products, services, and solutions they use. Therefore, businesses need to address what is called the *sustainable imperative* to keep up with competitors (George, Merrill, & Schillebeeckx, 2020).

It is important to understand that Big Tech companies are not the main concern of authors and scientists in terms of energy use in the world relatively to their scale³, but in term of their social, economic, and financial impact. This is due to their worldwide and massive influence on trends that these companies have a huge role to play in addressing climate change. Nevertheless, they may find business and technical efficiency opportunities in these new constraints.

a – The economic benefits of sustainable strategy implementation

According to Polman and Winston (2021), "it's never been easier or more profitable to shift a business to low-carbon operations ». The authors also reassess the outdated idea that sustainability is an antibusiness practice to undermine free markets. The literature shows that corporate sustainability initiatives, on the one hand, are highly correlated with financial performance, and on the other hand can participate in value creation (Swartz & Bonini, 2014). Key findings show that many, if not all, of the Big Tech companies of the tech industry have addressed the concern of sustainability in their strategy, even making it the core topic of their business development strategy as the acknowledgement of its role in driving competition and creating long-term competitive advantage is quickly rising (Jones and Wynn, 2021). According to the former CEO of Unilever, social, environmental or governance challenges even presents "the greatest economic opportunity of our time" (Polman & Winston, 2021). Swartz and Bonini (2014) identified through their research within the literature that corporate-sustainability initiatives had different financial effects on businesses. First, they would provide a higher return on investment than companies with poor sustainability initiatives – around \$7.2 more per dollar invested. Second, the effect would also be noticeable when looking at return on assets and

³ Big tech companies' energy use and emissions are however important in absolute terms.

return on equity. With the same research question, the authors mentioned that companies with a higher ESG rating are showing lower costs of debt and capital in 89% of the cases. Finally, incorporating sustainability within a corporate strategy also means taking advantage of business opportunities and innovation, and can be a valid reason for companies to start embedding it. For instance, redesign products or engage in circular economy and natural-resource management can, of course limit risks, but also lead to a significant reduction of costs. Older works carried out by McKinsey are presented in Figure 8. It shows the results of the McKinsey survey about industry-specific opportunities to create value through sustainability.



Figure 8 - Industry-specific opportunities, McKinsey sustainability survey (Bonini & Görner, 2011)

In fact, the high-tech and telecom industry followed the same trend than the energy industry by creating value through regularly revisit the composition of their business portfolio as well as their innovations to insure their alignment with sustainability trends. Besides, one of the most important drivers for value creation in the high-tech and telecom industry is the management of corporate reputation for sustainability. Therefore, companies need to answer to all their stakeholders' requests and expectations in decarbonizing the global economy. Among all industries, the technology industry is one of the most polluting sectors worldwide and need to address this shift to a net zero world even more than others. First, investment decisions are more and more oriented towards companies with high ESG ratings, as there is growing evidence that sustainability increase performance and investment returns. For instance, Larry Fink chief of Black Rock, one of the world's leading providers of investment, advisory and risk management solutions, reinforced in its 2022 Letter to CEOs the transition of investment towards green investment and asked companies to set short, medium-, and long-term targets for greenhouse gas reductions and to answer to shareholders' economic interests (BlackRock, 2022). Then, companies have now no other choice than drive their actions and ambitions towards decarbonization and energy transition if they want to remain attractive to investors. In addition, sustainability is somewhat seen as a risk management tool. Whelan & Fink (2016) state that 70% of companies' EBITDA could be at stake from sustainability challenges. Hence investors are searching to mitigate these risks.

Besides investors, consumers and especially Millennials and Generation Z consumers are rethinking their consumption habits as they are convinced that they need to address the impacts of climate change today to live in a better future. Studies show that young consumers expect more transparency as well as tangible impact of companies in reducing emissions. A study conducted by Deloitte in 2022 shows that choosing brands that have environmentally sustainable practices and values represent for 40% of the respondents⁴ the main action to take to lead a more sustainable lifestyle. This figure shows an increase of 6 percentage points compare to 2021 (Deloitte, 2022). Finally, an important point that companies need to consider is the human resource impact of their sustainability actions. Indeed, employees are seeking for companies taking responsible positions, especially in terms of climate change, in addition to seek for purpose and mission in their jobs. The trends are at being hired by sustainable companies driving drastic change and addressing environmental as well as social impacts. Research shows that companies with greater accountability and responsibility performance can reduce average turnover by 25-50% over time (Whelan & Fink, 2016).

As a conclusion, companies have understood the way stakeholder's engagement is driving competitive advantage, whether it is through investment decisions or risk management, search for better consumption habits or for shared value with its employer.

b – The urgent need for energy efficiency improvement to respond to increasing volume of data and offset the sector's emissions

Jones and Wynn (2021) identified in their literature review the main measures regarding environmental sustainability undertaken by Big Tech companies of the technology industry, from their published annual report. The first identified sphere of actions relates to climate change and the reduction of carbon footprint through the decrease of carbon dioxide emissions and the shift to low carbon economy. Water and waste management initiatives come second and third in the rank of importance given by digital companies to sustainability targets. Follows circular economy topics and the need for a circular business model including circular design, circular operations, circular consumption, or circular solutions. Finally, companies seem to commit to ecosystems and biodiversity (Figure 9). The assessment and prioritisation of social, environmental, and economic topics which create value for the organisations start with a materiality matrix. The company needs to assess 1) the potential of each issue to have a positive or negative impact on growth, cost, or trust of the organisation and 2) the importance of each issue for stakeholders.

One of the top priorities for Big Tech companies is energy management and GHG emissions of their scope 1, 2 and 3. They all have published clear ambitions and targets in their annual sustainability report, all committing in powering their systems and operations with 100% renewable electricity, improving their energy efficiency, and achieving net zero carbon by a few years from today.

⁴ This survey was conducted online with a nationally representative sample of more than 2,000 UK adults aged 18+ between 1-2 June 2022.



Figure 9 - The sustainable development initiatives of the technology companies (Jones & Wynn, 2021)

In fact, ICT companies need to support technologies such as IoT, machine learning, 5G, cloud computing or artificial intelligence which all increase the volume of data storage and processing, hence the need for an efficient infrastructure: data centers. Unfortunately, in 2020, data centers accounted for 1.5% of global electricity (World Economic Forum, 2022). These infrastructures are highly tackled by the ICT sector literature as they are heavy consumers of electricity and affect CO₂ emissions indirectly. By 2030, CO₂ emissions from data centers are estimated to reach 720 million tons. Zhang & Liu (2022) explain that, in present, there are two main challenges for hyper-scale data centers, and for ICT companies, (1) decrease power usage effectiveness (PUE) and improving the energy efficiency, and (2) switch from traditional power supply to renewable energy.



Figure 10 - Top corporate off-takers of renewable power purchase agreements, 2010-2020 (Varro & Kamiya, 2021)

First, PUE is a universally recognized indicator developed by the Green Grid to measure the energy efficiency of data centers. It is calculated by dividing the total energy consumed by a data center by the total energy used by the IT equipment (server, storage, network). On average, hyperscale data centers have a PUE close to 1.1, which means that for every Watt consumed by IT, 1.1 watts are needed at the data center entrance. Traditional or corporate data centers have a PUE comprised between 1.67 and 1.8 on average (lebigdata.fr, 2022).

Figure 11 depicts the shift over the years to greater shared of cloud and hyperscale data centers, the last ones being used by big Big Tech companies such as the GAFAM and, in comparison to traditional data centers, manage more efficiently gourd space they have and must be at least 10,000 square feet and include a minimum of 5,000 servers connected to a high-speed network. Hyperscale data centers show more efficient cooling systems for IT infrastructure called heating, ventilation, air conditioning (HVAC) systems, largely participating in energy efficiency as the refrigeration accounts for 40% of data centers' total energy consumption (Zhang & Liu, 2022) and consequently represent a major cost item. Their specificity also lies in the optimization of air flows throughout the structure. Besides, they achieve cost reduction by eliminating power redundancy, allowing workload redundancy instead as well as enabling workload distribution to more appropriate processors or unused servers to avoid servers overload, which can affect IT equipment performance. Shehabi, et al. (2020) stated that if 80% of American small data centers were aggregated into hyperscale facilities, energy usage would decrease by 25%. Consequently, the increasing demand for data storage and processing linked to ICT companies' technology development led to an increase in energy efficiency capabilities and solutions in the recent years. Due to their size and capacity, hyperscale datacenters

have high demand for electric power and are thus pushed to settle where electricity is cheaper. Authors are divided on whether energy efficiency improvement will offset the increase of energy demand from ICT companies in the next few years. Malmodin and Masanet remain optimistic on the fact that data centers' operational energy consumption has been increasing only marginally in the 12 last years (194TWh in 2010 and 205 TWh in 2020, that efficiency efforts are continuing and finally that in the next 5 years, data centers emissions should not increase above the level of emissions of 2015. The growth of data centers would be, therefore uncorrelated with the increase in their environmental impact. On the other hand, some authors write about the ICT industry following rebound effects, according to which improving energy efficiency would lead to an increase in total energy demand in a greater proportion. (Freitag, et al., 2021).



Figure 11 - Global data center energy demand by data center type, 2010-2022 (Varro & Kamiya, 2021)

c – Tech industry as the pioneer in renewable energy consumptions to reduce their environmental footprint

While the first challenge of internet companies implies to optimize energy efficiency of a data center to ultimately reduce electricity costs of data centers, their second challenge lies in the use of alternative power. Leaders in the ICT sector are investing heavily in renewable energy. In terms of figures, the GAFAM procured 7.2 gigawatts of renewable capacity (30% of all PPAs or 3.5% of all global renewable capacity) in 2020. Big tech companies such as Google, Facebook or Apple, respectively purchased 12 TWh in 2019, 7 TWh in 2020 and 1.7 TWh in 2020 of renewable electricity and succeeded to match 100% of their operational electricity consumption. In the past five years, ICT businesses have accounted for about half of global corporate renewable energy purchases (IEA, 2021). Several solutions exist for Big Tech companies to be provided with renewable electricity: the guarantees of origin (GO) allow companies to prove and trace the purchase of a certain amount of renewable energy. Other solutions are the to subscribe to green electricity supply from a supplier or to consumer green energy produced directly on site by photovoltaic (PV) panels on the roof or on a car park.

A fourth solution, in which GAFAM already readjusted their economic models around is investing in Green Purchasing Power Agreements (PPAs). They are long-term renewable energy contracts enabling corporations to decarbonize their electric emissions and to support the energy transition. Their recent success is due to their economic, social, and environmental advantages. First, PPAs are a way to hedge against power price volatility and secure certified green energy supplies at a stable price over the medium to long term (5 to 20 years). Second, they allow companies to build up carbon-free roadmaps and third, companies investing in renewable purchases also invest in their brand reputation. These new offers of green energy come in support to public support to renewables, which has led to the decrease in their prices in many countries in the past 10 years (ENGIE, 2021). Green PPAs are favoured by big consumers that are Big Tech companies as the costs of renewable energy are falling. It is therefore the uncertainty of long-term electricity prices, coupled with reported increases in commodity and CO2 prices, and the growing interest of companies in the energy transition, that explain the growing popularity of PPAs.

Figure 12 shows the mechanism of Green PPAs for an energy provider point of view, here Engie, a global reference in low-carbon energy and services. In the case of a client of Engie buying a Green PPA, the power is produced by a defined renewable energy asset, then the produced green electricity is bought at predefined rate (whether fixed or indexed). Finally, the client receives the GO which is a tracking instrument defined in article 15 of the European Directive 2009/28/EC. Since 1 January 2012 only guarantees of origin certify that the electricity is produced from renewable sources. This makes it possible to demonstrate to end customers the share of so-called "green" energy in their offer contracted with an energy supplier. This offer can help companies to offset their indirect greenhouse gas emissions with minimal contract complexity and

low price and volume risks. Green PPAs are available to companies of all sizes. However, the pioneers remain the tech giants, and specifically those which operate hyperscale data centers (see figure 10). Powering data centers with renewables through green PPA contracts are the main concern of Big Tech companies nowadays.



Figure 12 - Green Power Purchasing Agreements (ENGIE internal source)

Notwithstanding that renewable energy also shows some technical constraints that limit their use for powering ICT equipment such as data centers. Indeed, PPAs have three main power supply profiles due to the use of renewable energy (wind or PV): PPA "As produced", PPA "baseload" and PPA "As consumed" (Figure 13). This means that even when ICT companies which are seeking to feed their datacenters with 100% renewable electricity, the nature of the energy does not guarantee continuous power providing and many have fossil fuel-powered backups for unexpected demand increases.

To bridge the gap and match data centers' demand profile on a continuous basis, ICT companies have a significant role to play in decarbonizing the electric grid through advanced digital technologies. For instance, digitalization can help the transition of computing tasks to times and regions with plentiful low-carbon sources, complete physical networks capacity by applying IoT on electricity networks, use AI to forecast wind and solar production or use smart inverters to maintain grid stability (Varro & Kamiya, 2021). With the acceleration and intensification of R&D investments in advanced technologies combined with an increase data center 'density', relative carbon emissions could fall by 19% despite the intensity of data center activity expected to increase by 250% by 2040 (Journaldunet, 2022).



Figure 13 - Power supply profiles of PPAs (Engie internal source)

d - Other actions of Big Tech companies to support climate change

In addition to energy efficiency improvement and renewable energy, we have identified circular economy and waste management and ecosystems and biodiversity as the key topics tackled by Big Tech companies. Circular economy is designated in opposition to the traditional linear value chain in which inputs come in, waste comes out and products have a short lifespan. Instead, circular economy introduces the concept of recycling, resources reuse and decoupling of resource use from growth. According to authors, its benefits are as much economic both for the economy and business as environmental. Embed this new way of production requires first to design products and services for circular economy, in other words, think and conceive products according to either they are consumable or durable components. Consumable components are made of several components from natural resource, and which can be then individually transformed in other products whereas durable components such as iron or steal are thought to be reused, remanufactured, or refurbished (Swartz & Bonini, 2014). According to the European Commission, 80% of a product's environmental footprint is determined at the design face. To address the growing e-waste volume and encourage ICT companies to invest in circular economy, the European Commission proposed a "Circular Electronics Initiative". For the ICT sector, it means reducing virgin resource extraction, extending use-life of products, and minimizing waste and pollution of electronics. The Platform for Accelerating the Circular Economy (2021) defined 3 key principles characterizing the circular economy for electronics:

- 1. New products use more recycled and recyclable content
- 2. Products and their components are used for longer
- 3. End-of-use products are collected and recycled to a high standard

Following the ecosystem concept to increase sustainability, circular economy is a main reason for which Big Tech companies are starting to partner with value chain actors and create an ecosystem to develop standards and certification materials, better understand how to create for recyclability, or also identify opportunities for innovation in sorting, pre-processing, and recycling technologies. Finally, shifting from linear economy to circular economy has economic benefits for companies which can reduce costs and enhance customer relationship.

Section 2 – The limitations of Big Tech companies' sustainability strategies

a – The Greenwashing practices of Big Tech companies to reinforce their brand image

According to Corporate Affairs professionals, more than one in five organizations have been accused of greenwashing in the past (Global Scan, 2022). Greenwashing is a marketing misleading practice of promoting ecological campaigns, products or services, and practices that conflict with the companies' core content of the commitments. It can take different forms such as suggesting through image or sound that a product is green, misplacing priorities (focusing on switching to recycled plastic packaging when the biggest emissions come from the companies' operations) or promoting an activity that is polluting today on the pretext that it will be carbon neutral in some years. Lyon & Wren (2015) identified in their extant literature on greenwashing several different methods of greenwash: selective disclosure, blank green claims and policies, questionable certifications and labels, co-opted NGO endorsements/partnerships, ineffective public voluntary programs, misleading narrative and discourse and misleading images. These practises largely emerge from the lack of policies and standardization among the products and solutions in terms of ESG. Among tech leaders, Amazon has been at the forefront of such greenwashing practices. Indeed, figure 14 shows the lack of achievement from Amazon in 2020 compared to its goals for 2030. The main issue lies in the lack of information shared by the Big Tech company on the means to procure 100% renewable by 2030 reach net zero carbon by 2040. Besides, some practices are going against the attitude and initiatives that the company should be taking to reach these goals, such as an increasing energy demand by data centers outpacing Amazon's investment in renewables.

Company	Carbon Footprint (MtCO2e)	Renewable Matching Deadline	Fossil Fuel Phase Out Deadline	Using Unbundled RECs	Includes Supply Chain	Pursuing Al for Oil?
amazon	44.4	2030*	None	Yes	No	Yes
Microsoft	16	2025	None	No	Yes	Yes
Google	1.5	2017	Ongoing**	No	Yes	Yes

*Amazon has not stated that it will match its data center energy demand with real and additional renewable energy projects, and to-date has in part used lower-impact renewable energy credits to make its RE claims.
** While Google has no public deadline, it has embarked on a path to power its data centers with carbon-free energy 24x7.

Figure 14 - Achievement of Amazon, Microsoft and Google compared to their climate change goals (Engie source)

Legislation rises in many states to avoid greenwashing practices from companies. According to Ademe, the French Environmental and Energy Managements Agency, from 1st of January 2023, French companies will no longer be able to claim to be "carbon neutral" unless they can prove it (Beaujon, 2022). Likewise, the UK's Competition and Markets Authority (CMA) has set out rules in its Green Claims Code, to make sure, from 2022, that all organizations' claims about their environmental initiatives and goals are "truthful, accurate, clear, unambiguous, fair and meaningful, and that they do not omit or hide important relevant information" (UK Government, 2021). Finally, the ISO norm 14068 should be published in 2023 to promote a common understanding of carbon neutrality and how to contribute to it, across public and private organisations. It should bring some common language to the ICT sector and make greenwashing practices disappear or at least diminish.

b – The limitations in Big Tech companies' negative environmental impacts calculation

Chapters 1 and 2 allowed us to understand that Big Tech companies are growing fast and need to be accompanied to understand how to decouple their development from their CO2 emissions. This is all the more complex as it is not always easy to calculate the quantities of carbon actually emitted. For example, Engie Impact, the consulting entity of Engie specialized in decarbonization of companies, has collaborated with Netflix to work on the company's sustainable strategy. The most interesting question according to Mathias Lelièvre, Engie Impact CEO, was whether to consider the energy consumed by the television set of the subscriber who watches a Netflix series to compute the total energy consumption of their services. It is therefore important to define the relevant limits to what should be measured and included in such cases. Besides, a common and frequent challenge for companies is to compute Scope 3 emissions, which are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions (Greenhouse Gas Protocol, 2022). Indeed, there exist many different methodologies to estimate GHG emissions and scope present even more difficulty as it requires that all suppliers' own emissions have been calculated, hence can appear the challenge of double counting when aggregating data from multiple organizations. This scope 3 measurement challenge has raised some interrogations in the literature and news on whether Big Tech companies should better reinternalize their activities to have a better vision and measurement of their impacts but also to reduce the costs associated with their measurement. Many authors have discussed the uncertainty of carbon calculations and the limits of the methodologies used. In particular, Bieser and Hilty (2018) used the PRISMA⁵ framework to identify 15 assessment methods for indirect environmental effects of ICT among them the Life cycle assessment (LCA), system dynamics (SD), agent-based modeling (ABM), ICT enablement method (ICTem) or regression analytics methods. The conclusion of their research mainly demonstrates the lack of assessment of indirect

⁵ Preferred Reporting Items for Systematic Reviews and Meta-Analyses

effects from the consumption of ICTs when many researchers investigated the direct effets, the changes in patterns of production (Bieser & Hilty, 2018). Likewise, Freitag et al. (2021) mention in their study of the systematic underestimation of carbon footprint when using LCA methodology. Indeed, according to their research, the LCA calculation method does not include neither the supply chain pathways of a products nor the full supply chain carbon emissions related to the use of electricity to run ICT equipment (Freitag, et al., 2021). In this literature review, we focused on understanding how Big Tech companies' data centers are very energy-intensive and how their owners could leverage energy efficiency improvements, innovation in technology and the rise of renewable energy to reduce their negative impact on the environment. It is thus noteworthy that data centers' emissions computation is very complex and that there does not exist standardized assessment methods which can be applied to all data centers and by all companies. Lannelongue, Grealey & Inouye (2021) explain that to ease green computing, which is the study of environmentally responsible information and communications technologies, and to diffuse user adoption, there is an urgent need to set a simple and generic methodology for estimating carbon emissions that can be applied to any computational task.

c – A necessary organizational change

In the case of Big Tech companies, shifting from a linear economy to a circular economy, powering their activities with renewable energy, or improving energy efficiency of their data centers require to understand what the transformation means beyond a simple technical evolution. Unfortunately, many companies have not been fully comprehended this profound organizational change that this race to sustainability is demanding yet. Indeed, when we focus on the three shifts we mentioned, effects can be seen quite rapidly in the organization's impact on the environment, while the consequences of more complex systems such as offsetting prices, carbon prices or regulation remain more abstract to executives. The latter examples of sustainability actions involve precise business cases to economically justify this transformation. Besides, as mentioned in section 1, chapter 2-b., restructuring existing business model around sustainability and innovation is very complex for businesses. Within the organisation, the transition towards a sustainable business model require to reshare supply chains, to implement new digital platforms to understand and measure the transformation but also to train employees who need to be a vector of this change as well. All this energy transition coupled with digital transition require to set a clear sustainable business model innovation SBM-I (see section 1, chapter 2-b) and identify the organizations' dynamic capabilities, which plays a significant role in business's wish to respond to quick change and to maintain its competitive advantage while addressing environmental challenges. Dynamic capabilities result from the combination of management, learning, and reconfiguration processes and are essential to be understood and comprehended by an organization to sense its internal capabilities, to properly use these resources to answer external changes to

ultimately reshape its organizational structure, processes, and strategy (Kargar Shouraki , Hajiheydari, Mohammadian, & Vares, 2022).
CHAPTER 3: METHODOLOGY

I. First step: business cases

After reviewing relevant academic work on the topic related to environmental sustainability in the tech industry and the challenges associated, we selected three companies of the information and communication technology industry to understand how they are approaching and incorporating environmental challenges within their strategy. We considered these companies as major leaders of the digital transformation and estimated that both from their size and their worldwide influence, their approach to environmental sustainability is the reflect of the most advanced innovation and initiatives of the tech sector.

Therefore, the first step of our analysis will be to conduct three business cases:

Business case 1: Microsoft Corporation

Microsoft is a global technology company specialized in computer software, personal computers, and consumer electronics with a balanced portfolio of clients and large user base in both BtoC and BtoB markets. It has recently extended its product leadership beyond operating systems and business productivity software into public and hybrid clouds with Azure, becoming second in the public cloud services market (behind AWS). In 2019 Microsoft became the 3rd US company to pass a market cap of \$1 trillion and is seen as one of the world's most valuable company.

Business case 2: Amazon.com Inc.

Amazon.com is a global Big Tech company created in 1994 by Jeff Bezos. The group's activities are organised between online retail shopping services, third-party seller services, subscription services, Amazon Web Service (AWS) and advertising services. On the B2C market, Amazon.com is the intermediary between thousands of suppliers and customers, with its two activities: retail sales and subscription services. While on the B2B market, Amazon.com connects suppliers and customers via its Marketplace and its AWS services. In 2021 and 2022, Amazon was the world's largest corporate purchaser of renewable energy with a capacity of renewable energy portfolio to 15.7 GW.

Business case 3: Alphabet Inc.

Google is a multinational company founded in 1998 by Larry Page and Sergey Brin that provides web search and aims to organize the world's information and make it accessible and useful to everyone. The company also displays advertising tools, cloud computing, software, and hardware. Since October 2015, Google is a subsidiary of Alphabet holding. The company organized its business around two core activities: google services, which comprises Google Search, YouTube ads and Google Network and Google Cloud. The first part of our results is based on findings from the Internet and are thus in the public domain. The research consisted in analysing reports published by the companies themselves on their group website: sustainable reports, annual reports. In addition, when available, we used CDP (Carbon Disclosure Project) reports to analyse data from emissions and energy consumption for companies. As the table below summarizes, only Amazon has not partnered with CDP. For this specific business case, the data regarding emissions and consumption will be collected from their own published data reports.

Companies		RE 100	GREENHOUSE GAS PROTOCOL	SCIENCE BASED TARGETS
Microsoft	\checkmark			\bigcirc
amazon	\bigotimes	⊗	\bigotimes	
Alphabet	\bigotimes	\bigcirc	\bigotimes	\bigotimes

The objective of this paper is to draw clear and justified conclusions to our research questions, rather than drawing a comparative analysis of the Big Tech companies in terms of sustainable strategies. Therefore, we thought appropriate to use a simple method of identification of the context of the companies, their key initiatives in terms of addressing global environmental challenges and the quantitative results of their actions (by analyzing the evolution of their emissions over the years and the evolution in the use of renewables in their energy mix for example). Aligned with our objective, chapter 4 will transcribe observations through graphs and tables that can be easily understood and analyzed in depth in chapter 5. Finally, the main idea of chapter 4 is to faithfully transcribe the corporate authenticity of the three business cases. Besides, it is noteworthy that our analysis was carried out between June and September 2022, hence the data reported and analyzed in chapter 4 does not include 2022 data as we deliberately took the decision to focus on fiscal year data rather than on quarterly data. Therefore, the reader must take into consideration that energy and emissions data may have been impacted (in a positive or negative way) within the current fiscal year.

II. Second step: interviews

The second step of the methodology consists in conducting qualitative interviews of three Global Account Managers working at Engie, in the Key Client Office department.

a. Context and choice of the interviews

First of all, given the core business of Engie, their focus on renewables and energy efficiency as well as its global footprint, we thought strategic to carry out interviews within the energy company to understand what the main initiatives and requests from their clients are and specifically withing the tech industry. Indeed, Engie is a global reference in low-carbon energy and services. Engie's raison d'être is to reconcile economic performance with a positive impact on people and the planet, using its core businesses (Renewables, Energy Solutions, Networks and Thermal & Supply) to offer competitive solutions to its customers. Under the leadership of Catherine MacGregor since the beginning of 2021, the group has set its sights on renewable energy while investing in gas-fired power plant projects. Engie focuses on four main activities representing its four Global Business Units (GBUs) responsible for their own P&L: renewable energies (leading producer of onshore wind and solar in France, leading independent producer of hydroelectricity in Brazil, producer of geothermal and biomass resources), infrastructure & networks (leading underground gas storage in Europe and 2nd largest terminal operator in Europe), energy solutions (leader in low-carbon distributed energy infrastructure) and thermal generation & power supply (leading independent producer of electricity in the world). With 170,000 employees worldwide, Engie is a global energy player with 36% of its turnover (€55.8 billion in 2020) coming from France, 28% from the rest of Europe, 7.5% from North America, 9% from Latin America and 4% from the Middle East, Africa & Asia. In terms of renewable capacity, Engie has 31 GW of installed capacity and aims to reach 50 GW by 2025 and 80 GW by 2030. The group wants to contribute to avoiding 45 MT of CO2 emissions per year by 2030 for its customers. Three years ago, the group decided, based on the opinion of the employee representative bodies, to undertake a geographical simplification to reduce the number of countries from 70 to 30 by 2023, identifying 3 regional clusters: North America, South America and Asia-Middle East-Africa (EMEA).

Second, aligned with our objective to find the most significant responses to answer our research questions, we decided to carry out interviews in the Key Client Office (KCO) department of Engie. The KCO department is part of the Global Business Unit Energy Solutions (GBU ES) managed by the Chief Business Development, Marketing, Clients, and Innovation Officer, who oversees 4 departments: Customers, Business Platforms, Operational Marketing and R&D Innovation. The KCO is a sub-department of Customers within the Market Segments department. The KCO was born in 2018, in a highly user-centric world and in response to the need to better address customers. Engie therefore decided to better structure relationships with large companies and implement the best practice of key account management, with the most valuable customers

globally, in order to invest in expansion. The main tasks of the KCO are to work closely with selected strategic B2B customers and implement key account management in GBUs and countries, create a pipeline of large organic contracts and develop the adoption of a common CRM. The creation of the KCO aims to answer several questions:

- How to optimize strengths to address the global customer?
- How to better understand the strategic needs of customers and direct them early enough?
- How to leverage multi-entity and cross-business offerings?
- How to offer a more global and meaningful Engie experience?

The KCO is organised around 12 Global Account Managers (GAM), each of them overseeing two accounts, The role of a GAM is to take a relationship-based approach, with the aim of better understanding the stated and unstated needs of customers and customizing solutions. Each GAM works with its accounts and with a designated internal account team (Engie KAMs - Business Units, Markets). Here, we had the opportunity to exchange with three GAMs in the context of this paper: Anne Cateaux, GAM of Microsoft Corporation, Tom Van den Bussche, GAM of Amazon.Com, Inc. and Ivan Bel, GAM of Alphabet Inc. The selection of these interviewees lies on their in-depth knowledge of the three accounts respectively coupled with their excellent understanding of the energy and climate change challenges that all sectors and companies need to face nowadays.

Finally, the KCO is associated to the consulting entity of Engie, called Engie Impact, which was created to accelerate organizations' transition towards a greener and more sustainable model at the international level. Employing and applying consulting methods such as actionable roadmaps and on-the-ground execution, Engie Impact allows their clients to understand how to reduce their carbon emissions and control their energy expenditures to mitigate the risks brought by climate change.

This second step dedicated to qualitative interviews allows us to enrich our understanding of the sustainability challenges and actions of Big Tech companies observed through the business cases. In fact, the first step of this methodology gives quantitative and some qualitative insights of the companies' strategy by giving figures and targets relayed to carbon reduction, climate change, biodiversity, energy, water and waste management. However, qualitative interview can bring out many nuances that would not necessarily have emerged in the business cases. The objectives of these interviews are multiple. First, after understanding what the role of the interview in the sustainable strategy of the selected account is, we tried to understand the state of the relationship between the GAM and the account he/she manages as well as his/her understanding of the issues faced by their client in terms of environmental sustainability of their operations. Then, the objective of these interviews is to be able to understand where their client is positioned in terms of achievements and whether their objectives are reachable in the milestones stated in their publications. Finally, the interviews

were conducted with open questions to allow the interviewees to mention subjects judged useful to respond to our questions.

b. Qualitative Interview Questionnaire

The role of the interviewee

- 1. For how long do you work with [client name]?
- 2. How would you define your relationship with [client name]?
- 3. Could you mention some key collaborations between Engie and [*client name*]? how were they aligned with the client's commitments in terms of sustainability?

The tech industry

- 4. How do you think [*client name*] is positioned among the other Big Tech companies? Is the company in advance or lagging?
- 5. Net positivity is a hot topic these years. Do you think Big Tech companies are concerned and can reach it?
- 6. Would you say that Big Tech companies are genuinely looking for to opportunistically accompany a change that they do not control?
- 7. Are you able to mention one or two key leaders on the tech market in terms of sustainable strategy?
- 8. Do you identify limits to the implementation of a sustainable strategy in Big Tech companies?

The company

- 9. In your opinion, what was the main driver for [*client name*] that has led it to implement a sustainable strategy?
- 10. In your opinion, what is the most important topic for [*client name*] in terms of environmental sustainability?
- 11. Do you think that [client name] has set reachable objectives and targets?
 - a. If so, do you think it could have been more ambitious?
 - b. If no, what are the obstacles you could identify?
- 12. Would you say that [*client name*] publications of their emissions and energy data are trustful and represent their actual figures?
- 13. One of the biggest issues for emissions measurement is Scope 3. According to you, what are the main solutions to reduce [*client name*] scope 3 emissions?
- 14. What is, according to you, the key next steps for [client name] in terms of sustainability?

General questions about sustainability

- 15. Would you say that Big Tech companies have fully understood the stakes of their transition towards decarbonization?
- 16. What would be the key elements that still need to be incorporated in their strategy to have sustainable operations?
- 17. Do you have any other topic you would like to share about?

CHAPTER 4: RESEARCH RESULTS

I. Business case n°1: Microsoft Corporation

Section 1 - Analysis of Microsoft's sustainable data and initiatives

a- Microsoft Corporation company overview and sustainable strategy

Microsoft Corporation is a global technology company founded in 1975 in the United States by Bill Gates and Paul Allen, which, according to Fortune 500 ranking (United States Environmental Protection Agency, 2022), has one of the most successful sustainability strategies. Microsoft's revenues for fiscal year 21 reached \$168 billion (half of which coming from US business), a 34% increase versus 2019, and shows a net margin of 36%. The company employs 181,000 people globally and has activities in 60 countries in which operate more that 140 data centers. Between 2019 and 2021, we observe a significant shift of business activity from productivity and business process (-0.6 ppt) and personal computing (-4.2ppt) into an increase in intelligent cloud services thought by the largest global enterprises and public sectors (+4.8ppt). Cloud services now account for 36% of Microsoft revenues, compared to 32% for both other segments. In fact, the increasing margin in 2021 results can be attributed to cloud infrastructure and cloud-based software, with Microsoft Cloud revenue showing a 32% YoY increase.

Microsoft Corporation's 2021 sustainability strategy is organized around four key pillars:

- **Carbon negative** to accompany the world's ambition towards a net zero carbon emissions economy by 2050 with an objective of carbon reduction, 100% renewable energy, data empowering of suppliers to reduce footprints and innovation investments. To do so, Microsoft commits to improve methodologies and measurements of emissions data
- Water positive to respond to the increasing global water demand with an objective to reduce water consumption of data centers and campuses as well as participate in expanding access to clean water
- Zero waste to engage in the circular economy by rethinking manufacturing including responsible sourced materials and reuse, recycling, and repair of materials
- Ecosystems to maintain the very foundations of the economies, livelihoods, food security, health, and quality of life worldwide by aggregating and measuring global environmental data and advocate for public policies.

Microsoft announced in 2020 its commitments to engage in a carbon negative future. In 2021 Sustainability report, commitments for 2030 and before are clearly stated. Fiscal year 2021 is therefore the year where cumulative two-year achievements were measured. Table 3 below summarizes Microsoft's 2030 keys goals and achievements across all four pillars.

Target	Deadline	Progress in 2021
Carbon negative		
Removing an equivalent amount of carbon to all its historical emissions	2050	Removed 2.5M tons on FY21 and FY22 cumulated
Reaching 100 percent renewable energy	2025	Ongoing
Microsoft aims at replacing with 100/100/0 ⁶ carbon free energy	2030	> 8 GW of renewable energy from PPAs or long-term contracts (5.8 signed in 2021)
Diesel-free data centers	2030	Ongoing
Reducing Scope 3 GHG emissions intensity per unit revenue by 30% against 2017 baseline	2030	Reached a 25% reduction against 2017 baseline
Water nositive		
Reducing water waste in datacenter operations by 95 percent	2024	Ongoing projects in Amsterdam, Dublin, Virginia and Chicago, and desert regions like Arizona
Replenishing more water than used by reducing water intensity of direct operations	2030	45% of water replenishment
Provide more than 1.5 million people with access to clean water and sanitation services	2030	> 90 000 people concerned
Zero waste		
Reuse 90% of servers and components within regional datacenter network	2025	5 Circular Centers launched
Reach 90% diversion of operational waste at datacenters and campuses	2030	More than 15,200 metric tons diverted
Eliminate single-use plastics for all Microsoft primary product packaging and all IT asset packaging in datacenters	2025	18% of reduction in single-use plastics
Ecosystems		
Protect more land than used by 2025	2025	Contracts to protect 17,000 acres of lands
Build a Planetary Computer	2025	500 Planetary computer users and 24 petabytes of available data
		1 • 1 • .

Table 3 - Microsoft Corporation 2030 key goals and achievements in sustainability

 $^{^{6}}$ 100/100/0 is Microsoft's new approach to carbon-free energy to match 100 percent of its electricity consumption to zero carbon energy purchases 100 percent of the time.

b- In-depth analysis of Microsoft's carbon negative 2030 target strategy

This part of the results focuses on Microsoft's 2030 net-zero carbon and 2050 carbon negative strategy. Behind this commitment lies the objectives of carbon reduction, energy efficiency and the use of renewables in the company's operations.

First, in their 2021 Sustainable Report, Microsoft Corporation published its environmental data (Appendix D of Sustainable Report 2021), which indicated total emissions⁷ of approximately 14 million mtCO2 in 2021, a 21% increase compared to 2020. To measure the genuine efforts of the group in reducing its emissions, we looked at GHG emissions intensity, the emissions per revenue (mtCO2e/Revenue M\$). We observed a significant decrease of the intensity across the three scopes between 2017 and 2020. Indeed, table 3 shows a 25% reduction in GHG emissions intensity per unit revenue compared to 2017, that is 5 percentage points to its 2030 target, supporting Microsoft's engagement in reducing emissions while growing its revenues. Microsoft's engagements and projects already generated significant results since the announcement of their carbon negative target by 2050. First, the group's actions regarding their own scope 1 and 2 emissions enabled a decrease its scope 1 and 2 emissions of nearly 17% in 2021. Figure 17 shows the evolution of scope 1 and 2 over the past 6 years. Our analysis of Microsoft's sustainable strategy emphasized two main axes developed by the group to reduce its emissions: energy efficiency and renewable energy. The first axis relates to the way campuses and data centers are built to ensure energy efficiency of all facilities leading to significant decrease in GHG emissions. Among the most recent initiatives, we can cite the implementation of LEED (Leadership in Energy and Environmental Design) Gold certification in Silicon Valley and Redmond campuses and its future implementation in all data centers, which optimizes the lightning and cooling systems according to the facilities' requirements.



Figure 15 - Microsoft's Scope 1 and 2 CO2 emissions in metric tonnes CO2 equivalent 2015-2021

market-based method reflects emissions from electricity that companies have purposefully chosen (or their lack of choice).

⁷ Scope 2 and 3 are market-based value. The

The second axis aims attention at transitioning to 100 percent renewable energy. Their renewable energy comes both from contacted PPAs or long-term contracts (more than 8 GW already contracted) and from innovation from their own campuses. For instance, photovoltaic (PV) solar panels as well as thermal energy centers were installed in several campuses to generate its own electricity, cooling and heating systems matching its annual consumption. In addition, the tech giant set a target to quit the use of diesel fuel in their data centers by 2030. The underlying idea is to use renewable fuels, batteries operating on highly reliable grids and the use of hydrogen fuel cells for backup power of datacenters. This ambitious sustainable initiative will allow significant reduction in GHG emissions. Finally, Figure 16 shows the evolution in the use of renewable electricity over the years, with 62% coming from PPAs and 38% from RECs.



Figure 15 – Microsoft total energy consumption in GWh 2015-2021

This positive outcome of the group's strategy is, however, counterbalanced by an increase in Scope 3 emissions, representing 97% of the group's total emissions. They are mainly driven by the cloud service business growth and an increase in devices sales and usage. Thus, the company committed to cut theses emissions by 50% by 2030, which can mainly happen by rethinking design of products, decarbonization its supply chain, but mainly by implementing sustainable strategies for their data centers to become carbon negative. Indeed, the global increasing demand for cloud has required high investments in research and development to be able to compensate emissions from data centers operations: cooling, water use, e-waste, electricity consumption.

Microsoft launched in July the Microsoft Cloud for Sustainability project, which enables its users to comprehend, measure, analyze and automatize their sustainability management hence allowing a better recording, reporting and reduction of their emissions. The service uses data intelligence to create a sustainable IT infrastructure to *in fine* reduce the environmental impact of operations and build sustainable value chains. The success of this platform is due to the large ecosystem of global partners upon on which it rests. In fact,

Microsoft has built trustful partnerships with many industry experts and work in close collaborations with independent software vendors (ISVs) such as ABB, Bentley Systems or EcoVadis and advisors such as Accenture, PwC or EY which are all determined to grow Microsoft Cloud for Sustainability to encourage sustainability globally by driving innovation. The usefulness of this platform for Microsoft's own reduction in emission needs to be highlighted. Indeed, it has a positive impact for Microsoft's scope 3 emissions as their providers and customers are now able to track their emissions data and act on it.

Summary

- Microsoft has one of the most successful sustainability strategies among the Fortune 500 companies and commits to being carbon negative by 2030.
- Microsoft wants to reach 100% of renewable energy for its Scope 1 & 2 by 2025
- Microsoft is known as a sustainability leader and must continue differentiating itself by focusing on its Scope 3 targets (i.e., reduce intensity per unit revenue by 30% in 2030).
- Microsoft continuously strives to promote sustainability in its operations, products, policies, and help enable customers and partners to do the same by creating larger ecosystems of partners.
- Their main strategy is to focus on datacenters energy efficiency, sign more PPAs and on-site energy production contracts, and develop services and solutions for sustainability (Cloud-based, IoT for Smart Buildings and Smart Cities etc.)
- Through its \$1B Climate Innovation Fund, Microsoft wants to accelerate the development of decarbonization technologies.

Section 2 - Interview of Anne Cateaux, Global Account Manager of Microsoft at ENGIE

To complete and enrich our Microsoft business case, we chose to interview Anne Cateaux, the Global Account Manager for Microsoft at Engie, in charge of generating deals with the top executives of Microsoft with the goal of decarbonizing their operations. Anne has been working at the KCO for Microsoft account since March 2020 and has established closed relationships with key stakeholders of Microsoft who are from far or near involved in the group's sustainability strategy. She is in direct contact with Satya Nadella's office, the CEO of Microsoft, and with the lines of reporting of Brad Smith, who's the president of Microsoft and several in his direct reports, which includes Lucas Joppa, the Chief Sustainability Officer. On the COI side, so cloud operations and innovation, she has contacts with the EVP, Scott Guthrie and Noelle Walsh, the VP. Anne was able to establish a highly integrated and respectful relationship with these people over the years, which enables her to get thorough discussions about Microsoft's actions and initiatives in terms of sustainability.

First of all, over our 30 minutes exchange with her, we were able to confirm the group's engagement in operating for sustainability first and foremost by acting on its data centers. Indeed, according to its core activities of development and marketing of software, services and hardware services, Microsoft's data storage and processing account for a large part of their emissions, energy, and water consumption and finally e-waste generation. Besides, Anne mentioned the hourly chats between Microsoft and RED, an entity of ENGIE Impact, which are the data center design experts. This relationship underlines the focus of the tech giant to power its data centers with renewables and to increase their energy efficiency. Among the deals between ENGIE and Microsoft, the interviewee mentioned the very innovative partnership in Texas in 202, which she says, "is the most innovative and inaugural deals that Microsoft did to meet their 100% green by 2025 and it was one of the first ones of its kind". The deals consist in a 230 MW long-term solar and wind energy PPAs that provides 24/7 supply in the United States and the implementation of Darwin, an energy software developed by ENGIE using the intelligent cloud services of Microsoft Azure to optimize performance of ENGIE's wind, solar, and hybrid (wind + solar) renewable assets worldwide. The very innovative work that RED did to design this solution was to respond to. Microsoft's ambition to reach gold LEED certification, and ultimately platinum LEED. ENGIE entities are well identified partners in Microsoft's data centers' design and construction with opportunities to deploy high value added, sustainable solutions for secured power (e.g. cryogen or H2 batteries) and water efficient critical cooling

The upmost reason that led us to carry this interview is to be able to understand the genuine drivers for Microsoft to lead such initiatives on sustainability. The exchange with Anne allowed us to understand that sustainability challenges were taken from different angles according to where you stand in the group. Indeed, Anne was able to understand that the engineers in charge of designing futuristic data centers and the ones "who get to play with all the cool technology like putting data centers in gel liquids, in a submarine and in the ocean", are concerned about these new initiatives because it is technically challenging. On another side of the group, some decision makers are concerned about security and safety of populations and infrastructure. As soon as Microsoft decided to because tenant of its owned data centers, risk management appeared. Anne Cateaux illustrated the risks of climate change through the Northern Carolina catastrophe where Microsoft built a data center and had to deal with recurrent fires in the region. All these risks are now carefully managed by the group, hence their wish to participate in building a safer world for communities (and their buildings). Nevertheless, Anne Cateaux did not contradict Microsoft's ambition to increase its profitability and brand reputation by investing in climate tech for example. In conclusion, according to Anne Cateaux, the sustainability efforts from the group come from many reasons at the same time: humanitarian reasons, its care for the planet, risk management and profitability.

Another subject tackled during the interview concerns the ecosystem that Microsoft was able to build so far, and all the innovations that it has created. Anne highlighted the partnership between Microsoft and Plug Power, the fuel cell solutions company who led a pilot together powering a row of data center servers for 48 hours with hydrogen fuel cells to stop their diesel use. This innovative pilot was made possible by Microsoft which identified the best of the best to work with and then tried to figure out how they could "work directly just one to one or bring in this vendor to work with other vendors to create a collaborative comprehensive solution where Microsoft at the end is the benefactor of what all the partners got together". According to the interviewee, Microsoft believes that this ecosystem of partners (energy providers, technical providers, and integrators) is the best way to become leader in many climate tech which will allow them to reach carbon neutrality and carbon negativity on time.

Finally, we tried to understand how Microsoft could tackle its Scope 3 emissions. Therefore, we questioned Anne Cateaux on Microsoft Cloud for Sustainability and on where the group was going with this initiative and whether it will allow to help them measure their Scope 3 emissions in time for their objectives. She, though rather optimistic, recognized the need for real measurement standards to be able to measure scope 3 emissions. She insists on the fact that today, the race is at being able to tackle this scope 3 and that "many players have entered the space and everybody's claiming they're doing something", including Microsoft, which has joined Carbon Call, an initiative launched to solve data quality issues, measurement and reporting inconsistencies, siloed platforms, and digital infrastructure challenges to allow companies in the race of net-zero carbon to have measurement standards to compare, combine, and share reliable data.

II. Business case 2: Amazon

Section 1 – Analysis of Amazon's sustainable data and initiatives

a- Amazon.com company overview and sustainable strategy

Amazon.com is a global Big Tech company created in 1994 by Jeff Bezos. The group's revenues are mainly generated by online retail shopping services, third-party seller services, subscription services, Amazon Web Service (AWS) and advertising services. On the B2C market, Amazon.com is the intermediary between thousands of suppliers and customers, with its two activities: retail sales and subscription services. While on the B2B market, Amazon.com connects suppliers and customers via its Marketplace and its AWS services. Nowadays, Amazon.com evolves in a highly changing environment, where regulators and clients are increasingly demanding regarding business practices. In terms of performance, Amazon.com showed net sales of \$469.8 billion in 2021, or a 21% increase versus 2020. FY21 financial results are divided between North America, International and AWS segments. Even though the latter accounts for only 12% of the group's revenues, it is the only one showing a positive operating income growth between 2020 and 2021, a 37% increase. Thus, it is likely that Amazon.com 2021 profits come from AWS.

Amazon.com growth is working on decarbonizing its operations while it's growing fast. To respond to an increasing demand triggered by Covid-19 and the shift of companies to cloud storage, the tech giant had to expand its footprint in terms of facilities for its consumers, its fulfilment and transportation network. All these investments generated a significant increase in carbon emissions in two years. Therefore, Amazon.com states in its 2021 sustainability report clear ambitions to reduce its carbon footprint and improving its operations efficiency by implementing sustainable solutions. Table 4 below summarizes Amazon.com keys goals and achievements by 2040.

b) In depth analysis of The Climate Pledge of Amazon.com

This part of the results focuses on Amazon.com 2040 net-zero carbon strategy. The Climate Pledge is the name given by the group to all its commitments to reach carbon neutrality by 2040, ten years ahead of the Paris Agreement. It was developed in 2019 with the underlying objective to create a cross-sector community of businesses, organisations, and individuals to address the challenges face by the economy in times of climate change. To date, the community gathers more than 300 organisations across 51 industries and 29 countries and has generated more than \$3.5 billion of global annual revenue. The pledge is organized around three key pillars, listed below.

- Regular reporting of GHG emissions
- Carbon elimination by focusing on energy efficiency, renewable energy, and materials reductions
- Credible offsets to neutralize remaining emissions

In the Appendix of its Sustainable report, Amazon.com published its carbon data which indicate total emissions of approximately 71.54 million mtCO2 in 2021, a 18% increase compared to 2020. In details, scope 1 emissions (fossil fuels and refrigerants) showed a YoY increase of 26%, scope 2 emissions (purchased electricity) decreased by 23% and scope 3 emissions increased by 21%. Figure 17 illustrates the YoY evolution in emissions and details the nature of scope 3. However, we also observe a continuous decrease in carbon intensity, which quantifies total carbon emissions, in grams of carbon dioxide equivalent (CO2e), per dollar of gross merchandise sales (GMS). The 22% decrease over 4 year testifies of the efforts of a high performing tech giant to cut emissions independently of its growth and investment.



Figure 17 - Amazon.com total CO2 emissions in metric tonnes CO2 equivalent 2018-2021

In their 2021 Sustainable Report, Amazon.com aligns its objective with the Pledge commitments and focuses its carbon footprint reduction goal on four main pillars and had led since 2019 many initiatives to reduce its carbon emissions.

100% renewable energy powered operations. To reach this ambition, Amazon.com invests heavily in renewable energy since 2014 in 71 utility-scale wind and solar projects, 135 on-site PV solar rooftops and green tariffs to power all its facilities including corporate offices, fulfillment centers, data centers and physical

stores in the US, Canada, Spain, Sweden and the UK. As table 4 states, the group has reached 85% of its operations powered by renewable energy, which accounts for 12 GW production capacity. The 23% reduction in scope 2 emissions in 2021 are directly correlated to this initiative. In parallel, these projects allow to respond to electricity storage needs coming from solar and wind farm and, using AWS Cloud technology, the Big Tech company enables the improvement of Amazon's renewable energy projects' performance by managing and optimizing data.

Target

Deadline Progress in 2021

Carbon footprint

Reach net-zero carbon emissions	2040	On going
Power operations with 100% renewable	2025	85% renewable electricity in 2021
energy		274 renewable energy projects
Empower other to reach net-zero carbon	2040	>300 companies have joined The Climate Pledge
emissions through The Climate Pledge	2040	since 2019
Build data centers with from renewable		
energy and 100% recycled content		
Decarbonizing transportation		
Make 50% of Amazon shipments net-zero	2030	30% reduction in per-shipment packaging weight
carbon		50% reduction in per simplifient packaging weight
Sustainable buildings		
Reduce environmental impact of corporate offices, fulfillment facilities and stores	2040	Around 70 on-site solar systems globally generating as much as 80% of a single fulfillment facility's annual energy; offices awarded with LEED certifications; district energy system recycling heat generated at neighboring data centers.
Sustainability in the Cloud		
Reducing AWS data centers' energy use of	2040	No data
cooling equipment by 20%		No data
Implement evaporative cooling, recycled		
water and on-site water treatment in AWS	2040	No data
data centers.		

Table 4 - Amazon.com 2040 key goals and achievements in sustainability

More sustainable transportation infrastructure. With the ambition to make 50% of their shipments netzero carbon to 2030, the group has ordered 100,000 electric vehicles to be on road by 2030, thanks to \$440M investment in Rivian. It also searches to maximize the efficiency of current vehicles through skirts, automatic tire inflation system.

More-sustainable buildings. Amazon.com developed several projects to build carbon-free construction using technology, the electrification of building systems and food services originally powered by fossil fuels. In its fulfillment centers such as on-site water management, onsite-solar installation, carbon insulation. Moreover, AWS datacenters represent a significant challenge to address in terms of building, as concrete and steel are two of the largest contributors to carbon emissions. The alternative consists in using materials from 100% recycled content six datacenters are already built this way in 2021).

Decarbonized supply chain by engaging in waste management, bio-sourced materials, product sustainability and packaging improvement.

Finally, Amazon.com insists on the importance of partnerships to reach net-zero carbon by 2040. Indeed, The Climate Pledge was founded in collaboration with Global Optimism in 2019 to allow industry experts, groups, and organisations to gather within a rich ecosystem and generate strong alliances that have the power to co-develop low-carbon products and services. Besides, Amazon.com partners with many organisations and companies to achieve its sustainability goals. For instance, the group partnered with ChemFORWARD, a science-based value chain collaboration to advance better chemistry in order to co-design Amazon's devices with safer chemistry. The group constantly seeks for new alliances and partnerships with industry leaders or invest in start-ups to support its initiatives.

Summary

- Amazon.com is committed to **reach net-zero carbon in 2040**, ten years ahead of the Paris Agreement.
- Amazon.com wants to reach 100% of renewable energy by 2025
- Amazon.com is the world's largest corporate purchaser of renewable energy and announced 37 new energy projects in 2022, which rises its capacity of renewable energy portfolio to 15.7 GW.
- Amazon.com is known as a sustainability leader within the tech industry with a decreasing carbon intensity level over years.
- Amazon.com continuously strives to promote sustainability and deliver transformations by growing The Climate Pledge.
- AWS data centers are 3.6 times more energy efficient than the median of US enterprise data centers and 5 times more than the average data center in Europe
- Their main strategy is to focus on transportation and buildings energy efficiency, especially for AWS datacenters by continuously investing in renewable energy and 100% recycled materials.

Section 2 - Interview of Tom Van den Bussche, Global Account Manager of Amazon at ENGIE

In the same way than for Microsoft, we conducted an interview with Tom Van den Bussche to complete and enrich our Amazon business case. Tom Van den Bussche is the Global Account Manager for Amazon at Engie, in charge of generating deals with the top executives of Amazon with the goal of decarbonizing their operations. He has been working with Amazon for the past year and a half. After trying to understand how the company was organized during its first year working with Amazon, he finally started to move up to the more executive level with meetings with the Executive Committee of Amazon.com. His most important interlocutor is Kara Hurst, the Vice President of Worldwide Sustainability at Amazon, with who he has multiple and recurrent exchanges about Amazon's sustainability strategy, mainly on corporate PPAs, as ENGIE has been the biggest seller of cPPA to Amazon in 2020 and 2021. The interviewee mentioned that, in 2022, ENGIE will be losing their position as the energy provider does not have the assets to answer Amazon's demand in renewable energy. ENGIE has been working closely with AWS on greenifying its data centers, as they account for a huge part of their carbon emissions and one of the group's biggest challenges in terms of sustainability. Moreover, Tom Van den Bussche insists on the fact that Amazon is very secretive on its initiatives, especially on its PPAs deals, but they do take many initiatives to reach 100% of renewable energy by 2025. Indeed, besides PPAs, Amazon has specific groups working on these topics, such as the S-Team, dedicated to work on highly efficient data center concept, that will, once approved, replace the old ones, and become the new standards. Also, Amazon has a \$2 billion fund for sustainability, which they invest in companies to progress on sustainability topics.

Tom Van den Bussche, stated three main challenges for the tech giant in terms of tackling its emissions and energy consumption. First, he says "today and in the following years, data centers are and will remain the biggest and hardest challenges for Amazon". He explains that the complexity of powering data centers with renewable energy comes from the diverse geographical position of Amazon's data centers. In fact, the greenfying process is not the same in every country, he says "you're not always in a good spot". The second biggest challenge Amazon has to deal with is the lack of regulations that the entire industry faces. Indeed, there is an obvious need to define what should be measure in terms of data center efficiency, where the energy comes from, what is green and what is not green. Finally, the third challenge for Amazon comes from the internal pressure from top management to sustain their growth and their position. There are crucial questions inside the organisation on whether to invest in new initiatives for sustainability, which represent huge costs for the company. They currently focus on investing in the right initiatives to keep growing and competing to be able to reinvest. Tom Van den Bussche insists on the very shots decision process of the group, which enables them to "try things and fail fast". Tom Van den Bussche adds "and so if they think that's not going to work, then they'll pull it out of the table, pull the plug in and have no issue". Also, he argues that this is one of the reason Amazon decided to shut down some warehouses in the US. They took the decision to reduce the number of new locations to reduce their direct emissions.

However, Amazon's activities do not only involve AWS data centers but also delivery, transportation, and warehousing. The tech giant also needs to tackle these activities' emissions and consumption. Therefore, ENGIE has been working on supporting Amazon on their mobility and warehousing. Recently, the energy provider has been organising workshops in Europe and the US (the two largest markets) to identify how to support Amazon on mobility, as "this is a big drive for Amazon". Tom Van den Bussche explains that ENGIE lost a very recent tender against Plug Power, which signed with Amazon to supply 10,950 tons of green hydrogen every year starting 2025 that it will use to replace grey hydrogen, diesel, and other fossil fuels. Besides mobility, warehousing remains a top priority for Amazon. Here again, ENGIE is involved in energy efficiency workshops and were asked for an energy efficiency audit, which they did not conclude at the end. Engie's objective is to lower energy consumption (which is the main driver to decarbonisation according to the interviewee) at all warehouses that are not property of Amazon and owned by third party companies. Finally, Amazon is working on biogas and biomethane and on the electrification of its vehicles, more on the vans and the trucks, which is the main big item for them. Regarding this initiative, Tom Van den Bussche mentioned the partnership of Amazon with Rivian, with who it plans to bring thousands of electric delivery vehicles to more than 100 cities by the end of 2022, and 100,000 across the U.S. by 2030. Tom Van den Bussche adds "I don't think that [partnership] is helping to reduce the footprint, it is maybe increasing it because that company has a lot of data, but that one is a very visible one where they have invested into to actually go electric".

A key takeaway from the interview is the fact that, according to Tom Van den Bussche, "It's not on sustainability, it's on speed of deployment first. Unfortunately for us we would wish the other way around, but it is not". Amazon tries first to differentiate on for instance on the architecture of the data center, which processes they use, which type of memory et cetera. They have developed the most energy efficient processor for data centers. Here, according to him, the primary focus of the group would not be on sustainability but on speed of deployment, which itself will lead to answer sustainable challenges.

Our final exchanges with Tom Van den Bussche related to the way Amazon is tackling its own scope 3 emissions and how it helps organisations in quest to measure their scope 3 emissions. In fact, AWS developed a new data architecture in 2020, called Lake House Architecture, which is a high-level architecture capable of gathering the necessary data for emissions calculations and reporting. This new built architecture allows to gather all the data of the carbon footprints of everybody and then tries to put forward solutions. Finally, to highlight Amazon's ambitions in sustainability and resume their mindset, Tom Van den Bussche explained how, even though Amazon had very ambitious targets, the group was led by "a very pragmatic approach in the sense that if nobody can supply, and if they think it's crucial, then they'll go ahead and do it themselves."

III. Business case 3: Alphabet

Section 1 - Analysis of Google's sustainable data and initiatives

a. Overview of Google's sustainability strategy: commitments, and key achievements

Google is a multinational company founded in 1998 by Larry Page and Sergey Brin that provides web search and aims to organize the world's information and make it accessible and useful to everyone. The company also displays advertising tools, cloud computing, software, and hardware. Since October 2015, Google is a subsidiary of Alphabet holding. The company organized its business around two core activities: google services, which comprises Google Search, YouTube ads and Google Network and Google Cloud. All other activities are gathered in the business segment 'Other bets''. In 2021, Google generated revenues of \$257.6 billions, or an exceptional 41% increase compared to 2020. The group showed a 31% growth in operating margin.

Since 2007, Google showed its engagement in protecting the planet and acting for sustainability. After becoming the first major Big Tech company to be carbon neutral and to power 100% of its annual electricity use with renewable energy (2017), Google wants to further accelerate the transition towards a carbon-free economy. Therefore, the group launched in 2020 their third decade of climate action stating its targets by 2030:

- Reach net-zero CO2 emissions throughout the value chain
- Provide carbon-free energy 24/7 to 100% of data centers and offices
- Enable 5 gigawatts of zero carbon energy through by investing energy by investing in its core manufacturing areas
- Accompany more than 500 cities and local governments in the reduction of their annual emissions

About Google Cloud, the group has 23 data centers worldwide and infrastructure services in locations across North America, South America, Europe, Asia, and Australia. According to Google's 2022 Sustainability Report, Google Cloud is the cleanest and most energy efficient in the industry.

Target	Deadline	Progress in 2021
Designing efficient data centers		
Maintain or improve average annual PUE	2021	PUE declined to 1.10 in 2021, after
across data centers YoY	2021	stagnating at 1.12 since 2012.
Reach zero waste for global data centers	NA	In 2021, global landfill diversion rate for data center was 78%
Replenish of 120% of the water consumed on	2030	In 2021, 13 water stewardship projects were
average and restore water quality	2030	operated
Advancing carbon-free energy		
Match 100% of electricity consumption with	2021	Achieved for 5 consecutive years
renewable energy		
Operate on carbon free energy 24/7	2030	66% of data center use in electricity are matched
Achieve net-zero emissions across all	2020	Ongoing
operations and value chain	2030	
Maintain carbon neutrality for all operations	2021	Achieved for 15 consecutive years
Building better devices and services		
Use recycled or renewable material in $> 50\%$	2025	Ongoing Nest and Pixel products
of plastic used across consumer hardware	2023	
Eliminate plastic from packaging and make		Ongoing
packaging 100% recyclable	2023	ongoing

Table 5 - Google's passed and future key goals and achievements

b. In depth analysis of Google carbon footprint and 24/7 goal by 2030

Google published in its 2022 Sustainable Report its total emissions for 2021. We observe that total GHG emissions, all scopes included reach nearly 11.4 million metric tCO2e, a decrease since 2019 if we put apart 2020 results, impacted by Covid-19 effect. Besides, despite the large investment in renewable energy purchases, total Scope 1 and 2 (market based) GHG emissions were increased by 918,096 tons (+96% increase). The company stated in its CDP report 2022 on FY21 results that this on major contributor to this increase in emissions between 2020 and 2021 is the growth of its operations in some data centers where it is not possible to source big volumes of renewable energy such as in its Singapore site. Figure 18 illustrates how carbon intensity has increased with the increase in revenues linked to Google's performance.



Figure 18 - Google carbon intensity vs total revenues 2017-2021

However, Google proved its engagement in sustainability by achieving many performances over the last decade. First, in terms of energy, Google has been answering its operations' needs in energy by 100% renewable energy for five years in a row and has been purchasing more than 73 million MWh of renewables through PPAs through on-site generation and electric grids. Finally, the group's investment in renewable energy projects tends to reach \$3.3 billion for an expected capacity of 8.7 GW. These investments in PPAs allowed Google to reduce its Scope 1 and 2 emissions by 65% in 10 years as well as decrease their carbon intensity per revenue by 81%. But the GAFAM would not stop its sustainability journey here. In 2020, Google set an ambitious sustainability goal related to energy consumption of its datacenters and offices: by 2030, the tech giant aims to operate carbon-free energy (CFE) every hour, without offsetting emissions from a different part of the grid. Its ambition is to reach 24/7 operations from clean energy, in addition to be produced by renewable energy. Along with their annual results by region publication, Google published its own methodology to calculate its CFE performance. The underlying idea of the group is to drive other companies to decarbonize their site and achieve zero-carbon operations. This 2030 24/7 objective will achievable though

Google's development of new technologies supporting demand for Google services, new transaction models and the advocacy for policies at all scale. Figure 19 depicts all the 23 data centers which are involved in the 24/7 CFE goal. All data centers are completely covered by PPAs but only 66% have electricity use which matches with regional carbon-free sources.

Finally, Google declare in its 2022 sustainable report that its cloud is the cleanest and most efficient. In fact, to improve its Power Usage Effectiveness (PUE), Google acts on smart temperature and lighting controls to improve energy use, machine learning to continuously optimize data centers and automatically adapt cooling and finally on the timing of compute tasks when low-carbon power sources are available. These actions led to high performing results gathered in figure 20, where we observe a significant decrease of Google's data centers PUE, reaching an average of 1.10 in 2021, considering all data centers around the world.



Besides, to support its 24/7 Carbon-Free Energy by 2030 project, Google initiated in 2021 an international organization in partnership with the United Nations to engage discussions and actions towards the transformation of global electricity grids to "absolute zero", called 24/7 Carbon-Free Energy Compact. It is -organized around 5 principles: procurement, market mechanisms, policy, technology, and data & transparency and gathers energy buyers, energy suppliers, governments, investors, system operators and solutions providers with the common mission to decarbonize the energy systems and specifically the electricity grids.

Finally, in October 2021, Google announced the launch of Google Cloud partner ecosystem which has as first objective to provide businesses, communities, and consumers with data-drive insights to develop industry-focused solutions to answer climate change challenges. To date, the ecosystem powered two tools: Green Fleet Dashboard resulting from the collaboration of Geotab, a leader in IoT and connected transportation, is monitoring and decision-making tool that reduce environmental impact of organisations. TraceMark is a platform developed by NGIS to provide robust data management using Google Cloud's geospatial platform and the ecosystem's partners to transform and gather satellite imagery into insights

Summary

- Since 2007, Google is carbon neutral thanks to its aggressive energy efficiency initiatives and its high-quality carbon offsets purchases
- Since 2017, Google matches 100% of annual electricity consumption with renewable energy sources
- In 2020, Google launched its 24/7 Carbon-Free Energy goal to be carbon-free every hour of every day during the whole year without offsetting emissions. In 2021, 66% of its data centers operate with carbon-free energy.
- Google has invested **\$3.3 billion in renewable energy projects** for an expected **capacity of 8.7 GW**
- Google Cloud directly helps users avoiding Scope 2 GHG emissions. By switching to Google Cloud, companies transfer their energy consumption to Google.
- In June 2021, Google joined the Exponential Roadmap Initiative and the Race to Zero, committing to halving emissions before 2030 towards net zero

Section 2 - Interview of Ivan Bel, Global Account Manager of Alphabet at ENGIE

We finally conducted an interview with Ivan Bel to complete and enrich our Google business case. Ivan Bel is the Global Account Manager for Google at Engie, in charge of generating deals with the top executives of Google with the goal of decarbonizing their operations. He has been working with the company for the past 9 months, during which he was able to comprehend the structure of the organisation and the key people in charge of sustainability. He explains that "with the players I talk to, we really want to build something. So I think we've moved away from a purely client-supplier relationship".

Our discussions confirm the main topic tackled by Google in terms of sustainability, the 24/7 Carbon Free Energy (CFE) ambition: "It's been a very busy subject for the last year or so in the sense that all of their decisions today are taken with a criterion of how it helps to advance the 24/7 CFE objective". ENGIE has taken part in this initiative by signing a 140 MW deal with Google in Germany in august 2021 securing the continuous supply of decarbonized energy during which Engie is responsible for developing and negotiating an energy portfolio with the aim of supplying Google with renewable electricity from solar and wind technologies to ensure close to 80% decarbonization of its German operations by 2022. With this ambition, Google is addressing a huge challenge as today they know to measure how much green energy, they have bought on annual basis but being able to say that at a specific time the power comes from green energy or not is much less easy. According to Ivan Bel, Google's core statement is to be able to free data and allow access to data for everyone, hence the group's objectives and achievement can be trusted. In that sense, Google has developed a real-time map to monitor and report its 24/7 CFE achievements. Figure 19 is an overview of the map, in which are displayed all Google's data centers with a disk cut into 24 segments. The idea there is to indicate the data centers' power supply in real time for the last 24 hours. The greener they are, the higher the percentage of green energy and the darker they are, they have not reached your carbon target. Yet, when we look at this map, we observe that it is far of being all green. This proves the transparency of Google on its achievement. Besides, the interviewee insists on the trust he has in Google's publications as ENGIE is one of the superiors of a contract for Google in Germany, hence the energy provider has set up a solution that uses a portfolio of renewable energy production in order to be able to cover the different hours of the day. They are committed to being 80% of the time carbon-free for the consumption of the data centers. This project allows them to monitor these installations, and thus have the real figures. Finally, to be able to monitor and follow this new objective, Google had to develop indicators and means of measurement to follow how it was done in real time. In particular, one element that is fairly new, or in any case that very few other players have done, is the time stamp of their contracts. Google can track its energy purchase contracts on a regional or national level on the grid hour by hour and they also track the carbon rate of the network hour by hour to be able to see when they don't have everything and when they are drawing on the network. Plus, they have developed a KPI or a measurement standard that they are trying to make available to the rest of the world. Finally, they have turned

this 24/7 approach into what is called a *Compact*, which is an open approach shared and signed by the UN committing its signatories to try to monitor their carbon level in their energy consumption in real time. All these initiatives prove the dedication of the tech giant to monitor and report its projects' evolution for the sake of transparency. Here again, the tech giant has initiated the 24/7 CFE Compact to involve stakeholders across the energy ecosystem and gather their assets and competencies to greenify the grid and the networks and make sure that when they have to draw energy from the grid, they are not able to do so.



Figure 20 - Google data centers involved in Carbon-free energy 24/7 (Google, 2022)

When tackling the question on what the drivers to Google's sustainability initiatives were, Ivan Bel explained Google's race for excellence. Indeed, profitability and brand reputation are already achieved for the giant int some way. Now that the environmental-related topics are the main concerned for many players, Google is playing the game and which to invest as much as it can to be a leader in this race as well. Ivan Bel explained that, according to Google core missions to free data, its main sustainability actions were to greenify its data centers. Nevertheless, Google has led other very interesting initiatives at local and regional levels, in particular around the recycling of electronic waste and a whole host of initiatives to be able to recover old computers and refurbish them instead of throwing away, so that they can be reused, rebuilt and then taken back, but also regarding the tracking of metals, the short circuit of waste etc. An example is their Google Maps tools than allows you to choose the journey not by the duration but by the amount of carbon the journey will emit.

Nevertheless, we shall underline that, even though Google is leading great initiatives to greenify its data centers, the Big Tech company still has many efforts to do. For instance, Google still relies heavily on colocation, shared data centres. Several Google Cloud services are supported by data centres that are hosted by third parties, which do not allow Google to monitor their activities. The location of some data centers, such

as in Singapore, Taïwan or Japan do not allow the company to address fully the challenge as they are places that are particularly constrained and where the availability of green production resources is very complicated.

To conclude, Ivan Bel highlights the importance of international organisations in building strong regulation to enable companies to fully address the climate change-related challenges: "the issue is no longer at the level of our countries. It's really an international and global level, and the international bodies that have completely lost their power, they still have, I think, legitimacy, but no means of action, no reasonable means of action".

CHAPTER 5: DISCUSSIONS AND LIMITATIONS

The two-step methodology used in this paper to answer our research questions allowed to confront published engagements of Big Tech companies in their reports with thoughts of professionals of the energy sector about their client's strategy. Finally put in parallel with the academic research mentioned in the literature review, this research has led to constructed conclusions about the challenges of Big Tech companies, their commitments and finally their initiatives, individual or common, to drive sustainability within their organisations but also at local, regional, and international level. Our research questions were:

RQ 1: What are the actions taken by the Big Tech companies to respond to climate change while staying competitive?

RQ 2: How does this inform the debate on the role of Big Tech companies in the quest of the entire economy to environmental sustainability?

The following sections draw constructed conclusions and answers to these questions and highlights limits both on the subject covered and, on our research, and methodology.

I. The current challenges and initiatives of Big Tech companies in terms of environmental sustainability

a. The Paris Agreement: the ultimate deadline Big Tech companies must align their goals with

The business cases conducted on three major Big Tech companies, Microsoft Corp., Amazon.com and Google all led to the same conclusion: companies are constrained by the Paris Agreement which set a global climate action agenda to limit global warming to below 2°C and pursuing efforts to limit it to 1.5°C by 2050. The sustainability strategies of these Big Tech companies are thus fully thought and planned according to this ultimate objective set at the COP21 in 2015. As stated by Ivan Bel Engie GAM for Google, "there's one topic that is on everyone's lips at Google, it's what they call 24/7 Carbon Free Energy. It's been a hot topic for the last year or so in the sense that all their decisions today are made with a criterion of how it helps to advance the 24/7 CFE goal". This proves the level to which sustainability-focused topics are taking the lead on Big Tech companies' actions. Also, Mr. Bel explains that this is possible only for these companies as "the question of profitability for Google is almost a given. It's one of those companies that make so much profit that it is almost not a question. So, the other non-financial issues, which are not directly linked to the financial results, are obviously becoming very important". In the case of Microsoft, Anne Cateaux, Engie GAM for Microsoft, explains that the discussions with Microsoft's top management about sustainability "comes down to the individual and is really dependent on who [she is] talking to and each of [the] pain points and [the] challenges

that keeps them up at night". The companies' agenda to reach sustainability focus on their emission reductions, which require to address the whole value chain and activities. Indeed, academics research and our research describe the wat carbon emissions are organized between Scope 1, Scope 2 and Scope 3. When Scope 1 relates to direct emissions from owned or controlled sources and Scope 2 emissions are indirect emissions from the generation of purchased energy, Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions. Hence, for the past decade, companies work towards the reporting of all emissions from the three scopes, first for transparency matters, and second to be able to understand where and how to act to reduce their emissions. Thus, companies started to set ambitious goals to reduce their carbon emissions, all before 2050. When Microsoft aims at reaching net-zero carbon by 2030 and to become carbon negative by 2050, Amazon set the objective to reach net-zero by 2040. The pressure is also on the type of energy used to power their systems and activities. In the same way than the race to reduce emissions, Big Tech companies are racing to reach 100% renewable energy, both in 2025 for Microsoft and Amazon. All these targets represent very ambitious challenges, even more so when the search engine giant Google has already reached these targets: since 2007, Google is carbon neutral and matches 100% of annual electricity consumption with renewable energy sources since 2017. In its turn, Google set the goal to operate 100% carbon free energy by 2030, twenty years ahead of the Paris Agreement. The interviews allowed us to understand that Big Tech companies do not only race for carbon neutrality, but to reach the highest existing standards, such as Microsoft, which, according ot Mrs. Cateaux, "as a U.S. company they at a minimum want to be gold LEED certified and then platinum if they can do it". In the same way, Google which "want to go further than carbon offsetting and be carbon neutral [...], they are aiming for excellence, even in sustainability. One of Google's modes is "We're going to the moon" as stated by Mr. Bel.

If the three pioneers in terms of sustainability are racing to be the first achieving their goals, and this, a few years ahead of the Paris Agreement, other tech companies must certainly follow their example and set very ambitious goals by 2050, certainly with less financial, investing, innovation and technological capacity. The challenge may not be easy to take up for all players of the industry.

b. The role of Big Tech companies to lead the transition of the economy towards carbon reduction and ultimately to net-zero carbon

The final main challenge faced by Big Tech companies identified through our research is their significant role to lead the sustainability and energy transition for the whole economy in several ways. First, Big Tech companies are positioned as leader of the modern economic systems, especially the GAFAM, but not only. Many Big Tech companies are seen by consumers, investors, and governments as the main influencers within the economic sphere. From this position, they have a crucial role to play in leading the transformation towards a net-zero carbon and carbon negative society. They have the great responsibility to use and leverage their brand image and recognition to encourage the world to transform their operations, to invest in new technologies and to change their habits. Second, as providers of technological products, solutions, and services, they have the assets, the capabilities, and the knowledge to design new tech solutions enabling the transformation towards sustainability. Their large financial capabilities position these companies as the main investors in innovation and research and development. Our research insisted on their role in the development of Scope 3 measurement solutions, such as the Data Lake House architecture of Amazon or Carbon Call of Microsoft. Google in the same way has developed many technologies to measure its footprint across its georgical presence. In particular, Mr. Bel mentioned one element that is quite new and "that few other players have done", is the time stamp of their contracts. They follow their energy purchase contracts and trace them on a regional or national basis, hour by hour. The group is also able to track the carbon rate of the network on an hourly basis, so that they can see when they don't have everything and when they are drawing on the network. Indeed, only them, the Big Tech, have the ability and resources to build such solutions and have the mission to make them accessible to everyone to mitigate the climate change risks. Then, these Big Tech companies have a role to support startups developing climate tech and accelerate their commercialization. For instance, Microsoft has been participating in 18 early-stage deals in the last two years via its Climate Innovation Fund, Amazon invests heavily in clean tech, in vehicle electrification and logistics via its \$2B climate fund and Google relies on its startup accelerator to support the development of climate technologies.

c. Strong ecosystems of players and partnerships as drivers for genuine change and competitivity

The literature review of this paper dedicated a section on business ecosystems, partnerships, and alliances to reach sustainability within organisations and, specifically within the technology industry. In this section, we underlined scholars' work on the importance for businesses combine their assets and capabilities through partnerships or collaborations to drive R&D and answer to market needs by developing new solutions. The three business cases carried out in the results chapter (chapter 4) allowed to understand how this concept

is currently applied in organisations. Indeed, Microsoft Corporation., Amazon.com and Google all three publish in their sustainable reports their partnerships and collaborations to develop new solutions and products to support their environmental initiatives across their value chain. First, we raised the ecosystems that these Big Tech companies were able to initiate. To cite the main ones, Microsoft has launched its Microsoft Cloud for Sustainability, enabling its users to comprehend, measure, analyze and automatize their sustainability management promoting a better recording, reporting and reduction of their emissions. Besides, Mrs. Cateaux explains that thanks to Microsoft's capacity to create strong ecosystems of actors, and by "identifying the best of the best of the best", they carried a massive hydrogen pilot with Plug Power, first of its kind. They ran it for 48 hours, that had never been done before by anyone like that had been done before. She states that "they have tried to figure out how they can work directly just one to one or bring in a vendor to work with other vendors to create a collaborative comprehensive solution, where Microsoft at the end is the benefactor of what all the partners got together". Likewise, Amazon.com developed its sustainability strategy on The Climate Pledge, an agreement joined by over 300 signatories all committing to reach carbon neutrality by 2040, ten years ahead of the Paris Agreement. Finally, Google transformed it 24/7 CFE initiative into a 24/7 CFE Compat, an approach signed and shared by the UN setting principles and actions for all stakeholders of the energy industry to fully decarbonize the electricity sector and guarantee access to clean energy to all. Thus, by creating such large ecosystems of partners gathering industry experts, communities, organisations, businesses, governments, and NGOs these tech giants can address a common mission and ambitions to drive the economy towards sustainability and to reach net carbon. At a lower scale, the business cases confirm the need for companies to partner and create cross-sector alliances (for instance with fuel cells solution companies like Plug Power who partnered with Amazon and Google, or with car manufacturers such as Rivian who partners with Google, or again between companies specialized in AI and machine learning and biology companies. As the BASF example in the literature review depicted, these alliances allow the emergence of new bio-based and recycled materials or new data-driven platforms

To conclude, a key take-away of this argument is that, besides from creating trustful relationships among actors and being the ultimate way to have a genuine impact on the economy and society, such partnerships are seen as key strategic actions by Big Tech players. Indeed, the underlying idea is to select the best players in each industry with the goal to drive innovations, either with one another or all together to be able to accelerate their pace of development and the marketisation of state-of-the-art technologies that will revolutionize the industry.

II. Limitations identified in Big Tech companies' actions for environmental sustainability

a. The resisting greenwashing practices

An important challenge of Big Tech companies relates to tackling all activities of the value chain to become net carbon. The interviews allowed to raise the topic of carbon offsets, which allow to reduce or remove carbon emissions made by a company to compensate emissions generated elsewhere. Interviewees acknowledge of the positive impact of carbon offsetting as a start to address sustainability a few years ago. For Google, Mr. Bel explains that Engie had 2 or 3 contracts signed with Google in 2021 including a small contract that was signed by for Google Asia-Pacific to do a study on the regulatory arrangements for carbon offsetting in the Asian region. He explains that "it is a first contact, but when half of the carbon offset certification bodies are based on nothing, this may raise questions". Mr. Van den Bussche, Engie GAM for Amazon.com, also states "Maybe 2-3 years ago, that was the best start, but I think the biggest challenge for them is now to find ways to actually become negative in all areas". This confirms that today, the system is not sufficient and new regulations need to be implemented to make the Big Tech companies' action trustful and necessary. Also, Google 24/7 CFE is the complete opposite, as now, the giant wants to go further than offsetting its emissions. In the same way, companies cannot ignore some parts of their environmental footprint anymore and are expected to address all their value chain. Tech giants, among them Google and Amazon have recently touched by the controversial topic of greenwashing. Indeed, as depicted our business case on Google, the company acts on scope 1 and 2 by addressing its data centers' emissions and energy efficiency. However, the emissions are still increasing YoY (+95% in 2021) and Scope 3 remains untouched, when it's accounting for 60% of total Google's emissions. But Google is not the only one, Microsoft and Amazon are still not showing interest in Scope 3 emissions as well. Amazon, in the same way is still heavily relying on carbon offsets based on tree planting or nature-based solutions. Besides the scope 3 issue, even though our research confirmed that all three companies started sustainability initiatives covering many of their operations, we still identified some areas where they need to go deeper into. Indeed, Google's core activities being data processing and sharing, the tech giant's strategy focuses on getting its data centers provided at 100% by green energy, 24h a day, every day of the year. The interview with the Global Account Manager of Google at Engie brought some nuance to the painting and stated the actions of the group in e-waste recycling, devices refurbishment. Yet, these initiatives remain anecdotic, while devices manufacturing account for a big part of the emissions. For Amazon, this challenge proves to be even more difficult as its business lies on many activities: online retail and services (AWS and online advertising) but also physical retail and delivery, which require warehousing and transportation activities. Its environmental footprint is therefore scattered, demanding Amazon to act on many aspects to become carbon neutral. So, the latest challenge identified is to be able to address not only the most emitting activity and offset the emissions of the others, but well and truly to address

the whole scope. As mentioned by Mr. Bel, "the issue of sustainability goes far beyond the energy problem. Of course, energy is an important part, but there are others and on this". Finally, as ambitious as they may be, not all Big Tech companies are showing great achievements compared to their agenda.

b. The renewable energy market is expanding fast, making it difficult for energy providers to keep up with demand

Another important limitation to highlight as the outcome of the interviews led in our research is the renewable electricity capacity shortage and consequently the increasing PPA prices that the market is going through. Our research has shown the very high investments of Big Tech companies in PPAs, Power Purchasing Agreements which allow them to purchase renewable energy to decarbonize their activities. In 2021, the energy market recorded its higher volume of clean power through power purchase agreements in 2021, with 31.1 gigawatts purchased by organisations. Amazon, Google, Microsoft all have targets in terms of renewables: Microsoft and Amazon want to reach 100% of renewable energy for its Scope 1 & 2 by 2025 and Google matches 100% of annual electricity consumption with renewable energy sources since 2017. The three tech giants represent the first PPA purchasers in 2021, with Amazon which purchased 6.2GW renewable energy via PPA in 2021, which is more than 20 percent of the total of PPAs in the world. But the market is going through rough times to keep up with the demand, which has resulted in a YoY 24% increase in PPA price in 2021 especially in the US. This impact is reinforced by the conflict in Ukraine as the increase in natural gas prices leads to lock in renewable energy at specific prices, thus driving demand. ENGIE was ranked second global PPA provider by Bloomberg New Energy Finance in 2021 with 2,1 GW of signed PPAs right behind the American energy producer and provider AES. The company's Global Account Managers in charge of Google, Amazon and Microsoft were clear "the ambitions of the tech industry may not be reachable as soon as they wish and could need some technological adjustments ".

Furthermore, many technical constraints still need to be addressed by the Big Tech and their ecosystem of actors, especially energy providers as Engie. Among all these constrains, the interviewees led us to identify the most important and frequent challenges linked to geographical presence of data centers (Mr. Bel mentioned Singapore, Taïwan, and Japan as difficult markets for Google in terms of greenifying the data centers), the grid constraints but also social constrains. Mrs. Cateaux explains that "there is the issue of where there is a power constraint in certain parts of the world where the local utilities and the grid operator do not mind if you've got a billion dollars to throw at it. If they decide that plugging in another data center will prevent getting power to their local community and because they cannot service it for blackouts, then they're not going to do it". In the same way, the R&D leader for Microsoft, Christian Belady, recently stated to Engie "there is legislation that says based on this power need it must be all green. So no, we won't let you use the local grid.

You must bring your own microgrid" and he insisting it must be green hydrogen. This shows how sustainability is not only about ecology and greenifying the grid, but it also needs to take into consideration where the population are and where Big Tech can or cannot plug their power in from the local grids. Finally, renewable energies are fully dependent to the climate, on wind and solar mainly. Therefore, these companies must also address the energy storage challenge if they aim at being 100% sourced by such energy.

c. A highly expected intervention of international bodies to regulate the system

As last limitations, certainly the most important take away of this research is the need for clear infrastructure to frame the measurement of the impact of climate change by corporations and verify carbon removal quality. Both the literature review and our research proved the urgency that policy makers establish a regulatory framework. For instance, Scope 3 emissions, one of the most discussed topics in this paper, need to be correctly reported by organisations. However, even though Big Tech companies such as Amazon and Microsoft are working on providing solutions to aggregate data and calculate this scope 3, companies still need clear guidelines on how emissions should be calculated and reported. The real question coming from the entire industry is when will climate change be considered as a major risk by states and international bodies. Big Tech have already started to advocate for net zero, as Mrs. Cateaux explains, "Microsoft is very vocal on this topic. They strongly advocate for the needed changes in regulations and policies, they even made it one of their pillars. They enhanced their policy advocacy on carbon and on net zero goals, energy grid decarbonization, measurement in the US and EU". For instance, Microsoft advocated for the United States' re-entry to the Paris Climate Agreement which occurred in January 2021 and for a US target to reduce emissions by 50% by 2030. Also, they recently joined the European Green Digital Coalition to develop standardized and comparable methodologies for computing the net impact of green digital solutions across industries. This proves the ongoing actions taken by the Big Tech companies to establish standards recognized by regulatory bodies.

The COVID-19 crisis showed that governments were able to deprioritize economics to primary address sanitary issues. Ivan Bel explained that now, "the stakes are not even at the level of our countries; it is to at the international and global level. The real challenges stay in the international bodies that have completely lost their power and have no reasonable means of action but still have, I think, legitimacy". The next biggest challenges for the players of the tech ecosystem will therefore to be able to reach common measurement and computation methodology for emissions as well as understand where the frontier between private and public actors stands in setting measuring standards.

CHAPTER 6: CONCLUSION

This paper has established the complex context of the technology industry, also called the Information and communication technology (ICT) industry, which has been facing the highest controverse about its environmental footprint due to its very energy-intensive activities and its high carbon emissions. We also tried to understand to what extent the Big Tech players of the ICT industry took initiatives to counter their negative effect on the planet and to what extent they had a role in addressing the challenges related to climate change. To respond to these questions, we have examined the extant academic literature on the topics of digital transformation, sustainability, and digital sustainability which we carefully analysed and reported in our literature review. To enrich our analysis, we conducted a research based on a two-step methodology, including the in-depth analysis of three Big Tech companies of the ICT sector to identify their key goals and actions in the environmental sustainability area. Then, we conducted three interviews of professionals within the energy industry, each of them working with one of the companies analysed in the first step of the research. These face-to-face interviews allowed to confront the identified key elements from published official reports with the reality of the current challenges and limitations that the sector is encountering. We recognize that our research has its limitations, notably the fact that we did not conduct any interviews with representant of the analysed companies themselves. Yet, we believe that our approach remains very interesting to understand how a main actor of the energy transition sees the opportunities and challenges faced by Big Tech companies to support the transition of the sector, and to some extant the whole economy, towards net carbon by 2050. Another limitation of the research deals with the very few numbers of business cases carried out. Here again, we believe that the analysed companies stand as the very example of the initiatives led within their industry and are the representatives of what can be done at the highest level of profitability, assets, recognition, and investment capacities. Most importantly, it is noteworthy that, even at the highest level, a lot is remained undone and untacked and still needs to be addressed in the very short term to respond to climate change.

From this research, we were able to identify the main challenges of the Big Tech companies, such as to primary address their data centers emissions and energy efficiency, which seems to be the biggest technological challenge of the times if they aspire to power them with green energy on a continuous basis and in all regions. Besides, we noted the impediment endured by the ICT sector linked to the lack of policy makers intervention to regulate their initiatives. This leads to a genuine lack of measurement and reporting standards which do not allow companies to address their full emissions properly. Also, the increasing demand for renewable energy in the past years, combine with the recent Covid-19 and Ukraine crises, are generating an increase in Power Purchasing Agreements and a shortage in the assets that energy producers are trying to resorb. Nevertheless, Big Tech companies such as Google, Microsoft and Amazon.com or constantly setting ambitious goals to reach carbon neutrality and carbon negativity before the Paris Agreement. They focus mainly on their data centers footprint across their geographies and are extending their objectives to their whole value chain. To do so, they invest heavily in research, development, and innovation to produce in-house
solutions and create large ecosystems of actors as well as cross-sector partnerships to share capabilities and assets and convey strong messages to other companies and sectors to accelerate decarbonisation. Yet, in this race to sustainability, tech leaders are trying to leverage their position to remain competitive and increase their brand reputation in a world where consumers, employees, investors, and governments are all very attentive to their initiatives to act for the planet. Finally, the paper informed the debate on the role of the tech giants in leading the transition towards decarbonisation. Indeed, today, these companies are in the spotlight to drive the whole economy, by using their financial capabilities, their brand reputation, and most importantly their technological capabilities to develop climate technology that will unlock the decarbonisation system of the whole economy.

Now, authors like Jean-Marc Jancovici, in his book "The Shift Project" published in 2022, in which he presents the transformation plan of the French economy", questions the capabilities of technologies to support the energy transition. He states that the very simple apparition of new technologies will not necessarily change the orders of magnitude of energy volumes and the way we consume. It is rather their massive deployment at a very large scale that counts, which in turn requires energy. Consequently, the technologies which can change the game of energy and materiality on are already "in the pipes".

Thus, where is now the role of the tech giants?

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APPENDICES

Appendix 1 – The Business Ecosystem Canvas of BASF's ecosystem (Rosani & Farri, 2021)

- Target customers: Modern farmers segment
- Core offering: Crop protection solutions (e.g., herbicides, fungicides, insecticides)
- Digital platform supporting the core offering: Xarvio farm management platform

Shared functionality	Complementors	Role: Orchestrator	Partnering Model
Achieve better yield on existing arable land preserving resources	 Products: Herbicides Fungicides Insecticides Services: Agronomic intelligence (e.g., weed and disease identification) Field monitoring Guaranteed leaf health 	 Ecosystem Architecture BASF delivers its own and partners' solutions to a wide user base, managing the connections with 25+ partners User base: 1.2 million farmers in over 120 countries. Multiple choice of service packages and crop protection products. Partners complement the value with their technology, capabilities, services or local access (that BASF alone wouldn't provide) 	R&D partnership (e.g., with Bosch for Smart Sprayer) Distribution partnerships (e.g., Agristar) University partnerships (e.g., Bonn University) Customer Relationship Models Multiplication of customer interactions through the monitoring of agronomic protocol execution and digital interactions on the farmer's portal

Value-sharing Model

- BASF: increased and stabilized revenues through subscriptions and customer's insights for product innovation
- Farmers: improved crop yield and efficient use of resources for enhanced sustainability of land
- Key commercial partners: access to large customer's base and data for complementary services

Appendix 2 – CO2e abatement per sector in million tons (GeSi - Global e-Sustainability initiative, 2022)



Appendix 3 – Interactive Map of Amazon's renewable energy projects (Amazon.com, 2022)



Appendix 4 – Interview with Anne Cateaux, Global Account Manager for Microsoft Corp. at ENGIE

Introduction to the interview

First of all, I wanted to thank you for accepting this interview. As an M2 International Business student I decided to focus on a topic that I am particularly interested in – the challenges and actions of Big Tech companies for environmental sustainability. This interview will last approximately an hour and may help me better understand your thoughts about Microsoft's sustainability strategy and actions. The interview is strictly confidential: no information, no content from this interview will be published or shared (except with the other student and my dissertation referee).

Interview starts

ADDA Lena So for how long have you been working with Microsoft?

CATEAUX Anne (ENGIE)

I had been working with Microsoft since March of 2020 as the global account manager.

ADDA Lena Who are you main contacts with Microsoft and how you would define your relationship with Microsoft?

CATEAUX Anne (ENGIE)

My responsibilities start at the top of the organization and work right down to whoever I need to work with. So for example, I'm in direct contact with Satya Nadella's *(CEO of Microsoft)* office and then the line of reporting on Brad Smith, who's the president of Microsoft and a number of his direct reports, which includes Lucas Joppa, the Chief Sustainability Officer. On the enterprise marketing sales side, there's the massive team that not only manages ENGIE because we have a bilateral relationship where one of Microsoft's largest clients, but we also have some connection points where we can co-develop platforms and that kind of stuff. And then on the COI side, so cloud operations and innovation, there's the EVP's, Scott Guthrie, a lady named Noelle Walsh and her entire organization. Almost all of them. We have direct mapping into so that we can support them, develop business. And since Microsoft and Engie have gone very public about what they want to do, on their own and together, for solving these critical world issues, we have identified who can actually do that. Like who's got the hand on the lever and where can we actually get this done. So a lot of touch points.

ADDA Lena

And would you say that today you have a close relationship with them and that you are able carefully listened when suggesting new ideas or is it only a one way communication rrelationship ?

CATEAUX Anne (ENGIE)

It's a highly integrated, respectful relationship built over several years of educating each other on who we are, what we can do, where are we at in the process. You know, there's the shiny marketing, say speech, and then there's the what can we actually do? And so particularly in the last six months, the getting passed the niceties and getting into the role of the sleeves and let's talk candidly has really been the focus to the point where last week we were on site for two weeks in Redmond and had a workshop.

ADDA Lena

And in your exchanges with Microsoft, how often would you say sustainability aspects and initiatives are mentioned?

CATEAUX Anne (ENGIE)

It comes down to the individual. Not even the department. That comes down to the individual that you're talking to and their pain points, their challenges, what keeps them up at night. So you take someone who's in their critical environment system and whose job is to keep the lights on and avoid what they call Black Swans when there's full outages. Which means that when that happens, we are so dependent on these. You know, we're impacted. So you talk tosomeone who's paid to keep the lights on and to grow the server farms and make sure that they can deliver on their products., they believe somebody else is taking care of the emissions reduction side. If you're talking to the engineer paid to design the futuristic data center and get to play with all the cool technology and submerge their servers in gel liquids and even, put a data center in a

submarine and put it in the ocean. Then it's all they think about because internally they're hurdle rates to be able to get financial approval on all these investments. You know, there are gates, and the gates will only open if they can prove certain things. And so internally they do have an emissions reduction requirement. But there's are a why they have to be fiduciary responsible to their stockholders. And so how do they balance that, which is why they put a fund together. So that was a long answer to a short question, which is, do I hear it every day? I do. But it's a really dependent on who I'm talking to.

ADDA Lena

And do you have regular chat with the second type of person that you mentioned, the one building data centers? Is it more often that you talk to these kinds of people or the first type of people?

CATEAUX Anne (ENGIE)

Well, so RED, ENGIE Impact entity, which are our data center design experts, they talked to them hourly, they're so involved with them. And I'm talking to these people. So at different times of the month or week or day, I'm either talking only to Microsoft and a whole bunch of people, or we go off into our corners for a while and then I'm actually talking to ENGIE people and ENGIE people are telling me, OK, I just hung up with this person. I just did this and we just responded to this RFP. We've just designed this. We just did something. I can't even tell you. It's in the tent of privacy, and I'm not even allowed to share the details with you. But list to say it's really super cool. And I go, OK, so I spend. So my source of information comes directly from Microsoft, comes directly from ENGIE, and then comes from outside sources, right? So I go off into the media and then suddenly I find out, oh, they just did this project and it was kept private and confidential until they were ready to share it

ADDA Lena

I would like to go over one last question before we move on to the more strategic part, could you name first, public deals that ENGIE did with Microsoft that was very aligned with their sustainability strategy? and second, main Microsoft's partnerships that are very important for you to mention.

CATEAUX Anne (ENGIE)

OK. So specific to ENGIE deals, one of the most innovative and inaugural deals that Microsoft did to meet their 100% green by 2025 was our Texas deal. That was the hybrid solar wind. It was one of the first ones of its kind. They did something similar for Vattenfall in the Netherlands and then they kind of modelled a lot of the deals after that based on what was done in Texas. And it was also very innovative for ENGIE. So it was not like we'd sold 1000 of these deals and they just were the next one. It was kind of like co-creating and that's why it caused good buzz in the industry. That is very, very important. The work that RED is doing, as I said from a design perspective, some of the most highly innovative because Microsoft, at a minimum wants to be gold LEED – so LEED is a North American standard for design and to prove sustainability and you have to get graded, get points on it, it's called different things in different parts of the

world. But if you think in terms of Microsoft as a U.S. company they at a minimum want to be gold LEED certified and then platinum if they can do it and it takes new design. And that's where red at the table, helping them design that and then of course, ENGIE behind bringing in the energy. And so to get to platinum, our microgrids, our new innovation around green fuels, green techno, that is exactly the conversations we are having. And let me go back to your second question that I didn't address, which is the ecosystem of partners. And so I talked about ENGIE and the role we're playing. They have a really big outreach to so many different partners and they're based on like energy providers, technical providers and integrators, and then more the boutique. They just did a massive hydrogen pilot first of its kind. They ran it for 48 hours, and that's big in the news. Nothing like that had been done. That was done with Plug Power, the fuel cell solutions company. So you know, they have definitely identified the best of the best and then they've tried to figure out how they can work directly just one to one or bring in this vendor to work with other vendors to create a collaborative comprehensive solution where Microsoft at the end is the benefactor of what we all the partners got together.

ADDA Lena

Could you mention the initiatives that Microsoft and you are mentioning the most in your daily chats. Or there's some key topics that are coming back very often compared to others.

CATEAUX Anne (ENGIE)

So what I've been hearing, especially since the Ukraine crisis has started, is that data centers tend not to use too much natural gas, but they do. And more importantly, is just the grid constraint. So there's the issue of where there's a power constraint in certain parts of the world where the local utilities and the grid operator doesn't care if you've got a billion dollars to throw at it. If they can't plug in another data center cause they can't service it for blackouts and can't get power to their local community, they're not going to do it. So you take Northern California. There, there are some places in the world right now whereyou're not going to get a data center build. So it always coincides over data centers need to be because that's where the population is, so there's definitely grid constraints, and that is keeping up. So Christian Belady, who is the R&D leader for Microsoft, one of our biggest champions, he said something brilliant last week. He said « there's maybe water, but there is legislation that says based on this match power need it has to be all green. So no, we won't let you use the local grade. You have to bring your own microgrid" and insisting it has to be green hydrogen. And meanwhile they can't even find the land. There's no land, there's no fiber. They need to have fiber optics. They've got these problems everywhere, and then it didn't help that COVID hit. So then something as simple as getting microchips for their servers and getting steel to build their stuff and then suddenly all of the construction delays associated to supply chain with supplies been choked off because of COVID. It's not for a lack of not wanting to do what's right, but there are some genuine, genuine, huge concrete walls in front of them, and not just Microsoft, all of them.

ADDA Lena

I see. I see that time is running but I had two main questions that I wanted you to answer specifically. What would you say drives Microsoft today to take these sustainability initiatives? is it brand reputation or real environment challenges, or investment opportunities in climate tech

CATEAUX Anne (ENGIE)

It's almost the answer I gave you a few questions ago. It depends on who you talked to. So why at the board level did the board let Brad Smith, the CFO and Satya stand up and say what they did when they came out. Their first public set of goals, including the Moon shot. What made the board? Stamp of approval and said you can do this and you can set up a \$1 billion fund and you can join all these boards and you can be a leader in this and you can start a coalition of that and this and that. I mean you look out there, Microsoft has started so many things. And triple your staff to support all these internal initiatives because not like they had the people in place, they had hired them all. It's for everything you said, and depending on who you talk to, so if you're Microsoft and you're looking at growth charts, and it's a hockey stick. You know, data centers, they were bnot building them. They weren't good, they were a tenant and every single one of their data centers. And two CEOs ago, someone said, well, why don't we do this? Why we giving our money as a tenant and don't have control of the buildings? We'll hire the guys, we'll decide it, we'll do it. And so the first few, apparently were really tricky and so they were just creating a black box and then it was Christian Belady who came up with the PUE. So PUE is now standard for data center, so he has a patent on that. And so as that was happening and it was the correlation. We're now growing outside of North America, we're 50% of their footprint wise and the growth went to like this like a hockey stick. And then everything you said, the local communities don't want us. There's backlash. There's no water, there's no power. It's expensive. And then there's reality. Now, evidence of the environment and the true humanity costs and the financial costs. So if you've got a data center in somewhere in the world where it's sitting on a fault line, or where there's fires almost every year, and it's to the tune of trillions of dollars to like you can't like what happened in a couple of years ago in Northern California where we we lost an employee, one of my colleagues. She died in a pool like they she and her husband had to dive into their pool and the flames came over them and they died. And it was in Santa Clara. And we had a small office there. And it's because something happened on the grid, too close to the tree on the lines. And within 48 hours, the entire community was up in flames. There was a data center really, really close to that. Now. Did it sustained damage? I don't know. But so there's all of these materialistic you can come up with a product list of 30 now who ranks them and what order it depends on who you talk to. So the question was, is it sincere? Is it real? Are they doing it for

ADDA Lena

Ok for all at once. I had another question more focused about Microsoft Cloud for Sustainability. But where

do you think that Microsoft is going with this project? Do you think that by 2050 the project will allow to be carbon negative? Do you think it will be enough to measure their Scope 3 emissions?

CATEAUX Anne (ENGIE)

They hope so.

ADDA Lena

And what do you think? Do you think it's feasible?

CATEAUX Anne (ENGIE)

I don't know my answer to that. If you'd ask me that a year ago, I would have said yes because I'm an eternal optimist. But digital? Platforms? Getting alignment on what even must be the code to put into platforms to then report out, which is super subjective to those who then take their report. And if there's no standards, which is why **Carbon Call** was created. I'm too removed from the heat of the topic to say if I have faith or no faith in it. All I do know is that everyone agrees that's the problem that must be solved for, and whoever does solve for it is going to make money for decades and ever more. So there are so many players who have entered the space, everybody's claiming they're doing something.

Interview ends

Appendix 5 – Interview with Tom Van Den Bussche, Global Account Manager for Amazon.com at ENGIE

Introduction to the interview

First of all, I wanted to thank you for accepting this interview. As an M2 International Business student I decided to focus on a topic that I am particularly interested in – the challenges and actions of Big Tech companies for environmental sustainability. This interview will last approximately an hour and may help me better understand your thoughts about Amazon's sustainability strategy and actions. The interview is strictly confidential: no information, no content from this interview will be published or shared (except with the other student and my dissertation referee).

Interview starts

ADDA Lena

For how long do you work with Amazon? How would you define your relationship?

VAN DEN BUSSCHE Tom (ENGIE)

For one year and a half now. I think the first year was really trying to understand what the company was doing, what they are doing. And now the last half, it's really moving up to the more executive levels with some meetings on Executive Committee, executive team from their side. I still think contrary from what I want there's still a big drive on cross selling, you buy from us and we buy from you.

ADDA Lena

Could you cite people from the executive committee that you have relation relationship with, for example in regard to sustainability?

VAN DEN BUSSCHE Tom (ENGIE)

Yes, well, Kara Hurst, which is the Vice President of Worldwide Sustainability at Amazon. I have mail exchanges with her, and we were setting up to meeting in June and for, let's say, health reasons, she was not able to join two days prior, so that set us back actually. Then we had a discussion to set it up and actually have a second round going out when Julia was in the US, but she couldn't travel up from San Francisco up to Seattle for that. So on that level, I'm a bit blocked on now. We need to get our own organization in line.

ADDA Lena

In the recent exchanges that you had with Amazon, are you able to tell me which key topics were identified in terms of sustainability?

VAN DEN BUSSCHE Tom (ENGIE)

I think the first one and this is the longest one and it's also the one making the most headway on is on the energy, the corporate PPAs. So that is definitely where we work. I'll call it greenify their data centers

because everybody in understands that data centers as they are extremely, extremely power consuming. 2% of the world energy consumption is due to the data center.

ADDA Lena Indeed, I saw this figure.

VAN DEN BUSSCHE Tom (ENGIE)

OK. So you could see that if that would all be on bad carbon footprint, they would not be able to go any further and nobody would even authorized the building of data centers. So they have been working on, we've been the biggest seller of corporate PPAs to Amazon in 2020 and still in 2021. We were the biggest. Now in 2022 we will not be but because we don't have the assets.

ADDA Lena

In fact, that's one of my questions. But I will come back on it.

VAN DEN BUSSCHE Tom (ENGIE)

That was just to say the biggest deals we were making with them. But that doesn't mean that that's the only thing we're offer.

ADDA Lena

Yes, because what you mentioned on data centers is focused on AWS.

VAN DEN BUSSCHE Tom (ENGIE)

Exactly.

ADDA Lena

So for example in its sustainability report, it tackled the idea of AWS data centers but it also tackles all initiatives on reducing emissions and energy consumption in transportation and building. So according to what you said, your latest exchanges with Amazon were about data centers. Do they also tackle transportation and building?

VAN DEN BUSSCHE Tom (ENGIE)

OK, then I was just trying to say where we started with and where we are now. As I said the last half year is made a lot of in ways on the executive level. Right now we have workshops coming up, one starting to identify how to actually support them on their mobility. We'll do one for Europe later scheduled and also one for the US. You have to see the size from it, Europe is important. The US is the largest market, no discussion. Then it's Germany, UK etc. and Japan is 4th or 5th or so. The others are all the Europeans in that top list. So thet have a big drive on mobility. It's huge and they're just on hydrogen. They've just announced a big deal in the US for Texas and California, where we were in the tender, but the prices were rock bottom, we could manage but they finally understand the company that they actually wanted was Plug Power. Amazon did take across sharing them. So if the price is bad, it doesn't matter we'll pay because otherwise

they lose money. So there's this, I think it's a pretty tricky one actually. But anyway that what we now also intended for the Italy training in Europe and it will be one launched on the Northeast coast for the US.

So that is a clear drive, but also besides mobility, the warehousing. There we are involved in energy efficiency workshops, we were asked for an energy efficiency audit. That, we didn't get. We went out. So anyway, we are there, but we are still involved now and have been contacted again for all warehouses that are not property of Amazon. A lot of them are owned by third party companies. There, we will again see on how we could help them to actually lower their energy consumption, which is the main driver to decarbonization. Also if we have other solutions to propose. So they are looking at the whole.

But at the same time they're working on biogas or biomethane. And electrical especially not on the personal cars but much more on the vans and the trucks, which is the main big item for them. OK, we won all biomethane in France and we're looking actually to expand that to the other regions where we can. So we need to apply capabilities as well, but at least they are doing a job there and they have us in that sense. Amazon has taking a bid to ship role, they ordered 800 Clio methane trucks and sold them to their partners. Then, the hydrogen negotiations is all driven on they look at price point, they won't do anything for free. You know, if it doesn't make money sense, then Amazon is not playing either. But anyway what they do then is looking at how to negotiate and to set volumes against it so they get that price points that is not penalizing or not significantly penalizing going to the new technology.

ADDA Lena

Very interesting, thank you. And could you cite some past public agreements that were done between ENGIE and Amazon that were a big success for the sustainability strategy of Amazon.

VAN DEN BUSSCHE Tom (ENGIE)

We only have on corporate PPAs and they are very secretive. They don't like to communicate on that.

ADDA Lena

Ok. Now, regarding the industry do you think that Amazon is well positioned? I mean you answered my question because they were the first purchaser of renewable energy. But maybe in terms of energy efficiency or any other sustainable topic, do you think that they're well positioned within the industry?

VAN DEN BUSSCHE Tom (ENGIE)

I think they are, but I think on the other hand, it's very difficult to see in the way they set up. The company is set up in a kind of two layered approach. Meaning the one is what you see on the front end, which is asking tenders for data centers and they have basically 2 main data center concepts and it's like a prefab - so it's basically this size, everything is defined, but that one is basically I would say very inefficient itself because it's not designed for efficiency and all of that it's defined for deployment and speed of deployment because that's the main driver, getting out there getting the marketing whilst it's there and emerging otherwise, if

you're not, they see it as a thread for them, or that to somebody else might come there and grow faster. And that is what happened in Asia because they're not very big in Asia, they don't fight a big fight there. Then you've got the Alibaba US in all of that technique in the biggest start there - and then they have another group which reports to what is called the S-Team, that is dedicated to work on highly efficient data center concept that will then once they are approved will replace the old ones and that will become the new standard. OK that's how that works. So, once they're in the approval phase then they will just be that and it's nothing else. Can it be blue? No. White. It says white. It's white.

ADDA Lena

OK. And regarding data centers especially, have Amazon ever mentioned their competitors to you? For example, what Google has been doing with 24/7 carbon free energy?

VAN DEN BUSSCHE Tom (ENGIE)

No, no. They don't compare to any other companies. No, no, no.

ADDA Lena

OK then where do their goals come from? How do they set them?

VAN DEN BUSSCHE Tom (ENGIE)

Well, first of all, this is again to the S-team. There's a team working on this. They have established The Climate Pledge 10 years before Paris agreements and they work back from that what it needs to be and they, well they do. They're internal benchmarks, but they will not discuss with us *[Engie]* what they think of other players.

ADDA Lena

What, in your opinion, drives the company to achieve the goals? Because we talk about the ecosystem, the climate change, but also, they have huge investment opportunities in climate change, climate tech opportunities. What is for you the main driver?

VAN DEN BUSSCHE Tom (ENGIE)

You ask that with the view looking on environmental. But I mean although interestingly, number one wants to stay number one. So it's not on sustainability, it's on speed of deployment but that unfortunately you can talk to many other companies, it's the same for everyone. It is a market in high demand. It will be deployment and then will be sustainability. OK, unfortunately for us we would wish the other way around, but it is not. They also try to differentiate on and what they also work on is on the architecture of the data center, which processes you use, which type of memory et cetera. They actually have developed the most energy efficient processor for data centers. So the approach is definitely from there. But there we can't help. That's not an urge. That's none of our business. If you want to look at purely building and all of that, then it is the new generation that should come which we look at liquid cooling and all of that. So they will only

deploy that if they first have their internal blessing and then everything will be liquid cooling. Then all will be air cooling and air cooling is not the most efficient, but at least they're sure. And this is also their engagement. Because we had never have to underestimate the engagement to uptime, to their customers. So it's really important, you can't just play with a data center once it's out there. If you change something in it which is in the field, yeah, you don't control it.

ADDA Lena

Do you think that the published numbers can be trusted in terms of scope emissions, in terms of energy consumption?

VAN DEN BUSSCHE Tom (ENGIE)

I have not read the contrary, so I have not specifically delved in there, but they have got it certified by CDP so they do and external parties too. And I think they're scared enough that they're big and watched on by many, many.

ADDA Lena

And do you think that the goals that they set are reachable? for example, the Climate Pledge 10 years before Paris Agreement.

VAN DEN BUSSCHE Tom (ENGIE)

I don't know. I don't underestimate their drive for that. About 2025, all the energy should be green. So in two years they actually won three years. They actually are planning to use only green energy. But it's by 2040. So yes. But I mean, it's still very ambitious, but it's fairly goal driven. And there's also they don't spend time on PowerPoints.

ADDA Lena

Regarding the goals and the achievements Amazon has, have you identified some limits in the economy and in the market that will make them unable to reach these goals, for example, the PPA shortage, the capacities that we don't have?

VAN DEN BUSSCHE Tom (ENGIE)

Yeah, that is a big risk for now. They have more money to pay than anyone else. But yes, this is definitely a risk.

ADDA Lena

Do you see any other?

VAN DEN BUSSCHE Tom (ENGIE)

I feel that they would have the advantage of being the only one in there. So they've pretty much secured something to all the contracts getting somewhere between 2035 and 2040 or something. They have a lot of contracts and the pipeline was pretty well period. Last figure I got from them was 80% already covered with

corporate PPAs. So they're good. And then my worry was more that if it really becomes a big shortage, they might actually turn around and start becoming an electricity company selling green energy. They have a market place they can absolutely do it. I know it's absolutely possible and this is one of the worries that some people have is like, hey, what does this say that actually bought by the whole market and they turn around and then start selling?

ADDA Lena

This is absolutely true. Do you have any thought regarding scope 3 from Amazon? Because it's a huge topic for all companies, but do you think that Amazon is able to measure its Scope 3? And do you think they have a role to play in implementing some sort of tech tool to be able to help their suppliers and customers to do so?

VAN DEN BUSSCHE Tom (ENGIE)

They do, they have Carbon Lake where they gather all the data of the carbon footprints of everybody and then actually also try to put forward solutions and so on.

ADDA Lena

And so, do you think there exist real solutions to reduce Scope 3 emissions and that Amazon is able to invest in them?

VAN DEN BUSSCHE Tom (ENGIE)

They are investing. Yo can go on Carbon Lake and you can see that this is what they are trying to do also for their customers. I don't remember if they have reduced their Scope 3 significantly because it's just expanding, becoming bigger company and you have so many more sites opening. So it's very difficult.

ADDA Lena

So do you think that by 2040, Amazon will be be able to measure it and to reduce it?

VAN DEN BUSSCHE Tom (ENGIE)

I think it will be always a challenge, but on the other hand, they already have scaled back. They've reduced the amount of new locations. They closed now a few sites in the US, so they're reducing that which will directly help.

ADDA Lena

OK, but by 2040? I guess it's easy for them to reduce Scope 1 and 2, it's already happening, it's reducing. But Scope 3?

VAN DEN BUSSCHE Tom (ENGIE)

I mean, if you look at the data center, where are the pain points from your point of view in the data centers?

ADDA Lena

What is Scope 3 for data centers? Yes, I have no idea.

VAN DEN BUSSCHE Tom (ENGIE)

Exactly, neither have I any idea what Scope 3 means for data center. Because basically, if you look at how is it transported to your customer, then we need to look at the net. That's why it's very hard to detect, but they have stated their scope three in their report.

ADDA Lena

Yes, they have, they all have. But the next step is to reduce them more than report them.

Do you have any idea of the challenges that Amazon could have compared to other Big Tech companies? because compared with Microsoft and Google, the business of Amazon is completely different. But do you think that they have sustainability challenges that they need to address, which other Big Tech companies don't need to address?

VAN DEN BUSSCHE Tom (ENGIE)

They have warehousing and all that, the whole distribution access is very, very different. They have Amazon platform to sell through.

ADDA Lena

Regarding products sold by Amazon on its platforms, have you heard about Amazon blocking the access to some companies to the marketplace for sustainability reason?

VAN DEN BUSSCHE Tom (ENGIE)

No, not really. I haven't noticed any of it.

ADDA Lena

Do you there are some sustainability areas that Amazon hasn't tackled and that should be tackled?

VAN DEN BUSSCHE Tom (ENGIE)

No, I didn't because they're pretty thorough in it. But on the other hand, we're trying to push much more on the data center, the new generation of data center layout that we can get involved in. Also, they're very secretive and that's where I think there is part you don't know.

ADDA Lena

You mentioned to me once that it's not because they don't publish on their website that they don't act.

VAN DEN BUSSCHE Tom (ENGIE)

Yes, they act a lot. They have specific groups working on these topics and they actually have a \$2 billion fund for sustainability, which they invest in companies to actually progress, but that's under the climate

pledge you can see. But it's also a company that tries things and fail fast and so if they think that's not going work, then they'll pull it out of the table, pull the plug in and have no issue.

ADDA Lena

OK, you said that the big agreements with ENGIE were corporate PPAs. But besides the PPAs capacity shortage in the market, have you identified areas where ENGIE was not able to keep up with Amazon's wish or initiatives in terms of ideology or knowledge? Maybe areas were Amazon is too ambitious?

VAN DEN BUSSCHE Tom (ENGIE)

Well, they are ambitious. But not too much. Clearly, they want to go faster than the market, which is not possible. But they also do have a very pragmatic approach in the sense that if nobody can supply, and think it's crucial, then they'll go ahead and do it themselves. If you look at the pedigrees of the people there, they have top, top notch universities, so they can do it on their own if they want to. I think what the differentiation of Amazon with others is that they have a very short decision making process, they go much faster than the others. If they decide and they want to do something, then they can they. They have a very flat kind straightforward decision making that makes a big difference between with the others.

ADDA Lena

One last question, but I think we answered it a bit already. According to you, what are the next steps for Amazon internal sustainability strategy?

VAN DEN BUSSCHE Tom (ENGIE)

It's a very broad question, but the next step is definitely looking at how to get carbon out of the air.

ADDA Lena

OK. So, about that because there were a lot of controversy regarding the offsetting. Do you think that Amazon should still put its carbon offsets forward as a real strategy?

VAN DEN BUSSCHE Tom (ENGIE)

OK, maybe 2-3 years ago, that was the best start. But today is it OK to still publish and mentioning the offsetting, I think it will still go ahead because it serves their purpose, but is it the real light, I don't think so. And I think the biggest challenge for them is to find ways to – well, they know that they have to reduce consumption – but find ways to actually become negative in the areas. Because they have a lot of fresh and distribution, like supermarkets and that's not very environmentally friendly. So they have a lot of that to deal with and I think they're really looking at innovation to make it work.

ADDA Lena

And do you think that there will be able to reach net zero on all the value chain, not only data centers but also the all the others?

VAN DEN BUSSCHE Tom (ENGIE)

I think data centers would probably be a big, big challenge, the hardest one. Because you're not always in a good spot, greenify is not the same process in every country. I think the biggest challenge is to sustain their growth and their position as always, decide on how much you can push for something. If everything goes well, then you have money for everything, and I think that's the biggest challenge for Amazon right now. That's also why they have now closed down some warehouses. There is pressure coming to the management to maintain their sustainability which is basically huge cost, and does it always pay? That's a question. I think the biggest help would be regulations to them. If you would put in regulations for data centers in America, Asia, Africa, if everybody puts in sustainability regulations, that would help them a lot. So I think regulations on what the efficiency should be on data centers and where the energy comes and what is green and what is not green would really help. So that's one of the main challenges.

ADDA Lena

Sure, because big companies report their missions, but we don't know if it's all the same things which is reported, how to measure it, just scope 3 for example or even scope 1 and 2, if you use different methodologies.

And according to you, is there one partnership that, let's say in the last year or last two years that made a change for Amazon's emission reduction or energy efficiency?

VAN DEN BUSSCHE Tom (ENGIE)

Rivian is a very clear one that they have because they bought Metro, Goldwyn Mayer. I don't think that one is helping to reduce the footprint that's maybe increasing it because that company has a lot of data, but that one is a very visible one where they have invested into to actually go to electric.

Interview ends

Appendix 6 – Interview with Ivan Bel, Global Account Manager for Google at ENGIE

ADDA Lena

Tout d'abord, je voulais te remercier d'avoir accepté cette interview. En tant qu'étudiante en M2 International Business, j'ai décidé de me concentrer sur un sujet qui m'intéresse particulièrement : les défis et les actions des entreprises technologiques en matière de durabilité environnementale. Cet entretien durera environ une heure et pourra m'aider à mieux comprendre ton opinion sur la stratégie et les actions d'Amazon en matière de durabilité. L'entretien est strictement confidentiel : aucune information, aucun contenu de cet entretien ne sera publié ou partagé (sauf avec mes référents de mémoire).

Interview starts

ADDA Lena Depuis combien de temps travailles-tu avec Google ?

BEL Ivan (ENGIE North America) Moins d'un an, 9 mois.

ADDA Lena

Et comment est-ce que, à l'issue de ces 9 mois tu juges ta relation avec eux ? Comment est-ce que tu estimes les connaître ? Et est-ce que t'as réussi à entrer en contact avec des personnes clés de chez Google ?

BEL Ivan (ENGIE North America)

Je dirais oui et non. Oui, dans le sens ou, partant de rien, je pense que j'ai réussi à comprendre comment était faite l'organisation. J'ai réussi à comprendre qui sont les acteurs, comment ça se passe, comment les décisions sont prises, et cetera. Et puis finalement, j'ai pu commencer à identifier quels sont les grands acteurs de la sustainability pour Google en revanche. Donc, donc c'est déjà un énorme travail, sachant que ce sont des organisations avec un mode de fonctionnement qui est très particulier. Ce n'est jamais vraiment fait comme on a l'habitude de le voir dans des entreprises plus traditionnelles ou des grands groupes plus traditionnels. Que ce soit, des entreprises privées, donc leur manière de communiquer, et c'est vraiment eux qui dessinent, donc bref c'est ce sont d'habitude des organisations qui sont assez dur à percer et à comprendre. Et moi je j'ai l'impression, après 9 mois de commencer à savoir comment s'est organisée puis être capable de connecter les gens. En fait quand je rencontre quelqu'un de chez Google « ok, d'accord, tu trouves là, t'es à tel endroit, du coup t'es tel niveau du coût, c'est ça, du coup c'est ça ton reporting, c'est comme ça que ça se passe » etc. Et puis je comprends du coup le niveau relationnel nécessaire ou les responsabilités qui sont prises par les différents acteurs et comment ils sont organisés, en tout cas sur la partie sustainability énergie. Sachant que ce sont encore une fois habituellement des postes en matrice, je veux dire, ils sont tous patrons, ils sont tous managers de leader ou Head of Something tu vois, ils sont tous auditeurs, ils ont tous des titres incroyables. Et puis en fait tu ne comprends jamais quand tu leur poses la

question, tu ne connais jamais vraiment le mode de reporting. En revanche, est ce que j'ai le numéro de Sundar Pichai ? Non. J'obtiens mes rendez-vous plus ou moins rapidement et puis on a partagé des bonnes informations. J'ai le sentiment d'être dans une relation de confiance. Il n'y a vraiment pas de méfiance, pas de menace. Avec les acteurs avec lesquels je parle, on a vraiment envie de construire quelque chose. Donc on est sorti un petit peu, je crois, de la relation purement clients fournisseurs. On est en train de se dire que l'on doit être capable de construire quelque chose. Par contre je n'ai pas encore réussi à mettre en place ce niveau de confiance là avec des niveaux exécutifs et des membres du COMEX.

ADDA Lena

OK, et donc en amont de ta relation avec Google, est ce qu'eux ont eu des échanges avec Engie impact sur leurs objectifs de décarbonation ?

BEL Ivan (ENGIE North America)

Oui, alors juste pour impact, il doit y avoir 2 ou 3 contrats qui ont été signés avec Google l'année dernière où il y a à peu près 12 mois ou 18 mois, dont un petit contrat qui a été signé par Jim Pack pour Google Asie-Pacifique afin de faire une étude sur les modalités réglementaires de *carbon ofsetting* dans la région d'Asie. C'est un premier contact. Et puis dans la foulée, ils ont essayé de faire des choses un peu équivalentes pour l'Amérique du Nord, qui a à moitié bien marcher. Puis finalement ça aboutit sur des travaux qui se lancent, une étude faite par Engie impact pour Google en Amérique du Nord, sur le carbone, pour établir une roadmap zero-carbone. Mais je ne suis pas impliqué directement.

ADDA Lena

Et justement au cours de tes échanges avec les différents interlocuteurs que t'as pu avoir chez Google, y-a-t'il des sujets plus récurrents que d'autres sur leurs objectifs de décarbonation ?

BEL Ivan (ENGIE North America)

Alors, il y a un sujet qui est dans toutes les bouches chez Google. C'est ce qu'ils appellent le 24/7 Carbon Free Energy. C'est un sujet très prenant depuis l'année dernière à peu près dans le sens où je pense que l'ensemble de leurs décisions aujourd'hui sont prises avec un critère de comment est-ce que ça permet d'avancer sur l'objectif 24/7 CFE. De ce que j'en comprends et de ce qu'on m'en explique, c'est d'abord un objectif que s'est imposé Google concernant ses consommations d'électricité, pour l'ensemble de ces activités qui doivent permettre d'être couverte à chaque heure de la journée par de l'énergie verte local. C'est la mission que Google s'est donné « nous nous on veut aller plus loin que faire du *carbon offsetting* et être neutre en carbone. Nous ce qu'on veut c'est être sûr qu'en temps réel toute l'énergie qu'on consomme, elle vient bien de l'énergie verte. Et ce qui rend la tâche beaucoup plus difficile, parce qu'aujourd'hui autant on peut dire que l'on a acheté une consommation annuelle d'énergie verte. En revanche être capable de dire, qu'à cette heure-ci, où je suis en période de pic et en fait j'ai que des centrales à charbon qui tourne pour pouvoir tenir ce pic, est-ce que j'ai vraiment acheter de l'énergie verte ou pas c'est beaucoup moins facile.

ADDA Lena

Justement, est ce que selon toi, il s'agit d'objectifs atteignables ? est-ce que c'est réalisable d'un point de vue énergétique et est-ce que ce que Google publie est, selon toi, 100% fiable ?

BEL Ivan (ENGIE North America)

Est-ce que j'ai confiance dans les chiffres qu'ils présentent et la manière dont il monitor ? Oui, plutôt. Et ça fait partie aussi des valeurs de Google quand même, d'annoncer que leur objectif est de libérer la donnée, de la rendre accessible partout, et cetera, et notamment les leurs. Et puis même s'ils ne sont pas connus pour être toujours les plus transparents, malgré tout, en termes de données accessibles et de de rendre ce genre de choses-là accessible, je ne les trouve pas mauvais. Un des trucs qui est d'ailleurs disponible sur leur site web ouvertement, c'est la carte du monde dans laquelle tu as chacun des data centers en temps réel, avec l'indication sur la dernière 24h d'alimentation en énergie.

Donc en gros, pour chaque data center tu as un disque qui est découpée en 24 segments représentant chacun 1h de la journée. Et puis pour chaque heure de la journée, il *monitor* et rapporte. Plus on est vert, plus le pourcentage d'énergie verte est élevé et plus on est sombre, on n'a pas atteint l'objectif de carbone. Et puis, quand tu regardes leur carte, bah tu vois ce n'est pas une carte toute verte, loin de là. Donc je veux dire qu'ils montrent aussi les endroits dans lesquels ce n'est pas nécessairement atteint encore. Alors d'autre part, 2e élément, comme tu le sais on est un des supérieurs d'un contrat pour Google en Allemagne et donc on nous on a mis en place une solution qui utilise un portefeuille de production d'énergie renouvelable afin d'être capable de couvrir les différentes heures de la journée et on s'est engagée à être 80% du temps carbon-free pour les consommations du data centers et donc nous on moniteur ces installations. 3e élément qui me semble assez pertinent à noter, c'est que pour être capable de monitorer et de suivre ce nouvel objectif Google a dû développer des indicateurs et des moyens de mesures pour suivre comment est-ce c'était fait en temps réel. Et notamment un élément qui est assez nouveau, ou en tout cas que peu de d'autres acteurs ont fait, c'est le time stamp de leurs contrats et donc ils suivent leurs contrats d'achat d'énergie et les tracent par heure et en fonction des implantations, et cetera. Ils sont capables à la maille d'une région ou d'un pays de suivre leur contrat sur cette grille de réseau là heure par heure et puis ils suivent aussi les indications de taux de carbone du réseau heure par heure pour être capable de voir quand ils n'ont pas tout et qu'il tire sur le réseau. Et puis ils ont développé du coup un KPI ou en tout cas un standard de mesure qu'ils essayent de rendre disponible pour le reste du monde. Et cette approche 24/7, ils en ont fait du coup ce qu'on appelle un *Compact*, qui est une approche ouverte partagée et signée par l'ONU engageant ses signataires à essayer de tendre vers le suivi de leur niveau de carbone dans leur consommation d'énergie en temps réel.

ADDA Lena

Quelle est leur motivation à faire ça ?

BEL Ivan (ENGIE North America)

Un des objectifs clés ? Alors, à mon avis, un des objectifs clés et une des visions qui est la leur, c'est de se dire « nous on est un énorme consommateur d'énergie, on fait plein d'argent mais on a la volonté de protéger la planète. Notre mission première, c'est de libérer la donnée, mais on ne veut pas faire cela au prix de détruire la planète. » Donc c'est assez clair et ils ont conscience que lorsqu'ils ne sont pas capables d'acheter de l'énergie verte, ils doivent utiliser l'énergie qui est sur le réseau. Et donc leur volonté, c'est de rendre les réseaux d'énergie le plus vert possible puisqu'eux doivent tirer de l'énergie sur le réseau quand ils ne sont pas capables de le faire.

ADDA Lena

Selon toi, qu'est-ce qui pousse quotidiennement Google à mener ces actions ? il y a toute cette notion d'image de marque, d'investissement dans les climate tech. Dans ce contexte de changement climatique, quel est pour toi leur driver principal ?

BEL Ivan (ENGIE North America)

Je ne sais pas comment est-ce que leur *shareholders* réfléchissent. Je pense que la question de la profitabilité pour Google, c'est finalement presque un acquis. Ça fait partie de ces boîtes qui font tellement de profit que ce n'est presque pas une question. Donc les autres sujets non financiers, qui ne sont pas directement liée aux résultats financiers, deviennent hyper important évidemment. J'ai l'impression qu'en termes d'image de marque, Google se positionne vraiment comme le meilleur du marché, c'est le meilleur moteur de recherche du marché : le plus rapide, le plus efficace, le plus simple, le plus facile et cetera. Et donc tout ce qu'ils font, c'est pour être le meilleur moteur de recherche du monde. Et donc le pays de leur data Center, ça rend le truc plus efficace, plus rapide, plus fort leur les algorithmes de recherche c'est les plus. Tu vois ce que je veux dire donc c'est dans ce truc là sur la partie cloud c'est encore un peu nouveau pour eux donc là je ne sais pas comment est-ce que ils défendent leur image. Mais je crois que leur image, c'est, vraiment encore une fois autour de l'excellence. Il y a un côté excellence derrière l'image de Google qui, je crois qu'ils entretiennent et qui est très important pour eux. Et donc dans l'excellence, évidemment les plans environnementaux sont dedans.

ADDA Lena

Dans ce que t'as pu retenir te vos échanges, estimes-tu que Google a abordé tous les sujets clés en termes de sustainability ou en restent-ils qui n'ont pas été abordés et qui selon toi sont essentiels pour leur transition vers la décarbonation ?

BEL Ivan (ENGIE North America)

Pour le moment, le scope 3 ne fait pas partie des choses dont on parle. Pour moi, c'est un petit peu de l'hypocrisie générale. On fait tout ce qu'il faut pour le scope 1 et 2, en revanche le scope 3 personne n'en

parle et les voyages tout le monde voyage les fait en avion. Mais là je ne peux pas vraiment le reprocher à Google, ça fait vraiment partie du paysage général.

ADDA Lena

Ce scope 3 aujourd'hui, beaucoup d'entreprises voire la grande majorité, ne l'adresse pas. Mais est-ce qu'aujourd'hui on pourrait l'adresser ? est ce qu'il y a des solutions pour adresser ce scope 3 et pour le réduire ?

BEL Ivan (ENGIE North America)

Il y a plus de solutions que qu'on veut bien l'entendre. Mais la question avant tout c'est est-ce qu'on est prêt à y mettre le prix ? Parce qu'être capable de suivre quelle est l'empreinte carbone de tes supérieurs, ça, c'est quand même quelque chose à priori que tu es capable de faire. Comment suivre les déplacements de tes employés, c'est aussi quelque chose qu'on devrait être capable de faire. Donc aujourd'hui le fait que ce ne soit pas pris en compte à mon avis, ca reste une hypocrisie générale sur le fait qu'aujourd'hui on pourrait le faire si vraiment il y avait mais ça exploserait tout.

ADDA Lena

Ne penses-tu pas qu'aujourd'hui c'est leur rôle à ces grandes entreprises tech justement de fournir une solution à ses clients, ses partenaires, ses fournisseurs pour justement eux-mêmes calculer leurs émissions et donc in fine récupérer ce calcul de scope pour calculer leur propre scope 3 ?

BEL Ivan (ENGIE North America)

Oui, tout à fait. Je ne sais pas si c'est Google ou Microsoft mais en tout cas, ces entreprises qui sont riches et profitables devrait être exemplaires sur ces questions-là, on est bien d'accord, ça serait la moindre des choses. Bon, je pense que ce n'est pas toujours le cas. L'exemple c'est qu'autant Google est exemplaire je trouve sur ses data centers en revanche je crois qu'il fait encore beaucoup appel à des colocations, des data centers partagés. Un certain nombre de services de Google cloud sont portés grâce à des data centers qui sont hébergés par des tiers. Ce que ça m'a évoqué moi quand tu m'as posé la question, c'est la question de la *sustainability* chez Google et est ce qu'elle est traitée de manière complète ? Parce que pour moi, la question de la *sustainability* dépasse quand même assez largement le problème énergétique. Certes l'énergie est une part importante, mais il y en a d'autres et là-dessus, pour le coup, je trouve qu'ils ont quand même énormément d'initiatives assez intéressante chez Google sur la partie recyclage et limitation des retours, sur la partie traitement des déchets et économie circulaire, et cetera. Ils ont beaucoup d'initiatives assez locale et régionales que je que j'ai trouvé parfois intéressant.

C'est très intéressant car en effectuant mes recherches, ce ne sont pas des choses qui ressortent systématiquement. Est-ce que tu aurais un exemple ?

BEL Ivan (ENGIE North America)

C'est probablement anecdotique par rapport à leur cœur de métier, qui est quand même de distribuer de la data au travers le monde sur des data centers donc c'est logique que l'énergie et les Data Centers soit vraiment au cœur de ces questions-là, mais ils ont tout un tas d'autres business aussi et j'ai vu plusieurs de leurs initiatives que j'ai trouvé assez pertinentes. Par exemple autour du recyclage de déchets électroniques et tout un tas d'initiatives pour pouvoir récupérer des anciens ordinateurs et les *refurbished* au lieu que ça parte dans les bennes, que ce soit réutilisé, reconstruit et puis repris, et cetera. Aussi, le suivi des métaux, le circuit court de déchets, et cetera. Donc ils avaient pas mal d'initiatives, en tout cas en Californie et au niveau de leur siège social à Montagny ou là-dessus, c'était quand même assez bien fait. Ils viennent juste d'annoncer un de leurs outils de Google Maps aujourd'hui lors d'une recherche de trajet pour indiquer les différents trajets possibles en fonction du type de véhicule que tu conduis et il va t'indiquer la quantité de carbone émise par chacun des trajets pour te permettre de choisir le trajet non pas par la durée mais par la quantité de carbone que le trajet va émettre. Ils font quand même pas mal de choses qui vont dans la bonne direction, qui permettent d'aider finalement les usagers finaux.

ADDA Lena

Comment positionnerais-tu Google dans l'industrie des Tech Giants ? Tu as dis qu'ils étaient leaders sur leur domaine, mais est-ce que sur la sustainability tu les positionnerais aussi en tant que leader ?

BEL Ivan (ENGIE North America)

Je suis probablement aussi un peu biaisé, tu l'as bien compris mais moi je les trouve quand même vraiment bon. Et puis dans les discussions que j'ai, c'est un sujet quoi, ils n'achètent pas de l'énergie qui ne colle pas à leurs ambitions donc ils essaient vraiment. Bon, encore une fois quand t'as pas de problème de financier, c'est évidemment plus facile de se poser ces questions-là et de faire en sorte qu'elles soient prioritaires dans les discussions. Mais donc je ne sais pas, un jour ils s'y. S'il devait faire face à beaucoup plus de concurrence ou à des contraintes plus fortes en termes de profitabilité, je ne sais pas s'ils maintiendraient le même cap mais en tout cas pour le moment je trouve que ça tient la route.

ADDA Lena

Est-ce qu'au cours de tes échanges avec Google, il y des noms de concurrents ou d'autres sociétés qui reviennent comme exemple de choses qu'ils aimeraient bien faire qui n'ont pas encore apprivoiser chez Google ?

BEL Ivan (ENGIE North America)

Non pas trop. Je dois t'avouer qu'ils sont quand même assez focus.

ADDA Lena

Est-ce qu'il y a des deals que Google a pu faire avec Engie qui ont été déterminants pour leur stratégie ? Est-ce qu'Engie a participé à des initiatives significatives pour Google ?

BEL Ivan (ENGIE North America)

Le deal de 140 MW en Allemagne, signé en 2021 contribue clairement à la réalisation de l'objectif Carbon-Free Energy [contrat signé en août 2021 garantissant la fourniture en continu d'énergie décarbonée au cours duquel Engie a la responsabilité d'élaborer et de négocier un portefeuille énergétique dans le but de fournir à Google de l'électricité renouvelable issue des technologies solaire et éolienne afin de garantir une décarbonation proche de 80 % de ses opérations allemandes à l'horizon 2022] et c'est le premier en Europe. Depuis, on est en train d'en faire 3 ou 4 aux Pays-Bas.

ADDA Lena

Est-ce que tu identifies des limites aux ambitions de Google ? Est ce qu'aujourd'hui on est capable de répondre à leur demande ? Est-ce que leurs ambitions sont réalisables avec les ressources que l'on a aujourd'hui ?

BEL Ivan (ENGIE North America)

Non, tu vois cet objectif le 24/7 CFE il n'est pas encore atteint. Il y a quand même encore des endroits sur la planète ou c'est particulièrement compliqué à réaliser. Je pense à Singapour, Taïwan, le Japon. Donc ces endroits qui sont particulièrement contraints et dont la disponibilité de ressources de production verte est très compliquée. Ils ont donc un certain nombre de géographies comme ça. Et donc non, je pense qu'ils n'ont pas encore fini, ils n'ont pas encore atteint leur objectif et donc il y a encore beaucoup de choses à faire. Alors après dans ta question c'est est ce qu'eux est ce qu'ils vont y arriver ça ou c'est ? Alors, un des modes de de Google, c'est « Nous on va sur la Lune ». Donc je pense que de manière générale, ce sont quand même souvent des choses assez ambitieuses et qui ne semblent pas simple à atteindre. Le 24/7, ce n'est pas simple à atteindre, je te confirme. Est ce qu'ils vont y arriver ? Moi je pense qu'ils font tout ce qu'ils peuvent pour. Outre le temps réel, à un moment quand même il y a une question de la batterie, il y a une question du stockage de l'énergie, de production d'énergie verte dans des zones compliquées où l'on n'a pas toujours du soleil, du vent ou de la géothermie disponible. Donc technologiquement parlant, pour un acteur comme Google qui a les moyens financiers et qui est prêt à mettre les moyens, je pense que c'est en effet tout à fait jouable. Est-ce que c'est jouable à l'échelle de la planète, c'est à dire est-ce c'est suffisant pour faire en sorte que toute la planète soit alimentée par de l'énergie verte 24/7 partout ? ça c'est une autre paire de manche quand même. Alors ça c'est un peu le but ultime. On va être clair, je pense que tous ceux qui ont un petit peu de conscience écologique en ce moment se posent exactement cette question-là, celle de l'adéquation énergie/ressources/biodiversité, enfin l'ensemble des grands axes du système terre qui sont tous en déséquilibre en ce moment.

ADDA Lena

Est ce que, selon toi, il y a des aspects de régulation, des aspects légaux qui sont vraiment des freins à la stratégie de Google ?

BEL Ivan (ENGIE North America)

Alors, encore une fois, là je te dis, pour moi ça dépasse Google. Enfin je veux dire Google à lui tout seul n'est pas responsable des actions de l'humanité. Donc je ne peux pas leur en vouloir de pas avoir réussi à changer le système de valeurs de l'humanité aujourd'hui. Bon et puis après je pense qu'ils sont quand même un bénéficiaire d'un système capitaliste qui leur a permis d'avoir une position dominante donc je les vois mal-être l'acteur clé pour changer le système économique du monde. Or on est à peu près tous d'accord pour dire que tant qu'on sera régi par des systèmes politiques qui sont complètement au service d'un système économique qui est lui-même complètement au service du capital et donc de la richesse pour entretenir la richesse, je pense qu'on aura beaucoup de mal à s'en sortir puisqu'évidemment il n'y a aucun intérêt pour les ultra riches. Ne plus être ultra riches. Par rapport aux problèmes qu'on a sur le climat, la biodiversité, c'est quand même le plus simple, je pense d'assez loin mais donc malheureusement, je pense que réussir à convaincre nos dirigeants et que c'est ça qu'il fallait faire, je crois qu'on va avoir beaucoup de mal. Mais je pense que l'enjeu, il est un petit peu ailleurs quand même. L'enjeu, il est même plus au niveau de nos pays. Il est vraiment un niveau international et mondial et aux organismes internationaux qui ont complètement perdu leur pouvoir, ils ont, je trouve encore de la légitimité, mais aucun moyen d'action, aucun moyen raisonnable d'action. Et puis on est en face de gouvernements partout dans le monde qui sont obligés de se faire réélire avant tout dans des *timings* qui n'ont rien à voir avec l'enjeu qui nous concerne. Donc je crains que on ait du mal à s'économiser une petite révolution, quoi.

ADDA Lena

Pour revenir sur le sujet Google est-ce que tu penses que Google est concerné par ces polémiques sur leurs publications de leurs carbon offsetting et le fait qu'il les mettent en avant ?

BEL Ivan (ENGIE North America)

Je pense que comme beaucoup, ils ont commencé par faire de l'*offsetting* il y a un an ou deux. C'était plutôt une bonne idée, faut être clair, moi je suis assez, je suis assez partisan et je trouve qu'il a quand même du bon s'il est bien mis en œuvre. Évidemment, quand tu as la moitié des organismes de certification de *carbon offset* qui ne repose sur rien, ça peut soulever des questions, je suis conscient qu'il y a certainement des abus et probablement plus que je ne le crois. Mais malgré tout je pense qu'il n'y a rien de nécessairement mauvais derrière. Est-ce que Google a été concerné par le *carbon offsetting* ? Oui, je pense c'est a priori sur ça qu'il ont commencé. Maintenant le 24/7 CFE, c'est complément l'opposé. Ça signifie suivre en temps réel d'où vient la production ? Ils ont déjà offset toute leur toute production d'avant pour compenser. Mais donc oui, ils sont probablement fait de l'offset, bon je ne suis pas allé vérifier d'où viennent leur garanties d'origine mais ils sont probablement concernés. Après je ne sais pas à quel point ils ont traité le problème.

Interview ends

SUMMARY (14 pages)

CHAPTER 1 – INTRODUCTION

"Since 1850, human activities have released around 2,400 billion of tons, we are emitting 40 billion of tons per year, still more or less than twenty years and our carbon budget will be emptied", explains Jean-Marc Jancovici, the owner of Carbon 4, the independent consultancy company specialized in low-carbon strategy. To avoid such a disaster, the Paris Agreement states in 2015 the goal to reduce emissions by 5% per year by 2050 to avoid global warming to exceed 2°C. In the same year, the United Nations members signed the 2030 Agenda for Sustainable Development which establishes the 17 Sustainable Development Goals (SDGs) to create a global partnering of all countries to act for health, education, poverty, inequality, geopolitical instability, economic growth, to preserve biodiversity, oceans, and ecosystems by 2030. The agenda was established for all actors involved in inclusion and economic growth, i.e., companies, non-profit organisations, and academia across the globe. Beforehand, The United Nations Environmental Protection Agency (2014) states the idea that "[pursuing] sustainability is to create and maintain the conditions under which humans and nature can exist in productive harmony to support present and future generations". Since then, as the main pollutants, companies from all industries started to address SDGs in their strategy in the matter of driving growth - by expanding to new markets, attract talent and investing in operations - of addressing risks - related to climate change, depletion of resources, geopolitical instability, etc. – of attracting investment and in building strong values to in fine, drive growth. Thus, companies have a corporate responsibility along with a humanitarian responsibility to address the SDGs.

In this paper, we chose to tackle the specific case of Big Tech companies, which since their apparition, have been the target of all critics about sustainability. Indeed, the global share of greenhouse gas emissions of the information and communication technology (ICT) sector is estimated to 1.8%-2.8% and is expected to keep growing over the years. In the first part of the paper, we tackle the lively debate of digital sustainability, which is used to define the need for ICT to consider their competitive advantage in sustainable development as a priority to maintain their competitivity within the industry. This concept is defended by the part of the authors who consider that Big Tech companies have a significant role to play in the climate change by driving positive social and environmental change through their financials and technological assets and contribute to a more sustainable world. Indeed, some research raise the idea that "ICT-enabled solutions could reduce emissions up to 12.08 gt CO2e by 2030 across many industries globally, which is 9.7 times higher than the ICT sector's own direct emissions, thus reducing the global environmental footprint" (GeSi - Global e-Sustainability initiative, 2022). Authors such as Ojala, Mettälä, Heinonen, & Oksanen (2020) support the idea that ICT solutions are enabling reductions in carbon footprint of these sectors as well as reduction in energy consumption such as optimization of industrial processes, replacement of physical products or by facilitating the creation of urban infrastructure which includes resource efficiency. Yet, on the contrary, some authors

insist on the major responsibility of the tech industry in destroying the planet as it would be the least sustainable sector with ICT's share of greenhouse gas emissions estimated to 1.8%-2.8% and should keep increasing with trends such as AI, big data and IoT (Lancaster University, 2021).

Thus, this paper aims at addressing the contrast between the very broad research that authors, institutions and governments led on Big Tech companies' environmental footprint and the means and actions by which these companies are tackling climate change. Hence, we developed a research approach, both quantitative – by the sustainability and annual report analysis – and qualitative – by the carried-out interview – through which we attempted to answer to two research questions (RQs):

RQ 1: What are the actions taken by the Big Tech companies to respond to climate change while staying competitive?

RQ 2: How does this inform the debate on the role of Big Tech companies in the quest of the entire economy to environmental sustainability?

With this context, this paper aims at providing some answers and at drawing conclusions on the main challenges that Big Tech companies are facing regarding climate change and how they intend to address them.

The topic has been carefully chosen for many reasons. First, the topic is highly related to the cursus of the author, which focus on International Business and digital technologies applied to the corporate environment. During the two-year Master's program of this cursus, the author was able to tackle many topic related to digital transformation and technologies such as Blockchain, Information Systems, Digital Marketing etc. but also to address them in the scope of corporate strategy applied to the international environment. In addition, the authors have been working at Engie, a leader in energy supply and services, for a full year, working in close collaboration with the three interviewees mentioned in the qualitative results (see chapter 4 and 5). The combination of these elements coupled to the very lively debate on climate change and the actions that should be taken at corporate level led the author to add some research to the extant literature review. Also, the readers should note that we have deliberately chosen to focus this paper on the environmental aspect of sustainability. First, in reason to the urgency of the subject of tackling environmental negative effects of the economy, second because we wanted to align the paper's topics to the author's job position, which is in the energy sector and third because covering all aspects of sustainability, such as inclusion for instance, would necessitate much further investigation and time. Besides, this paper aims at informing the debate on the very debated role of these Big Tech companies in driving towards genuine change and leading the sustainability efforts of the entire economy.

CHAPTER 2 – LITERATURE REVIEW

I. Digital sustainability: a complex relationship between digital transformation and environmental sustainability

Section 1 – State of research and definition of digital sustainability

a – *Digital transformation*

Existing literature allows us to increase our understanding of the concept and characteristics of digital transformation for companies. Costa et al. (2022) define digital transformation as the "DT refers to the idea of new products or services driven by the increasing number of innovations and use of digital technologies" (Costa, et al., 2022). However, nowadays a digital transformation is much more complex as it affects all the value chain of a company. This could explain why managers are struggling to understand what a digital transformation means for a company and how to deal with it.

b – Sustainable development and environmental sustainability in the digital corporate environment

The term of sustainable development appeared for the first time in the 1980s, before being generalized by the Brundtland report and the Rio Conference in 1992. In 2015, the 2030 Agenda for Sustainable Development introduced the Sustainable Development Goals (SDGs) which were adopted by all United Nations Member States. Environmental sustainability is one of the three principals of sustainable development. In 1995, Goodland defines environmental sustainability as "the maintenance of natural capital" or Porritt (2007) defining "ecological sustainability" as "the capacity for continuance into the long-term future, living within the constraints and limits of the biophysical world".

c – *The complex interrelation of digital transformation and sustainability*

From the interrelated concepts of digitalization and sustainable development mentioned in the previous parts of the literature review, emerges the concept of digital sustainability. The extant literature on digital transformation and sustainable development states that to maintain a certain level of competitivity in the digital industry, companies need to see their competitive advantage in sustainable development as a priority. On the other hand, literature challenges the idea that the interrelation between the two widely debate concepts is straightforward and underline that digitalization is not inherently sustainable.

Section 2 – Academic theories applied to digital sustainability

a – *The Net-Positive Initiative:* "put back more into the global system than they take out"

The concept was born with the Net Positive Project aiming at creating an ambitious alliance of partners from different industries to develop a positive, robust and coherent approach, underpinned by a common set of principles and good practice (BSR, Future, & Norris, 2019). The authors explain that being net positive requires to draw awareness on all the ways businesses affect the environment, which means going beyond carbon-reduction goals and seek to give back what they took.

b – *The concept of Sustainable Business Model Innovation (SBM-I) as a driver of competitive advantage*

The SBM-I definition originates from the definition of a sustainable business model, which refers to "the transformation/creation process that balances economic, social, and environmental aspects, mitigating possible tensions between these aspect". The SMB-I enables the intertwining of the need for companies to accomplish economic aspects and market disruptions while developing a sustainable business model. This definition implies the 4 main characteristics of the traditional SBM-I framework: the consideration of sustainable principles and objectives in the value proposition, the shift from an economic to a shared value creation, the integration of non-financial interests in the decision-making process and the promotion of a new sustainability mindset across the organisation (Ferlito & Faraci, 2022).

c – The concept of business ecosystems, partnerships, and alliances as an answer to sustainable challenges

The emergence of ecosystems brings out opportunities for technological companies to explore and leverage their dependencies and to innovate as well as sustain their competitive advantage in an environment where interest may not be aligned. In the case of companies building their SBM-I, business ecosystems often appear as the alternative to a lacking universal standards framework. Thus, these businesses often create cross-industry or cross-sector partnerships to respond to the increasing sustainability challenges that they are not able to address on their own (Young, Reeves, & Gerard, The Secrets of Sustainability Front-Runners, 2021).

II. Implication of digital sustainability for Big Tech in the tech industry

The society's expectations towards sustainability have significantly changed in the past few years, emphasized by the very recent events of the COVID-19 pandemic, the Ukrainian war and the increase in gas prices, and many natural disasters. Therefore, businesses need to address what is called the sustainable imperative to keep up with competitors (George, Merrill, & Schillebeeckx, 2020).

Section 1 – The implementation of efficiency strategies to reach sustainability and competitivity

a – The economic benefits of sustainable strategy implementation

The literature shows that corporate sustainability initiatives, on the one hand, are highly correlated with financial performance, and on the other hand can participate in value creation (Swartz & Bonini, 2014). First, investment decisions are more and more oriented towards companies with high ESG ratings, as there is growing evidence that sustainability increase performance and investment returns. In addition, sustainability is somewhat seen as a risk management tool. Whelan & Fink (2016) state that 70% of companies' EBITDA could be at stake from sustainability challenges. Besides studies show that young consumers expect more transparency as well as tangible impact of companies in reducing emissions; according to Deloitte, in 2022, 40% (+6% vs. 2021) think that choosing brands that have environmentally sustainable practices and values represent for the main action to take to lead a more sustainable lifestyle (Deloitte, 2022). Finally, employees

are seeking for companies taking responsible positions, especially in terms of climate change, in addition to seek for purpose and mission in their jobs.

b – The urgent need for energy efficiency improvement to respond to increasing volume of data and offset the sector's emissions

Unfortunately, in 2020, data centers accounted for 1.5% of global electricity (World Economic Forum, 2022). These infrastructures are highly tackled by the ICT sector literature as they are heavy consumers of electricity and affect CO₂ emissions indirectly. By 2030, CO₂ emissions from data centers are estimated to reach 720 million tons. Zhang & Liu (2022) explain that, in present, there are two main challenges for hyperscale data centers, and for ICT companies, (1) decrease power usage effectiveness (PUE) and improving the energy efficiency, and (2) switch from traditional power supply to renewable energy. Hence, one of the top priorities for tech companies is energy management and GHG emissions of their scope 1, 2 and 3. They all have published clear ambitions and targets in their annual sustainability report, all committing in powering their systems and operations with 100% renewable electricity, improving their energy efficiency, and achieving net zero carbon by a few years from today

c – *Tech industry as the pioneer in renewable energy consumptions to reduce their environmental footprint*

In the past five years, ICT businesses have accounted for about half of global corporate renewable energy purchases (IEA, 2021). Several solutions exist for tech companies to be provided with renewable electricity: the guarantees of origin (GO) allow companies to prove and trace the purchase of a certain amount of renewable energy. Other solutions are the to subscribe to green electricity supply from a supplier or to consumer green energy produced directly on site by photovoltaic (PV) panels on the roof or on a car park. A fourth solution, in which GAFAM already readjusted their economic models around is investing in Green Purchasing Power Agreements (PPAs). They are long-term renewable energy contracts enabling corporations to decarbonize their electric emissions and to support the energy transition.

d - Other actions of Big Tech companies to support climate change

In addition to energy efficiency improvement and renewable energy, Big Tech companies, we have identified circular economy and waste management and ecosystems and biodiversity as the key topics tackled by Big Tech companies. Circular economy introduces the concept of recycling, resources reuse and decoupling of resource use from growth. Following the ecosystem concept to increase sustainability, circular economy is a main reason for which tech companies are starting to partner with value chain actors and create an ecosystem to develop standards and certification materials.
Section 2 – The limitations of Big Tech sustainability strategies

a – The Greenwashing practices of Big Tech to reinforce their brand image

Greenwashing is a marketing misleading practice of promoting ecological campaigns, products or services, and practices that conflict with the companies' core content of the commitments. Among tech leaders, Amazon has been at the forefront of such greenwashing practices. Indeed, figure 14 shows the lack of achievement from Amazon in 2020 compared to its goals for 2030. The main issue lies in the lack of information shared by the big tech company on the means to procure 100% renewable by 2030 reach net zero carbon by 2040.

b – The limitations in Big Tech companies' negative environmental impacts calculation

The urgent need for tech companies to decouple their development from their CO2 emissions is all the more complex as it is not always easy to calculate the quantities of carbon actually emitted. A common challenge for companies is to compute Scope 3 emissions, which are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions (Greenhouse Gas Protocol, 2022). It is noteworthy that data centers' emissions computation is very complex and that there does not exist standardized assessment methods which can be applied to all data centers and by all companies

c – *A necessary organizational change*

In the case of Big Tech companies, shifting from a linear economy to a circular economy, powering their activities with renewable energy, or improving energy efficiency of their data centers require to understand what the transformation means beyond a simple technical evolution. The energy transition coupled with digital transition require to set a clear sustainable business model innovation SBM-I and identify the organizations' dynamic capabilities, which plays a significant role in business's wish to respond to quick change and to maintain its competitive advantage while addressing environmental challenges.

CHAPTER 3: METHODOLOGY

I. First step: business cases

We selected three Big Tech companies of the information and communication technology industry to understand how they are approaching and incorporating environmental challenges within their strategy. The first part of our results is based on findings from the Internet and are thus in the public domain. The research consisted in analyzing reports published by the companies themselves on their group website: sustainable reports, annual reports

Business case 1: Microsoft Corporation Business case 2: Amazon.com Inc. Business case 3: Alphabet Inc.

II. Second step: interviews

The second step of the methodology consists in conducting qualitative interviews of three Global Account Managers working at Engie, in the Key Client Office department. Indeed, Engie is a global reference in low-carbon energy and services. Here, we had the opportunity to exchange with three GAMs in the context of this paper:

- Anne Cateaux, GAM of Microsoft Corporation
- Tom Van den Bussche, GAM of Amazon.Com,
- Ivan Bel, GAM of *Alphabet Inc*.

CHAPTER 4: RESEARCH RESULTS

I. Business case n°1: Microsoft Corporation

Key findings from the business case:

- Microsoft has one of the most successful sustainability strategies among the Fortune 500 companies and commits to being carbon negative by 2030.
- Microsoft wants to reach 100% of renewable energy for its Scope 1 & 2 by 2025
- Microsoft is known as a sustainability leader and must continue differentiating itself by focusing on its Scope 3 targets (i.e., reduce intensity per unit revenue by 30% in 2030).
- Microsoft continuously strives to promote sustainability in its operations, products, policies, and help enable customers and partners to do the same by creating larger ecosystems of partners.
- Their main strategy is to focus on datacenters energy efficiency, sign more PPAs and on-site energy production contracts, and develop services and solutions for sustainability (Cloud-based, IoT for Smart Buildings and Smart Cities etc.)
- Through its \$1B Climate Innovation **Fund**, Microsoft wants to accelerate the development of decarbonization technologies.

Key findings from the interview with Anne Cateaux:

• The sustainability efforts from the group come from many reasons at the same time: humanitarian reasons, its care for the planet, risk management and profitability.

• Microsoft believes that this ecosystem of partners (energy providers, technical providers, and integrators) is the best way to become leader in many climate tech which will allow them to reach carbon neutrality and carbon negativity on time.

• There is a need for real measurement standards to be able to measure scope 3 emissions. Today, the race is at being able to tackle this scope 3 and that "many players have entered the space and everybody's claiming they're doing something", including Microsoft, which has joined Carbon Call, an initiative launched to solve

data quality issues, measurement and reporting inconsistencies, siloed platforms, and digital infrastructure challenges to allow companies in the race of net-zero carbon to have measurement standards to compare, combine, and share reliable data.

II. Business case 2: Amazon

Key findings from the business case:

- Amazon.com is committed to reach net-zero carbon in 2040, ten years ahead of the Paris Agreement.
- Amazon.com wants to reach 100% of renewable energy by 2025
- Amazon.com is the world's largest corporate purchaser of renewable energy and announced 37 new energy projects in 2022, which rises its capacity of renewable energy portfolio to 15.7 GW.
- Amazon.com is known as a sustainability leader within the tech industry with a decreasing carbon intensity level over years.
- Amazon.com continuously strives to promote sustainability and deliver transformations by growing The Climate Pledge.
- AWS data centers are 3.6 times more energy efficient than the median of US enterprise data centers and 5 times more than the average data center in Europe
- Their main strategy is to focus on transportation and buildings energy efficiency, especially for AWS datacenters by continuously investing in renewable energy and 100% recycled materials.

Key findings from the interview with Tom Van den Bussche:

- First key challenge of Amazon is and will be the complexity of powering data centers with renewable energy in the diverse geographical position of Amazon's data centers.
- Second challenge of Amazon has to deal with is the lack of regulations that the entire industry faces.
- Third challenge for Amazon comes from the internal pressure from top management to sustain their growth and their position.
- The primary focus of the group would not be on sustainability but on speed of deployment, which itself will lead to answer sustainable challenges.
- Amazon's activities do not only involve AWS data centers but also delivery, transportation, and warehousing (partnership with Plug Power Amazon to supply 10,950 tons of green hydrogen every year starting 2025 that it will use to replace grey hydrogen, diesel, and other fossil fuels)
- Partnership of Amazon with Rivian, with who it plans to bring thousands of electric delivery vehicles to more than 100 cities by the end of 2022, and 100,000 across the U.S. by 2030
- AWS developed a new data architecture in 2020, called Lake House Architecture, which is a highlevel architecture capable of gathering the necessary data for emissions calculations and reporting, which helps measuring scope 3 emissions.

III. Business case 3: Alphabet

Key findings from the business case:

- Since 2007, Google is carbon neutral thanks to its aggressive energy efficiency initiatives and its highquality carbon offsets purchases
- Since 2017, Google matches 100% of annual electricity consumption with renewable energy sources
- In 2020, Google launched its 24/7 Carbon-Free Energy goal to be carbon-free every hour of every day during the whole year without offsetting emissions. In 2021, 66% of its data centers operate with carbon-free energy.
- Google has invested \$3.3 billion in renewable energy projects for an expected capacity of 8.7 GW
- Google Cloud directly helps users avoiding Scope 2 GHG emissions. By switching to Google Cloud, companies transfer their energy consumption to Google.
- In June 2021, Google joined the Exponential Roadmap Initiative and the Race to Zero, committing to halving emissions before 2030 towards net zero

Key findings from the interview with Ivan Bel:

- With its 24/7 CFE, Google is addressing a huge challenge as today, being able to say that at a specific time the power comes from green energy or not is very complex.
- Google has developed a real-time map to monitor and report its 24/7 CFE achievements, which proves the transparency of Google on its achievement.
- Google launched an approach called a *Compact*, which is an open approach shared and signed by the UN committing its signatories to try to monitor their carbon level in their energy consumption in real time
- Google core sustainability actions are to greenify its data centers. Nevertheless, Google has led other very interesting initiatives at local and regional levels, in particular around the recycling of electronic waste and a whole host of initiatives to be able to recover old computers and refurbish them
- Importance of international organisations in building strong regulation: "the issue is no longer at the level of our countries. It's really an international and global level, and the international bodies that have completely lost their power, they still have, I think, legitimacy, but no means of action, no reasonable means of action".

CHAPTER 5: DISCUSSIONS AND LIMITATIONS

I. The current challenges and initiatives of Big Tech companies in terms of environmental sustainability

a- The Paris Agreement: the ultimate deadline Big Tech companies must align their goals with

The business cases conducted on three major Big Tech companies, Microsoft Corp., Amazon.com and Google all led to the same conclusion: companies are constrained by the Paris Agreement which set a global climate action agenda to limit global warming to below 2°C and pursuing efforts to limit it to 1.5°C by 2050. The sustainability strategies of these Big Tech companies are thus fully thought and planned according to this ultimate objective set at the COP21 in 2015. The companies' agenda to reach sustainability focus on their emission reductions, which require to address the whole value chain and activities. Indeed, academics research and our research describe the wat carbon emissions are organized between Scope 1, Scope 2 and Scope 3. Thus, companies started to set ambitious goals to reduce their carbon emissions, all before 2050. The interviews allowed us to understand that Big Tech companies do not only race for carbon neutrality, but to reach the highest existing standards. One of Google's modes is "We're going to the moon" as stated by Mr. Bel. If the three pioneers in terms of sustainability are racing to be the first achieving their goals, and this, a few years ahead of the Paris Agreement, other tech companies must certainly follow their example and set very ambitious goals by 2050, certainly with less financial, investing, innovation and technological capacity.

b- The role of Big Tech companies to lead the transition of the economy towards carbon reduction and ultimately to net-zero carbon

The final main challenge faced by Big Tech companies identified through our research is their significant role to lead the sustainability and energy transition for the whole economy in several ways. First, Big Tech companies are positioned as leader of the modern economic systems, especially the GAFAM, but not only. From this position, they have the great responsibility to use and leverage their brand image and recognition to encourage the world to transform their operations, to invest in new technologies and to change their habits. Second, as providers of technological products, solutions, and services, they have the assets, the capabilities, and the knowledge to design new tech solutions enabling the transformation towards sustainability. Their large financial capabilities position these companies as the main investors in innovation and research and development. Google has developed many technologies to measure its footprint across its georgical presence. In particular, Mr. Bel mentioned one element that is quite new and "that few other players have done", is the time stamp of their contracts. Then, these Big Tech companies have a role to support startups developing climate tech and accelerate their commercialization. For instance, Microsoft has been participating in 18 early-stage deals in the last two years via its Climate Innovation Fund, Amazon invests heavily in clean tech, in vehicle electrification and logistics via its \$2B climate fund and Google relies on its startup accelerator to support the development of climate technologies.

c- Strong ecosystems of players and partnerships as drivers for genuine change and competitivity

The literature review of this paper dedicated a section on business ecosystems, partnerships, and alliances to reach sustainability within organisations and, specifically within the technology industry. First, we raised the ecosystems that these Big Tech companies were able to initiate. To cite the main ones, Microsoft has launched its Microsoft Cloud for Sustainability, enabling its users to comprehend, measure, analyze and automatize their sustainability management promoting a better recording, reporting and reduction of their emissions. Besides, Mrs. Cateaux explains that thanks to Microsoft's capacity to create strong ecosystems of actors, and by "identifying the best of the best of the best". She states that "they have tried to figure out how they can work directly just one to one or bring in a vendor to work with other vendors to create a collaborative comprehensive solution, where Microsoft at the end is the benefactor of what all the partners got together". Likewise, Amazon.com developed its sustainability strategy on The Climate Pledge, an agreement joined by over 300 signatories all committing to reach carbon neutrality by 2040, ten years ahead of the Paris Agreement. Finally, Google transformed it 24/7 CFE initiative into a 24/7 CFE Compat, an approach signed and shared by the UN setting principles and actions for all stakeholders of the energy industry to fully decarbonize the electricity sector and guarantee access to clean energy to all. To conclude, a key take-away of this argument is that, besides from creating trustful relationships among actors and being the ultimate way to have a genuine impact on the economy and society, such partnerships are seen as key strategic actions by Big Tech players. Indeed, the underlying idea is to select the best players in each industry with the goal to drive innovations, either with one another or all together to be able to accelerate their pace of development and the marketisation of state-of-the-art technologies that will revolutionize the industry.

II. Limitations identified in Big Tech companies' actions for environmental sustainability

a- The resisting greenwashing practices

An important challenge of Big Tech companies relates to tackling all activities of the value chain to become net carbon. The interviews allowed to raise the topic of carbon offsets. Interviewees acknowledge of the positive impact of carbon offsetting as a start to address sustainability a few years ago. For Google, Mr. Bel explains that "it is a first contact, but when half of the carbon offset certification bodies are based on nothing, this may raise questions". Mr. Van den Bussche, Engie GAM for Amazon.com, also states "Maybe 2-3 years ago, that was the best start, but I think the biggest challenge for them is now to find ways to actually become negative in all areas". This confirms that today, the system is not sufficient and new regulations need to be implemented to make the Big Tech companies' action trustful and necessary. In the same way, companies cannot ignore some parts of their environmental footprint anymore and are expected to address all their value chain. Tech giants, among them Google and Amazon have recently touched by the controversial topic of greenwashing. Indeed, as depicted our business case on Google, the company acts on scope 1 and 2 by addressing its data centers' emissions and energy efficiency. However, the emissions are still increasing YoY

(+95% in 2021) and Scope 3 remains untouched, when it's accounting for 60% of total Google's emissions. But Google is not the only one, Microsoft and Amazon are still not showing interest in Scope 3 emissions as well. Besides the scope 3 issue, we identified some areas where they need to go deeper into. As mentioned by Mr. Bel, "the issue of sustainability goes far beyond the energy problem. Of course, energy is an important part, but there are others and on this". Finally, as ambitious as they may be, not all Big Tech companies are showing great achievements compared to their agenda.

b- The renewable energy market is expanding fast, making it difficult for energy providers to keep up with demand

Another important limitation to highlight as the outcome of the interviews led in our research is the renewable electricity capacity shortage and consequently the increasing PPA prices that the market is going through. In 2021, the energy market recorded its higher volume of clean power through power purchase agreements in 2021, with 31.1 gigawatts purchased by organisations. The three Big Tech companies represent the first PPA purchasers in 2021, with Amazon which purchased 6.2GW renewable energy via PPA in 2021, which is more than 20 percent of the total of PPAs in the world. But the market is going through rough times to keep up with the demand, which has resulted in a YoY 24% increase in PPA price in 2021 especially in the US. This impact is reinforced by the conflict in Ukraine as the increase in natural gas prices leads to lock in renewable energy at specific prices, thus driving demand. The company's Global Account Managers in charge of Google, Amazon and Microsoft were clear "the ambitions of the tech industry may not be reachable as soon as they wish and could need some technological adjustments ". Furthermore, many technical constraints still need to be addressed by the Big Tech and their ecosystem of actors, especially energy providers as Engie. Among all these constrains, the interviewees led us to identify the most important and frequent challenges linked to geographical presence of data centers, the grid constrains but also social constrains. Mrs. Cateaux explains that "there is the issue of where there is a power constraint in certain parts of the world where the local utilities and the grid operator do not mind if you've got a billion dollars to throw at it. If they decide that plugging in another data center will prevent getting power to their local community and because they cannot service it for blackouts, then they're not going to do it". This shows how sustainability is not only about ecology and greenifying the grid, but it also needs to take into consideration where the population are and where Big Tech can or cannot plug their power in from the local grids. Finally, renewable energies are fully dependent to the climate, on wind and solar mainly. Therefore, these companies must also address the energy storage challenge if they aim at being 100% sourced by such energy.

c- A highly expected intervention of international bodies to regulate the system

As last limitations, certainly the most important take away of this research is the need for clear infrastructure to frame the measurement of the impact of climate change by corporations and verify carbon removal quality. Both the literature review and our research proved the urgency that policy makers establish

a regulatory framework. For instance, Scope 3 emissions, one of the most discussed topics in this paper, need to be correctly reported by organisations. However, even though Big Tech companies such as Amazon and Microsoft are working on providing solutions to aggregate data and calculate this scope 3, companies still need clear guidelines on how emissions should be calculated and reported. The real question coming from the entire industry is when will climate change be considered as a major risk by states and international bodies. Big Tech companies strongly advocate for the needed changes in regulations and policies. Microsoft even made it one of its pillars. They enhanced their policy advocacy on carbon and on net zero goals, energy grid decarbonization, measurement in the US and EU. This proves the ongoing actions taken by the Big Tech companies to establish standards recognized by regulatory bodies. The COVID-19 crisis showed that now, "the stakes are not even at the level of our countries; it is to at the international and global level. The real challenges stay in the international bodies that have completely lost their power and have no reasonable means of action but still have, I think, legitimacy".

CHAPTER 6: CONCLUSION

This paper has established the complex context of the technology industry, also called the Information and communication technology (ICT) industry, which has been facing the highest controverse about its environmental footprint due to its very energy-intensive activities and its high carbon emissions. We also tried to understand to what extent the Big Tech players of the ICT industry took initiatives to counter their negative effect on the planet and to what extent they had a role in addressing the challenges related to climate change. To respond to these questions, we have examined the extant academic literature on the topics of digital transformation, sustainability, and digital sustainability which we carefully analysed and reported in our literature review. To enrich our analysis, we conducted a research based on a two-step methodology, including the in-depth analysis of three Big Tech companies of the ICT sector to identify their key goals and actions in the environmental sustainability area. Then, we conducted three interviews of professionals within the energy industry, each of them working with one of the companies analysed in the first step of the research. These face-to-face interviews allowed to confront the identified key elements from published official reports with the reality of the current challenges and limitations that the sector is encountering. We recognize that our research has its limitations, notably the fact that we did not conduct any interviews with representant of the analysed companies themselves. Yet, we believe that our approach remains very interesting to understand how a main actor of the energy transition sees the opportunities and challenges faced by Big Tech companies to support the transition of the sector, and to some extant the whole economy, towards net carbon by 2050. Another limitation of the research deals with the very few numbers of business cases carried out. Here again, we believe that the analysed companies stand as the very example of the initiatives led within their industry and are the representatives of what can be done at the highest level of profitability, assets, recognition, and

investment capacities. Most importantly, it is noteworthy that, even at the highest level, a lot is remained undone and untacked and still needs to be addressed in the very short term to respond to climate change.

From this research, we were able to identify the main challenges of the Big Tech companies, such as to primary address their data centers emissions and energy efficiency, which seems to be the biggest technological challenge of the times if they aspire to power them with green energy on a continuous basis and in all regions. Besides, we noted the impediment endured by the ICT sector linked to the lack of policy makers intervention to regulate their initiatives. This leads to a genuine lack of measurement and reporting standards which do not allow companies to address their full emissions properly. Also, the increasing demand for renewable energy in the past years, combine with the recent Covid-19 and Ukraine crises, are generating an increase in Power Purchasing Agreements and a shortage in the assets that energy producers are trying to resorb. Nevertheless, Big Tech companies such as Google, Microsoft and Amazon.com or constantly setting ambitious goals to reach carbon neutrality and carbon negativity before the Paris Agreement. They focus mainly on their data centers footprint across their geographies and are extending their objectives to their whole value chain. To do so, they invest heavily in research, development, and innovation to produce in-house solutions and create large ecosystems of actors as well as cross-sector partnerships to share capabilities and assets and convey strong messages to other companies and sectors to accelerate decarbonisation. Yet, in this race to sustainability, tech leaders are trying to leverage their position to remain competitive and increase their brand reputation in a world where consumers, employees, investors, and governments are all very attentive to their initiatives to act for the planet. Finally, the paper informed the debate on the role of the tech giants in leading the transition towards decarbonisation. Indeed, today, these companies are in the spotlight to drive the whole economy, by using their financial capabilities, their brand reputation, and most importantly their technological capabilities to develop climate technology that will unlock the decarbonisation system of the whole economy.

Now, authors like Jean-Marc Jancovici, in his book "The Shift Project" published in 2022, in which he presents the transformation plan of the French economy", questions the capabilities of technologies to support the energy transition. He states that the very simple apparition of new technologies will not necessarily change the orders of magnitude of energy volumes and the way we consume. It is rather their massive deployment at a very large scale that counts, which in turn requires energy. Consequently, the technologies which can change the game of energy and materiality on are already "in the pipes".

Thus, where is now the role of the tech giants?