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Big Tech Firms and the Politics of Climate Change

Mapping the Low-Carbon Vested Interests of Alphabet, Amazon, Apple, Meta

Marcos Vinícius Isaias Mendes

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Resumo

Recentemente, as empresas passaram a ver a ação climática como uma oportunidade e não apenas como uma ameaça. Coalizões globais de corporações multinacionais surgiram para avançar compromissos climáticos. Essas coalizões empresariais desafiam estudos anteriores que criticaram a Responsabilidade Social Corporativa por ser simplesmente *greenwash*, levantando importantes questões de pesquisa: teríamos algum indicativo de que as corporações multinacionais estão efetivamente mais comprometidas com o enfrentamento das mudanças climáticas? O objetivo desta tese de doutorado é apresentar um mapeamento dos impactos climáticos e dos compromissos assumidos por quatro grandes empresas de tecnologia (Alphabet Inc., Amazon.com, Apple Inc., Meta Platforms) a fim de entender seus perfis históricos e atuais de emissões, pegadas de carbono, tecnologias e inovações para combate às mudanças climáticas, bem como os interesses embutidos nessas iniciativas. Embora as grandes empresas de tecnologias não contribuam muito para o aquecimento global (ou seja, suas emissões diretas e indiretas estão muito abaixo das empresas altamente poluentes), elas vêm se engajando em iniciativas visando a combater o aquecimento global, contribuindo assim para uma *tecno-economia de baixo carbono*. Eu emprego um método de estudo de caso múltiplo, analisando estas empresas individualmente e comparativamente. A coleta de dados foi realizada em duas etapas. Primeiro, realizei sete meses de pesquisa de campo no Vale do Silício, Califórnia, observação participante em workshops online da ONG *Citizens Climate Lobby*, visitas às sedes dessas corporações, e entrevistas semiestruturadas com cientistas de dados, engenheiros de software, e analistas de energia e sustentabilidade. Em segundo lugar, coletei documentos primários dessas empresas (Relatórios de Diversidade & Inclusão e Relatórios de Sustentabilidade) abrangendo o período de 2016 a 2020. A análise dos dados envolveu uma técnica de análise de conteúdo. Os resultados revelaram que as características e histórias pessoais dos executivos de sustentabilidade dessas firmas dizem muito sobre as estratégias climáticas adotadas. Todos eles trabalharam para o governo dos EUA ou têm formação em ciência política, portanto, podem ajudar as firmas a evitar perdas financeiras ou de reputação ligadas às mudanças climáticas. Essas firmas, exceto Amazon, vêm reduzindo suas emissões nos últimos anos. Além disso, todas, em particular Alphabet e Meta, vêm desenvolvendo tecnologias de baixo-carbono, reposicionando alguns de seus negócios para lucrar com as mudanças climáticas. A ação climática destas firmas ocorre principalmente por conta de três interesses velados: atrair funcionários conscientes sobre o clima, oportunidades de negócios relacionadas a produtos, serviços e tecnologias de baixo-carbono, e influenciar a sociedade sobre o papel benéfico da corporação.

Palavras-chave: empresas Big Tech; mudanças climáticas; corporações multinacionais; Economia Política Internacional

Abstract

Recently, business firms have come to see climate action as an opportunity rather than a threat. Global coalitions of multinational corporations have emerged in order to advance commitments to cope with climate change. These business coalitions challenge previous scholarship that has criticized Corporate Social Responsibility (CSR) for being *greenwash*, raising important research questions. Do we have any indicatives that multinational corporations have become more committed to cope with climate change? The goal of this doctoral dissertation is to present a mapping of climate impacts and commitments of four Big Tech firms (Alphabet Inc., Amazon.com, Apple Inc., Meta Platforms) in order to understand their historical and current emissions profiles, carbon footprints, climate-smart technologies and innovations, as well as their low-carbon vested interests. Although Big Tech firms do not contribute much to climate change (i.e., their direct and indirect emissions are far below those from heavy-polluting firms), they have nonetheless engaged in climate initiatives, aiming to tackle global warming, thus contributing to a *low-carbon techno economy.* I employ a multiple case study method through which these firms were analyzed individually and comparatively. Data collection was performed in two stages. Firstly, I conducted seven months of field research in Silicon Valley, California, participant observation in online workshops of Citizens Climate Lobby, visited these firms' headquarters, and performed semi-structured interviews with local data scientists, software engineers, and energy and sustainability analysists. Secondly, I collected primary documents from these firms (Diversity & Inclusion Reports and Sustainability Reports) covering the period from 2016 to 2020. Data analysis involved a content analysis technique. My findings revealed that these firms' sustainability executives' personal traits and histories have much to do with their climate strategies. All of them have worked for the U.S. government or have degrees in politics, thus are able to help these firms avoid financial and reputational losses as regards climate change. All these firms, except for Amazon, have been reducing their emissions in recent years. Additionally, these firms (particularly Alphabet) have been developing climate smart technologies, repositioning some of their businesses in order to profit from climate change. Their climate action occurs mainly because of three vested interests: to attract climate-aware employees; because of business opportunities related to climate products, services, and climate-smart technologies; and to influence society as regards the beneficent role of the corporation.

Keywords: Big Tech firms; climate change; multinational corporations; International Political Economy

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List of Acronyms

AI	Artificial Intelligence
BINGO	Business and Industry Non-Government Organization
BRICS	Brazil, Russia, India, China, South Africa
CDP	Carbon Disclosure Project
CEO	Chief Sustainability Officer
CSO	Chief Sustainability Officer
CSR	Corporate Executive Responsibility
EITE	Emissions-Intensive Trade-Exposed Industry
EPA	Environmental Protection Agency
ESG	Environmental Social Governance
FDI	Foreign Direct Investment
FPI	Foreign Portfolio Investment
FTE	Full-Time Employee
GHG	Greenhouse Gases
GPN	Global Production Networks
GPT	General Purpose Technology
GTAI	Germany Trade and Invest Agency
GVC	Global Value Chains
ICT	Information and Communication Technology
IoS	Internet of Services
IoT	Internet of Things
IPE	International Political Economy
IPEE	International Political Economy of the Environment
IR	International Relations
ISO	International Standards Organization
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
MNC	Multinational Corporation
NASA	The National Aeronautics and Space Administration
NGO	Non-Government Organization
OECD	Organization for Economic Co-operation and Development
PPA	Purchase Power Agreement
PPP	Public-Private Partnership
PUE	Power Usage Effectiveness
R&D	Research and Development
REE	Rare Earth Element
ST	Sustainability Transitions
TRIPS	The Agreement on Trade-Related Aspects of Intellectual Property Rights
TSOE	Transnational State-Owned Enterprise
UNCTAD	United Nations Conference on Trade and Development
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

INTRODUCTION

Climate change at the new frontier of Capitalism

The ingenious ways Money and Power intersect, which constitute the core of the field of Political Economy, have always challenged my intellectual curiosity. It is thus not a surprise that I adopt the lenses of Political Economy in this doctoral dissertation. In this project, I investigate how climate change challenges the capitalist system in what I believe constitutes its newest frontier: the digital economy.

Capitalism has been profoundly shacked by climate change since it became scientifically proved in the early 1980s that global warming has an Anthropogenic nature. At that time, major capitalist groups (such as Oil & Gas corporations) challenged this fact, questioning the scientific validity of these early studies. Subsequently, after Rio 92, market entities became progressively more convinced of global warming, but opted to emphasize the economic costs of tackling climate change. Businesses have created stalemate in climate negotiations such as in Kyoto in order to avoid strong action on the issue. Some corporations even partnered with oil-exporting states to avoid emissions cuts.

However, since the dawn of the 21st century, a growing number of business firms have come to see climate action as an opportunity rather than a threat. Global business coalitions have emerged in order to advance corporate commitments to cope with environmental issues, particularly climate change. Among these initiatives, one can cite the World Resources Institute, World Business Council on Sustainable Development, Global Compact, Climate Action 100+, We Mean Business, Business Ambition for 1.5°C, The Carbon Pledge, and others.

These emerging coalitions challenge previous scholarship that has criticized Corporate Social Responsibility (CSR) for being just *greenwash*, raising relevant research questions: Will this time be different? Do we have any indicatives that businesses are in fact becoming more environmentally responsible and committed to cope with climate change? If this is the case, are corporations making these commitments for free, i.e., just because they desire a "better world"? Or do they have vested interests for doing so?

Although these are old questions, the current configuration of the global economy begs a new analytical approach to investigate the private governance of climate change. Corporate interests are not as simple to uncover as they once were. Contemporary business entities have interests that go way beyond profit maximization and shareholder prosperity. Firms have become agents with stakes in socio-political arenas that, although may not directly expand their material gains, aim at bolstering their influence and power. After all, if the fundamental Political Economy principle of Power = Money holds true, by expanding their sources of social and political influence, firms will indirectly be enlarging their revenues and profits. But Big Tech firms crave more than that.

New socio-political interests were born with Big Tech firms. Actually, I believe that Big Tech corporations are the most complex business entities to date, with a set of interests that go far beyond money and power. These firms aim at influencing our ways of life, mundane behaviors, and everyday experiences. This poses a fundamental challenge to Political Economy because, as I said before, the discipline specializes in understating the intricate dynamics between States (Power) and markets (Money). However, beyond these resources, Big Tech firms aim at transforming the infrastructures of our everyday lives, as Shoshanna Zuboff has brilliantly theorized.

Big Tech firms helped to create the logic of a digital economy with far more intricacies than the analytical breath of this dissertation could reach. Platform economies, data privacy laws, misinformation and fake-news, artificial intelligence and new disruptive technologies, cybersecurity and surveillance capitalism, sharing economies, smart devices and the internet of things, big data and predictive analytics, and many other emergent social phenomena related to the "digital" have been introduced or advanced by Big Tech firms. These new phenomena make up a "digital economy," which in my view constitutes the new frontier of Capitalism. This new frontier urgently begs conceptual and theoretical clarification. How could the field of IR, informed by the lenses of Political Economy, contribute to this emerging and crucial debate?

In light of this challenge, I focus this dissertation on the rise of what I call a *low-carbon techno economy*. This concept brings to light new dimensions of climate change governance and more nuances to the political economy of climate change in the "digital economy epoch". Few authors, particularly in IR, have studied the implications of the "digital" for climate change governance and politics. In approaching this gap with case studies on Big Tech firms' participation in climate governance, this dissertation brings a new empirical contribution to IR, enhancing our comprehension of how the *low-carbon techno economy* is reshaping Capitalism in its current stage, clarifying some of the challenges ahead of global climate governance.

Connections and contributions to the IR literature on climate change and digitalization

This doctoral dissertation advances a contribution to an emerging IR literature that proposes to further investigate the effects of the increasing digitization of society and the economy to world politics. These scholars have approached the topic different ways. Some have diagnosed that we are witnessing a digitalization of global value chains, in which all production stages are impacted, causing, among other effects, a reduction in the number of employees in companies and value chains worldwide, particularly in functions more easily automated (LI, FREDERICK AND GEREFFI, 2018; THELEN, 2018; RAHMAN; THELEN, 2019; WU; GEREFFI, 2018; MENDES, 2021). These authors are mostly political economists working in the field of IPE. My thesis contributes to this literature by highlighting some environmental and climatic impacts that the digitization of global production chains may bring. This will most likely affect the ways in which digital companies advocate in different multilateral forums and negotiations in the environmental and climate international regime.

It is precisely in this aspect that a second stream of IR studies unfolds. Authors working with regime theory and international organizations, and more broadly with the idea of global governance of digital platforms (KENNEY; ZYSMAN, 2016; LANGLEY; LEYSHON, 2017; KHAN, 2017) have been diagnosing a growing complexity in platform governance (GORWA, 2019). In other words, platform firms, in particular Big Tech firms, challenge regulatory infrastructures at the national and global levels, becoming quasi-monopolies, and sometimes de facto monopolies, with great market concentration. As regards this literature, this dissertation helps to clarify how international climate regimes shape the behavior of Big Tech firms. For example, through the increasing engagement of these firms in the annual COPs, advancing the 2030 Agenda and the SDGs. While the international climate regime influences the business strategies and operations of these firms, I propose that such an influence is mostly adopted as *greenwash*. In other words, there are many business interests embedded in practices such as the development and adoption of low-carbon technologies by these firms. In this vein, my perspective is similar to the literature that has been advanced by authors such as Peter Dauvergne, Jennifer Clapp, Peter Newell, Stefano Ponte, and several other authors, including myself, that I classify as environmental critical political economists.

A third branch of literature discusses power in IR (AVANT; FINNEMORE; SELL, 2010; BARNETT; DUVALL, 2007), bringing important contributions to my analysis when I reflect on the growing power of Big Tech firms at the global level. I perform this discussion investigating recent theorizations that seek to clarify how technology is a growing source of international power. In my research, I diagnosed that Big Tech firms have used different modulations of power and influence (network effects, the manipulation of big data, strategic use of information, and providing infrastructures that gradually become common public goods). This is in line with theorizations such as Gorwa (2019), which developed the concept of "platform governance," and Zuboff (2019), which adopted the lenses of "surveillance capitalism" to investigate the power of Big Tef firms. In this dissertation, I advance this literature through the construction of an original conceptual framework that dissects and explores the different sources of power deployed by these firms, pointing out the global political risks and consequences of this escalation in the power of digital firms, especially for nation-states, which, for example, have their regulatory capacity routinely challenged.

As regards international climate politics and policy, this dissertation connects mainly with authors working on the sub-field of International Political Economy of climate change (NEWELL, 2000; 2008a; 2008b; CLAPP; NEWELL; BRENT, 2018). The literature points out the emergence of four trends in global climate governance: 1) privatization of the climate change regime, with increasing influence of economic operators on climate policy, through instruments such as lobbying; 2) influence and increasingly complex relationship between industrial policy and climate policy, both domestically and internationally (MECKLING, 2021); 3) growing complexity of climate institutions, in which specific sectorial agendas sparkle the interest of the legislative system and unions, shaping the behavior of countries as regards climate change according to their emissions patterns (MILDENBERGER, 2020); 4) growing influence of social dimensions such as human rights, intersectionality (race, gender, class), refugees and migration in debates on climate justice.

My thesis addresses all these dimensions. I analyze how the influence of private technology firms unfolds in climate governance. So, this is an original empirical contribution to this literature. I also point out how issues of race, gender, and class are present in these companies' environmental, climate and diversity agendas. Moreover, I touch on the aspect of green industrial policy, focusing on Silicon Valley, explaining how low-carbon technologies, some developed by Big Tech firms, modulate low-carbon transitions across the ICT sector at the local and national levels. Thus, I bring an interesting empirical contribution to the IPE and IR literature, which until then had not explored the connections between climate and digital governance.

Research problem and questions

The goal of this dissertation is to present a detailed climate profile of Alphabet, Amazon, Apple, and Meta, in order to understand their current environmental and climate impact, actions, and low-carbon vested interests. Although Big Tech firms do not contribute much to the climate problem (i.e., their direct and indirect emissions are far below those from heavy-polluting firms such as Oil & Gas, Cement, Manufacturing, and Utilities companies), they have nonetheless engaged in bold climate initiatives, aiming to tackle global warming, thus contributing to a *low-carbon techno economy*.

It is clear that Big Tech firms have incorporated climate action in their discourses, corporate plans, and sustainability reports, but it is nonetheless cloudy how discourse materializes into business operations and political action. Therefore, the central goal of this dissertation is to clarify how Big Tech firms engage in the business and in the politics of climate change, through case studies of Alphabet, Amazon, Apple, and Meta. These firms were selected because they are industry leaders (by revenues and market capitalization), thus, their actions not only provide market signals for other global corporations, but also represent the most sophisticated modes of business engagement in climate action. For instance: these firms try to solve the climate problem by developing climate smart technologies, among other strategies. But it is not yet clear if such technical interventions will help solve the problem. Also, it is not clear what are the indirect social, political, economic, and environmental externalities of these technical interventions.

Specific goals of this dissertation are the following: a) introduce Alphabet, Amazon, Apple, and Meta by presenting their business models, main corporate strategies, water-energy consumption profiles, GHG emissions, and climate justice initiatives; b) map their climate-smart technologies, green innovations, and other business strategies connected with solving environmental issues and climate change; c) describe recent diversity, gender, and race corporate policies and how they connect with climate justice; d) map the participation of these firms in global business councils and multilateral fora to discuss climate change; e) introduce how these firms sustainability leaders and CEOs perceive and act on climate change; f) point how these companies lobby as regards climate policy; g) analyze these firms' business-government relationships at the U.S. federal government and state levels in California and Washington, where they are headquartered, in regards to climate policy; and h) conceptualize and empirically demonstrate their low-carbon vested interests, i.e., how these firms benefit from climate action.

Data and methods

I employ a multiple case study method. The four Big Tech firms were analyzed individually and comparatively. Because my case studies were exploratory, there was no dependent variable that would be explained by independent variables. I adopted some analytical categories in order to perform my qualitative analysis.

My hypothesis was that Alphabet, Amazon, Apple, and Meta are interested in solutions to climate change, either because they foresee climate change as a profitable business opportunity, for instance, by developing green technologies or innovations, or because these firms attempt to hedge their businesses against the negative effects of global warming. As my results demonstrate, these firms have many more reasons for acting on climate change than those covered by this initial hypothesis.

The research was carried out in two phases. The first was an in-depth investigation of theories, concepts, and recent IR literature regarding climate change, multinational firms, digitalization, and Big Tech firms. The second phase was empirical, based on data collection and analysis.

Data collection was performed by means of two methods. First, I conducted seven months of field research in California, United States, near Silicon Valley (September 2021 - March 2022). I conducted participant observation in online workshops of Citizens Climate Lobby, a climate NGO very active in the region, in order to connect with interviews participants. I visited the headquarters of two of these firms (Alphabet and Apple) to conduct on-site observations. Additionally, I performed semi-structured interviews with local data scientists, software engineers, and energy and sustainability business analysists, some of which had worked for these firms. Therefore, these were expert interviews. All interviews were online due to the COVID-19 pandemic. Although they were not recorded, I took detailed notes.

My second data collection method was a content analysis of primary documents from these firms (Diversity & Inclusion Reports and Sustainability Reports) covering the period from 2016 to 2020, i.e., 5 years. Moreover, I collected secondary documents, such as consulting reports, newspapers articles, and studies from international organizations such as UNFCCC, World Economic Forum, UNCTAD, World Business Council on Sustainable Development, among others, in order to triangulate my findings.

Data analysis was performed through content analysis. Data was subjected to the following treatments: a) Categorization: data was allocated according to categories, such environmental KPIs, climate KPIs, firms' leaders and executives biography, climate justice programs, etc.; b) Coding, in order to build relationships between the empirical data and the conceptual literature (although I did not use a book of codes, I used MS Excel to perform much of my analysis, particularly the creation of Tables and Figures); c) Interpretation: theoretical references were contrasted with empirical data, in order build the relationships and interpretations that helped me to build the narrative of results.

Structure

The dissertation has three parts. Part I contains Chapters 1 and 2, with a background literature review on climate change, multinational firms, and digitalization in the field of IR. Part II includes Chapters 3 and 4, containing some conceptual results of my research. Part III compiles my empirical results as regards my case studies. I outline the content of each of these chapters in the following paragraphs.

Chapter 1 introduces three branches of IR and IPE literature that provide the conceptual grounding for my research. Firstly, I discuss the Anthropocene and its main developments internationally and in Brazil. Secondly, I present the literature on the International Political Economy of the Environment, emphasizing how it is still neglected in Brazil. Thirdly, I pinpoint how conceptual models of Sustainability and Low-Carbon Transitions might help guide future IR research. Chapter 1 also provides a recent diagnosis of the carbon footprint of the ICT sector. Moreover, I include some highlights on the climate impacts of AI and Industry 4.0.

Chapter 2 focuses on multinational corporations and climate change. The initial goal is to emphasize that MNCs and climate change is a hot topic in IPE, but few Brazilian and Latin-American scholars have adopted this agenda so far. Another goal of this chapter is to present a brief history of how multinationals and climate change have been studied in IPE, pinpointing where is the frontier of science on this agenda nowadays.

Chapter 3 is an introduction to the concept of "Big Tech firm", as well as a formal presentation of my cases: Alphabet, Amazon, Apple, Meta. Firstly, I discuss recent IPE theorization as regards digital technologies. Subsequently, I use my business training to provide a marketing outline of these firms, emphasizing their corporate values, business strategies, and recent financial indicators.

Chapter 4 presents an original conceptualization for Big Tech corporate power, based on a fourfold archetype: network power, data power, infrastructural power, and information power. While such archetype represents a tentative framework, it may be handy for a more nuanced understanding of platforms' political-economic behavior. The framework may also be helpful for regulators and policymakers while devising governance mechanisms for such corporations.

Chapter 5, the largest of the dissertation, presents my core empirical results. I start by introducing these firms' sustainability leaders, arguing that their biography and personal histories connect with these firms' approaches to environmental issues and climate change. An important dimension of gender, race, and climate justice is presented based on recent data on these firms' Diversity & Inclusion reports. I then proceed to analyze these Big Tech firms' Sustainability Reports, depicting several environmental and climate Key-Performance Indicators (KPI). I finish the chapter by challenging common media discourses that signal the relevance of Big Tech firms' CEOs acting on climate change. To challenge this naïve perception, I complement my case studies with a brief analysis of climate strategies at Tesla and Microsoft.

Chapter 6 concludes my argument. I wrote this chapter based on the business-government relationship conceptual literature that emphasizes vested interests motivating private corporations to take action on salient public issues such as climate change. This chapter draws extensively on original data collected in California during my field research. Thus, my analysis encompasses both Big Tech firms' acting on climate issues in the multilateral arenas and in their national (U.S.) and local (California) jurisdictions.

PART I

An International Relations approach to Climate Change and Digitalization

CHAPTER 1

Climate Change, Digitalization, and IR: The Global Carbon Footprint of the ICT Sector

1.1. Climate Change, Digitalization, and IR: understanding the nexus

In this chapter I explore some theoretical and conceptual connections between climate change, information and communication technologies (ICTs[1]), and International Relations (IR) (section 1.1). Throughout the dissertation, I adopt the concept of *digitalization* to refer to the wide application of ICTs in social life. Or, according to Brennen and Kreiss (2016, p.1), digitalization is "the way many domains of social life are restructured around digital communication and media infrastructures." This thesis aims to explore, through IR lenses, digitalization and climate change through case studies of Big Tech firms. Digitalization is a central concept to highlight, in further chapters, the particularities of Big Tech firms, and why these firms matter in the global architecture of climate change governance. This chapter also examines recent developments in Industry 4.0 (section 1.2) and Artificial Intelligence (AI) (section 1.3), and some of their implications to climate change. A thorough analysis of Big Tech firms and their role in the global climate regime will be the focus of the remaining of the thesis.

In section 1.1., I explore how (and by whom) climate change is studied in IR. Based on extensive literature review, and a discussion of wide conceptual developments regarding climate change in IR, I arrived at three branches of literature that explore the issue consistently with this thesis' proposal: a) the Anthropocene, b) the International Political Economy (IPE) of the Environment, and c) Sustainability and Low-Carbon Transitions. Subsequently, I develop a literature review on the intersections between climate change and ICTs. This was achieved based on a review of scholarship in the fields of Computer Science and Information Systems, the most dedicated to sustainable ICTs so far. I also dedicate part of this chapter to discuss Industry 4.0 and AI, and their implications to climate change. I conclude the chapter by highlighting two gaps in IR and IPE scholarship that this doctoral dissertation aims to fill.

1.1.1. Climate Change and International Relations

The first body of IR literature to investigate climate change was the liberal-institutionalist current of *regime theory* in the 1990s. Accordingly, regimes would be considered "a set of implicit or explicit principles, norms, rules and decision-making

[1] ICTs are also called Digital Technologies. In this thesis, I use both terms interchangeably.

procedures around which actors' expectations converge in a given area of international relations" (KRASNER, 1995, p.2). Or, still, institutions based upon "principles, norms, rules, decision-making procedures, and programs that govern the interaction of actors in specific issue areas" (YOUNG, 1997, p.6). With an analytical focus on the nation-state, regime theory suggested that the climate crisis would be solved through international negotiations under the custody of international organizations such as the United Nations Framework Convention on Climate Change (UNFCCC).

Although important, regime theory lost its centrality. Franchini (2016, p.52) pinpoints three reasons why this approach lost the centrality amongst environmental IR scholars: (i) the detachment between theory an empirical reality, since a set of countries moved forward with climate policies and measures independently from the UNFCCC; (ii) the conceptual challenges posed by other IR theoretical traditions, particularly the limitations represented by focusing strictly on the nation-state to address global climate governance; and (iii) the excessive optimism of the liberal-institutionalist current regarding international cooperation, thus disregarding the power dynamics and competition between countries in the international system (neorealist argument).

Following regime theory, the *global governance* approach was adopted by a large number of IR scholars. The concept of 'global climate governance' started to appear in IR literature. Inoue (2016, p.106) observed that global climate governance emphasizes the differentiation between actors and agents and their respective activities. Agency "refers to the ability of actors to prescribe behaviors and participate substantially and/or establish their own rules." Agency would exist in different levels. Based on this idea, Inoue (2016) presents an analytical framework for global climate governance, including three core concepts: governance architectures, climate governance networks, and polycentric governance. These three concepts are developed below.

First, *governance architectures*: a "broad framework of public and private institutions, i.e., organizations, regimes, and other forms of principles, norms, regulations, and decision-making procedures that are valid or active in a given area of politics" (INOUE, 2016, p.107). Second, *climate governance networks*: particular types of political networks, bringing together "business, civil society and governments in an arrangement, combining logics that are normally assumed to be separate and transcend state-centered and territory-based politics" (ibid., p. 1100). Third, *polycentric governance*: would be associated with multiple "formally independent decision centers," each meeting to manage common pool resources in particular contexts on smaller than global scales.

Within global climate governance, the polycentric approach clarifies why "negotiated solutions at the global level, if not supported by a variety of national, regional and local efforts, should not work" (ibid., p.112).

Another relevant approach in environmental IR, which also stems from the global governance literature, is *multilevel governance*. This approach was popularized by Harriet Bulkeley and Michele Betsill. It has to do with the imbrications between the "spaces" and the "scales" in the rearrangements of environmental governance, which is sensitive to the political geography of networks (BULKELEY, 2005). Accordingly, the implementation of climate policies challenges the traditional hierarchies and boundaries between the local, national and global levels. So, a multilevel perspective would be more appropriate to address and clarify challenges and possibilities for building more effective climate policies (BULKELEY; BETSILL, 2005). Bulkeley and Newell (2010) argued that global climate governance demands analytical tools that transcend strictly state-focused approaches across subnational and non-state actors. Thus, climate governance reaches *glocal (global + local)* proportions, in such a way that mitigation/adaptation efforts overcome hierarchical boundaries and geographical borders such as "local" and "global", achieving a multilevel perspective (BULKELEY; BETSILL, 2005).

More recently, the *complex systems* approach has been adopted by some environmental IR scholars. According to Orsini et al (2019), this recent body of literature usually follows one of the questions: (i) to which extent is this (complex systems) approach innovative to understand global climate governance? (ii) how can complex systems analysis be implemented in policy making? This is a recent research line, but it has theoretical potential to contribute to research on the relationship between digital technologies and climate change governance. Complex systems may also illuminate how firms exercise political agency in climate mitigation/adaptation.

While regime theory, global governance, and complex systems have been used by environmental IR scholars to study climate governance, in this chapter I will focus on three different perspectives, which explore climate change in IR through very specific lenses: a) the Anthropocene, b) the International Political Economy of the Environment (IPEE), and c) Sustainability and Low-Carbon Transitions. Following, I discuss each of these branches separately.

1.1.1.1. The Anthropocene

Despite the developments outlined above, climate change is still not a traditional research topic in IR (PEREIRA, 2017). Only a few IR scholars have incorporated climate change into their research agendas (CLAPP; HELLEINER, 2012; CLAPP; NEWELL; BRENT, 2018; KEOHANE; RAUSTIALA, 2008; KEOHANE; VICTOR, 2011; KEOHANE, 2014; VIOLA, 2002). Since the 2010s, the concept of *Anthropocene*[2] entered the vocabulary of environmental IR scholars, animated by the idea that our planet is now in a different geological epoch, where human activity has profoundly (and progressively) destabilized the Earth System's natural dynamics.

Two chief propositions inspire the work of IR scholars influenced by the Anthropocene: 1) planet Earth would have certain *planetary boundaries* which should not be trespassed (ROCKSTRÖM et al, 2009a, 2009b; STEFFEN et al, 2015); and 2) international (or global?) environmental politics should adopt the perspective of *Earth System governance* (BIERMANN et al., 2012), meaning a fundamental reorientation and restructuring of national and international institutions towards more effective planetary management. The core concepts of both propositions are delineated below.

Rockström et al (2009a, 2009b) introduced the concept of *planetary boundaries* to pinpoint the main global environmental challenges faced by planet Earth. There are 9 planetary boundaries: (i) climate change, (ii) ocean acidification, (iii) reduction of the stratospheric ozone layer, (iv) biogeochemical cycles of phosphorus and nitrogen, (v) global use of fresh water, (vi) changes in land use, (vii) loss of biological diversity, (viii) aerosol concentration in the atmosphere, and (ix) chemical pollution. Of this total, humankind would have already transgressed the limits of three: climate change, the level of biodiversity loss, and changes in the nitrogen cycle. In their reformulated planetary boundaries framework, Steffen et al (2015) recognized the centrality of two such limits: climate change and biosphere integrity (comprising terrestrial, aquatic and marine biomes), "each of which has the potential to change significantly the course of the Earth System if they are substantially and persistently transgressed." Based on these findings, the authors propose the adoption of global policies that transcend "sectorial

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[2] Term coined in 1995 by the Nobel Prize in Chemistry Paul Crutzen. The Anthropocene is a new geological epoch, in which human activity has caused deep and accelerated transformations in the environmental (physical, chemical and biological) dynamics of planet Earth.

approaches to growth limits”, and towards more "effective actions for planetary management" in search of a “safe operating space for humanity" (STEFFEN et al, 2015).

In this vein, Biermann et al (2012) understand that an incremental change in society's attitudes towards a more sustainable behavior is not enough to foster the transformations at the level and speed needed to mitigate the environmental impacts that characterize the Anthropocene. The change must be structural. Thus, the authors propose seven steps to improve *Earth System governance*: (i) reforms in the United Nations (UN) agencies and environmental programs; (ii) integration of the social, economic, and environmental pillars of sustainable development, from local to global levels; (iii) global regulatory gaps need to be closed; (iv) governments should place greater emphasis on environmental concerns in economic governance; (v) stronger reliance on qualified majority voting systems to accelerate international norms and standards regarding the environment; (vi) stronger intergovernmental institutions, but subjected to legitimacy and accountability standards; and (vii) equality and justice as core values of sustainable development at a global level (BIERMANN et al, 2012, p.1306-07).

In Brazil, the Anthropocene perspective has been adopted by authors such as Viola, Franchini and Ribeiro (2012), Viola and Basso (2016), Franchini, Viola, and Barros-Platiau (2017), Barros-Platiau et al (2015), Inoue (2016), Inoue and Moreira (2016), and Mendes (2020a). In line with the previously mentioned authors, these Brazilian IR scholars point out that the current configuration of global governance is not enough to solve the environmental crisis. In an international system characterized by *conservative hegemony* (VIOLA; FRANCHINI; RIBEIRO, 2012), countries have adopted different degrees of climate commitment, from conservatism to reformism. One central issue is that the major climate powers (countries with greater influence over global climate politics) are positioned between conservatism and moderate conservatism. In addition, there is currently no sign of a reversal in this scenario, and it actually seems to be worsening in recent years, with rising emissions by these climate powers (VIOLA; BASSO, 2016, p.12).

But not all IR scholars see the Anthropocene as a positive concept for climate governance. As a matter of fact, IR is well divided between scholars who see the Anthropocene as a powerful conception for prompting society to act more effectively in climate governance (BURKE et al, 2016; HAMILTON, 2016; HARAWAY, 2016; FRANCHINI; VIOLA; BARROS-PLATIAU, 2017; PEREIRA, 2017) and those who are critical of this idea (WAPNER, 2014; FAGAN, 2016; BAUER; ELLIS, 2018).

The Anthropocene can be understood as a "global biopolitics of carbon," inasmuch as it translates the essence of all human life and industry – the atom of carbon – as the central force that both shapes/creates life (since carbon is the main element of organic molecules) and threatens/destroys the natural environment (since CO_2 is a pivotal cause of climate change). The Anthropocene is, thus, a "powerful form of subjectivism ranging from atomic to global scales" (HAMILTON, 2016, p.1). In their "planetary politics" manifesto, Burke et al (2016) recognize the Anthropocene as a possibility for "forming alliances and fostering interdisciplinarity" both in order to strengthen IR organizational and intellectual practices and to improve responses to the climate crisis. "By rewriting itself and embracing the Anthropocene concept, IR may enhance its relevance and strengthen its impact" (PEREIRA, 2017, p.1). The Anthropocene is, thus, a "powerful term" that denotes not only an epoch, but a "limiting event." A metaphor that illustrates that the "collapse of the system" is not a thriller film, but the fact that immense irreversible destruction is actually occurring (HARAWAY, 2016, p. 140-141).

On the opposite spectrum, for authors critical of the Anthropocene, opinions usually converge. The Anthropocene may offer conceptual challenges, and even obscure attempts to escape the nature-culture dichotomy. As such, the concept is very limited regarding its contributions to a critical framework in the field of ecological security (FAGAN, 2016). The nature-human dichotomy also presents limitations, since environmental protection: "is not about cutting deals between human and nonhuman well-being but understanding the co-constitutive character of all life and working on its behalf" (WAPNER, 2014, p.38). Only when such a "politics of co-constitution" becomes fully recognized by environmentalists and politicians the concept of Anthropocene will be truly relevant. The Anthropocene periodization (Anthropocene divide) has also been criticized. The notion that only after certain "arbitrary" date human activity has started to affect the environment may conceal the "long-enduring process of human alterations of environments", thus "obscures rather than clarifies understandings of human-environmental relationships" (BAUER; ELLIS, 2018, p.209). Regardless of such criticisms and other limitations of the concept, the Anthropocene is a recent and growing approach amongst IR scholars working with climate change and environmental politics.

1.1.1.2. The International Political Economy of the Environment

Another branch of IR literature on climate change and environmental politics comes from IPE. This will be a central approach throughout this doctoral dissertation. This literature started to grow in the 1980s, with the development of the international regime theory, and was also influenced by the field of Global Environmental Politics (GEP), which emerged in the early 1990s (CLAPP; HELLEINER, 2012). In fact, one of the first contributions to this literature came from no less than Susan Strange, a leading IPE figure, which criticizes regime theory (STRANGE, 1982).

Clapp and Helleiner (2012) coined the term *International Political Economy and the Environment (IPEE)* to mark the intersection between the fields of IPE and GEP, which individually have inspired the work of a handful of IR scholars in the last three decades. Examples include topics such as MNCs' environmental impacts (CLAPP; DAUVERGNE, 2005; PINKSE; KOLK, 2009), sustainable agriculture and global commodity chains (CLAPP; NEWELL; BRENT, 2018), international trade and the climate change regime (AMARAL, 2007, 2014; WEBER; GLEN, 2009), green technology for development (DUBEUX, 2015; OH, 2017), and the climate change connections with international development (FALKNER; STEPHAN; VOGLER, 2010; TANNER; ALLOUCHE, 2011), to name a few.

Agriculture re-emerged as a hot topic within IPE especially after food and commodity prices spiked in 2007–2008. However, "there has been little attention so far within the mainstream of the field of IPE to the environmental implications of current commodity price trends, and IPEE scholars have not yet explored the issue in much depth" (CLAPP; HELLEINER, 2012, p.498). Although mainstream IPE still neglects the topic, IPEE scholars became interested in the subject mainly because the food and agriculture sector is "both a major contributor to climate change and especially vulnerable to its worst impacts" (CLAPP; NEWELL; BRENT, 2018, p.1). Currently there is a strong push for 'climate-smart agriculture' (CSA) and for "green" technologies to lessen the environmental impacts of agribusiness.

Similarly, technology and international development have received increasing attention from IPEE scholars. Oh (2017, p.11) studied the negotiations over technology development and transfer as a part of the Paris Agreement. In his study, the author found that technology transfer policies under the UNFCCC are negotiated according to three neoliberal precepts: *marketization* (developed countries focused on the facilitation of economic transactions of technology transfer while developing countries pushed for the actual implementation of bankable projects); *privatization* (developed countries pushed intellectual property rights in developing countries to be in harmonization with the TRIPS, but developing countries pushed back, arguing that such regime represents a hindrance to the transfer of environmentally sound technologies from the global North to the global South); and *deregulation* (developed countries preferred a facilitative process of technology transfer, while developing countries demanded a more robust regulatory arrangement). I use the concept of global South aware of its limitations. For example, the strong differentiation among high middle-income countries, low middle-income countries, and low-income countries, which make the category "global South" oversimplistic. Besides, China is usually considered to be a global South country, but cannot be analyzed as such, since today is has become a global power with hegemonic potential.

These results are in consonance with the works of IPEE scholars interested in international development in the extent that: "If in the 1990s the gap between European and American climate policy defined the main fault line in climate politics, more recently the divisions between developed and emerging economies have moved center stage. This shift manifests itself in climate politics in two principal ways: in the growing share of emerging economies in worldwide emissions; and in the demands that these countries are making for enhanced representation and influence within the established framework of international cooperation" (FALKNER; STEPHAN; VOGLER, 2010, p.257).

In Brazil, some IR scholars have adopted the IPEE approach, conducting research on the role of economic and societal forces influencing Brazilian climate change politics (VIOLA; FRANCHINI, 2014); the Brazilian setback in industrial policies to foster clean technologies, in comparison to other developing countries such as China, South Korea, and Taiwan (DUBEUX, 2015); conflicts and interrelationships between the climate change regime and the multilateral trade regime regarding the participation, engagement and embeddedness of public and private actors (AMARAL, 2007, 2014); and the impacts of the transformations of the global food regime on the Brazilian agricultural sector. Additionally, Führing (2018) found that the EU legal framework plays a central role in the relationship between the EU and Brazil, allowing for a convergence of policies around environmental obligations in Brazilian-EU trade relations.

To date, IPEE scholars have analyzed in depth the influence of MNCs on climate change and the environment.[3] Clapp and Dauvergne (2005, p.158) categorized these scholars in four branches: (i) *market-liberals*, those who believe that successful MNCs are a sign of a healthy global economy, meaning that "strong growth in national economies—in both rich and poor countries—translates into more state and corporate funds for better environmental management;" (ii) *institutionalists*, scholars who mostly agree with market-liberals, although they add that "the profit imperative of firms means that in some cases the international community needs to guide the actions of firms to ensure sustainable development;" (iii) *bio-environmentalists*, scholars who see MNCs as engines of overproduction and overconsumption, which "manufacture, brand, and sell the bulk of the world's products, constructing a culture of consumerism", through extracting, processing, and exporting to rich countries the bulk of the globe's natural resources, besides the fact that they "pollute the earth's air and water with dangerous chemicals like dioxins, furans, polychlorinated biphenyls" and other types of waste; (iv) *social greens*, authors who largely agree with bio-environmentalists, adding that "in the quest to maximize profits, MNCs are responsible, too, for the inequality and exploitation of much of humanity."

Based on such a classification, Clapp and Dauvergne (2005, pp.169-178) observe the development of two streams of IPEE literature regarding MNCs. First, a number of studies produced in the 1970s and 1980s connecting pollution havens and industrial flight, i.e., "the idea that firms relocate in response to changes in environmental regulations." Second, a literature that focuses on evaluating "the actual environmental practices of transnational corporations." One interesting aspect of this second branch is the bifurcation of MNCs' environmental practices in two types, Greening and Greenwash.

Greening would be a response to social criticisms regarding their environmental practices, many global firms began to "green themselves," by integrating environmental concerns into business practices, many times under the label *eco-efficiency* (CLAPP; DAUVERGNE, 2005, p.174-175). This perspective is mostly adopted by market liberals and institutionalists.

Greenwash occurs when a company tries to convince consumers and shareholders that it is environmentally responsible, even though its business practices are

[3] While here I briefly introduce studies regarding MNCs in IPEE, an extensive analysis of such literature will be presented in Chapter 2.

contrary to this notion. For instance, "a company that claims to be "green" but at the same time lobbies (or funds lobby groups) against environmental regulations" (ibid., p.178).

Additional works examining MNCs and climate change include Pinkse and Kolk (2009), who evaluated international business responses to global climate change, Eberlein and Matten (2009), who studied the relationship between business ethics and climate regulation in Germany and Canada, and Averchenkova et al. (2016), who analyzed corporate-led climate adaptation efforts through a three-tier framework including drivers, responses, and outcomes.

Future research connecting MNCs and environmental issues, particularly climate change, is needed. The literature is very poor concerning three specific types of MNCs: those from the financial sector, large agribusiness firms, and companies from new powerful countries, such as China and India (CLAPP; HELLEINER, 2012, p.487). Furthermore, no case studies of large expression were found regarding the environmental and climate impacts of Big Tech firms. In fact, studies linking ICTs and climate change are considerably recent and focused on the climate impacts of the broad economic sector, not specifically on Big Tech firms.

1.1.1.3. Sustainability and Low-Carbon Transitions

In light of the climate crisis, some climate committed governments, particularly the EU, in addition to research institutions, NGOs and some firms have been engaged in systemic actions — multilevel (BULKELEY, 2005), polycentric (OSTROM, 2009), and networked (ACUTO; RAYNER, 2016) — in search for solutions for the problem. Beyond exclusively political or economic approaches, these actions involve multi-stakeholder experiments (BULKELEY; BETSILL, 2005), public-private platforms, local-global action, science-business networks, or a mix of all of them. These approaches include socio-technical arrangements in search of pragmatic solutions to climate change and other environmental issues. This is in line with the idea of a transition to a *low-carbon economy* (VIOLA; FRANCHINI, 2012). In the Anglo-Saxon literature, these processes have been called *Sustainability Transitions* (PARRIS; KATES, 2003).

Much of the Sustainability Transitions (STs) literature has been concerned with the following questions: (i) What are the technologies that can assist STs? (ii) Are STs collective or do they only serve business interests? (iii) Are STs participatory and democratic, or developed apart from civil society, thus being restricted to political and technocratic elites? To analyze these issues, in this section I analyze the origins and recent developments in the STs literature.

STs emerged from the observation that certain dynamics have profoundly affected the planet's support systems: population growth, technological development, economic transformations. In this setting, it became mandatory to discuss objectives, indicators and metrics to guide the path to a sustainable future (PARRIS; KATES, 2003). From the social studies of science and technology (STS) and evolutionary economics (in particular neo-Schumpeterian approaches), the inaugural models of sociotechnical transitions were developed, which later culminated in the concept of STs.

According to Loorbach (2017), STs arise from the intersection between Politics and Science. In the 1990s, two fields in particular contributed to the origin of the concept: science, technology, and innovation (ST&I) studies, and research on environmental sustainability. However, only in 2001 the term STs was used for the first time, in the Dutch National Environmental Policy Plan (NMP4). In that document, the Dutch government presented four transitions which are urgent for a sustainable future: (i) energy; (ii) sustainable use of natural resources and biodiversity; (iii) agriculture; and (iv) mobility (LOORBACH et al. 2017, p.604).

Since then, STs were defined as "long-term, multidimensional and fundamental transformations, through which current socio-technical systems are gradually transformed into sustainable models of production and consumption" (MARKARD; RAVEN; TRUFFER, 2012, p.1).

From that point on, a series of STs models have emerged. Geels and Schot (2007) mapped some types of environmental transitions: regular and gradual, but of low intensity (regular); of high frequency or intensity, but in only one environmental dimension (hyper-turbulence); one that would occur but would dissipate quickly (specific shock); one that occurs rarely, develops gradually, but has profound effects on only one environmental dimension (disruptive change); one that occurs rarely, has high intensity and speed, affecting multiple environmental dimensions (avalanche change).

Based on this mapping, Geels and Schot (2007) developed a fourfold typology for STs: (i) *transformation*: social movements pressure agents to adjust the rules of the socio-technical regime (mobility, agriculture, etc.); (ii) *technological substitution*: startup companies develop 'green' innovations, competing with established firms and technologies; (iii) *reconfiguration*: symbiotic innovations, developed in niches, adopted initially to solve local problems, but subsequently triggering adjustments in the regime's basic architecture, replacing 'dirty' technologies; (iv) *misalignment and realignment*: deep changes in economic structures, followed by the emergence of multiple disruptive innovations, misaligning the previously established socio-technical system; eventually, another socio-technical regime is established, with new technologies, agents and firms.

Recently, Geels (2011) developed a more sophisticated approach — and to this day considered one of the principal theoretical frameworks on STs. The *Multi-Level Perspective (MLP),* “a mid-range theory to analyze socio-technical transitions towards sustainability” (GEELS, 2011, p.24). MPL is based on three components: regime, niches, and landscape.

Socio-technical regime is the 'deep structure' that explains the stability of an existing socio-technical system; it refers to the semi-cohesive set of rules that guide and coordinate the activities of social groups that reproduce the various elements of the system in force (ibid., p.27).

Niches are 'protected spaces' such as R&D labs, structured research projects, or market niches where users have specific demands and are willing to support emerging innovations; niche actors (entrepreneurs, startups, etc.) work on radical innovations that depart from the existing regime.

Landscape is the 'broader context,' which influences the dynamics of niches and regimes; it has similarities with Braudel's notion of the longue durée; highlights not only the technical and material landscape that sustains society, but also demographic trends, political ideologies, social values and macroeconomic patterns; it is the external ‘scenario’, which niche actors and regimes cannot influence in the short term.

In addition to STS and evolutionary economics, Geels' (2011) theory incorporates elements of neo-institutional theory and the agency-structure debate (structuration theory).

In a similar vein, Markard, Raven and Truffer (2012, pp.957-9) presented four theoretical currents on STs. First, *Transitions Management*: considers the existing economic sectors as complex and adaptive social systems, and their governance a reflexive and gradual process. Second, *Strategic Niche Management*: bottom-up perspective, suggesting that it is through processes of social learning and experimentation, articulating promising expectations and heterogeneous networks, that niche innovations gain momentum and may eventually compete with established technologies. Third, *Technological Innovation Systems (SIT)*: considers the emergence of new technologies and the political and organizational changes that need to accompany this technological development; analyzes the systemic interaction between companies and other socio-political actors in a broad institutional infrastructure to back up the generation, diffusion and use of technological innovation. Fourth, the MLP model, as already presented.

Avelino and Wittmayer (2016) observed that the literature on STs generally analyzes structures, but neglects the agency. To face this challenge, they developed the *Multi-actor Perspective (MaP),* in which the State, the market, the community, and the third sector are located at different levels of interaction in the public-private, formal-informal, for/not-for-profit dimensions. By focusing on the agency, it is possible to reflect with more layers about who are the actors exercising power in STs, how mutations in the power relations between them occur, what resources are mobilized in these transitions, and at whose expense (ibid., p.642).

Kivimaa and Kern (2016) use the notion of *policy mixes*, inspired by the Schumpeterian theory of innovation drivers and creative destruction. Creative destruction was conceptualized as a "process, in which an entrepreneur challenges existing companies and technologies in order to make them obsolete, forcing certain companies to withdraw from the market" (KIVIMAA; KERN, 2016, p.207). In this framework, they present indicators in two dimensions. *Creation of 'green' technologies* (ST&I policies, market niches, entrepreneurial experimentation, cost/price alignment, resources to be mobilized, support from elites and power groups). *Destruction or discontinuation of existing socio-technical regimes*, which is politically very difficult (transition and control policies, change in norms and laws, reduction of incentives for 'dirty' technologies, and replacement of key actors).

Loorbach et al. (2017, pp.609-11) systematized the debate in the following ST approaches. First, *Sociotechnical Transitions*: they understand technological innovation as a systemic process in which technologies evolve with an emerging market structure, specific governance context and conformation of new consumer preferences. Second, S*ocio-institutional Transitions:* they focus explicitly on the role of agency and governance in the STs, taking a more reflective stance; they emphasize issues of normativity, ambiguity and social construction, in addition to reflecting on the interaction between multiple sociotechnical regimes. Third, *Socio-ecological Transitions:* focus on ecosystem transitions, understood as non-linear changes from one environmental pattern to another, going through certain "tipping points"; changes from one dynamic equilibrium to another are almost irreversible, and follow a pattern of accumulation, breakdown, recovery and stabilization.

Insights from the governance literature also point to models of social organization in response to major socio-environmental challenges: (i) STs involve constellations of actors from diverse institutional contexts; (ii) they promote discursive changes at the social level, through which persistent problems are recognized and translated into new directions for the future; (iii) existence of common social values and belief in a viable sustainable future; (iv) transitions are complex and unstructured processes, in learning-by-doing style, not doing-by-learning; (v) it is important to emphasize periodic learning and evaluation (ibid., pp.94-97).

More recently, Geels et al. (2020) proposed the notion of *socio-technical scenarios* (STSc), providing a methodological strategy to mediate the dialogue between qualitative analysis based on MLP and quantitative approaches generated via computer modeling. In this way, they aim to increase the social acceptance and political viability of low-carbon innovations.

Despite these important developments in STs literature, others have criticized various aspects of transitions theory. Aykut et al. (2020) used the concept of *incantatory governance* to criticize the emergence of a "managerial culture" in international climate governance organizations, censoring the emphasis on technocratic-managerial models. Other criticisms (and challenges) include the following.

First, as an academic discussion, STs theory is still concentrated in niche journals (e.g., Energy Policy and Research Policy), but is less visible in mainstream journals in Political Science, Economics, Management, Sociology, and Geography. Second, STs are treated primarily as regards energy transition, but there are few studies on sustainability transitions in domains such as water, agriculture, mining, etc. Third, the debate is limited to developed countries, in particular Europe and Japan, yet distant from Africa, Latin America and most of Asia. Fourth, the diffusion of 'green' innovations is halted if they do not trigger or align with broader changes in socio-technical and cultural systems. Fifth, STs in different environmental domains are interdependent, but include actors, rules and institutions that do not necessarily have aligned or convergent objectives. Sixth, the progressive elimination of unsustainable technologies faces multiple resistances, mainly from large firms in established sectors (oil and gas, automotive, chemical, electrical, agro-industry, etc.). Seventh, STs are not only associated with public policies that encourage 'green' innovation and the decline of unsustainable technologies, but also with a series of governance challenges, such as the need for horizontal and vertical policy coordination.

Next, I proceed to discuss intersections between climate change and digitalization, where I focus on the global carbon footprint of the ICT sector.

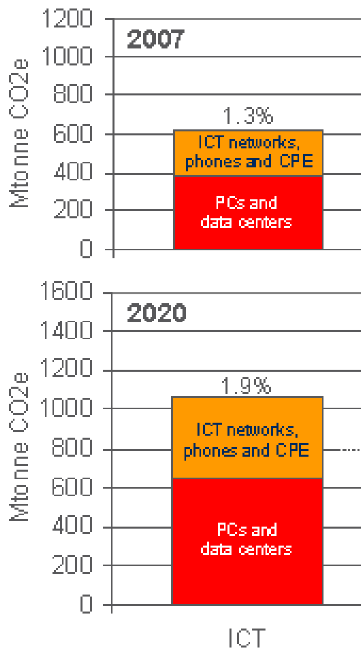
1.1.2. Climate Change and Digitalization

Only recently ICT scholars have incorporated the topic of sustainability into their research agendas. "Green Informatics constitute a new term in the science of information" (ANDREOPOULOU, 2012, p.1). But, in spite of its novelty, the topic quickly sparked the interest of a myriad of stakeholders: "the energy consumption resulting from the usage of ICT equipment and its impact on the environment have fueled a lot of interests among researchers, designers, manufacturers, and policy makers" (ZEADALLY; KHAN; CHILAMKURTI, 2012, p.1093). Besides Green Informatics (or Green IT/ICT), the number of approaches has multiplied considerably: Environmental Informatics, Computational Sustainability, Sustainable Human-Computer Interaction (HCI), ICT for Sustainability (ICT4S), ICT for Development (ICT4D), ICT for Energy Efficiency (ICT4EE), Energy Informatics, Sustainable Computing, Digital Sustainability, to name a few (HILTY; AEBISCHER, 2015, pp.14-18).

The motivations abound for the recent interest on energy-efficient ICTs. "ICT has become a major source of environmental contamination at all stages of the technology lifecycle: design, manufacture, operation and disposal (...) as, globally, hundreds of millions of computers and mobile devices are discarded in land-fill each year" (ELLIOT; BINNEY, 2008, p.2). Likewise, "the variety of materials contained in ICT hardware makes recycling difficult and less efficient (…), as ICT is the first technology claiming the use of more than half of the periodic table of the elements; (…) 57-60 chemical elements are used to build a microprocessor today; in the 1980s, a microprocessor contained only 12 elements" (HILTY; LOHMANN; HUANG, 2011, p.17).

Regarding the carbon footprint and energy use, the ICT industry is becoming a power drainer and contributes to approximately 2% of global CO_2 emissions (ELLIOT; BINNEY, 2008; ANDREOPOULOU, 2012). Besides, ICT's carbon footprint "is expected to grow from 530 $MtCO_2$ in 2002 to 1430 $MtCO_2$ in 2020" (BEKAROO; BOKHOREE; PATTINSON, 2016, p.1582). Malmodin, Bergmark and Lundén (2013, p.2) estimated that the global carbon footprint of the ICT sector was 620 $MtCO_2e$ in 2007, or about 1.3% of the total global carbon footprint (47 Gt, including all CO_2 equivalent emissions and effects). According to the authors, the figure of 2% is less correctly obtained by authors who calculate the ICT sector's footprint related to global CO_2 emissions (31 Gt, excluding other greenhouse gases and effects). Thus, the most appropriate measure is to use percentages of CO_2e (carbon equivalent), not of CO_2 alone. They also pinpoint that the ICT's carbon footprint "increases slightly (about 4%/year), and is estimated to increase by approximately 70% between 2007 and 2020, to a total of about 1100 $MtCO_2e$" (MALMODIN; BERGMARK; LUNDÉN, 2013, p.1-2). In 2007, the corresponding figures for global electricity use by the ICT sector were 3.9% (ibid, p.2), but "electricity consumption in ICT is growing nowadays over 15% year-to-year" (MAIHANIEMI, 2009, p. 1).

Figure 1. Global carbon footprint of the ICT sector in 2007 and forecast for 2020

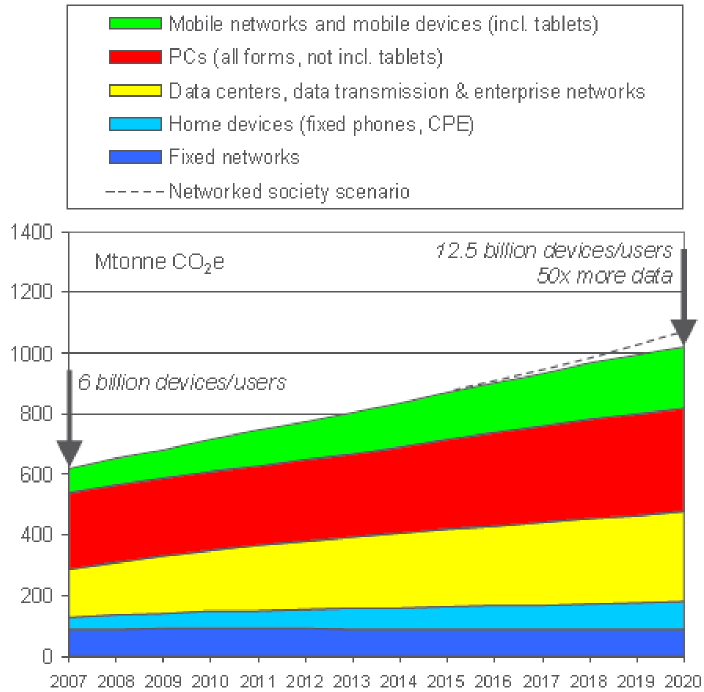


Source: Malmodin, Bergmark and Lundén (2013, p.13).

Note: PC is Personal Computer; CPE is Customer-Premises Equipment, and it means any terminal and associated equipment located at a subscriber's premises and connected with a carrier's telecommunication circuit at the demarcation point.

Dunn (2010, p.15) pinpoints that by 2010 the main contributing sectors within the ICT industry included the energy requirements of PCs and monitors (40% of the total emissions of the industry), data centers (23%), fixed and mobile telecommunications (24%). Energy consumption and the correspondent carbon footprint grew in all ICT subsectors by 2020, when there was 12,5 billion ICT devices and 50 times more data in comparison to 2007 (see Figure 2). The causes for this growth are related to the rising network economy/society: "emissions from the manufacture and use of PCs alone will double over the next 12 years as middle-class buyers in emerging economies go digital" (MALMODIN; BERGMARK; LUNDÉN, 2013). Similarly, "worldwide growth in the use of mobile phones will triple their carbon footprint by 2020" (DUNN, 2010, p.15). But the fastest-increasing contribution to carbon emissions is expected to come from the growth in the number and size of data centers, "whose carbon footprint have risen more than fivefold between 2002 and 2020" (ibid, p.15).

Figure 2. The carbon footprint of the main ICT subsectors 2007-2020



Source: Malmodin, Bergmark and Lundén (2013, p.14).

A recent study by Belkhir and Elmeligi (2018) updated these statistics and provided an interesting forecast for the ICT global carbon footprint by 2020 and by 2040. Table 1 below summarizes their data regarding the relative contribution in emissions by ICT category in 2010 and in 2020. In 2020, data centers responded for almost half the sector's emissions, followed by communication networks and smart phones.

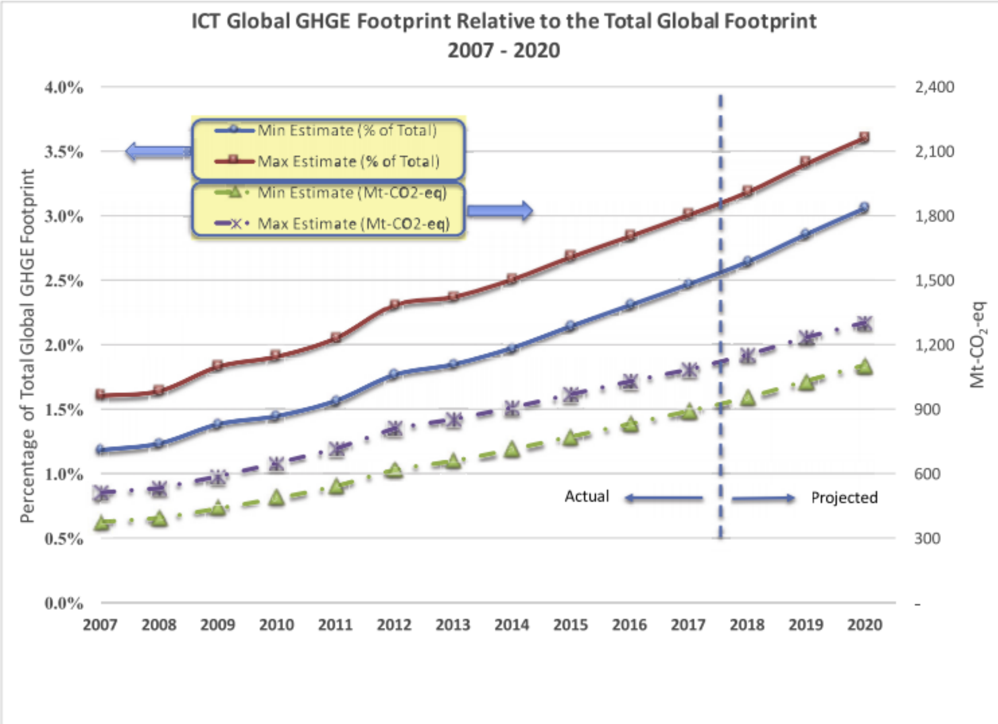
Table 1. Relative contribution to carbon emissions by ICT category, 2010-2020

ICT Category	Contribution in 2010	Contribution in 2020
Data Centers	33%	45%
Communication Networks	28%	24%
Desktops	18%	7%
Notebooks	8%	6%
Displays	9%	7%
Smart Phones	4%	11%
Tablets	≅ 0%	≅ 0%

Source: Adapted from Belkhir and Elmeligi (2018, p.457).

Figure 3 provides updated statistics regarding ICT global carbon footprint in 2007 and projected values for 2020. It is interesting to compare Belkhir and Elmeligi (2018) data in their most updated study with the data from Malmodin, Bergmark and Lundén (2013). While the older study estimated that by 2020 the global ICT footprint would be 1100 MtCO2e, the more recent study found, in the most pessimistic (maximum) projection, that by the same year it will be close to 1300 MtCO2e, a slightly higher value. However, while Malmodin, Bergmark and Lundén (2013) estimated that the global carbon footprint of ICTs would be 1,9% of the total global footprint, Belkhir and Elmeligi (2018) found that this participation will be superior to 3%, even in their most optimistic projection. According to their estimation, by 2040 this participation will rise to 6% (minimum) or to 7% (maximum), using a linear projection model, or to 14% (minimum) or 14,5% (maximum), using an exponential forecast model (BELKHIR; ELMELIGI, 2018).

Figure 3. Evolution on ICT global carbon footprint, 2007-2020



Source: Belkhir and Elmeligi (2018, p.457).

In spite of these growth forecasts, ICT emissions are not the main reason for the recent interest in Green ICT. Actually, ICTs are considered strategic intermediaries for the decarbonization of other sectors. “ICT is a *low carbon enabler,* (...) it can help cutting down emissions from various sectors including power, transportation and buildings” (BEKAROO; BOKHOREE; PATTINSON, 2016, p.1582). For instance, “the mobile technologies contribute to sustainable development through green banking, green commerce, green governance, green constructions” (ANDREOPOULOU, 2012, p.2). Within companies, ICT can contribute with decarbonization in a number of ways: “the advent of virtualization technologies (…) permits the creation of different virtual machines on one physical machine; and in the process, the number of physical computers within an organization can be reduced” (BEKAROO; BOKHOREE; PATTINSON, 2016, p.1587). *Rule-based techniques* and *eco-labels* are another strategy: the Energy Star, “a joint US and European Union scheme established in 1992 in order to set minimum energy consumption standards for ICT products,” and the electronic product environmental assessment tool (EPEAT), an “eco-label for ICT devices and electronics, managed by the US Green Electronics Council,” (ibid, p.1588) are two cases in point. The concepts of Sustainable Interaction Design (SID), “the design of systems that fit with human practices and needs while promoting environmentally sustainable use”, and Environmental

Information System (EIS), “monitoring systems, databases, analytical and simulation models, spatial information processing and other ICT applications for environmental protection, research, planning, and disaster mitigation” (HILTY; LOHMANN; HUANG, 2011, p.16-20) are other interesting examples. This wide process of greening ICTs has received increasing attention over the past 10-15 years, and it is being referred by scholars as “sustainability-oriented innovation” or “sustainability transitions” (MARKARD; RAVEN; TRUFFER, 2012), as we discussed earlier on.

From these examples, two basic concepts arise: greening in ICTs and greening by ICTs. Greening in ICTs is “making ICT goods and services more sustainable over their whole life cycle, mainly by reducing the energy and material flows they invoke”, while greening by ICTs regards “creating, enabling, and encouraging sustainable patterns of production and consumption by means of ICT” (HILTY; AEBISCHER, 2015, p.19). As we shall see later, greening by ICTs is a more interesting strategy in terms of the scale of emissions cuts.

Greening in ICTs can occur through three mechanisms: stakeholder actions (e.g., manufacturers, suppliers, end-users, regulatory agencies and research bodies), rules (policies, protocols and legislations), or by radical technological changes or innovations (BEKAROO; BOKHOREE; PATTINSON, 2016). Data center economies through virtualization and PUE (Power Unit Effectiveness) improvement (RUTH, 2011) are examples of such mechanisms. *Data center virtualization* encompasses a broad range of tools, technologies and processes that enable a data center to operate through cloud computing[4]. Thus, a single data center facility can be used to provide/host multiple virtualized data centers on the same physical infrastructure.

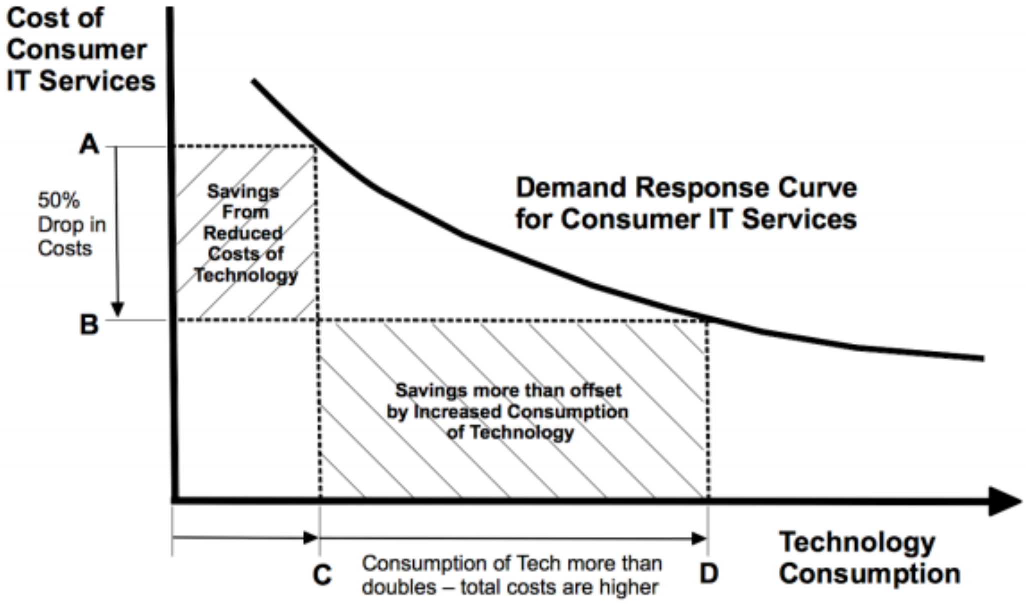
PUE, by its turn, is the most widely used metric regarding data center energy efficiency. “A score of 1 would mean that every watt of power expended in the data center is going toward ICT equipment, such as servers, mainframes, monitors, cooling systems, etc. A score of 2 means that only half the power expended is utilized for ICT tasks” (RUTH, 2011, p. 208). Thus, *the closest to 1, the better the PUE indicator* for a firm’s data centers. Keep this is mind because, in Chapter 5, I present PUE values for my four case studies.

[4] Data center virtualization, Available from: https://www.techopedia.com/definition/29883/data-center-virtualization, Accessed June 30, 2019.

Nevertheless, only measuring the carbon footprint is not enough to provide a thorough understanding of the resource consumption and sustainability impacts of ICTs. Expressions such as energy-efficient, carbon-neutral, and sustainable are an oversimplification, due to three reasons: i) the diffusion of energy efficient technologies does not necessarily lead to an overall reduction of energy use; ii) the production, use, and disposal of these technologies needs resources as well; and iii) although energy is crucial, the impact on other natural resources should also be included (HILTY; AEBISCHER, 2015, p.3). The most comprehensive methodology to evaluate ICTs environmental impacts is, thus, the *Life Cycle Assessment* (LCA) (HILTY; LOHMANN; HUANG, 2011, p.17). LCA is a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. Interestingly, in a recent LCA study regarding ICT's carbon footprint impact in Sweden, in which user equipment, access networks, control nodes, operators (companies) activities, data transmission equipment, third-party companies networks and data centers were analyzed, Malmodin et al (2014, p. 829) found that "*the parts closest to the user proved to be clearly responsible for the majority of the (environmental) impact,"* contrary to the more intuitive perception that the tech companies themselves (i.e., their operations) are the main sources of emissions.

Despite the exemplified efforts and available techniques, a major concern with greening in ICT regards the so-called *Jevons Paradox* (or rebound effect). Improving the efficiency of ICT services and equipment do not necessarily reduce the total amount of energy used, and thus the carbon footprint. This can be explained from economic and behavioral perspectives. Market dynamics are complex, so that resource decoupling (reducing the rate of use of primary resources, e.g., energy, per unit of economic activity) "may result in a growth rate higher than the decoupling rate, therefore counteracting the resource-saving effects of decoupling" (HILTY; LOHMANN; HUANG, 2011, p.22). Indeed, "as technological improvements increase the efficiency with which a resource is used, total consumption of that resource may increase rather than decrease" (TAINTER, 2009 apud HILTY; LOHMANN; HUANG, 2011, p.22). In Figure 4, below, we can observe that although the energy costs of ICT services may fall with cloud computing, the overall usage and energy consumption of networked ICT is likely to increase, as total technology consumption increases (CORCORAN, 2012).

Figure 4. Jevons Paradox



Source: Corcoran (2012, p.18).

These limitations are corroborated by Malmodin, Bergmark and Lundén (2013, p.14), which found that “the ICT sector’s total carbon footprint per average user has decreased from about 300 kg CO2e/year in 1995 to about 100 kg CO2e/year in 2007 and is estimated to decrease further to about 80 kg CO2e/year in 2020”, but this does not imply a decrease in total carbon emission. In fact, ICT’s total carbon footprint increases by about 4%/year (ibid., 2013). In their quantitative forecast for the ICT’s carbon footprint in 2020, based on data from the Carbon Disclosure Project, Malmodin, Bergmark and Lundén (2013, p. 14-15) reached some powerful conclusions. The ICT sector in 2020 compared to 1995 is estimated to have: i) increased number of users about 10 times to about 12,5 billion PCs, phones, etc.; ii) increased total data traffic volumes (including voice) about 1000 times; iii) decreased the footprint per average ICT user by about 70%; iv) increased its total absolute carbon footprint by a factor of about 3. Such conclusions, aligned with ICT’s limited total carbon footprint (about 2% to 3% globally), indicate that “only when used for transformative changes could ICT make a real difference to the overall global GHG emission level” (ibid, p.19).

Greening by ICTs has to do with the potential of these technologies to modify the life cycle of other products and services. “The long-term availability of ICT services may enable and foster a transition to a less material-intensive economy” (HILTY; AEBISCHER, 2015, p.16). Thus, the ICT industry may provide elements for a transformative structural change. This can happen through the following ways: a) optimizing the design; b) optimizing the production process; c) optimizing the use; d) optimizing the end-of-life treatment; and e) modifying the demand for other products, either by substitution (decreasing demand) or by induction (increasing demand) (HILTY; LOHMANN; HUANG, 2011). In this line, the ICT sector can be understood both as a problem and as a potential solution to the climate crisis and other environmental problems, through strategies that go "beyond the data center" (ELLIOT; BINNEY, 2008), i.e., beyond energy-efficiency per se.

In consonance with this idea, Hilty and Aebischer (2015, p.27) present an integrative framework regarding greening by ICTs. Such a framework is composed of three levels: 1) Life-Cycle Impact (L); 2) Enabling Impact (E); and 3) Structural Impact (S). Thus, it was called the LES model**.** *Life-Cycle Impact* regards the direct environmental impact of ICTs, or the environmental costs of providing ICT services. It includes the production and disposal of ICT equipment, covering the production of raw materials, the manufacturing of ICT hardware, recycling methods and final disposal of residues. It also concerns the environmental and social impacts of supplying the energy for ICT hardware and infrastructure. The Enabling Impact represents the indirect impacts of ICT, as well as the benefits of ICT services. It includes production/organizational changes, consumption/behavioral changes, and technological changes provided or facilitated by ICT products or services. Finally, the Structural Impacts are the macro socio-economic impacts enabled by (or influenced by) ICT. They are twofold: 1) Structural changes in the economic system, for instance through dematerialization of the society; and 2) Institutional changes, such as those provided by climate policies, sustainability social norms, or green development guidelines.

The LES framework can eventually be used to analyze how a business/industry has a wider environmental social/economic consequence for international development. For instance, tech firms' technologies, business models, and value chains regarding smart-grid projects influenced firms from the electric sector to increase their participation in the smart-grid business in Europe from 2000 to 2011. Incumbent firms from the electric sector did so through strategies such as acquisitions of many start-ups specialized in ICTs. Thus, tech companies "acted as catalysts for change" and played "a very crucial and transformative role" in the sectorial transition towards a smarter electricity in Europe (ERLINGHAGEN; MARKARD, 2012, p.897).

Regarding structural changes for international sustainable development, "ICT-enabled climate change mitigation could help pave the way for low-carbon development pathways in the world's developing countries" through sectorial opportunities in "energy generation, urban transportation and buildings, and manufacturing". However, major challenges for this include "lack of awareness of technological developments, unfavorable regulatory and political environment," and "limited incentives for investments and research" in these developing economies (ROETH; WOKECK, 2011, p.3-4). In line with this possibility, Zhang and Liu (2015, p.12) observed that, during the period 2000-2010, "the ICT industry contributed to reducing China's CO_2 emissions." This means that the ICT has an enormous unexplored potential to be applied in developing countries in order to contribute to their sustainability transitions. In fact, Viola and Mendes (2022) analyzed the application of emerging digital technology in Brazilian agriculture, to diagnose that there is an immense potential to improve climate governance in this sector by means of digital technologies.

1.1.3. Climate Change, Digitalization, and IR: a summary

What are the existing intersections between climate change, digitalization, and IR? As a matter of fact, few scholarly works on these topics investigate the use of ICTs for sustainable international development. Since the 1980s, the unequal world distribution of ICTs was considered a problem for development, even though the bulk of the literature on international politics neglected the subject (BRIEN; HELLEINER, 1980, p.446). With time, and with a "rapid accumulation of information systems in developing countries," (ibid, p.467), studies in IPE have given increasing importance to issues such as "technological determinism, state support of technological development (…) and unequal distribution of ICT resources" (WASKO, 2005, p.35-36).

Yet, there are still "large areas of the world, and considerable segments of the population, switched off from the new technological system" (CASTELLS, 2010, p.32). This is of course an important gap in IR literature. There are few IR and IPE studies on digital under-development in the global South, the technological setback of developing countries, and sustainable digital development in the poorest regions of the planet. In fact, "the second industrial revolution has yet to be fully experienced by 17% of the world as nearly 1.3 billion people still lack access to electricity" (SCHWAB, 2016, p.12-13).

Since the 2000s some studies have investigated sustainability and international development through ICTs. Hilty and Ruddy (2009, p.7) observed that ICTs can contribute to sustainable development "if these technologies are applied as enablers of dematerialized (less material-intensive) types of consumption." Heeks (2008, p. 26) defends a transition "from ICTs for international development (ICT4D) 1.0 to ICT4D 2.0", in which basically the "world's poor" would be considered "active producers and innovators" in the systems' design. This is of course a very naïve perspective, as the governance mechanisms of powerful corporations (including big tech firm) still remain top-down, and technological innovations are still restricted to a handful of professionals, corporate players and government bodies, far from the "world's poor" population.

As regards climate change, Oh (2017) studied the negotiations between developed and developing countries over the transfer of "environmentally sound technologies" in the context of the Paris Agreement. He found, as I have already analyzed, that such a process was embedded into three principles: marketization, privatization and deregulation. But other authors, such as Ono, Lida, and Yamazaki (2017) believe that ICT services are paramount to help achieve the objectives of the 2030 agenda, the Sustainable Development Goals (SDGs), and the Paris Agreement. This would be possible through a set of "smart" technologies, in the areas of water management, energy efficiency, mobility, city mobility, agriculture, and others. We will see in Chapter 5 that Alphabet, Amazon, Apple, and Meta are active in all these domains.

Alsamhi (2018, p.1) observed that smart technologies, such as Internet of Things (IoT), should be thought as "green tech", and developed as tools to "to reduce carbon footprint and promote efficient techniques for energy usage." Dubeux (2015), by its turn, investigated successes (China, South Korea, and Taiwan) and failures (Brazil) in state incentives to the development of clean technologies in developing countries. Others evaluated how ICT can contribute to climate change mitigation and adaptation in developing nations (ROETH; WOKECK, 2011; RUTH, 2011; ZHANG; LIU, 2015).

The focus on international development is a very relevant agenda for IPE (and IPEE) scholars, and for the analysis of the deeper impacts of ICTs on climate change. Firstly, because international development scholars understand how the private sector is linked to ICTs. Thus, international development literature is equipped to evaluate how Big Tech firms can be responsible for the production and distribution of green tech products and services in the global South. But, although there is a considerable literature connecting international development and MNCs with climate change (PINKSE; KOLK, 2009), it still widely neglects Big Tech firms (MENDES, 2021). This is one of the central discussions of the chapter 2 of this thesis. Secondly, because some distinguished IPE scholars have already shown interest in the use of ICTs in climate governance. For instance, some have considered the wide implications of digital technologies to global environmental politics, including climate politics (DAUVERGNE, 2020), which illustrate the growing relevance of this sector for IPE scholars.

The next section explores Industry 4.0, and its connections with climate change. The subsequent section presents a similar analysis for Artificial Intelligence (AI). Industry 4.0 and AI are recent developments in the frontier of the ICT industry. Thus, there is an interest in understanding if and how these concepts and technologies might help us tackle climate change.

1.2. Climate change and Industry 4.0

Two media articles provide an illustration of the meaning of Industry 4.0 (Fourth Industrial Revolution). For Perasso (2016, p.1), "more enthusiastic academics think of Industry 4.0 as: nanotechnologies, neuro-technologies, robots, artificial intelligence, biotechnology, energy storage systems, drones and 3D printers." For example, Silveira (2017) observed that cyber-physical systems, Internet of Things (IoT), and Internet of Services (IoS) result in production systems increasingly efficient, autonomous and customizable. This is because such technologies allow: a) real time operations - instantaneous data processing; b) virtualization - traceability and monitoring through remote sensors; c) decentralization: decision making performed by cyber-physical systems; d) orientation to services: software architectures aligned to the concept of IoS; and e) modularity: on-demand production systems.

These views resonate with the definition from the German Trade & Invest agency (GTAI, 2014), which coined the expression Industry 4.0 (or its German analogous, INDUSTRIE 4.0): "INDUSTRIE 4.0 connects embedded system production technologies and smart production processes to pave the way to a new technological age which will radically transform industry and production value chains and business models" (GTAI, 2014, p.6).

Industry 4.0 is, thus, the current industrial epoch. Naturally, it was preceded by three industrial revolutions. The 1st Industrial Revolution was characterized by the introduction of mechanical production facilities with the help of water and steam power. The 2nd industrial revolution happened with the deepening of the division of labor and mass production with the help of electrical energy. The 3rd, by the use of electronic and IT systems that further automate production, since the 1980s (GTAI, 2014, p.7).

Some concepts are crucial so we can understand Industry 4.0. (i) *cyber-physical systems*: enabling technologies which bring the virtual and physical worlds together to create a truly networked world in which intelligent objects communicate and interact with each other. (ii) *Internet of Services* (IoS): cross-sectional developments in applications connecting semantic technologies, cloud computing, and coupled platforms for concurrent services; streaming platforms used by tech firms such as Netflix and Spotify are examples of IoS. (iii) *Internet of Things* (IoT): cyber-physical systems and products applied in various niches: security, industrial operations, engineering and architecture, advanced training, mobility, etc. Examples of IoT are applications for smart factories, smart grids, and smart cities.

Klaus Schwab, founder and executive chairman of the World Economic Forum (WEF), is a leading figure on Industry 4.0. In Schwab's (2016) book *The Fourth Industrial Revolution*, Industry 4.0 is summarized as "a much more ubiquitous and mobile internet, along with smaller and more powerful sensors that have become cheaper, besides artificial intelligence and machine learning. Digital technologies that have computer hardware, software and networks at their core are not new, but in a break with the third industrial revolution, they are becoming more sophisticated and integrated and are, as a result, transforming societies and the global economy" (SCHWAB, 2016, p.12).

Industry 4.0 brings about a deep and systemic change, with impacts in the whole political-economic system. Such a change has a series of technological drivers, categorized by Schwab (2016) into three clusters: physical, digital and biological.

The physical manifestations of Industry 4.0 have a tangible nature, as exemplified by autonomous vehicles, 3D printing, advanced robotics, and new materials. The digital driver has a strong emphasis on IoT, sometimes also on the Internet of Everything (IoE), and it is predicated upon the "relationship between things (products, services, places, etc.) and people that is made possible by connected technologies and various platforms" (SCHWAB, 2016, p. 22). One interesting example of the digital driver is the *blockchain*[5] technology. The biological driver concerns the reducing cost and increasing ease of genetic sequencing. *Synthetic biology* is a fundamental element of this driver, once it allows genetic engineering, the ability to customize organisms by writing DNA. The CRISPR/Cas9 method[6], for instance, is a recent and controversial genome-editing technique that can revolutionize contemporary medicine. The amalgamation of these three technological drivers is at the core of Industry 4.0. A case in point is the combination of 3D manufacturing with gene editing to produce living tissues, a technique that has already been used to generate skin, bones and even organs (SCHWAB, 2016).

A recent literature is connecting Industry 4.0 and climate change. Youssef (2020) asked a question in this regard: can industry 4.0 help fight climate change? Accordingly, the only way Industry 4.0 can contribute to fighting climate change is if it "fulfils four conditions in order to be climate compatible. 1) It must promote energy efficiency and achieve substantial energy gains, 2) enable the circular economy and allow greater productivity and improved use of resources within closed loop supply chains which include re-use and recovery, 3) achieve sustainable development through eco-innovation, and 4) allow significant technology transfer to the least developed countries (LDCs) which must participate in industry 4.0" (YOUSSEF, 2020, p.161).

In addition, Fritzsche et al (2018) observed that "analysis of documents from intergovernmental organizations shows that Industry 4.0 is strongly associated with energy efficiency potentials that could contribute to climate change mitigation and more sustainable energy use in the industrial sector." However, the authors concluded that "based on a review of the scientific literature, it is currently not possible to validate this assumption" (Ibid., p.4511). This means that, although proponents of industry 4.0 (mainly governments from rich democracies/industrialized countries and the private sector) are positive about Industry 4.0 impact on climate change, much of the scientific community is skeptic about this possibility.

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[5] Blockchain is a "secure protocol where a network of computers collectively verifies a transaction before it can be recorded and approved" (SCHWAB, 2016, p. 23). So far, bitcoin is the best known blockchain application, but this technology can give rise to countless others.

[6] CRISPR/Cas9 is a method by which the genomes of living organisms may be edited. It is based on a simplified version of the bacterial CRISPR/Cas antiviral defense system.

1.3. Climate change and Artificial Intelligence

AI is a broad field of Computer Science which comprises the simulation of human intelligence by machines or computer systems. AI is considered a general-purpose technology (GPT) because it can be applied in upstream and downstream sectors in global production chains (AGRAWAL et al. 2018). AI has applications such as autonomous vehicles (FUNK, 2017), industrial robots (COMPAGNI et al. 2015), automated customer responses (LEVY, 2018), and in the military industry (ZHU; LONG, 2019). But AI can also be applied in tandem with other technologies in multiple products/services, including medical diagnosis, environmental monitoring, climate change adaptation (HUNTINGFORD et al. 2019), online education, civil construction and engineering, virtual personal assistants (such as Amazon's Alexa), recommendation engines, surveillance systems, crop prediction systems, smart grids, military drones, gene-sequencing algorithms and predictive analytics (MIAILHE; HODES, 2017).

A subset of AI is called Machine Learning. Machine Learning occurs when machines, or computer systems, develop the "ability to acquire their own knowledge, by extracting patterns from raw data" (GOODFELLOW; BENGIO; COURVILLE, 2017, p. 25). Deep learning, by its turn, is an approach to AI. Specifically, "it is a technique that enables computer systems to improve with experience and data" through a large number of repetitions of computational simulations (GOODFELLOW; BENGIO; COURVILLE, 2017, p. 31). In addition, big data are huge data sets that may be analyzed by computer systems, in order to unveil trends, patterns and associations. Goodfellow et al (2017, p.42) observe that deep learning has only recently become recognized as a crucial technology. That is because: "as more and more of our activities take place on computers, more and more of what we do is recorded. As our computers are increasingly networked together, it becomes easier to centralize these records and curate them into a dataset appropriate for machine learning applications (GOODFELLOW; BENGIO; COURVILLE, 2017, p. 42).

Taking AI as a backdrop analysis of our current digital society/economy, others have analyzed in depth this stage of digital revolution, although their analyses precede Industry 4.0. Ray Kurzweil's book *Singularity is Near* (KURZWEIL, 2005) is an interesting example. Kurzweil (2005, p.24) used the word *Singularity* to refer to "the human-machine civilization", once he understands that the technological evolution is a continuation of the biological evolution. According to him, the current stage of tech development (the merge of human technology with human intelligence) is characterized by three overlapping revolutions: a) genetics, the intersection of information and biology; b) nanotechnology, the intersection of information and the physical world, and c) robotics, based on AI. This approach is in close proximity with Industry 4.0 as presented by Schwab (2016).

Kelly (2017), by its turn, understands that 12 technological forces will shape the future of the global economy and society. In his book *The Inevitable*, the author lists such forces. Even though he never uses the term Industry 4.0, the processes he describes are encompassed by this concept. Accordingly, we live in a world where nothing is finished, everything is always becoming, in a process of continuous change (1 - Becoming). The present is characterized by the rise of technologies such as AI and machine learning, based on the culture of the algorithms and big data (2- Cognifying). This allows a plethora of flows of information and data in various forms – tweets, pictures, videos, etc. (3 - Flowing). In this networked political economy, there is a transition from the paper book to diverse types of screens, in computers, mobile phones and other devices (4 - Screening). Also, it is more important to have access to things than to own them, thus, people demand quick access to anything, opening space to a platform economy (5 – Accessing). As a consequence, ownership is giving way to a sharing economy - of cars, houses, workplaces, etc. - which allows the emergence of new kinds of tech firms and business models, such as Uber and Airbnb (6 - Sharing).

Six additional forces complete Kelly's (2017) rationale. As we live in a world of "information explosion", filtering is needed in order to select the few things and information that are relevant to us (7 – Filtering). This explosion of data is a result of the availability of universal tools and platforms that enable people to create their own online content, e.g., YouTube and Google Sites (8 - Remixing). This digitalization of life is mainly based on technologies such as virtual reality and augmented reality, and it is changing the way humans interact with machines and with each other (9 - Interacting). This process leads to a number of forms of self-track and quantification of personal data through many analytics' software (10 - Tracking). As a result of this "information explosion," the gap between what we know and what there is to be known is expanding, inciting us to question things more often (11 - Questioning). Finally, we are just at the beginning of these processes, which are actually *inevitable* (12 - Beginning).

The twelve forces identified by Kelly (2017) are in the genesis of what Yuval Harari (2018) describes as *the technological challenge* in his book *21 Lessons for the 21st Century*. The challenge regards the wide ethical and political implications originated by emerging digital technologies. These are hard challenges, but they are entering the international political agenda quite fast.

The *technological challenge* also concerns the increasing disillusionment with the liberal order, which is incapable of providing answers to the biggest problems we face: ecological collapse and the negative externalities of technological disruption – e.g., tendency of massive job losses, the possibility of loss of autonomy and privacy of humans in relation to machines, and the potential increase in global inequality between those who own the data and those who do not (HARARI, 2018, p.16-17).

Regarding AI and climate change, Cowls et al (2021) observed that there are "two crucial opportunities that AI offers in fighting climate change: it can help improve and expand current understanding of climate change, and it can contribute to combatting the climate crisis effectively." In their research, however, these authors observed that: "the contribution to climate change of the greenhouse gases emitted by training data and computation-intensive AI systems is significant" (ibid., p.1). Leal Filho et al. (2022) observed that AI can contribute to climate change adaptation similarly to climate-smart technologies, whereas authors such as Nordgren (2022) are more interested in the ethical dilemmas involved in using AI to fight climate change. These dilemmas emerge because, as other authors have observed, AI plays a dual role in climate change: AI can increase emissions, given that training machine learning models is a heavy energy consumer activity, but can also be employed in technologies to help in climate change mitigation and adaptation. Chapter 5 of the thesis will analyze extensively AI applications for Alphabet, Amazon, Apple, and Meta.

1.4. Two Gaps in IR and IPE literature

In this chapter, I connected climate change, digitalization and IR by means of a literature review. I've reached two conclusions after this exercise. First, neither the literature on the Anthropocene nor on IPEE have incorporated Big Tech firms so far, whereas Sustainability Transitions literature has already explored the power of multinational firms in affecting global sustainability and climate change. Yet, research connecting climate change and ICTs comes almost exclusively from Computer Science and Information Systems scholars. On top of that, even this technical literature has neglected the role of Big Tech firms on climate change.

The digital economy, illustrated here by an analysis of Industry 4.0 and AI (and their connections to climate change) is a powerful backdrop for us to understand recent debates on the role of technology in climate change governance. Yet, the connection between climate change and digitalization is yet to be added to the fields of IR and IPE. This is a central contribution this thesis aims to make.

CHAPTER 2

Multinational Corporations and the International Political Economy of Climate Change

2.1. An IPE approach towards MNCs and Climate Change

The headline of a recent article gives us interesting information to start discussing multinational corporations (MNCs) in IPE: *The world's top 100 economies: 31 countries; 69 corporations* (GLOBAL JUSTICE NOW, 2016). The article refers to a list produced by the NGO Global Justice Now, based on data from 2015, which compares the revenues of the Fortune Global 500 firms with the government budget of all countries that year. The list shows that out of the world's 100 largest economies, only 31 are countries, and the rest are MNCs. In addition, it demonstrates that the 10 largest MNCs have combined revenues exceeding those of the governments of the 180 poorest countries in the world (GLOBAL JUSTICE NOW, 2016). How does such a huge economic power translate into political power? Are IR and IPE scholars considering MNCs as (important) political actors? How are IPE scholars studying MNCs' influence on challenging social, political and environmental issues, such as climate change? These are some of the questions that animate this chapter.

In this chapter, I analyze some connections between digital MNCs, hereafter Big Tech firms, and climate change. While in chapter 1 I presented some intersections between climate change, digitalization, and IR, here I focus on Big Tech firms as a research topic in IPE, particularly in the IPE of climate change. I very briefly introduce Alphabet, Amazon, Apple, and Meta, my four empirical cases in the thesis (I will make their formal introduction next chapter).

The chapter is structured as follows. I analyze classical and contemporary IPE literature regarding MNCs. Recently, Latin American IPE scholars have developed interesting researches on the subject, thus I dedicate a subsection to Latin American IPE scholarship on MNCs. My central concern in the following part is to discuss the role of MNCs in the political economy of climate change. Subsequently, a brief conclusion closes the chapter, presenting some limitations of current IPE as regards Big Tech firms and climate change.

2.1.1. MNCs in IPE

In what is considered the seminal IPE paper, Susan Strange (1970, p.311) pinpointed the need for a theory to answer "some key questions at the border between economics and politics." In her words, such questions included: "the obsolescence of international trade theory vis-à-vis the reorganization of international production in light of the growing expansion of multinational corporations (MNCs)" (STRANGE, 1970, p. 311). Two decades later, Strange (1991) published *Big Business and the State*, a paper in which she argued that IR (and IPE) scholars still failed to include MNCs into their researches, simply because they defined power exclusively as the ability to create/destroy order in the international system. Thus, it was natural for them to focus on the state as a central actor. Strange (1991) observed that when power is conceived as the ability to create or destroy wealth (not "only" order) in the international system, and when the influence of elements such as justice and freedom in the composition of this wealth is considered, MNCs play a central role. In fact, "business actors have acquired political power to an extent that cannot be ignored by IR theory" (FUCHS, 2005, p.773).

To understand why MNCs are powerful agents (not only actors) in the international system (INOUE, 2016)[7], it is paramount to discuss the concept of power in IR[8]. Particularly, why do corporate power is so central to IPE and to IR? The concept of global governors provided by Avant, Finnemore, and Sell (2010) helps us to reflect upon this question.

Global governors are: "authorities who exercise power across borders for purposes of affecting policy (…) they create issues, set agendas, establish and implement rules or programs, and evaluate and/or adjudicate outcomes" (AVANT; FINNEMORE; SELL, 2010, p.2). Based on this concept, MNCs can be considered global governors in many respects. First, MNCs exercise power across borders when they "spread their tentacles" throughout the world by establishing subsidiaries in foreign nations, and thus have to negotiate with governments (and sometimes influence public policies) in these host countries (VERNON, 1971; KIMURA; ANDO, 2003; RAMSEY; ALMEIDA, 2010). Second, MNCs create issues and set agendas, for instance, when they exploit natural resources (GAMU; DAUVERGNE, 2018), or when they are involved in corruption (RODRIGUEZ et al., 2006) or environmental issues (KOLK, 2016) in host

[7] For Inoue (2016, p.106), the understanding of global climate governance should start from the differentiation between actors and agents, and the respective activities performed. Agency "refers to the ability of actors to prescribe behavior and to participate substantially and/or establish their own rules related to interactions between humans and their natural environment" (SCHROEDER, 2010, p.317). So, there are different levels of agency in global climate governance.

[8] In chapter 4, I make a thorough discussion on the concept of Big Tech corporate power. Based on extensive literature review, I developed an original typology for Big Tech power.

countries. In these cases, negotiations between States and corporations can lead to the establishment of rules or programs to regulate their activities (this is related to the concept of Corporate Social Responsibility, which I shall discuss later). Third, MNCs are able to evaluate and/or adjudicate outcomes, for instance when they disclose reports on corporate social and environmental activities to ensure transparency to investors (OLIVEIRA, 2017), or even when they help set environmental standards, such as ISO 14000[9].

Another approach for MNC's power can be derived from the work of Barnett and Duvall (2007). Accordingly, "power is the production, in and through social relations, of effects that shape the capacities of actors to determine their own circumstances and fate" (BARNETT; DUVALL, 2007, p.8). Based on this definition, they have developed a fourfold typology of power, from which I highlight two: structural power and productive power. The "structural power concerns the structures – (…) the co-constitutive, internal relations of structural positions – that define what kind of social beings actors are" (ibid., p.18). The very nature of the global capitalist economy qualifies MNCs as structurally powerful actors.

The productive power, by its turn, is "the constitution of all social subjects with various social powers through systems of knowledge and discursive practices of broad and general social scope" (ibid., p.20). Productive power leads to two important implications (i) it concerns discourse, or "the social processes and the systems of knowledge through which meaning is produced, fixed, lived, experienced, and transformed" (ibid., p.21); and (ii) "discursive processes and practices produce social identities and capacities as they give meaning to them" (ibid, p.21). In this sense, MNCs exercise their productive power whenever they employ resources (material, technological, financial, discursive...) in order to restate their legitimate role in providing services and products for society, either as the only agents interested in providing those goods or the only agents capable of doing so. Discourse is a central aspect of the MNC's power in global politics (FUCHS, 2005) and in climate governance (LEVY; EGAN, 1998; PULVER, 2011), as I demonstrate in section 2.2 of this chapter.

Another trait of MNC's power has to do with their political influence. Multinational firms showcase growing amounts of political (instrumental) power in

[9] ISO 14000 is a family of standards related to environmental management that exists to help organizations minimize how their operations negatively affect the environment.

international politics. “Instrumental power of business actors has increased," more visibly through practices such as *lobbying* (FUCHS, 2005, p.780), given that corporations have been “benefiting from improved access to politicians and bureaucrats, who have become increasingly dependent on the resources and inputs from business" (ibid., p.782).

In this vein, Fuchs (2005) provides another dimension of structural power. This has to do with MNCs’ agenda-setting and rule-setting power, which have also increased in recent decades: “business efforts to influence policy input go beyond the ability to move capital: self-regulation and Public Private Partnerships (PPPs) allow business actors today to actively set rules" (ibid., p.785). In this case, “rule-setting by business fills governance gaps public actors have left due to a lack of political will or capacity" (ibid., p.787). As a result, there is an increasing dependence of governments and bureaucratic agencies on business, suggesting that “the distribution of power between private and public actors is shifting towards private actors" (ibid., p.789).

In light of the concepts of global governors, structural, productive and political power, it is clear that MNCs bear a myriad of sources of influence in global politics. As a matter of fact, some IPE scholars have analyzed this issue substantially. Robert Gilpin (1987) analyzed in-depth the operations of MNCs in the global economy, with emphasis on the concepts of Foreign Direct Investment (FDI) and Foreign Portfolio Investments (FPI), and on the interesting relationship between U.S. MNCs and the global power of the United States. “Although some of the oldest and most successful multinational corporations are non-American, U.S. corporations had dominated the scene throughout the 1960s and into the next decade” (GILPIN, 1987, p.232). Curiously, this information can be extended to the present day (MENDES, 2018a), despite the fact that Chinese MNCs progressively climb the ladder towards the top of the global political economy (BRESLIN, 2016).

Joseph Nye (1974) emphasized that MNCs play at least three roles in day-to-day world politics: *private foreign policy*, when companies affect government’s decisions through economic means (promises of new investments, threats of withdrawal, bargaining); *instruments of influence*, when companies are used by governments as instruments of influence concerning trade, financial or security policies; and *setting the agenda*, i.e., intentional or unintentional roles of MNCs in helping setting the agenda of interstate politics. Robert Keohane and Van Ooms (1972) wrote an excellent review essay regarding these topics, based on the works of some of the most prominent authors that have studied MNCs so far: Charles Kindleberger, Edith Penrose, John Dunning, and

Raymond Vernon. After the discussion of FDI strategies and the importance of MNCs for the global expansion of the U.S. hegemony, and the relationship between MNCs and governments (both of host and home countries), Keohane and Ooms (1972, p.120) concluded that:

> (…) the multinational enterprise is a source of much complexity and confusion in contemporary international relations. Yet, the enterprise seems increasingly important for a number of issues of world politics: economic growth and income distribution, and the reactions to them by political actors; relative power positions of states; interstate conflicts caused or precipitated by economic factors; and the emergence of transnational relations in which the role of states is not so dominant as it may have been regarded in the past.

Despite being written 50 years ago, this statement still holds true. The power of MNCs continues to rise in the international system, as I shall demonstrate throughout this dissertation. In another essay, these authors highlighted the importance of regulating FDI, and the lack of an international institution to do so (KEOHANE; OOMS, 1975). Even though they pinpoint that FDI can be beneficial in a number of ways, these effects cannot be optimized without effective policies. Keohane and Ooms (1975) have observed that MNCs are the dominant organizational vehicles for direct investment, and should be regulated at a level above the nation-state. Recent scholarship corroborates that MNCs increasingly "drive the agenda of international trade politics" (RYU; STONE, 2018, p.273) and thus are subject to a series of OECD guidelines and prescriptions for good practices in international business. See, for instance, the OECD guidelines for the regulations of MNCs (MINISTÉRIO DA ECONOMIA, 2018). These "codes of conduct" are not always strictly followed by MNCs, what constitutes a major problem for corporate strategy, plus an evident flaw in the concept of Corporate Social Responsibility (CSR) (MENDES, 2018b; MENDES, 2021).

Recent IPE scholarship have analyzed MNCs through a variety of lenses. Some authors highlight the contemporary modes of capital accumulation and financial innovations linked with the offshore operations of MNCs (BRYAN; RAFFERTY; WIGAN, 2017). Others focus on how MNCs reshape global value chains and manage their international supply networks (SARKER; AZADEGAN; TRUCCO, 2017; VILLENA, 2018). Some researches argue that MNCs play an active role in global governance in order to increase their importance in various arenas, considering the costs of political participation and the benefits for their international competitiveness (LEVY;

PRAKASH, 2003). Advances have also been made concerning the role of MNCs on CSR issues (FALKNER, 2009; JAMALI, 2010; GAMU; DAUVERGNE, 2018), and on developing countries MNCs (AYKUT; GOLDSTEIN, 2007; CUERVO-CAZZURA, 2012; TUKIC, 2018; MENDES, 2021).

In spite of this flourishing literature, current studies suggest that "the role of corporations in international politics remains a neglected issue," in line with a more general perspective according to which "the role of actors other than the nation-state is one of the major challenges that IPE should come to grips with" (BABIC; FICHTNER; HEEMSKERK, 2017, pp.22-25). These authors pinpoint an interesting reason why such a perception holds true. It concerns the expansion of Chinese Transnational State-Owned Enterprises (TSOE) to BRICS countries, particularly Brazil, a topic so far little explored even by scholars from the BRICS: Brazil (…) appears as a preferred destination, especially for Chinese TSOEs, which might have further implications for the BRICS perspective: what does it mean for the power relations between two members, if one is heavily invested in the other? At the beginning of 2017, the Chinese TSOE State Grid – the largest utility company worldwide and in 13th place on the largest states/corporations list (…) – took over the third largest Brazilian energy firm, CPFL. Further important Chinese overseas investments in Brazil are food giant COFCO or Sinochem Brazil. Whether these kinds of activities should be understood as enhancing economic cohesion or as a leveraged Chinese power position towards Brazil, needs to be determined in more detailed studies" (BABIC; FICHTNER; HEEMSKERK, 2017, p.37). Based on this discussion, one interesting question is how MNCs have been studied by Latin American IPE scholars.

2.1.2. MCNs in Latin American IPE

Saguier and Ghiotto (2018) understand MNCs as a "meeting point" to IPE scholars in Latin America. Although they observe a little penetration of IPE content in university programs across Latin America, they emphasize the importance of recent research on MNCs, particularly those concerning global environmental governance. These authors pinpoint interesting studies about (i) the impacts of FTAs (Free Trade Agreements) on specific economic sectors, and on national and regional value chains; and (ii) the creation of new regulatory frameworks built from the clauses of such treaties.

Such studies proliferated particularly in Mexico, stressing the consequences of NAFTA for the region.

As regards environmental governance, Seguier and Ghiotto (2018) argue that corporations are key players in *environmental IPE*, “because MNCs are responsible for environmental damages, the generation and concentration of economic wealth through the commodification of the environment; but also, because they are the object of resistance on the part of socio-environmental movements” (SAGUIER; GHIOTTO, 2018, p.177). This is in line with recent works regarding the dynamics of exploitation and violence between mining corporations and local communities in Peru (GAMU; DAUVERGNE, 2018), the formation of South–South transnational advocacy networks against Brazilian (public-private) hydropower projects in the Peruvian Amazon (MOREIRA et al, 2019), and the synergy between big palm oil producing companies and the Brazilian government, regarding the use of labels and certifications recognized by stakeholders from the palm oil global value chain (VEIGA; RODRIGUES, 2016).

Tussie (2015) also recognized the importance of MNCs. “As long as politics is not only public policy, we must claim a wide constellation of actors, such as large companies and their capture of the State” (TUSSIE, 2015, p.171). Despite being studied by IPE scholars since the 1970s, recent scholarship considers firms especially relevant in IPE because of the rise of emerging countries MNCs (ibid., p.158).

Latin American IPE scholars concentrate their researches in the local subsidiaries of foreign MNCs, a more traditional issue in IPE. Examples include the expansion of Japanese MNCs to Latin America and East Asia in the late 20th century (KIMURA; ANDO, 2003), the geo-economic interests behind the presence of Chinese MNCs in Brazil (BECARD; MACEDO, 2014), and the expansion of Brazilian multinationals abroad (RAMSEY; ALMEIDA, 2010; SILVA-REGO; FIGUEIRA, 2017; RODRIGUES, 2018).

This last topic is particularly interesting because it congregates Foreign Policy Analysis, a very traditional topic in IR, with IPE. Let’s take as example the work of Silva-Rego and Figueira (2017). They explored the relationship between Brazilian foreign policy and the internationalization of local firms. The authors verified a close connection between Brazilian civil construction MNCs and the Ministry of Foreign Affairs, in search of technical and diplomatic support, and with the National Bank for Economic and Social Development (BNDES), in search of financial support, throughout the whole internationalization process of these firms. These results are in line with Rodrigues and

Gonçalves (2016), who observed that Brazilian agriculture, mining and civil construction firms played an important role regarding bilateral relations between Brazil and Angola, during their internationalization to Africa. Moreover, Rodrigues (2018) analyzed data from 1998 to 2014 to conclude that Brazilian MNCs became central agents in Brazil's international political strategy in the period. "Foreign policy has been an intermediary instrument to foster business opportunities and to protect Brazilian MNCs against political risks" (RODRIGUES, 2018, p. 6), in close alignment with the conclusions reached by Silva-Rego and Figueira (2017).

Recently, *platform MNCs* have sparked the interest of Latin American IPE scholars. Seoane and Saguier (2019) argue that we are entering a "new global political economy" characterized by data capitalism. "Capital accumulation based on the extraction, safeguarding, analysis and (ab)use of data for different purposes is led by few large internet companies," mainly headquartered in the United States and in China (SEOANE; SAGUIER, 2019, p.115). Big Tech firms such as Amazon, Apple, Meta, Alphabet, and Microsoft (U.S.) and Alibaba, Baidu, Tencent and Huawei (China) are global leaders in the tech sector. They are powerful rule-setters regarding the governance of digital trade (e.g.: U.S. tech firms lobby both in the US and in Europe to guarantee that digital trade rules are in tune with their economic interests), digital finance (e.g.: they contribute to the development of cryptocurrencies, e.g., Bitcoins, based on blockchain), and environmental exploitation (e.g.: these firms develop technologies that allow investigating with greater accuracy the availability of biological and natural resources, contributing to activities such as biopiracy or bioprospecting) (ibid., p.122-126).

Nevertheless, studies such as Seoane and Saguier (2019) are rare in Latin America. Despite the important contributions highlighted above, IPE scholars in the region still fail to study platform multinational (MENDES 2021). When it comes to more specific issues, such as the relationship between Big Tech firms and climate change, literature is non-existent. While on the one hand this is justified as regards digital technologies, whose studies are embryonic even in developed countries, on the other hand, Latin American IPE research on MNCs and climate change is lagging behind. As we shall see in the next section, there is already an extensive body of literature on MNCs and the political economy of climate change, particularly in global North IPE. Needless to say, global North IPE scholarship is meager when it comes to the particularities of MNCs from/in Latin America, including their environmental, climate and technological impacts in this region.

2.2. MNCs and the International Political Economy of Climate Change

The literature on MNCs' responses to climate change is extensive, dating back to at least the early years of the 21st century. Two authors in particular stand out in the development of this literature: Ans Kolk and Peter Newell. Therefore, their main works will be scrutinized in sub-section 2.2.1. Subsequently, in section 2.2.2., I explore contemporary scholarship on MNCs and climate change.

2.2.1. Early studies on MNCs and Climate Change: Ans Kolk and Peter Newell

Ans Kolk, a Business professor at the University of Amsterdam, was one of the first scholars to investigate the relationship between MNCs and climate change. Her initial concern orbited around *corporate environmental reporting*. At the turn of the 21st century, firms experienced "an increasing need to move from environmental statements and intentions to quantified, comparable, verifiable and even verified information" (KOLK, 1999, p.225). At that time, however, companies that published environmental reports were a minority. Research on the Fortune Global 250 firms revealed that only 35% of them published such documents (KOLK; WALHAIN; WATERINGEN, 2001, p.15). Those who published reports were from sectors with direct environmental impact, such as chemicals, pharmaceuticals, oil and motor vehicles. Out of 250 Fortune global firms, 100% coming from the pharmaceutical, mining, and forest/paper sectors published environmental reports, compared to less than 20% of firms coming from the telecommunications, retail and insurance sectors (ibid., p.20). Less than 40% of firms from Japan and the United States published reports, while in firms from the Netherlands, Norway, and Sweden, the reports exceeded 70%.

Kolk investigated with particular interest the *Oil & Gas* sector, due to its obvious climate impact. After Kyoto, MNCs from this industry increasingly took measures to address climate change. In their case studies of British Petroleum, Royal Dutch Shell, Texaco and ExxonMobil, Kolk and Levy (2001, p. 501) found that "BP and Shell had moved toward supporting emission reductions and investing in renewable energy, while Texaco had begun to move in a similar direction." But at that time ExxonMobil still strongly opposed climate initiatives. "Divergent behavior was explained in terms of company-specific factors, particularly corporate histories of profitability and location, (…) degrees of centralization and the presence of climate scientists" (ibid., p.501). Country institutional context also played a major role in these firms' climate strategies. “The disparate reactions of U.S. and European oil companies in the early phase of the climate issue were (…) related to regulatory expectations, norms concerning the conduct of business-government relations, and cognitive assumptions regarding the future of fossil fuels and substitute technologies” (LEVY; KOLK, 2002, p.296). However, stakeholder pressures, social and political structures, and the interactions with competitors, governments, and media also played an important role (KOLK; LEVY, 2001; LEVY; KOLK, 2002).

A further analysis of MNCs from the Fortune 500 revealed that two climate strategies prevailed. First, an *information strategy* aiming to influence policy makers. In this case, “instead of trying to withhold governments from doing something against rising GHG emissions, most firms (…) aimed to push policy makers in the direction of market-based solutions such as emissions trading and voluntary programs” (KOLK; PINKSE, 2007, p.225). Second, a *self-regulation strategy*, involving “a broad range of other political actors, such as business groups, environmental NGOs, and international institutions” (ibid., p.225). To implement both strategies, firms worked mostly in collective action. Interestingly, firms from Australia and the United States, that did not ratify Kyoto, more often cooperated with NGOs and business groups in comparison to Japanese and European firms which had ratified the agreement.

The evolution of these corporate practices culminated in more advanced reporting mechanisms, such as the Carbon Disclosure Project (CDP). The CDP was successful in pushing companies to increasingly disclose information about their climate change activities. Nevertheless, such detailed carbon accounting did not necessarily led to lower levels of GHG emissions. CDP 2006, for instance, “concluded that high-impact sectors such as utilities, oil and gas, metals and mining generate most emissions and that the trend shows increasing emissions in these sectors (…) in spite of all attempts to increase accounting and reporting” (KOLK; LEVY; PINKSE, 2008, p.742).

In recent works, Kolk investigated MNCs’ capacity to develop corporate innovations for climate change mitigation and adaptation. Firms face numerous challenges and trade-offs for adopting green innovations, particularly: (i) the trade-off between technology development (towards a radical departure from the existing energy infrastructure, requiring huge R&D investments in disruptive innovations) or technology deployment (by understanding that significant emissions reduction could also be achieved by scaling up technologies based on existing know-how, an approach called “stabilization wedges”); (ii) how low-carbon solutions can be brought to market, by targeting consumers in either mainstream markets or niche markets; (iii) challenges regarding companies' bargaining power and willingness to cooperate with others (including competitors) in order to implement climate change innovations (PINKSE; KOLK, 2010, pp.264-5). These are the "three main issues faced by companies in the transition towards a low-carbon economy" (ibid., p.263).

In a recent study, Kolk (2016) investigated more broadly how the two top (and long-standing) journals in International Business (*Journal of World Business* and *Journal of International Business Studies*) addressed CSR issues. In the last 50 years, these journals consistently published papers regarding the (green) environment, poverty and (sustainable) development, and climate change.

Now, let's change the focus in order to present another scholar who developed seminal research on MCNs and climate change: Peter Newell. Dr. Newell is an IR professor at the University of Sussex, UK. He has investigated in particular the role of *fossil fuel lobbies*[10], whose "empirically observable influences" on climate policy include actions throughout the whole policy cycle. In essence, at the turn of the 21st century such lobbies led to a kind of "un-politics of climate change", a process of "non-decision-making", which helped frame climate change policies as issues "that governments were unable to consider because of the negative impact they would have on industries represented by the fossil fuel lobbies" (NEWELL, 2000, p.118). Interesting at that time were the reactions of the US and European industries: while the latter started to play a constructive part in climate policy debates, the former framed the debate on whether or not climate change was a problem at all (ibid., p.121). In the U.S., the strategy of avoiding climate policies took place in six stages:

> First, (business) groups sought to challenge the science behind climate change. (…) a second strategy started at recognizing that skeptical publics were more likely to trust NGOs over government and business in environmental debates, (so) the idea was to create business-funded environmental NGOs (…) The third element of the strategy was to emphasize the economic costs of tackling climate change (…) This led to the adoption of a fourth strategy: double-edged diplomacy aimed at creating stalemate in the negotiations towards an agreement at Kyoto. (…) Each of these strategies

[10] Newell (2000, p.97) defines fossil fuel lobbies as "globally organized corporate coalitions representing the coal and oil industries, as well as heavy industry and the car and chemical sectors, which have a key interest in the form that climate policy takes."

> fed into the sixth pillar of firms' political strategy at the time: directly influencing the climate change negotiations. Groups such as the Global Climate Coalition and the Climate Council (…) worked closely with oil-exporting states whose interests were also threatened by the prospect of emissions cuts (BULKELEY; NEWELL, 2010, pp.88-91).

Nowadays "climate change has been repositioned by some elements within the business sector as a business opportunity, which has led to more positive engagement with climate governance initiatives" (ibid., p.92). Firms dominate every stage of the value chains that eventually make up most of the GHG emissions. So, corporations "can also serve as powerful engines of change" (LEVY; NEWELL, 2005, p.1). In fact, in the formation of the UNFCCC and the subsequent Kyoto Protocol, "strategies have broadened to target the corporate sector (…) in an attempt to hold these actors to account for their climate footprints" (NEWELL, 2008a, p.123). This fact clearly reflects perceived shifts in political authority towards an *increasing role of the private sector* in the governance of climate change. One strategy in this respect was the construction of *carbon markets* (BULKELEY; NEWELL, 2010, p.94). There is also a growing tendency towards the adoption of corporate accountability strategies, particularly those involving *private regulation*.

A note is necessary here, since private regulation is a broad concept. In essence, "private regulation can emerge in two main forms: i) when civil society directly empowers private regulators for the achievement of socially desirable results; and ii) when civil society 'delegates' regulatory powers to government, and the latter decides to delegate regulatory activities to private players through self- or co- regulation" (CAFAGGI; RENDA, 2012, p.12). Considering the concept of private regulation, it is interesting to see how private firms started to act on climate governance. "Businesses have sought to set up their own forms of standards and voluntary regulation that allow firms to show that they are compliant with certain performance criteria, e.g.: The Voluntary Carbon Standard and the Climate, Community and Biodiversity standard" (ibid., p.97).

One important turning point is that now there is a change of focus from regulating major Oil & Gas companies to increasingly regulating firms in the financial sector. "From targeting the largest polluters in the fossil fuel economy, attention has increasingly turned to the financial sector actors, whose investments in industry and demands for a short-term return play such a decisive role in the contemporary global economy" (NEWELL, 2008a, p.149). Thus, the political economy of climate change has also to do with the dynamics of international investments and financial markets in countries such as India and China, whose ambitious growth targets may represent future challenges in environmental governance. Considering the poor climate leadership of these countries (VIOLA; FRANCHINI, RIBEIRO, 2012), foreign investments and MNCs will most likely play a strong role in their future climate profiles (NEWELL, 2008b).

But again, despite important, initiatives such as private regulation, targeting especially the strategic financial sector, carbon markets, and looking deeper into the climate profiles of fast-growing developing countries are no silver-bullet solutions. Indeed, *climate capitalism* has a wicked side in international political economy:

> The world we are referring to is that of the financial markets (whose credibility is not currently at a historic highpoint) and large transnational corporations, who have been empowered to turn climate change into a question of trading and investment. (…) How did we end up with this way of responding to climate change? And are efforts to buy and sell units of carbon little more than a scam, where business people and financiers get to make money without delivering real cuts on greenhouse gas (GHG) emissions? Or, do these new markets represent the start of the greening of the global economy, a serious attempt to mobilize those with power in the global economy to address perhaps the greatest challenge we have ever collectively faced? More specifically, can they lead to the decarbonization we need? (NEWELL; PATERSON, 2010, p.2)

A curious approach regarding climate capitalism refers to "novel and imaginative forms of *coalition and alliance-building*" (NEWELL; PATERSON, 2010, p.188). Such an approach would bring together "people who could never have previously imagined working together – environmentalists with venture capitalists, trade unionists, and business leaders, local government officials with UN bureaucrats" (ibid., p.188). Even though very naïve in imagining a future where financial capitalists and environmentalists would "work together," this comment sparks some questions. How would business leaders and MNCs executives fit in such a picture, i.e., how would they act in climate/environmental governance? What would be the contribution of Big Tech firms' business leaders and CEOs to the future of climate change? The next two sections go beyond the works of Ans Kolk and Peter Newell in addressing these reflections in light of contemporary literature. Yet, Chapter 5 of this thesis answers this question empirically based on my research on Alphabet, Amazon, Apple, and Meta.

2.2.2. Current IPE Perspectives on MNCs and their Responses to Climate Change

Companies adopt climate strategies for reasons that go well beyond social responsibility. In particular, MNCs apply voluntary GHG emissions reductions for strategic reasons, ranging from operational improvement (e.g. energy cost reductions); anticipating and influencing climate change regulations; accessing new sources of capital (e.g. GHG trading schemes); improving risk management (e.g. using financial tools to hedge against climate risks); elevating corporate reputation; identifying new market opportunities (e.g. products and services involving technologies for GHG/other pollution reductions); and enhancing human resources management (changing organizational culture, enhancing firm's morale and thus enhancing retention rates of skilled workers) (HOFFMAN, 2005).

Okereke (2007) distinguished motivations, drivers, and barriers to corporate climate change management. Motivations, or those "factors that closely relate to the innate concern of business for profit and comparative advantage" (ibid., p.475), included: profit, credibility, and leverage in climate policy development, fiduciary obligation, guiding against risks, and business ethics. Drivers, understood as "factors that are rooted in wider societal pressures and concern for the environment" (ibid., p.475), included: energy prices, market shifts, regulation and governments directives, and technological change. Barriers included the lack of a strong policy framework and uncertainties regarding future government regulations and market responses.

A critical note is valid here. Okereke (2007) considers the technological change in a very limited operational sense. According to him, it refers to the "the installment of new or replacement of existing office equipment and machinery with the bid to curtail in-house GHG emissions or increase energy efficiency" (ibid., p.478). In this doctoral dissertation, however, technological change is considered a broader structural process, related to the potential changes brought up by the digital economy towards a low carbon future. That is, a process in which the ICT sector is a pivotal driver in the international political economy of climate change.

Besides operational guidelines, *the political and social context* also play a major role in firms' environmental decisions. "Changes in firm environmental behavior are not exclusively dictated by (…) firms' operational characteristics but are also motivated by perceptions of profit opportunities generated in the social networks and policy fields in which firm managers are embedded" (PULVER, 2007, p.74). Both internal (organizational characteristics, investors, etc.) and external (regulatory, legal, reputational, market) drivers push corporations to adopt climate adaptation strategies (AVERCHENKOVA et al, 2017).

Therefore, we must evaluate "firm greening" not only at the level of the firm, but also from a broader political, social and economic perspective, in line with IPE. Thus, corporate responses to climate change can be examined in at least three areas: (i) business practices, such as the ones analyzed by Hoffman (2005); (ii) corporate governance, i.e., systems of rules, practices, processes, and decision-making structures guiding those who control the corporation; and (iii) political action, or how "corporations attempt to shape the organizational, informational, legal, and political contexts in which they operate" (PULVER, 2011, p.456).

In essence, *corporate responses vary* considerably. These variations are due to differences in national political contexts, such as the contrasting climate responses of US corporations in comparison to their European counterparts (LEVY; KOLK, 2002; BULKELEY; NEWELL, 2010; PULVER, 2011). Responses also vary because of sectorial differences. In terms of physical risks, the sectors of agriculture, forestry, healthcare, pharmaceuticals, insurance and tourism will be the most highly impacted by climate change (PULVER, 2011). Different levels of pressure from the civil society of countries where companies operate also play a role (IHLEN, 2009). Interestingly, even the specificities of distinct categories of MNCs influence their climate responses regarding carbon reporting. Global MNCs, highly integrated to international forces and less likely influenced by (host) country institutional pressures, seem to present a consistent overall quality of reporting on climate change (Big Tech firms are within this category). Multi-domestic MNCs, by their turn, grant more autonomy to subsidiaries, with products and services designed to meet the demands of local markets, and usually find more difficulty in delivering standardized/high-quality reporting (COMYNS, 2017).

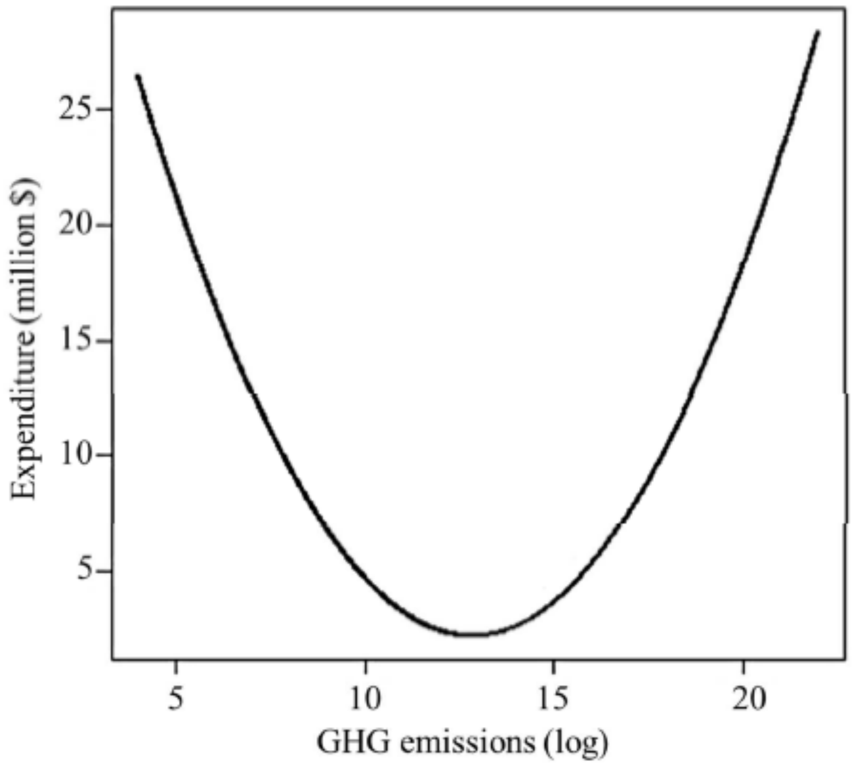
Moreover, the IPE literature has been steadily citing transnational channels and mechanisms for *corporate action on climate change governance.* There is currently a "shift from intergovernmental regimes to public-private and increasingly private-private cooperation in global (climate) policy making" (BIERMANN, 2011, p.537), even though "transnational channels of corporate influence" are as old as the Business Council on Sustainable Development (today, World Business Council for Sustainable Development, WBCSD), founded in 1992 (LEVY; EGAN, 1998, p.343).

These channels are considered by some as Global Public Policy Networks (GPPN), and include initiatives such as the OECD's Guideline on Multinational Enterprises, the Global Reporting Initiative (GRI), and the Global Compact (GC), linked to the United Nations (CLAPP, 2003; DETOMASI, 2007). Others evaluate these practices as Transnational Private Governance (VEIGA; RODRIGUES, 2016). Biermann (2011) and Newell and Paterson (2010) see such mechanisms as positive and maybe transformative initiatives to cope with climate change. Others are more in tune with my argument in this thesis. They argue that MNCs use their power within these policy networks to influence environmental institutions and to advance convenient agendas (DAHAN; DOH; GUAY, 2006). In this sense, such initiatives are considered practices of "ecological modernization," inasmuch as MNCs use their influence to shape and frame discourse around climate change to fit their own business interests (LEVY; EGAN, 1998).

This leads us to another well-studied topic regarding MNCs' responses to climate change: lobbying. In the United States, both "brown" (heavy GHG emitters) and "green" (lower GHG emitters) firms are active in lobbying related to climate change. Between 2006 and 2009, 1.141 U.S.-based firms spent together over US$ 1 bi on climate-related bills (DELMAS; LIM; NAIRN-BIRCH, 2016). These authors found an interesting "U" share relationship between climate performance (GHG emissions) and lobbying activities (Figure 5), i.e., "both dirty and clean firms are active in lobbying, suggesting that while dirty firms lobby to maintain the *status quo* clean firms view environmental regulation as an opportunity to gain firm-level advantages" (ibid, p.5).

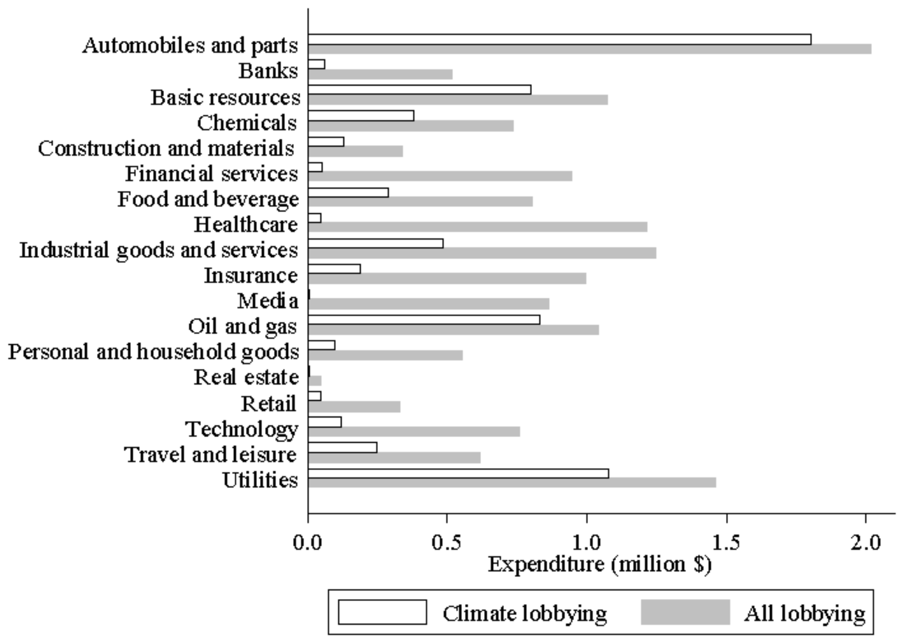
Another finding of this study is that the mean estimated annual lobby was around US$2.3 million per firm, with a maximum of US$29 million spent by Exxon Mobil in 2008. Regarding the amounts spent on legislative lobbying, Figure 6 shows that automobiles and parts, basic resources, utilities, and oil and gas sectors devote the majority of their lobbying to climate change.

Figure 5. Relationship Between Emissions and Lobbying Expenditure in the U.S., 2006-2009



Source: Delmas, Lim and Nairn-Birch (2016, p.40).

Figure 6. Means of Lobbying and Climate Lobbying Expenditure by Sector in the U.S., 2006-2009



Source: Delmas, Lim and Nairn-Birch (2016, p.38).

While the bulk of the scholarship regarding business lobbying on climate change negotiations concluded that "business efforts to influence negotiations have been more prevalent and effective at the state level than at the international level" (VORMEDAL, 2008, p.36), recent studies suggest that business and industry NGOs (BINGOs) have been increasingly active within the UNFCCC. In particular, BINGOs "target and collaborate with a multitude of national delegations and international institutions, using corporate technological power on their transnational business lobbying strategies" (ibid., p.37). Two concepts are paramount in Vormedal's study. *Corporate technological power* highlights the "critical role corporate actors play in shaping the knowledge framework of international environmental policymaking by having the power to innovate, develop, diffuse and implement new technologies that help regime implementation" (VORMEDAL, 2008, p.47).

Another powerful concept is *transnational business lobbying*. Besides participating in international environmental negotiations, BINGOs have been relatively successful in their efforts to influence such negotiations and their outcomes, thus showcasing influence within the international climate regime at the bureaucratic and political levels (VORMEDAL, 2008, p.37). These shifts in business strategies from opposition to support for international climate regimes could potentially "create more enabling conditions for inter-state bargaining and lead to the adoption of more extensive and stringent international institutions" (VORMEDAL, 2010, p.270). Obviously, we have to balance Vormedal's argument with the fact that, even though business sectors increasingly support more effective climate legislations, their climate operations and strategies may not be the best practices or even effective. The cement industry in Europe, for instance, embraced climate change and the need for action, recognizing that current legislation is "inadequate and unfavorable" to achieve emissions reductions. But, at the same time, they "are also shifting their CO_2 emissions to less developed countries of the South" (OKEREKE; KUNG, 2013, p.286). Besides unethical, this is a highly problematic greenwash strategy.

As we have seen, several authors have analyzed how manufacturing and oil multinationals influence climate governance (IHLEN, 2009; PINKSE; KOLK, 2009; DELMAS, 2016; KOLK, 2016; STARR, 2016). But, so far, few studies have focused on Big Tech firms. Research on the intersections between ICTs and climate change is incipient, despite growing, as I have demonstrated throughout chapter 1. Current studies highlight ICTs' importance on providing climate adaptation measures on the agricultural sector (SALA, 2009); building capacity to manage and respond to extreme events (EAKIN et al, 2014); enhancing databases and meteorological information to adaptation and mitigation (UPADHYAY; BIJALWAN, 2015); improving energy efficiency in the urban environment (MARIC et al, 2016); analyzing how green IoT can promote efficient techniques for energy usage in ICT infrastructures (ALSAMHI et al, 2018), to name a few. In spite of emphasizing the crucial role of ICTs in tackling climate change, these studies have mostly neglected the firms that provide digital technologies.

Big Tech firms increasingly engage in strategies to cope with climate change. Alphabet, the parent company of Google, has recently published a report stating that it has clear targets concerning carbon emissions reduction, applying strategies such as sustainable workplaces, efficient data centers, and incentivizing the use of renewable energy (GOOGLE, 2017). Amazon has achieved 50% of renewable energy use in 2018. Also, it has six solar farms in the state of Virginia, and wind farms in the states of Indiana, North Carolina and Ohio, all in the U.S.[11] Facebook was successful in developing a data center model that was 38% more energy efficient, and used 80% less water, compared to the average used in the industry. Meta (when it was still Facebook) funded the Open Compute Project, publicly sharing these data centers designs across the industry. The firm committed to power its operations and data centers with 100% renewable energy by 2020[12.] In 2018, Apple claimed to have achieved 100% of energy use from renewable sources, including all its facilities - offices, retail stores, and data centers, in 43 countries[13.]

2.3. Limitations of IPE regarding Big Tech Firms and Climate Change

At the end of this chapter, I reached some important conclusions, particularly to IPE. (i) Although the IPE literature is extensive in analyzing MNCs, Big Tech firms have been neglected, and this represents a central limitation in contemporary IPE (MENDES, 2021; ATAL, 2020). (ii) There is an extensive literature analyzing MNCs'

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[11] Amazon Web Services e Sustentabilidade. Available from: https://aws.amazon.com/pt/about-aws/sustainability/#progress Accessed July 3rd, 2019.

[12] Sustainable data centers. Available from: https://sustainability.fb.com/data-centers/ Accessed July 3rd, 2019.

[13] Environmental Responsibility Report. Available from: https://www.apple.com/lae/environment/pdf/Apple_Environmental_Responsibility_Report_2019.pdf Accessed July 3rd, 2019.

influences on climate change, but research is lacking as regards Big Tech firms' impact on climate change (this is a central contribution of this thesis). (iii) Latin American IPE scholars have widely disregarded MNCs so far, but some few recent studies can be found. (iv) Big Tech firms are some of the most valuable global firms in market capitalization, they have huge economic power and growing amounts of political power, yet they are still neglected by the IR and IPE research community. (v) IPE theories need to be rethought in order to understand the complexity of Big Tech firms' governance and global political economic impacts.

PART II

Big Tech Firms and the Challenges of Platform Governance

CHAPTER 3

Big Tech Firms and their Platform Logic: Introducing Alphabet, Amazon, Apple, Meta

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3.1. Digital Technologies in IPE

This chapter introduces Part II of the dissertation. In Part I, I was interested in demonstrating how climate change, multinational corporations, and digital technologies intersect in IR and IPE literature. Now I change the focus to discuss more specifically Big Tech firms, some of their particularities, and the challenges ahead of the global governance of these emerging global corporations. I also introduce my four case studies (Alphabet, Amazon, Apple, Meta), highlighting some of their market drivers and corporate dimensions. How are scholars responding to the challenges imposed by digital technologies and by Big Tech firms? Have IR and IPE scholars incorporated these topics into their research agendas? What are the theoretical, methodological, and epistemological consequences of these new actors for the disciplines of IR and IPE?

In the book Technologies of International Relations, edited by Kaltofen, Carr and Acuto (2019), prominent IR scholars commented on how they have approached technology in their scholarship. Ole Wæver, for instance, believes that researchers have now to upgrade their understanding on technical transitions: "not because of a shift from industrial to digital technology, but rather because of the increasingly autonomous actions of technology. The whole artificial intelligence tendency for systems to increasingly act on themselves is kind of a revolutionary change" (MONSEES; WÆVER, 2019, p.15). When asked about how technology should be studied in IR, Saskia Sassen observed that it is firstly necessary "to recognize that there is always a much larger operational space that needs to be seen and problematized beyond what is commonly argued," for instance, the physical and mundane aspects of "everyday technologies", exemplified by "the huge waste implication of the digital revolution, the masses of electronic waste and the global logistics required to keep it all together and 'new'" (ACUTO; SASSEN, 2019, p.41-42).

Joseph Nye pinpointed that technology has played a central role in his work, which includes the role of technology in nuclear policy, the influence of ICTs on the increasing and complex interdependence, and the effects of the Internet on domestic policies in the USA (CARR; NYE, 2019). Recently, Nye wrote about dissuasion and deterrence in the cyberspace (NYE, 2017), emphasizing the novel role of ICTs in international security. When asked about the most significant challenges and opportunities of the ongoing technological change for IR, the author was emphatic regarding two research lines: climate change, as "some people say that it's going to require climate engineering," and artificial intelligence and machine learning, topics about which he believes "there is going to be no shortage of need for IR departments to have people who are able to at least be literate or conversant with these technological problems because I think they're going to be increasingly important to politics and to our lives" (CARR; NYE, 2019, p.95).

Barry Buzan observed that "we should go beyond seeing technology as a 'sector', rather conceptualizing it as a variable that affects all domains of the international system" (TANCZER; BUZAN, 2019, p.116). But the most interesting aspect of his thinking is the possibility of "globalizing IR" through technology: "The information age provides opportunities for the globalization of IR. IR as a discipline is, has been, and will probably continue to be far too much based on Western history. (…) It seems to me that there is a real need to bring other people's histories and other people's political theories into thinking about IR in a more global way. The technologically connected world and technologies underlying interaction capacities provides opportunities to achieve this" (TANCZER; BUZAN, 2019, p.121). In spite of these "high-tech" approaches being extremely recent in IR, some (few) authors have already introduced the "tech perspective" into their work. So far, these works orbit around three main currents: (i) cybersecurity and the internet global governance; (ii) the implications of the technological change for IPE; and (iii) complex systems as an approach to global environmental governance. These three currents are explored with more depth in the paragraphs that follow.

Cybersecurity has permeated the work of established IR scholars such as Nye (2017), who analyzed how countries can deter or dissuade others in the "cyberspace," and of hybrid scholars such as Kshetri (2015), who investigated issues of cybercrime and cybersecurity in the BRICS (Brazil, Russia, India, China, South Africa) countries. In Brazil, the issue has been studied by authors such as Diniz, Muggah and Glenny (2014, p.3), which observed that the "Brazilian government is adopting a securitized approach to cyber threats rather than addressing the most pressing challenges confronting citizens, especially cybercrime." Others have analyzed how CyberIR can be analyzed in Brazilian IR academic research (LOPES; MEDEIROS, 2018). The internet global governance has also become a hot topic. Lucero (2011) investigated internet governance as a complex international regime, and explored the limits and opportunities for diplomatic action regarding the issue. Others explored challenges and future perspectives of internet global governance (CANABARRO; WAGNER, 2014), the internet as a global public good, and the idiosyncrasies of its multi-stakeholder governance (CANAZZA, 2018).

IPE scholars have been particularly interested in how digital technologies might transform the global economy. This topic was extensively discussed in Chapter 2, but, for now, I will highlight this argument shortly. Technology has been explored as a tool for international development (BRIEN; HELLEINER, 1980). Kshetri (2016, p.1), for instance, explored the many ways IoT can positively impact Global South countries, including "improvements in agricultural and food systems, enhancement of environmental security and resource conservation, achievement of better healthcare, public health and medicine, and enhancement of the efficiency of key industries." The same author believes blockchain could impact these countries' economic, political and social ecosystems (KSHETRI, 2017, p.1). International trade and finance are also being affected by digital tech. In this sense, the work of Azmeh and Foster (2016, p.5) is particularly interesting because it investigated how digital industrial policy and the Silicon Valley's powerful companies will influence mega-trade agreements such as the Trans-Pacific Partnership (TPP) (already redefined by the withdrawal of the USA) and the Transatlantic Trade and Investment Partnership (TTIP), now in stand-by because of the protectionist policies of the Trump administration.

Finally, the complex systems approach is being explored especially by environmental IR scholars, despite the fact that even these researchers "have been slow to embrace complexity" (ORSINI et al, 2019, p.2). Complexity thinking concerns digital tech, since new digital technologies might revamp the structures of world politics, thus complementing and enriching IR analytical thinking about such structural transformations. Furthermore, both approaches are compatible with the variety of concepts currently being used in IR, especially regarding global environmental governance: the Anthropocene, regime complexes, orchestration theory, transnational private governance, networked approaches, experimentation, etc. (ibid, pp.5-6, 13-14).

3.2. The Political Economy of Digital Platforms

There are many expressions to identify the information revolution that took place in international political economy since the 1970s. Information society (BENKLER, 2003), network society (CASTELLS, 2010), information economy (BRIEN; HELLEINER, 1980; SHAPIRO; VARIAN, 1999), network economy

(SHAPIRO; VARIAN, 1999), advanced services economy (SURBORG, 2006), internet and platform economy (BENKLER, 2003; FUCHS, 2009), digital economy (MUTULA; VAN BRAKEL, 2007; MENDES, 2021), information capitalism (FUCHS, 2009; SEVIGNANI, 2016), networked information economy (BENKLER, 2003), to name a few. Such expressions are attempts to analyze the characteristics and impacts of ICTs in contemporary societies, politics and economy. Yet, such expressions denote a phenomenon whose specificities and consequences are still cloudy. What are, then, with IPE lenses, the main features of the information society?

It is appropriate to start with a key concept: ICTs. By ICTs I adopt Castells (2010, p.29) definition: "the converging set of technologies in micro-electronics, computing (machines and software), telecommunications/broadcasting, and opto-electronics (...). I also include in the realm of ICTs genetic engineering." Thus, information processing methods and techniques used in synthetic biology can also be included in the domain of ICTs.

Castells (2010, pp. 61-64) has observed that the digital revolution was originated in a specific place and time. *The ICT revolution was born in the 1970s, in the United States, more specifically in California*. Two drivers help explain the digital revolution: 1) the foundation of ARPANET[14] in 1969, the first computer network, as a result of efforts from the United States Department of Defense and research institutions such as the University of California, Los Angeles (UCLA); and 2) the fact that "young minds from around the world" gathered around Silicon Valley by the mid-1970s, attracted by the latest technological progresses and by huge public and private investments. These "young minds" founded groups such as the Home Brew Computer Club, whose visionaries included names such as Bill Gates and Steve Jobs, who would go on to create in the following years some the world's leading Big Tech firms: Microsoft and Apple. Silicon Valley became a *milieux of innovation*, a place where there is "a spatial concentration of research centers, higher-education institutions, advanced-technology companies, a network of ancillary suppliers of goods and services, and business networks of venture capital to finance start-ups" (CASTELLS, 2010, p.66). Places alike Silicon Valley are cornerstones for the development of innovations in the digital economy.

[14] ARPANET was the first computer network, which was named after one of its sponsors, the Advanced Research Projects Agency Network (ARPANET), founded by the U.S. Department of Defense in 1969.

The economics of digital goods is also a topic worth discussing. Shapiro and Varian (1999) developed a framework to interpret the digital economy according to some fundamental concepts. The first is "*information goods.*" Information is a commodity with a high production cost, but a very low reproduction cost. In economic language, it has high fixed costs, but low marginal costs. For this reason, companies price information according to the value attributed by the consumers, not according to production costs. In other words, it is in the interest of tech companies that consumers attach significant value to information. The most reasonable strategy for these firms is, therefore, to make information a necessary asset in all spheres of society, from the productive level (other firms) to the individual level (consumers), not to mention the public sector.

Another relevant concept is "*information technology.*" Information technology included the infrastructures that make information more accessible and therefore more valuable, by means of tools that allow customers to search, store, copy, view, retrieve, receive and manipulate data and information (SHAPIRO; VARIAN, 1999). As such activities become fundamental in our everyday lives, tech providers (especially Big Tech firms) have become unavoidable intermediaries in virtually every aspect of the global political economy. "The availability of new telecommunication networks and information systems prepared the ground for the global integration of financial markets and the segmented articulation of production and trade throughout the world" (CASTELLS, 2010, p.60).

The longevity of digital technologies, and the power of Big Tech firms, is based upon two other concepts: "*lock-in*" and "*switching costs.*" "Once you have chosen a technology, or a format for keeping information, switching can be very expensive" (SHAPIRO; VARIAN, 1999, p.19), particularly for the corporate customers of tech firms. Because corporate customers were (BRIEN; HELLEINER, 1980) and still are (BUSINESS INSIDER, 2017) the prime revenue sources for Big Tech firms[15], lock-in is still a valid strategy, especially considering that in many cases such firms are the unique providers (or at least the most effective or cheapest). "Lock-in can occur on an individual level, a company level, or even a societal level" (SHAPIRO; VARIAN, 1999, p.19).

[15] This is true for some, but not for all, Big Tech firms. For instance, in 2016 Alphabet (parent company of Google) acquired 88% of its revenues from Advertisement, a service contracted essentially by other companies (thus, B2B). At the same year, Facebook had 97% of its revenues coming from its Advertising business. For the sake of comparison, in 2016, 63% of Apple's revenues came from a single product, the iPhone, sold to individual customers (B2C) (BUSINESS INSIDER, 2017).

Beyond businesses and customers, the current technological condition resonates in the most basic structures of society: the economy (new ways of organizing production and consumption) and politics (how democracies and autocracies adapt to current technological transformations). The internet is central in both these spheres (BENKLER, 2003, p.1246).

Developing, but particularly developed countries, have made two parallel shifts in the course of the last 20 years: 1) the move towards an information economy, "centered on information (financial services, accounting, software, science)" and 2) the move towards a networked environment, structured around "high computation capabilities" and the pervasiveness of the internet (BENKLER, 2003, p.1250). The result was the building of a *networked information economy*.

In a networked information economy, knowledge and information are the most valuable assets. This is easy to comprehend when we take a look at the labor market. Benkler (2003, p. 1256) pinpoints the emergence of a novel working model: peer production. Peer production is "a process by which many individuals, whose actions are coordinated neither by managers nor by price signals in the market, contribute to a joint effort that effectively produces a unit of information or culture." The concept resonates with the idea of user-generated content (FUCHS, 2009), a practice made possible by the emergence of free access social networking platforms and websites, such as Facebook and YouTube. Examples include we growing number of individuals that work full time through digital platforms, such as YouTubers, bloggers, online sellers, and many journalists.

Recent features of the networked information economy are represented by the mobile economy (GSMA, 2019) and by the sharing economy (COHEN; KIETZMANN, 2014). The mobile economy is predicated upon any economic transaction that occurs on a smartphone or tablet. The mobile economy is transversal, i.e., it touches other industries such as banking, healthcare, entertainment and education (MENDES, 2020b). According to the GSM Association, the corporate representative of several mobile network operators worldwide, "in 2018, mobile technologies and services generated US$ 3.9 trillion of economic value (4.6% of the global GDP)" (GSMA, 2019, p.6). The sharing economy, by its turn, is "an economic model defined as a peer-to-peer (P2P) based activity of acquiring, providing, or sharing access to goods and services that is often facilitated by a community-based on-line platform."[16] Despite the fact that only now the sharing economy is gaining widespread popularity, Big Tech firms organized around this business model (e.g., Uber and Airbnb) have already reached central positions in the global market (COHEN; KIETZMANN, 2014, p.279).

Besides the economic impact, the internet (and its associated models of producing, sharing and trading information) have also powerful political implications. Castells (2008) believes that, by strengthening the movement of the public opinion, the internet is now a crucial instrument of the global civil society. "Internet and wireless communication, by enacting a global, horizontal network of communication, provide both an organizing tool and a means for debate, dialogue, and collective decision making" (CASTELLS, 2008, p.86). Based on survey data regarding the 1996 and 2000 presidential elections in the United States, Tolbert and Mcneal (2003) found that the internet not only enhanced voter information about candidates and elections, but also stimulated increased participation. According to the authors, "this was true even after controlling for socioeconomic status, partisanship, attitudes, traditional media use, and state environmental factors" (TOLBERT; MCNEAL, 2003, p. 175).

However, we also have to take into account the spread of fake news and how it has influenced political results globally, such during the 2016 US presidential elections (GRINBERG et al, 2019). Grinberg et al (2019, p.374) analyzed the "exposure to and sharing of fake news by registered voters on Twitter," and found that "engagement with fake news sources was extremely concentrated. Only 1% of individuals accounted for 80% of fake news source exposures, and 0.1% accounted for nearly 80% of fake news sources shared." Thus, even though fake news had a limited effect on this U.S. presidential campaign, their political influence cannot be ignored.

Despite its function as a platform for political participation, issues of unequal information access, distribution, and capacity of interpretation are of paramount importance in the political economy of the internet. Mossberger et al (2008, p.10) observed that "digital citizenship requires educational competencies as well as technology access and skills; and problems such as poverty, illiteracy, and unequal educational opportunities prevent more people from full participation online and in society more

[16] Sharing economy, available from: https://www.investopedia.com/terms/s/sharing-economy.asp Accessed June 28, 2019.

generally." According to Wasko (2005), topics such as technological determinism and state support of technological development regarding ICTs have been analyzed by political economists since long ago. Particularly, attention "has been directed at the unequal distribution of such resources, with analysis of issues such as access and equity, including discussions of 'the information poor' or 'the digital divide'" (WASKO, 2005, p.35-6). Indeed, one of the oldest studies on the political economy of ICTs, published at *International Organization*, pointed out a serious question regarding global information access: "will these new developments (on ICTs) increase the already substantial potential for centralization and control of information in traditional world centers, thus enhancing their power and leverage?" (BRIEN; HELLEINER, 1980, p. 465). Obviously, this is still a fundamental question in the political economy of ICTs.

Sevignani (2016) brings to the table another concern regarding the digital political economy: "*online surveillance*," and the issue of "*digital privacy*." The author observes that the digital economy brings about two central problems: alienation (the stimulus for people to spend increasing amounts of time online) and exploitation (of people's private data by Big Tech firms). Giant firms such as Facebook (now Meta) have been constantly dealing with issues regarding user privacy[17]. In this vein, Fuchs (2009, p.82) criticized the business model of many Big Tech firms, particularly those focused on online advertisement: "The more users make use of advertisement-based free online platforms and the more time they spend online producing, consuming and exchanging content, (…) the higher the advertisement prices will rise and the higher the profits of the specific Internet corporations will be."

To conclude, the digital economy is an important backdrop to understand the influence of Big Tech firms in contemporary societies and on climate change. In a similar vein, Industry 4.0 and AI represent powerful developments in today's global political economy, as digital technologies become strategic productive/financial assets in developed and developing countries.

3.3. Introducing Alphabet, Amazon, Apple, Meta

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[17] Facebook's privacy problems: a roundup, available from: https://www.theguardian.com/technology/2018/dec/14/facebook-privacy-problems-roundup Accessed June 28, 2019.

In this section, I present some information as regards Alphabet, Amazon, Apple and Meta. I introduce their business models, highlighting current operational structures and corporate strategies. I also outline some of the consequences of Big Tech firms to the discipline IPE.

Big Tech firms are central players in international politics and economics for several reasons. These firms have become powerful actors in the international economic system, as represented by their constant rise since 2005 at the Fortune 500 lists (WOLF, 2017). The four cases considered in this thesis are among the top global firms, as represented in the Fortune Global 500 Firms (classification based on annual revenues), which considers multinational across all countries and all sectors.

Accordingly, Table 2 shows the classification of these firms, globally, for the year 2021 (which considers the accumulated revenues in 2020). Based on their revenues, Amazon is the 3rd largest multinational corporation in the world, and Apple is 6th. Alphabet is the 21st, and Meta is 86th, which means that my four case studies are amongst the *top 100 largest firms in the world* (considering all sectors).

Table 2 also represents the Fortune 500 ranking of 2022 (which considers all the revenues collected in 2021). This ranking includes only firms from the U.S. Based on these results, Amazon is currently the 2nd largest U.S. multinational, and Apple is the 3rd. Alphabet is the 8th, and Meta is the 27th. Which means that my four cases are amongst the *top 30 largest firms in the United States* (considering all sectors).

Table 2. Big Tech Firms in the Rankings of Fortune Global 500 and Fortune 500

Big Tech firm	Ranking Fortune Global 500 (2021)	Ranking Fortune U.S. 500 (2022)
Amazon	3	2
Apple	6	3
Alphabet	21	8
Meta	86	27

Source: Author’s own elaboration, based on: https://fortune.com/global500/2021/search/ and

As the digital economy advances, society becomes more and more dependent on the products and services provided by these firms. Therefore, their power can guide specific courses of action in their customers and suppliers (i.e., their supply chain), regarding, for instance, sustainable practices and energy efficiency measures. For instance, let's consider the influence of Facebook on the building of online communities. Once put together, communities oriented towards sustainable practices and energy efficiency can be strengthened by the tools and services provided by the company. In a nutshell, Big Tech firms, particularly social media firms, provide infrastructures that have become platforms able to influence societies globally (influencers not necessarily being these firms).

Moreover, emerging digital technologies (e.g., AI, blockchain) will most likely increase our dependency regarding Big Tech firms. The use of AI to produce advanced services, and the interconnection between cyber-physical systems (IoT and IoS) will affect our lives in many ways, from the way we communicate to the pattern of products/services we will consume in the future. Alphabet, for instance, has recently acquired companies such as Boston Dynamics (military robots), Deep Mind Technologies (AI), and Apigee (predictive analytics), showcasing intensive investments in the technologies of the future (DOLATA, 2017). Amazon Web Services (AWS), by its turn, uses the concept of Industrial IoT (IIoT) in order to bridge industrial equipment and infrastructure with future technologies, such as machine learning, cloud computing and mobile applications[18]. These are only some examples of how future technologies shape the Big Tech firms' strategies and the future of the ICT sector.

As a result of their global relevance, scientific scholarship is growing as regards these firms' particularities (MIGUEL; CASADO, 2016; DOLATA, 2017; BARWISE; WATKINS, 2018). Together with Microsoft, Alphabet, Amazon, Apple, and Meta have been called 'Big Five'. Although very different as individual companies, these firms have many similarities. They are the most innovative companies in their respective industries, which are mainly: search engine, AI and synthetic biology (Alphabet), retail e-commerce and cloud services (Amazon), social network (Meta), and multimedia devices (Apple). In sum, Alphabet, Amazon, Facebook, Apple are tech powerhouses with huge international, economic and political influence. As climate change advances to be one of the "the most pressing issues of our time" (UN, 2017, p.1), Big Tech firms are set to play a relevant role in the future of climate governance, as I demonstrate in Chapter 5.

[18] Amazon Web Services (AWS) is a subsidiary of Amazon that provides on-demand cloud computing platforms to individuals, companies, and governments. As I will show later, AWS is central so we can understand the climate impacts of Amazon's data centers. More information about AWS can be found here: https://aws.amazon.com/iot/solutions/industrial-iot/ Accessed July 16th, 2019.

Alphabet, Amazon, Apple, and Meta have been considered the "four giants of the internet age" (THE ECONOMIST, 2012). The GAFA (Google, Amazon, Facebook, and Apple) was first used in 2011 by Simon Andrews, executive officer of Addictive Marketing, an advertising company from London (MIGUEL; CASADO, 2016). Since then, the acronym was used for some time in press news, such as the Financial Times (RACHMAN, 2015; GAPPER, 2017) and The Economist (2017); and in academic papers and books (MIGUEL; CASADO, 2016; DOLATA, 2017; BARWISE; WATKINS, 2018). In order to understand the similarities and differences amongst these firms, hereafter I present some data as regards their market domains, operations, financial indicators, and business strategies.

Miguel and Casado (2016, p.129) analyzed these firms using the theoretical lenses of business ecosystems. Business ecosystems are “dynamic and co-evolving communities of diverse actors who create and capture new value through increasingly sophisticated models of both collaboration and competition.” Each of these companies is considered a business ecosystem on its own, given that their activities are scattered around various different industries. These firms are thus intermediaries, or platforms, where a vast array of actors converge: content producers, advertisers, sellers, application developers, and others. In 2015, the revenues originated outside the U.S. were: Apple (70%), Alphabet/Google (57%), Amazon (38%), and Facebook (>50%). As regards the number of employees worldwide for 2015: Apple (92.600), Alphabet/Google (53.600), Amazon (154.100), and Facebook (9.199).

Table 3 presents Big Tech firms’ business models, segmented as the front stage (as the business is perceived by customers) and backstage (all the infrastructure and physical stores that support their operations). Analyzing these data, it is possible to verify that Alphabet and Meta compete directly over the advertisement industry (both have XXL-sized “free services” concerning Ads). Apple is the only focused on hardware and possesses a large number of physical retail stores (both XXL-sized in scale). Amazon’s operations are basically concentrated on its e-commerce platform and thus are heavily dependent on its supply chain and logistics expertise. But this is now changing with the growth of Amazon Web Services (AWS). Apple, Alphabet and Amazon all have XXL-sized infrastructure for 3rd party software development, which is central for their role as platform infrastructures.

Table 3. Alphabet, Amazon, Meta, Apple: business models, front and backstage operations

Company	Primary Revenue Driver / Core Business	Front Stage of Business Model				Back Stage of Business Model				
		Own hardware	Free services	Own content	Cloud sales	Online Services	Platform for 3rd party software	User-generated content	Own cloud infrastructure	Own retail stores
Apple	Hardware	XXL	S	-	-	XL	XXL	XL	L	XXL
Alphabet	Ads	S	XXL	-	S	XL	XXL	XL	XL	-
Amazon	Online Retail	M	S	L	XL	S	XXL	S	XL	S
Meta	Ads	S	XXL	-	-	-	-	XXL	XL	-

Source: Adapted from Strategyzer (2017).
Notes: S (small), M (medium), L (large), XL (extra-large), XXL (extra extra-large).

Regarding their openness to suppliers, Miguel and Casado (2016, p. 140) observe that: “Alphabet, Amazon, Facebook, Apple tend to be autonomous concerning basic issues such as energy, building electric power plants and buildings for data storage. The degree of openness of business systems, understood as the degree of external dependence, could be considered, for example, in terms of innovation and/or manufacture. It would doubtlessly be very high, since Apple, Amazon, and Facebook develop their own software and applications and acquire hardware, so the ecosystem is not completely closed. It is actually impossible to close because there will always be some activity that is impossible or difficult to integrate, such as applications. They all, particularly Apple and Alphabet, have an application platform which is open to developers which propose applications to make them available to users. However, Apple's case is interesting as it depends on its rival Samsung to supply strategic components of its devices such as microprocessors.”

These firms are relatively heavy energy consumers. In 2011, Alphabet’s energy consumption was equivalent to that of Austin, Texas (MIGUEL; CASADO, 2016). Nowadays the firm has been investing in solar panel companies and other sources of more environmentally friendly electricity. But this is a subject that will be explored in depth in Chapter 5.

Table 4 presents a comparison of these firms' businesses, products, and services, as well as their contribution for revenues in 2016. One can see that Apple's iPhone is the leading revenues driver of the company. Similarly, advertising is the main source of revenues both for Alphabet and Meta. Amazon's e-commerce is responsible for the majority of its revenues.

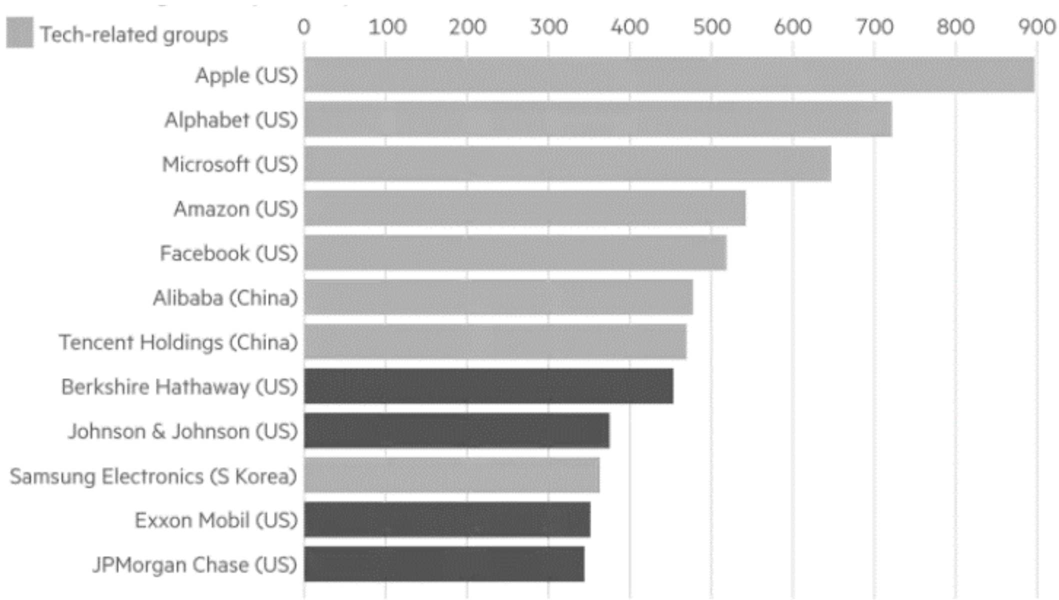
Table 4. Alphabet, Amazon, Meta, Apple: capitalization, revenues, profits, and business breakdown

Company	Market Capitalization (2017)	Revenues (2016)	Earnings/ Profits (2016)	Businesses	Contribution to Revenues (2016)
Apple	US$ 804 B	US$ 216 B	US$ 46 B	iPhone	63%
				iPad	10%
				Mac	11%
				Services	11%
				Other products	5%
Alphabet	US$ 651 B	US$ 90 B	US$ 19 B	Advertising (Google, AdWords, YouTube)	88%
				Other (Google Play, Pixel, Android)	11%
				Other Bets (Calico Labs, Google Fiber, Nest, Verily, Google Ventures, CapitalG, X)	1%
Amazon	US$ 455 B	US$ 136 B	US$ 3 B	Amazon Products	72%
				Amazon Media	18%
				Amazon Web Services	9%
				Other	1%
Meta	US$ 434 B	US$ 28 B	US$ 10 B	Facebook Ads	97%
				Other	3%

Source: Own elaboration, based on data from Strategyzer (2017) and Business Insider (2017).

As regards their market value (or market capitalization), one can see that these companies have much more market value than what they generate in revenue terms. Barwise and Watkins (2018, p.21) pointed that these four firms plus Meta are now the five most valuable public companies in the world by market capitalization. This is the first time ever that tech firms have dominated the stock market—even more than at the end of the 1990s' Internet bubble. Figure 7 illustrates a market capitalization list for tech firms as of 2017.

Figure 7. The world's largest companies by market value (US$ Bi) in 2017



Source: Wolf (2017, p.1)

According to Barwise and Watkins (2018), tech markets are *winner-takes-all*. Firstly, because in such markets predominate the so-called *direct network effects*. The utility customers attribute to each product/service increases as others start consuming these goods. Secondly, platform firms also possess *indirect network effects*, as they match customers with complementary needs (e.g., publishers and book buyers, developers and users, etc.). The growth in one side of the platform foments the growth on the other side. Some of these companies go beyond the two-sided model and become multisided. "Facebook connects six distinct groups: friends as message senders, friends as message receivers, advertisers, app developers, and businesses as both message senders and receivers" (ibid., p.27).

The internet helps tech firms to collect extensive and real-time usage data at low cost. Big data sets can be collected with the help of automated techniques (machine learning), and be used to improve the quality of products, services, pricing, demand forecasting, and advertising targeting (ibid, p.28). Big data and machine learning offer simultaneously revenue economies of scale, scope, and learning. Their use can be tactical (continuous improvement) and strategic (better analysis of potential customers and competitors).

Big Tech firms' business strategies are also based on mergers and acquisitions (M&A). **Table 5** illustrates some of my four cases' recent M&A movements. This strategy is adopted not only to safeguard their market position as *quasi-monopolies* in their respective industries, but also "to acquire know-how and interesting applications that support the respective core business" (ibid., p.11).

Table 5. Alphabet, Amazon, Apple, Meta: Selected M&A operations until 2017

Firm	Year	Company	Purchase Price (Bi US$)
Alphabet	2004	Picasa (photo service)	0.01
	2004	Where 2 Technology (mapping service)	n/a
	2005	Android (mobile software)	0.05
	2006	YouTube (videos, media)	1.65
	2008	Doubleclick (internet advertising)	3.10
	2009	Admob (mobile advertising)	0.75
	2011	Motorola (mobile devices)	12.50
	2013	Waze (GPS navigation software)	0.97
	2013	Boston Dynamics (military robots)	n/a
	2014	Nest Labs (thermostats; fire alarms)	3.20
	2014	Skybox Imaging (satellite technology)	0.50
	2014	Deep Mind Techn. (Artificial intelligence)	0.80
	2016	Apigee (predictive analytics)	0.63
Meta	2009	FriendFeed (social networking aggregator)	0.05
	2010	Hot Potato (social media platform)	0.01
	2011	Beluga (messaging)	0.01
	2011	Gowalla (social network)	n/a
	2011	Snaptu (app developer)	0.07
	2012	Instagram (photo and video portal)	1.00
	2013	Parse (app platform)	0.09
	2014	WhatsApp (messaging service)	19.00
	2014	Oculus VR (virtual reality)	2.00
	2015	Surreal Vision (augmented reality)	n/a
	2015	Pebbles (augmented reality)	0.06
Amazon	1999	Junglee (online shop; electronics, clothing, books)	0.19
	1999	Alexa Internet (server; website rankings)	0.25
	2008	Audible (audiobook download provider)	0.22
	2009	Zappos.com (online shop; shoes, clothing)	0.82
	2010	Quisidi (online shop; drug store, pet food)	0.55
	2011	Living Social (special offers; gift cards)	0.40
	2011	Lovefilm (video rental)	0.30
	2012	Kiva Systems (automatic ordering systems)	0.78
	2013	Goodreads (book community)	0.20
	2014	Double Helix Games (video games)	n/a
	2014	Twitch (video game platform)	0.97
	2016	Curse (game portal)	n/a
Apple	1996	Next Computer (software; operating systems)	0.40
	1997	Power Computing (computer manufacturer)	0.11
	2010	Siri (voice assistant software)	0.20
	2012	AuthenTec (biometrics hardware)	0.36
	2013	Topsy Labs (media research)	0.20
	2013	PrimeSense (3D sensor manufacturer)	0.35
	2014	Beats Electronics (headsets; music streaming)	3.00
	2016	Turi (machine learning)	0.20

Source: Adapted from Dolata (2017, p.12)

Moreover, Dolata (2017) observed that three main business strategies (concentration, competition, and innovation) prevail in these firms, as shown in Table 6.

Table 6. Big Tech firms' business strategies: concentration, competition, and innovation

Strategies	Description
Concentration	• Two-sided and multisided markets, quasi-monopolies, and network effects. • The *search engine* segment is globally dominated by **Alphabet** • The *social networks* sector, **Meta** had evolved from a newcomer to a worldwide dominant company • E-commerce is the domain of **Amazon**, by far the largest retailer on the internet • **Apple** is (…) a trend-defining manufacturer in the *multimedia devices market* (iPod, iTunes – music, iPhone, iOS – smartphones, iPad – tablet PCs)
Competition	• **Alphabet**'s main competitors: *Advertising* (Facebook, Yahoo, advertising firms); *Media* (Apple, Amazon, Netflix, Hulu, media companies); *Social Networks* (Facebook, Twitter, Flickr); *Mobile software and hardware* (Apple, Amazon, Microsoft); *Connected car* (Apple; car manufacturers); *Smart home* (Microsoft, Cisco, appliance manufacturers). • **Meta**'s main competitors: *Advertising* (Google, Yahoo, advertising firms); *Social networks* (Google+, YouTube, Twitter, Flickr); *Apps* (Google, Apple). • **Amazon**'s main competitors: *Trade* (Retail companies, specialized online dealers); *Media* (Google, Apple, Microsoft, Netflix, Spotify, game manufacturers, media companies); *Mobile hardware* (Apple, mobile device manufacturers); *IT Services* (Microsoft, Apple, Google). • **Apple**'s main competitors: *Mobile hardware and software* (Smartphone/tablet manufacturers, Amazon, Google/Android, Microsoft); *Media* (Google, Amazon, Netflix, Hulu, Spotify, media companies); *Connected car* (Google; car manufacturers).
Innovation	• All these firms present strong **'in-house orientated' R&D** (Research and Development), with strategic alliances and cooperation on rare occasions. • All these companies "are highly research-intensive, have **large-scale R&D centers,** and allocate a substantial portion of their staff to R&D • **Alphabet's innovation policy** is representative of all four Big Tech firms: "*We rely on a combination of patent, trademark, copyright, and trade secret laws in the U.S.and other jurisdictions as well as confidentiality procedures and contractual provisions to protect our proprietary technology and our brand"*

Source: Own elaboration, based on the framework of Dolata (2017).

Based on the sources of business power explained so far, Big Tech firms have become political and economic powerhouses. Dolata pinpoints four types of Big Tech firm's power: (i) *economic power*: financial strength, strong research capacity, market dominance, culminating with the ability to "keep competitors at bay" (DOLATA, 2017, p.23); (ii) *power over data*: data are used as strategic resources in order to "refine their products and services and to tailor these as closely as possible to user preferences" (ibid, p.23); (iii) *power to shape social contexts*: their "underlying technology incorporates rules, standards, and instructions that impact the activities of users similar to how social institutions influence people's behavior" (ibid, p.24); (iv) *infrastructural and rule-setting power*: these firms "develop and provide the essential infrastructural foundations of the web and act as gatekeepers to access the web, and become the main rule-setting and controlling actors (…)" (ibid, p.24)." Big tech firm's rule setting power oftentimes is unnoticed by governments and citizens: "as companies that seek to have a socio-political vision and voice, they help structuring and shaping large segments of private and public life on the web through the technically mediated social specifications of their offers—all below the radar of public perception and control (ibid, p.24)." In Chapter 4, I will develop my own power typology for Big Tech firms.

Recently, two of my case studies changed their corporate identity: Alphabet (previously, Google) and Meta (previously, Facebook). When and why Google became Alphabet, and Facebook became Meta? Which subsidiaries these new parent companies possess? Facebook was renamed as Meta Platforms, Inc. in October 21, 2021, and the previous brand (Facebook) became a subsidiary. This was mainly due to the company's CEO (Mark Zuckerberg) ambition to expand the business beyond social media, advancing into a new type of business that incorporates all types of activities in the virtual world, *the Metaverse*. Google became Alphabet in August 11, 2015, and, similarly to Facebook, Google remains as a subsidiary of Alphabet. The reason why this business movement occurred is not clear, but some believe this was a strategy to increase investor visibility of Alphabet's new ventures and strategic M&A operations.

Table 7 illustrates a recent compilation of the most important subsidiaries of Alphabet, Amazon, Apple, and Meta. However, firms represented below *do not represent the totality of these Big Tech firms' subsidiaries*. Amazon, for instance, has more than 40 subsidiaries, and Meta has more than 90, as of March 2022. Table 7 also shows the core-business of each subsidiary, based on which we can observe the varied types of businesses these Big Tech firms concentrate on nowadays.

Table 7. Alphabet, Amazon, Apple, and Meta: main subsidiaries as of 2022.

Parent Company	Main Subsidiaries
Alphabet Inc.	Calico (human health by overcoming aging) CapitalG (private equity for growth-stage tech companies) DeepMind (artificial intelligence) Google (internet services, includes YouTube, Android, and Search) Google Fiber (internet access: via fiber) GV (venture capital for technology companies) Intrinsic (robotics software) Isomorphic (labs Drug discovery) Verily (human health) Waymo (autonomous driving) Wing (drone-based delivery of freight) X Development (research and development for space technologies)
Amazon.com	Amazon (e-commerce) Amazon Web Services (cloud computing) Audible (audiobook and podcast) Goodreads (social cataloging) IMDb (online database for media information) Amazon Robotics (mobile robotics fulfillment systems) Amazon Studios (television and film producer) Shopbop (fashion apparel and accessories) Twitch (video live streaming service)
Apple Inc.	Apple (consumer electronics, software, and online service) Anobit (flash-memory developer) Beats Electronics (consumer audio) Beddit (sleep tracking monitoring devices) Braeburn Capital (asset management) Claris (computer software development)
Meta Platforms, Inc.	Facebook (online social media and social networking) Messenger (instant messaging app) Facebook Watch (video on-demand service) Oculus (virtual reality and augmented reality) Giphy (online database and search engine) WhatsApp (instant messaging and voice-over-IP (VoIP) service) Instagram (photo and video sharing social network)

Source: Developed by the author, based on consultations in the parent companies' websites.

Because these Big Tech firms have so much economic power, they have increasing authority in international political processes as well. Wolf (2017) identifies seven challenges these firms impose to nation-states. First, the close alignment between technology and economic power showcases two trends in the international system: (i) the dispute between the U.S. and Asia (China[19] in particular), given that the majority of Big Tech firms are either U.S.-based or Chinese; and (ii) the possibility that if one economy is not in the "tech game", it will not play the "economic game" in the future. This is an obvious threat for the European Union, which only holds one global Big Tech firm: the German SAP (Systems, Applications & Products in Data Processing).

Second, these firms' quasi-monopolies at the national and international levels are a challenge for competition law. Third, governments are still figuring out how to regulate these companies. For example, should Big Tech firms be allowed to buy their smaller competitors? Fourth, what are the macroeconomic impacts of Big Tech firms? Firth, how should they be taxed, given that their global operations are not attached to territorial borders? Sixth, what are their impacts on the media industry? In 2017, for instance, Google and Facebook alone received 63% of all U.S. digital advertising revenue (WOLF, 2017). What is the impact of such competition for smaller competitors? And what are the risks of data manipulation, dissemination of fake-news, and misuse of customers personal information? Seventh, what are these firms' impacts on labor markets, with the rise of AI and a potential fracture on the job market in the near future? Despite not being cited by Wolf (2017), this doctoral dissertation explores an additional challenge: *how Alphabet, Amazon, Apple, and Meta are connected with the climate crisis, and how these firms participate in the global governance of climate change?*

As I have demonstrated in this section, my four cases have many similarities and are considered competitors in various dimensions. However, they are eventually individual firms, with very unique characteristics. Amazon has immense logistics operations, including warehouses, and global deliveries. Thus, its energy consumption is huge. Apple has a large number of retail stores and also assembles physical products (hardware); so, its energy consumption is of considerable size as well. Alphabet and Meta, on the other hand, have a large portion of their energy consumption linked to data centers. They do not have considerable numbers of retail stores and manufacturing facilities, which impacts their climate footprints in different ways when compared to Apple and Amazon.

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[19] Considering Chinese corporations, two points deserve emphasis: 1- the intimate relationship between the corporations and the Chinese state in order to strengthen the exercise of totalitarian control of the Communist Party over society; 2- the direct subordination of the corporations to the global political strategies of the Chinese state.

Variations in energy consumption are important drivers to consider as we analyze these companies' interests in the global climate governance. Is the innovation driver relevant when it comes to these firms' strategies regarding climate governance? Are these firms developing low-carbon technologies? What is their business/market vested interests regarding the future of the climate crisis? These are important questions in the political economy of climate change. These topics will be discussed in Chapter 5. In the following section, I conclude this chapter by highlighting some conceptual and theoretical implications of Big Tech firms to IPE.

3.4. Big Tech Firms, Digital Technologies, and a New Research Agenda for IPE

Will Big Tech firms impact the future of the international political economy (our object) and of IPE (our discipline)? This is an intricate question, for which there is obviously no simple answer. The technological transition is characterized above all by its dizzying speed, leading to fast and unpredictable changes. The first blockchain database, for instance, was developed in 2008 (only 14 years ago!) and by now this technology has already given birth to countless applications, including cryptocurrencies, smart contracts, financial services, security protocols, video-games with augmented reality attributes, IoT and IoS, among others (KSHETRI, 2017). The consequences are cutting-edge technologies that have already disrupted traditional economic sectors: "Uber, the world's largest taxi company, owns no vehicles. Facebook, the world's most popular media owner, creates no content. Alibaba, the most valuable retailer, has no inventory. And Airbnb, the world's largest accommodation provider, owns no real estate. Something interesting is happening" (GOODWIN, 2015, p.1). Are current IPE theories, concepts and methods well-equipped enough to investigate these developments?

My answer to such a question is "no." I believe so because of a series of aspects. First of all, IPE scholars (and most political scientists) are still aloof regarding the social impact of emerging technologies. Obviously, there are some (few and recent) exceptions, such as the book Technologies of International Relations, edited by Carolin Kaltofen, Madeline Carr, and Michele Acuto (2019), which I reviewed in the final pages of Chapter 1. But even this book is very preliminary. Although it describes the receptivity of prominent IR scholars to the power of technology in international politics, as well as how they have approached technology throughout their career, the book leaves us in the dark regarding what would be the most appropriate approach to study digital technologies in IR and in IPE.

My second argument, then, regards the intrinsic complexity of the contemporary technological change. Such complexity makes it difficult even for computing experts to understand and forecast the future developments and impacts of emerging technologies. "Dealing with disruptive changes – and grand challenges in particular – raises several conceptual, methodological and operational issues" (CAGNIN; HAVAS; SARITAS, 2013, p.379). How, for instance, can we combine quantitative and qualitative methods to understand the current technological change? Or, still, what are the best ways to orchestrate joint (public, private, and civil society) responses to the technological challenge? (ibid., p.379).

This goes in line with the recent introduction of complexity thinking in IR, revealing the "limitations of traditional frameworks of policy-making" and research (ORSINI et al, 2019, p.23). But how can complex systems contribute new approaches and theorizations in IR/IPE, "embracing complexity," and by the same time moving away from simplistic and reductionist explanatory frameworks?

To "govern in complexity" means break down the barriers imposed by limited IPE thinking, such as the over-focus on productive systems, processes, and material flows. This leads us to my third argument: IPE scholars are still very much concerned with the material aspects of the international political economy. Even important theorizations regarding global value chains (GVC) and global production networks (GPN) are limited inasmuch as they still embrace international trade theory (+ its many adaptations) and global supply chains as the quintessential focus of interest in IPE (NEILSON; PRITCHARD; YEUNG, 2014). But the digital economy is associated with cutting-edge processes and nonmaterial flows, featuring information and knowledge, programming and algorithms, computer and data transmission. Certainly, I am not arguing that material flows are unimportant and must be disregarded (indeed, even the ICT sector heavily depends on raw-materials and physical infrastructures). What I argue is that the nonmaterial aspects of the global economy (such as the servitization process, enhanced by the digital revolution; and digital finance or fintech – much more studied in IPE) need also to be incorporated to the analytical frameworks and theoretical developments of IPE. How to do that is still a puzzle, to which this doctoral dissertation aims at contributing.

CHAPTER 4
Digital Platforms and the Global Governance of Big Tech Power

4.1. The Global Political Power of Tech MNCs

IR and IPE scholars have been theorizing the global political power of business at least since the 1970s, inspired by the rise of contemporary MNCs. Among the classics, Gilpin (1987) observed that MNCs possess both a political and a productive nature; thus, such firms are inherently associated with states. Keohane and Ooms (1972, 1975) were interested in how MNC's activities affected power relations among states. They analyzed how MNCs are influenced by their home country domestic policies and by the governments of MNCs' host countries. They also advocated in favor of the creation of an international organization to regulate foreign direct investments (FDI). Nye (1974) analyzed three corporate roles in world politics: private foreign policy, instruments of influence, and as political actors capable of agenda setting, while Vernon (1971) studied the power of U.S. MNCs in legitimizing this country's global hegemony. Furthermore, in an influential IPE study, 'Big Business and the State', Strange (1991) criticized IR for its marginalized conception of MNCs.

Recent IPE scholarship concentrate on the extent of the corporate political power in the 21st century. Some authors analyzed the global circulation of Chinese business elites, and their linkages with Western capitalism, to reinterpret globalization through the lenses of contemporary China (GRAAFF, 2020; GRAAFF; APELDOORN, 2018). Cuervo-Cazzura (2008) focused on the global spread of emerging market MNCs, and the influence of state ownership on firm internationalization (CUERVO-CAZZURA; LI, 2020). The analogy between firms and states advanced by Ferreras (2017), which proposes to implement 'economic bicameralism' in modern firms, encourages workers to democratically participate in MNCs' decision-making processes. This new 'political theory of the firm' aims to make companies more egalitarian and fairer, since current "investor-owned firms remain profoundly oligarchic, hierarchical, and unequal" (LANDEMORE; FERRERAS, 2016, p.53). Other perspectives evolved from the corporate social responsibility (CSR) literature. Clapp and Dauvergne (2005) and Pulver (2011) studied corporate environmental practices, to find out that firm's environmental responses are a product of many variables, e.g., firm strategies, national regulations, and public opinion. Accordingly, such variables can determine the amount of lobby firms spend on environmentally sound issues like climate change (DELMAS; LIM; NAIRN-BIRCH, 2016; KOLK, 2016).

Notwithstanding the relevance of previous scholarship, I argue that their analytical frameworks are not appropriate to analyze the (perhaps) most important MNCs of our times: Big Tech firms (ATAL, 2020; KOLK; CIULLI, 2020). To explain why I believe so, I adopt Morozov's concept of Big Tech firms: "the big companies associated with data-intensive platforms, almost all located in the U.S., and also increasingly in China" (MOROZOV, 2018, p.121). The corporations differ considerably from traditional MNCs (MENDES, 2021; UNCTAD, 2017). Let's take as examples Alphabet, Amazon, Facebook, Apple, and Microsoft, the "Big Five" tech platforms. They are now the five most valuable public companies in the world by market capitalization (BARWISE; WATKINS, 2018). Similarly, Chinese platforms such as Alibaba, Baidu, Tencent and Huawei have become global powerhouses (JIA; KENNEY; ZYSMAN, 2018).

From these examples, intriguing (and still unanswered) questions emerge: Why do Big Tech firms focus on expanding their networks before worrying about profits? How to analyze power relations in these firms' multi-sided markets? What are the implications of their business models for the acquisition of economic and political power? Do these firms represent the national interests of their home countries? What are their implications for the contemporary state? Current IPE scholarship is unable to answer most of these questions. This is problematic because, borrowing Atal's (2020, p.3) words, "if the largest companies of the era do not conform to the prevailing picture of twenty first century capitalism (…) then perhaps the prevailing picture is wrong." So, how can we interpret the contemporary global capitalism through an analysis of Big Tech?

In this chapter, I explore these questions by providing a tentative typology for Big Tech corporate power. I scrutinize the most up-to-date literature in IR and IPE to distinguish four modalities of power: 1) network power, 2) infrastructural power, 3) information power, and 4) data power. To do so, this chapter is designed as follows: next, I present how digital platforms are reshaping international political economy, and what are the central challenges in their governance. Subsequently, I develop a typology for Big Tech power, based on an extensive literature review and secondary data analysis. Lastly, the conclusion presents limits and implications of my framework.

4.2. Value Chains and Platform Governance

It is hard to deny the centrality of digital technology in contemporary international politics and economics. Mayer, Carpes and Knoblich (2014a, 2014b) analyzed the ways in which states have historically used science and technology in the search for international power. Concepts like 'expertise' in nuclear science, biotechnology and nanotechnology have been used as bargaining sources in international negotiations, e.g., in intellectual property rights disputes and trade negotiations (MILLER; CONKO, 2000). Technology is also an asset in the search for international status, as has been happening with universities and scientific groups worldwide (BRAKOVIC, 2018). Technology affects the direction of trade flows and international cooperation, both North-South and South-South (FLINT; ZHU, 2019).

In the field of International Security, Mayer, Carpes and Knoblich (2014b) suggest that the use of drones and robots in military interventions reveals more than an instrumental superiority (higher military capacity) of certain states. It represents symbolic status, whether by polishing the enemy's imagery, or by enabling an alleged 'neutrality', useful to the interests of military powers, since, at least potentially, hi-tech weaponry produces less casualties (SCHÖRNIG, 2014). Thus, scientific knowledge, symbolized or materialized through technological superiority, becomes a crucial asset in foreign policy.

In this setting, this section aims at discussing digital platform governance. Firstly, I analyze Big Tech firms with the lenses of global value chains (GCV) theory. Next, I analyze such firms through theories of global governance.

4.2.1. The Digitalization of Global Value Chains

A recent special issue of the Review of International Political Economy (RIPE) reflected upon the “technological infrastructures” of the digital transformation in global finance. Bernards and Campbell-Verduyn (2019, p.776) observed that the infrastructure metaphor "helps to examine how the emergence and adoption of new technologies are driven by internal patterns of political economy (e.g., accumulation, governance)”, but also called attention to the limits of this ‘technological breakthrough’ in the redesign of global finance. RIPE’s special issue suggests, for example, that 'big data' has created considerable risks of indebtedness for marginalized populations in the global South, while, paradoxically, it has increased the value capture capacity of financial markets (LANGEVIN, 2019). Others discussed how international remittances, multiplied by digital platforms, connect emerging countries with international financial flows, thereby contributing to the financial inclusion of poor populations (RODIMA-TAYLOR; GRIMES, 2019).

In parallel to global finance, global production has been widely influenced by digitalization. Global value chains (GVC) scholars are particularly interested in how start-ups and Big Tech firms affect global production, trade and the distribution of goods. While some have studied government initiatives concerning internet governance (WU; GEREFFI, 2018), cybersecurity, data privacy, and platform firm's regulation (THELEN, 2018; RAHMAN; THELEN, 2019), the bulk of GVC literature is interested in global production relations and networks. An example is handy. Li, Frederick and Gereffi (2018) described the digitalization of the Chinese apparel industry, highlighting two developments: a) some firms were extinct, as they did not adapt as digital platforms; b) internet and e-commerce were progressively incorporated by the remaining firms.

Others have scrutinized the current economic context in which digital technologies have emerged. Spanning across different domains of GVC theory, digital technologies can be seen either as (1) a product of contemporary developments in the global economic system (transition from an industrial to an information economy), or as (2) forces that will likely reshape the industrial ecosystem in the near future (by means of technologies such as IoT, AI, blockchain, etc.).

The first trend takes into account the 2008 global financial crisis and its consequences (recession, unemployment, re-emergence of nationalism, rising trade wars), but also the longer process of de-industrialization, occurring since the 1970s, especially in rich democracies, partially as a consequence of the expansion of the services sector - i.e., servitization process (SASSEN, 1991; GERMANY, 2014). In light of de-industrialization, the use of advanced technologies in industry, e.g., through smart production systems, smart factories, and the integration between digital and physical technologies (pioneered in Germany's *Industrie 4.0*) aims to revamp the role of industry in developed nations, helping them to recover from economic and industrial stagnation.

The second trend is highlighted in Schwab (2018, p.56): "the foundational technologies of Industry 4.0 are likely to be AI, distributed ledgers and new computing technologies, while both energy technologies and biotechnologies are likely to have outsized impacts in influencing other fields." Accordingly, advanced technologies, such as additive manufacturing (3D printing), are being pioneered by companies based in the global North. "In 2012, for example, 40% of 3D printing systems were installed in North America, 30% in Europe, 26% in Asia-Pacific and only 4% in other locations" (ibid., p.297). The future of the digital economy might be, thus, driven by rich democracies, as already stated in UNCTAD (2017), which shows that Big Tech firms and related FDI are heavily concentrated in U.S., Europe, and Japan. The vast majority of Research and Development (R&D) investments in digital technologies is also concentrated in the global North (KONRAD ADENAUER FOUNDATION, 2019a; 2019b; WEF, 2018), despite an outstanding exception: China (2015, 2017).

China has been successful in upgrading its participation in higher-value linkages of GVCs, becoming a global manufacturing power in just a couple of decades (GEREFFI, 2011, p.37). Probably the most thriving emerging economy on Industry 4.0, China has integrated its industrial capacity into higher value goods and services, both domestically and regionally. China's 13th Five-Year Plan (2016-2020) presents six strategies aiming at "a shift from capital accumulation-led growth to innovation-led growth; integrated urban-rural development; green development; inclusive development; finance and State-owned Enterprise-(SOE) reform; opening up to the world" (AGLIETTA; BAI, 2016, P.1). Notably, China's political strategy aimed until 2019 at a global economic integration - in association with green growth, rural development and social inclusiveness. To implement this strategy, the pivotal role of industry was pinpointed in Made in China 2025: "build internationally competitive manufacturing" by enhancing innovation capability, integration between informatics and industry, green production, service-oriented manufacturing and internationalization (CHINA, 2015, p.1-2). Since 2020, China has moved to a more inward and self-reliant model of development.

Recently, in light of global AI rise, China's political strategy places AI centerstage in military and economic competition. AI is considered a strategic technology in light of: its implications for military security; global scientific projection/status; the need to attract top talent and develop technical standards, software platforms, and semiconductors; the dilemma between having access to international AI know-how but, at the same time, the need to reduce technology dependence; the pivotal role of semiconductors in the future of AI competition; and the need to enhance Chinese's strength in commercial AI (ALLEN, 2019).

Besides such geoeconomics/geopolitical concerns, Gary Gereffy, Stefano Ponte and Timothy Sturgeon, leading GVC scholars, have analyzed in depth the impact of digitalization on global production, considering Big Tech firms both from developed and emerging countries. Firms are central in GVC theory (DALLAS, 2015), and Big Tech firms are vital for supply chain digitalization. Banalieva and Dhanaraj (2019) studied how digital firms develop their network advantages. In line with UNCTAD (2017), Banalieva and Dhanaraj (2019, p.1382) argue that, in digital GVCs, "the network plays a dual role – as a governance mode and as a strategic resource." Digital network advantages differ considerably from asset-based and transaction-based advantages deployed by traditional firms - in accordance with Rahman and Thelen (2019). Digital firms' specific assets may include (a) generic or advanced human capital skills (from computer programmers to high-skilled data scientists, software engineers, and system architects), and (b) modular technologies (core or peripheral), allowing these firms to have more or less centrality in the control of their network. In light of digitalization, network-based advantages also become core intangible assets in firm internationalization.

GVC theory places the firm as a central actor in global production and trade. "In GVC governance theory, power mainly resides in the lead firm" (DALLAS; PONTE; STURGEON, 2019, P.669). Big Tech firms are thus central in the governance of the digitalization of global production. These firms are technology providers. Big Tech firms thus hold *lock in advantages* concerning individual customers and business (buyers and suppliers) across all sectors which depend on digital technologies to operate.

Nevertheless, *lock-in advantages challenge traditional GVC theorization*, because such advantages force us to analyze Big Tech firms' dynamics beyond the centrality of individual firms. This is explained by contemporary approaches in GVC, which, going beyond lead firms, assume that power in GVCs is multipolar and networked:

> The rise of global suppliers and platform leaders such as Intel in formerly producer-driven chains led some to speculate whether a new era of supplier-led value chains was dawning (...) Over time, *the conception of power in GVCs has thus broadened from a focus on buyer power to include how key suppliers in some industries have been able to establish more powerful positions by following paths and strategies that not only create value but also retain it* (...) This leads away from the unipolarity of governance, where power is concentrated in one functional position in the value chain, towards *multipolarity*, where power might appear in various functional positions (…) Multipolarity can also involve actors outside the value chain, such as international NGOs, trade unions, governments and multi-stakeholder initiatives (DALLAS; PONTE; STURGEON, 2019, p. 670; italics are mine).

Such a view inevitably brings GVC theory closer to GPN (global production networks) literature. "GPNs scholars have proposed a structural-cum-relational approach to power (…). They argue that power in a production network is not reducible to a firm's position within the network (like network centrality) or to the strength of association (network density); rather, these structural attributes are overlain by relational ties between specific actors which are contingent and dynamic, and thus do not automatically lead to pre-ordained outcomes" (ibid., p.671). This means that Big Tech firms alone cannot be hold responsible for the outcomes of their operations. Other actors (public, private and civil-society) influence, constrain, and shape these firm's power relations within GVCs.

In fact, "the *concept of multipolarity* has drawn attention to actors that operate outside the value chain, such as international non-governmental organizations (NGOs), trade unions, governments and multistakeholder initiatives (…). The cognate literature on GPNs also highlighted the complexity and variety of non-firm actors in shaping the organization of economic activity" (PONTE; GEREFFI; RAJ-REICHERT, 2019, p.10). Multipolarity has thus enlarged the explanatory power of traditional firm-centric GVC analysis, attributing agency in digital value chains to external, non-firm, actors.

Dallas, Ponte and Sturgeon (2019) developed a four-fold typology of power in GVCs, suited to analyze Big Tech power relations in multipolar global production chains: bargaining power, institutional power, demonstrative power, and constitutive power. They "are not mutually exclusive and typically coexist – mixing, layering and combining in complex ways over time" (ibid., p.678). This four-fold typology for power can be used to understand the relative power of Big Tech firms. However, because this framework was built to explain general power relations within GVCs, encompassing multiple actors, it is not the most appropriate to highlight the particularities that emerge in Big Tech-coordinated GVCs. In this sense, I believe the typology I develop later in this Chapter is more appropriate to understand the global power of these companies.

As we have seen, recent developments in GVC literature can shed light into new types of relations between states and markets. GVC literature has developed power typologies useful to analyze the role played by Big Tech firms in "greening" global supply chains. These typologies shed light on the sources of influence Big Tech firms deploy in order to shape global climate governance, either greening their own supply chains, or, on the opposite direction, avoiding environmental/climate regulations.

The next sub-section addresses how the global governance approach can be handy to analyze Big Tech firms' governance.

4.2.2. The Governance of Digital Platforms

Who governs Big Tech firms? How are they regulated? These questions animate a recent (and thriving!) IPE literature, which is still looking for answers to them. The governance of Big Tech firms has to take into account their *platformization logic*, which lays the foundation for many other businesses to operate (KENNEY; ZYSMAN, 2016), including their rivals (KHAN, 2017). This includes their *network effects*, which allow platforms to have very competitive (sometimes predatory) prices, eventually engaging consumers to back their, not always transparent, political and economic behavior (RIEDER; SIRE, 2014). Platform firms may operate in various domains, e.g., online exchange markets, social media, user-generated content, crowdsourcing, advertising, etc. (LANGLEY; LEYSHON, 2017, P.11), and often in more than one at the same time, puzzling consumers and legislators about what is their business after all. For example, Khan (2017, p. 710) describes Amazon's business model: "in addition to being a retailer, it is now a marketing platform, a delivery and logistics network, a payment service, a credit lender, an auction house, a major book publisher, a producer of television and films, a fashion designer, a hardware manufacturer, and a leading host of cloud server space." The author deploys this description in order to question why, despite raising anticompetitive concerns, Amazon has so far escaped antitrust legislation. Amazon's business model exemplifies the essence of platform capitalism (SRNICEK, 2017).

Because Big Tech platforms operate simultaneously in different businesses, they can deploy competitive price strategies, and benefit from network effects. Thus, platform capitalism is said to have accelerated "structural tendencies toward monopoly" (RIDER; SIRE 2014, p.206). This has had particularly contentious consequences to labor markets, tax systems (THELEN, 2018), data privacy (CULPEPPER; THELEN, 2020), and information law (CARLSON, 2017), areas in which governance issues have emerged.

Uber, for instance, gave birth to important controversies as regards tax policy and labor relations. The firm had different receptions in the U.S. and in Europe as regards these issues. While in the U.S., Uber has been able to overcome regulation, mobilizing users "against unpopular taxi lobbies," in Germany, taxi associations, in coordination with public transportation authorities, isolated Uber by defending a well-regulated market, whose high-quality and reliable services would be in the best interest of consumers. In Sweden, a coalition of taxi companies, labor unions, and state actors mobilized against Uber's lack of a tax mechanism suited to national policies, but, eventually, adjustments in legislation provided a level playing field for the firm's operation. In this case, even though Uber had to adjust to each specific national scenario, its disruptive effects were felt in all three countries (THELEN, 2018, P.948-949).

Big Tech firms have a "voracious appetite for data" (SRNICEK, 2017, P.254), as their business models depend on perpetual data gathering and processing. "In contrast to traditional business models based on selling goods or services, platform companies create and capture value through their capacity to harvest and harness immense amounts of data" (CULPEPPER; THELEN, 2020, p.2-4). Srnicek (2017, p.256) observes that the surge in M&A by these firms is transforming them into "data extraction empires," reshaping the economy according to a data-centric logic. Yet, data empires are being increasingly exposed. Scandals like 2013 Snowden's revelation of U.S. government surveillance with the cooperation of platforms like Google and Yahoo (ATAL, 2020), and the 2018 Facebook–Cambridge Analytica issue, which revealed that millions of Facebook users' data had been leaked without consent, brought data privacy centerstage in global politics. How to avoid private data to be collected (and sold) by Big Tech firms without user's consent? Are governments capable to oversee their global operations?

In order to tackle these issues, a series of platform governance frameworks have recently emerged. Gorwa (2019, pp.10-13) developed the concept of *platform governance* in order to highlight three governance mechanisms. By means of *self-governance*, platform firms would make decisions with minimal external oversight, without complex regulatory interventions. Governments wouldn't have to worry about the 'black box' nature of platform' operations. This is the opposite of *external governance*, in which platforms would have to abide to strict privacy and data protection laws, competition regulations, and other governance mechanisms. In a third scenario, a *co-governance* approach would prevail. Platforms and governments would cooperate, by strengthening democratic accountability, but without extreme changes to the status quo. In this scenario, global civil society would be a fundamental democratic tool, by investigating user complaints and helping develop ethical frameworks for platforms.

Whereas relevant, these three types of platform governance are still limited. They lack specific directions on what type of policies would adjust to each governance approach. There is also no explanation as regards the transition from one governance archetype to another.

To clarify platform governance, Rahman and Thelen (2019, pp.177-178) concentrate on the platform business model, stressing its specificities in comparison to previous corporate standards. While the mid-20th century firm would emphasize the *nexus of reciprocal relationships* between the firm and its stakeholders (traditional corporate governance approach), and the late-20th century firm would rely on a global *network of contracts* (NOC) (consider Nike's or Zara's contracts with cheap apparel contract manufacturers across the globe, particularly in developing countries), the 21st century platform firm would differ from these archetypes in at least three important ways.

First, in contrast to NOC firms, platforms have benefited from more "patient" forms of venture capital, as market expansion became more important than short-term profits. Second, investor patience is explained by a different business proposition by digital platforms: "the central goal is to secure a level of market dominance and concentration, eventually becoming the foundational infrastructure of a given business sector" (RAHMAN; THELEN, 2019, p.180). Third, platforms' success is also explained by the renewed role of consumers. Central for market strategy since the NOC firm (due to shrinking product prices), consumers become even more strategic for the political strategy of platform firms: "platforms (at least at this stage of their development) feel to the consumer like liberation from market distortions that keep them from getting the lowest price for a ride (Uber) or prevent them from finding publicly available information (Google). (…) this situation creates a bias in favor of *deregulatory politics*, where consumers and the dominant companies are on the same side — against state intervention" (CULPEPPER; THELEN, 2020, p.9).

Both Gorwa (2019) and Rahman and Thelen (2019) governance approaches suggest that distinct national systems have different levels of "porosity" to platform firms. How to govern digital firms simultaneously entering the U.S. (full of incumbents) and Brazil, whose digital ecosystem essentially lacks competitors? Or, put differently, which kinds of governance mechanisms would better adapt to platforms operating in free-market economies, such as the UK, and in coordinated market economies, such as Germany? How would the same platform firms adapt to heterogeneous national political-economic systems? Few IPE scholars have analyzed these questions, yet important insights have already emerged. For instance, the risk of digital dependency in developing economies (MENDES, 2021; WEBER, 2017), and the distinct regulatory reception of platforms in multiple developed countries, e.g., the U.S. and European countries (THELEN, 2018).

Avant, Finnemore, and Sell (2010, p.2) have discussed the concept of global governors, which is also insightful for the analysis of digital platforms, with IR lenses. Global governors are "authorities who exercise power across borders for purposes of affecting policy (…) they create issues, set agendas, establish and implement rules or programs, and evaluate and/or adjudicate outcomes." It is not new that firms can act as global governors, e.g., when they cross borders and "spread their tentacles" across the global economy by establishing subsidiaries in foreign nations (STRANGE, 1991); by creating economic issues and setting political agendas when they exploit natural resources (GAMU; DAUVERGNE, 2018), when they are involved in corruption schemes (RODRIGUEZ ET AL., 2006) or environmental issues (KOLK, 2016); or, still, by establishing mandatory sustainability reports across their supply chains, to ensure transparency for customers, investors, and the society (CHOUCRI, 2005).

But, is the concept of global governors suitable to describe Big Tech firms' power? Considering the literature on platforms behavior, my answer is: partially, yes. It is very clear that Big Tech firms have motivated international governance frameworks, although they are still incipient. Platforms are now central players in areas like financial technologies (fintech), because they influence "new and established systems through which payments are settled, risks are assessed, and prices agreed" (BERNARDS; CAMPBELL-VERDUYN, 2019, p.776). Platforms also inspire regulations concerning data privacy (WEBER, 2017), algorithmic ethics in selecting and ordering online news (CARLSON, 2017), antitrust practices (KHAN, 2017), and laws to prevent the spread of fake news (GRINBERG ET AL., 2019).

Yet, despite useful to analyze platform power, the concept of global governors is insufficient in at least two respects. One, it treats governors as agents, thus failing to recognize an important trait of platform firms: they are also infrastructures. Thus, besides the firm's agency, socio-political and market structures play a major role in platform behavior, and conversely are also shaped by platform power. A second problem is that global governors are conceptualized as 'rational actors', endowed with control power over their own future. Platforms, however, operate in complex regulatory and political environments, often leading to a difficult decision-making process as regards how to act amid high levels of unpredictability and uncertainty.

Other power conceptualizations are useful, but limited, to analyze platform power. This is the case even when we analyze platforms with the lenses of more "materialistic" conceptualizations of power, thus recognizing the structure they are embedded in. One such conceptualization was provided by Barnett and Duvall (2007). Accordingly, "power is the production, in and through social relations, of effects that shape the capacities of actors to determine their own circumstances and fate"

(BARNETT; DUVALL, 2007, p.8). In this setting, relevant concepts include structural power (co-constitutive, internal relations of structural arrangements that define the relative position of social actors) and productive power (social influence through systems of knowledge and discourses) (ibid., p.18-20).

These power conceptualizations are somehow adequate to describe digital platforms; e.g., as infrastructures for innovative business models, and as central players in multi-sided markets. However, they are meager to clarify some of these firms' traits. For instance, the complexity (and unpredictability) of platform logic and its social effects, e.g., if they influence or not mental health issues in their users (SHENSA et al., 2018). Notions of structural and productive power are also inadequate to illuminate the vulnerability ingrained in platform's business model. Platforms may be weak against emerging political coalitions, like workers-consumers or producer-consumers, which rise as a consequence of social issues propelled by digital technologies: e.g., data privacy, citizen surveillance, *social dumping*[20], tax evasion, labor exploitation, inequalities (RAHMAN; THELEN, 2019, p.196-7).

In order to contribute to this debate, in the next section I introduce an original conceptual framework for Big Tech firm's power.

4.3. Towards a Typology for Big Tech Corporate Power

In light of the above, in the following subsections I present an original typology for Big Tech power. My typology is based upon four power archetypes: network power, infrastructural power, information power, and data power. Although the IR literature has already theorized some of these power concepts separably, e.g., network power (GREWAL, 2008), infrastructural power (KHALILI, 2017; SCHWARTZ, 2019), and information power (KEOHANE; NYE, 1998; LONDSDALE, 1999; AKER et al., 2017), the typology I develop here is original in at least three respects. First, neither of these concepts were developed to analyze Big Tech firms in IR. Thus, my conceptualization differs considerably from previous IR studies that employed these power concepts to analyze nations or politicians. Second, as far as my research shows,

[20] For Alber and Standing (2000), social dumping is a practice of employers to use cheaper labour than is usually available. Migrant workers can be employed under cheaper salaries; or production can be moved to a low-wage country or area. The company will thus save money and potentially increase its profit.

the concept of data power has not yet been theorized in IR, despite its use in fields such as media studies (KENNEDY; BATES, 2017; KENNEDY; HILL, 2017). Third, the literature hasn't described nor applied these four concepts in a conjoint analysis, not least as regards Big Tech firms.

4.3.1. Network Power

Why, in the platform logic, market expansion is more critical than profit generation? Why are platforms so concerned in expanding their 'network'? Amazon's case can be clarifying. Jeff Bezos founded Amazon in 1994, with the long-term mission of making it the Earth's most customer-centric company. After a series of business movements, the firm grew from a bookseller, to a music retailer (1998), and then to an online marketplace (1999), a platform for videos on-demand/Amazon Prime (2006), an on-demand cloud computing platform and API[21] provider/ Amazon Web Services - AWS (2006), an online payment processing service/ Amazon Pay (2007), an e-book reader and book seller/ Amazon Kindle (2007), a publishing house/ Amazon Publishing (2009), a digital content provider and distributor through Amazon Studios (2010) and Amazon Video (2016), a video-game developer/ Amazon Game Studios (2008), and, more recently, a cloud gaming service/ Amazon Luna (2020), among other businesses.

Amazon's considerable growth (in only 25 years!) entails a skillful use of network power. This concept encompasses three features. First, firms that possess network power provide a basic service system so that network players can interact more or less freely, usually developing and nurturing their own businesses. Facebook's expansion into the global mobile ecosystem by means of its Messenger app was a strategic move in this direction (NIEBORG; HELMOND, 2018). Second, platforms with network power are capable of giving more or less centrality to certain actors in their network (GRANOVETTER, 1973; KNOKE 1974). Third, by expanding the network size through

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[21] An API (Application Programming Interface) is a kind of software, which defines interactions between multiple software intermediaries. It establishes the kinds of calls or requests that can be made, how to make them, the data formats that should be used, the conventions to follow, among other features. According to Nielborg and Helmond (2019, p.202), APIs "provide third-party developers access to platform data and functionalities to build new platform integrations and extensions such as plug-ins and apps."

economies of scale, digital platforms can grow until monopolistic trends emerge, situation where they peak their network power (BARWISE; WATKINS, 2018). Each of these features is analyzed below.

A perception of freedom for customers and collaborators is central in platform's business models. Big Tech platforms such as Facebook and Twitter are disclosed as techno-spaces where people can democratically exercise freedom of speech (CARLSON, 2017). Customers may exercise their political views by sharing images, videos or text, either by using their real identity or through anonymization tools. Anonymization gives users a sense of protection, which further incentivizes engagement with the platform. Through intermediation, Uber and Airbnb connect customers and service-providers anytime and anywhere, creating a sense of privilege and empowerment. Entrepreneurs, both those willing to drive for Uber and those aiming to rent their houses through Airbnb, are endowed by these platforms to easily open almost risk-free businesses. In essence, platforms provide the fundamental conditions for a network to be built and thrive. The scale and growth of the network depends on platform firms as much as they are able to convince social actors to engage in their community as a consequence of a broad perception of value. This phenomenon has been called 'digital circulation' (content dissemination through peer-to-peer, prosumer and co-production models), 'sharing economy' or, more broadly, as a 'network economy' (KENNEY; ZYSMAN, 2016; LANGLEY; LEYSHON, 2017).

A second characteristic of network power is that it allows platforms to give more or less centrality to certain actors in their network. Let's take Instagram as example. The more a given user is able to attract visitors to its profile and engagement with its content, the more central it becomes to the wider Instagram network. Its profile and content can be easily reached by users, propelling its centrality within the platform. Another example is Amazon, which empowers developers by allowing them to launch their own apps for cheap prices in the AppStore. Both cases illustrate the network incentives platforms grant to their main users and developers. This happens either by stimulating them to spend time online in order to increase their (and the platform) network, or by becoming a marketplace where partners advertise and sell their products. Centrality within platforms is achieved through 'reputational devices' (number of followers, views, shares), where reputation functions as a kind of capital and measure of value for participants (LANGLEY; LEYSHON, 2017, p.20). Twitter is an example of platform where reputational devices can be encountered in varied formats.

In addition, the power of platform firms is driven by "network effects", where "the value to users largely depends on the number of others using the same goods or services" (WU; GEREFFI, 2018, p. 332). This is a kind of economy of scale, through which platforms may grow until they achieve monopolistic trends. "Scale is critical to their ability to cultivate and capture value" (CULPEPPER; THELEN, 2020, p.7). The bigger the number of consumers, the lower the prices and, therefore, the higher the market domination of a given platform. "Google controls almost 90% of the global market share of search advertising, Facebook controls 77% of mobile social traffic, and Amazon has almost 75% of the e-book market" (SCHWAB, 2018, p.59). Analyzing Facebook, Nieborg and Helmond (2019) developed the concept of platform instances, to clarify the logic behind multisided-markets. "Individual platform instances serve as stand-alone derivatives that each provide a distinct 'view' of the platform as a whole and offer different functionalities tailored to distinct user groups" (ibid., p.199). In this setting, platforms explore economies of scale because they enjoy "patient forms of (venture) capital," particularly in countries like the US. "Not 'core competencies,' but network effects, potential for market dominance, explosive and perpetual returns justify a much longer time horizon of patience from investors" (RAHMAN; THELEN, 2019, P.195). This logic forges a strategic unity between investors and firm managers, so that platforms can expand their markets, engage in pursuing winner-take-all strategies and, eventually, become global monopolies.

Together, these three characteristics (ability to provide a sense of empowerment for users, power to grant centrality to their most "committed" users, capacity to spark and propel network effects) amalgamate into Big Tech firms' network power. This is complemented by their huge material capabilities, as the next power type illustrates.

4.3.2. Infrastructural Power

Notions of structural and instrumental power have long been studied in IR, particularly to analyze global business power (FUCHS, 2005; CLAPP; FUCHS, 2009). Business political power is visible through lobbying, given that politicians and OI bureaucrats "have become increasingly dependent on the resources and inputs from business" (FUCHS, 2005, p.782). China's example is handy. The Chinese transnational business community has successfully engaged with Western capitalism and its liberal institutions, becoming important sources in China's global strategy (GRAAFF, 2020). This case illustrates the use of instrumental power by business groups, either to influence political decisions on countries receiving Chinese investments, or to materialize (and demonstrate) their growing international political influence. Internet firms follow a similar trajectory: "in the United States in 2017, companies in the Internet sector spent $50 million on lobbying, a threefold increase since 2009; Amazon alone increased its spending on American lobbying to roughly $13 million in 2017, as opposed to equivalent spending of $2.5 million 5 years earlier" (CULPEPPER; THELEN 2020, P.6). Lobbying is a central feature in infrastructural power because it is indispensable for the operation of *platform capitalism* (LANGLEY; LEYSHON, 2017; SRNICEK, 2017) and *surveillance capitalism* (ZUBOFF, 2019).

Concretely, businesses may influence global economic infrastructures, especially if they are from certain sectors (RUGGIE, 2013, 2020). The GVC literature is emphatic on the agency of firms in global economic governance: "The firm as a strategic actor is a foundational concept that unites all GVC approaches to fragmentation. This means that firms develop long-term strategies which may contradict the short-term cost-minimization/profit-maximization strategy implicit in economic analyses. (...) The capacity for diverse firm strategies means that firms are not simply rankable by size or productivity (as in firm heterogeneity), but vary by type according to their roles in the broader industrial ecosystem" (DALLAS, 2015, p.883).

In the 1970s and 1980s, Oil firms like British Petroleum, Shell, Texaco and Exxon Mobil provided fundamental infrastructures for the oil-based global economy (KOLK; LEVY, 2001). Sectors such as automotive, chemical, transports and utilities depended heavily on oil suppliers, making Oil firms central in *global economic infrastructures*. Besides economic strength, their political power was immense. Throughout the 1990s and 2000s, however, financial firms (chiefly banking and insurance) became even more important infrastructures in the global economy (SASSEN, 1991). The financial sector's influence was particularly felt after the 2008 crisis (HELLEINER, 2014).

Since 2010s, however, Big Tech firms became central, surpassing Oil firms, and now acting in tandem with financial firms as driving global infrastructures, from telecom operators to internet providers. Big Tech firms produce fundamental services for everyday life (CULPEPPER; THELEN, 2020), are leaders in market capitalization

(WOLF, 2017), and accommodate the digitalization of global finance and production, in most economic sectors, both in rich and in developing nations (UNCTAD, 2017).

In this setting, infrastructural power is characterized by two features. One, it is a type of financial capability. In the tech sector, this is perceived mostly in the mobilization of venture capital in M&A operations, so that Big Tech firms can buy promising start-ups. Second, infrastructural power works as a system of services, material structures, codes of conduct, and business models available to other firms. Because of this trait, digital platforms are becoming driving forces in the ongoing process of supply chain digitalization. Business models such as e-commerce and e-payment, central in contemporary capitalism, rely on the infrastructures provided by Big Tech firms (UNCTAD, 2017). I analyze both these traits of infrastructural power below.

Infrastructural power embodies the financial capacity to support a given political economic structure. A chief trait of Big Tech behavior is their M&A practices towards outstanding start-up firms. Through M&A strategies, internet firms provide the infrastructure for innovative businesses to scale up (under Big Tech ownership), as illustrated by the acquisition of WhatsApp and Instagram by Facebook, and of YouTube, by Google. By means of strategic M&A operations, Big Tech firms have expanded their "modes of control over online infrastructures," keeping their prominence as the most innovative businesses in the world (LANGLEY; LEYSHON, 2016, p.10).

In this vein, Langley and Leyshon (2016) highlighted some specificities of infrastructural power, which further illustrate their financial capabilities. Platforms represent "distributed capitalism", where 'infrastructure is primarily distributed with the promise to make everyone a small capitalist.' Another dimension concerns what they call "netarchical capitalism", i.e., such infrastructures are in the hands of "centralized private owned" enterprises (ibidem). Infrastructural power is, thus, a financial capability, working through venture capital financing in order to (1) boost promising new businesses under Big Tech ownership, and (2) secure market dominance across a growing array of emerging busines models, maintaining their position as the top innovative global firms.

A second trait of infrastructural power is the provision of certain services, material basis, and codes of conduct upon which other businesses can scale up. Without Big Tech firms acting as platform infrastructures, a transnational chain of digital businesses wouldn't have emerged. As basic infrastructures, platforms are essential in the digital economy. Under the notion of platform power, Culpepper and Thelen (2020, p.7) highlight that companies such as Google and Amazon "provide the infrastructure to which an entire economic ecosystem—consisting of myriad other businesses—is now attached." This is even more evident when we analyze the discourse of Jeff Bezos in recent hearing before the U.S. House of Representatives: "Amazon's success depends overwhelmingly on the success of the thousands of small and medium-sized businesses that also sell their products in Amazon's stores" (BEZOS, 2020, p.4-5). Of course, Bezos is not referring only to U.S. businesses, but to a global array of small firms partnering with Amazon - certainly, with exponentially less power or authority than Amazon.

It is important to highlight the mutual (yet asymmetrical) dependency between Big Tech platforms and the businesses community. Infrastructural power is, thus, the control over the foundation upon which other businesses are structured and fostered. When this substructure achieves global proportions, as it is the case with Alphabet, Amazon, Facebook, Apple's business ecosystem, platforms achieve global infrastructural power. Facebook's case is illustrative:

> Facebook's past and current investments concern three levels: (1) internal growth through an increasing number of platform-owned and operated app and web instances; (2) through acquisitions of existing apps such as Instagram (2012) and WhatsApp (2014); and (3) external growth through the platformization of the web and app space. While political economists have traditionally focused on the first two levels, it is through the analysis of how platforms attract business sides, leverage direct and indirect network effects, afford programmability, and offer boundary resources, that platforms operationalize their infrastructural agendas (NIEBORG; HELMAN 2019, p.211).

Facebook's business dynamics illustrates well how internet platforms apply and benefit from their (global) infrastructural power. Thus, in my typology, infrastructural power encompasses two dimensions: i) huge financial capability, especially used in strategic M&A operations, and ii) a set of services, material basis, and codes of conduct and business models "freely" available for other businesses and entrepreneurs, although designed to maintain very asymmetric power relations between Big Tech and all other players. These relations are secured by the control of information, as illustrated next.

4.3.3. Information Power

Platforms have the power to emphasize and utilize the most convenient information, according to their preferences, values, and perceived opportunities. Big Tech firms such as Twitter and Facebook use *algorithmic judgement* to censor conservative voices on the web (CARLSON, 2017). Recently, Twitter excluded posts from the @realDonaldTrump account, in order to prevent “further incitement of violence” by the former U.S. president. This occurred after crowds of Trump supporters invaded the Capitol, on January 6, 2021, questioning his defeat in the 2020 U.S. presidential elections (TWITTER, 2021). Other Big Tech firms have used their algorithmic judgement to exclude or promote certain types of content. Based on survey data from the 1996 and 2000 U.S. presidential elections, Tolbert and McNeal (2003) found that internet platforms not only enhanced voter information about candidates, but also increased political participation. Elsewhere, Grinberg et al (2019) analyzed how fake-news influenced the 2016 U.S. presidential elections, and found that fake news had limited effects and were concentrated amongst small groups of the population. Recently, Facebook framed its role on the web as a social service provider:

> In February 2017, after a wave of criticism on the company’s alleged role in spreading misinformation and influencing the ‘Brexit’ referendum and the US elections, Zuckerberg posted a 6000-word manifesto outlining Facebook’s changing direction from ‘connecting people’ to building ‘social infrastructure’ (FB2017a). Implying that the solution to Facebook is simply more Facebook, this framing positions the platform as a ubiquitous, foundational, if not essential gateway supporting ‘social’ services (NIEBORG; HELMOND, 2019, p. 198).

Curiously, in a 2018 survey where U.S. citizens were asked the question “who — tech firms or government — should regulate the dissemination of false information online? (…) 56% of Americans thought technology companies should perform these functions” (CULPEPPER; THELEN, 2020, p.11).

Media and communications scholars consider ‘information power’ an ability of Big Tech platforms to manipulate public opinion. While “there are growing calls for platform companies to exercise more editorial judgement, to employ more human curators, and ban extremist accounts” (ATAL, 2020, p.11), public perception, particularly in the U.S., believes that platforms - not governments - should be responsible for this type of governance, i.e., self-governance (GORWA, 2019).

In light of these examples, it is reasonable to state that information power encompasses two features. First, through the orchestration of the public opinion, platforms can advance specific political, economic, cultural or behavioral agendas.

"Google can influence where we go on the Internet by its auto-complete function; Facebook is the news portal of choice for many; and Jeff Bezos, the founder and CEO of Amazon, has bought the influential U.S. newspaper The Washington Post" (CULPEPPER; THELEN, 2020, p.24). Second, Big Tech platforms use information as a strategic tool in their business models. For example, via the Messenger app, Facebook entered the mobile ecosystem "through a platform that became ubiquitous in the exchange of information between users" (NIEBORG; HELMOND, 2019, p. 202). With algorithmic treatment of user's information, Big Tech firms can also adapt their products, services and overall business strategies. Each of these dimensions is analyzed below.

Big Tech firms have a "deeper relationship" with their consumers than other types of businesses simply because they are part of the "infrastructure of customer's lives" (CULPEPPER; THELEN, 2020). Such power allows platforms to, among other things, manipulate public opinion. This has been analyzed as a kind of "perception of freedom" platforms grant to their users (CARLSON, 2017), or a way to use "technology as a tool for empowerment and social change" (LEVINA; HASINOFF 2017, p.489). Regardless of the means, platforms became essential information and communication tools, e.g., WeChat in China (PLANTIN; SETA, 2020) and Facebook/WhatsApp globally. With consumers locked in by platform ubiquity, Big Tech firms take advantage of "customer's tacit allegiance" to (a) avoid regulation, since "consumers and the dominant companies are usually on the same side—against state intervention" (CULPEPPER, THELEN, 2020, p.9), (b) dodge antitrust laws, in order to keep predatory pricing, exploit information collected on rival companies, and ensure market dominance through integration across distinct businesses (KHAN, 2017).

Having customer's support, platform firms develop a second feature of information power: they use strategic information to improve their business models. In the absence of a "powerful regulator", and in a social environment where Big Tech firms receive increasing legitimacy from citizens-consumers, information becomes a strategic business asset. Castells (2010) and others have already discussed how contemporary social relations are embedded in the "information society." In my view, business relations are more than embedded in - they are heavily dependent upon - information. In such scenario, as both providers and facilitators of information (from processing to diffusion). Big Tech firms have achieved information power, and have used it strategically in their businesses. This is emblematic in my four cases. As technical infrastructures, these firms create a business platformization[22] logic by "offering a set of application programming interfaces (APIs), software development kits (SDKs), and plugins, which facilitate platform's programmability" (NIEBORG; HELMOND, 2019, p.198). Even though this logic can be assessed with the lenses of 'infrastructural power', the concept of information power gives us more nuance. To increase its level of information access (and control), in 2013 Facebook turned from an advertisement business into a mobile business (ibid., p.207), following the mass growth of the mobile ecosystem. Similarly, typical e-commerce or tech businesses entered the financial ecosystem - e.g., Alipay, Apple Pay, Google Pay, Amazon Pay (WU; GEREFFI, 2018) - not only to acquire revenues from the growing business of online payments, but also to access finance-related information on people worldwide.

To sum up, Big Tech firms' information power encompasses two features: i) the ability to orchestrate information access and use by the public opinion, thus advancing specific political, economic, cultural or behavioral agendas; and ii) the use of information as a strategic tool in their business models. In the next section, we see how these features are associated with big data generation, as Big Tech firms became powerful monopolies.

4.3.4. Data Power

Data privacy and regulation are salient issues in platform governance. As the political economy of 'big data' is reshaping the epistemologies social sciences (KITCHIN, 2014; KENNEY; ZYSMAN, 2016), data regulations have multiplied globally - e.g., the EU General Data Protection Regulation (GDPR), myriad of laws both at the federal and state levels in the U.S., and data privacy regulations in emerging economies like Brazil (MENDES, 2021). Consumer concern and government action towards data privacy are consequences of a growing social perception of the power pursued by Big Tech firms, which allows them to extract, use, release and sell user's data (CULPEPPER; THELEN 2020). We have thus entered a *data economy.*

Data economies are predicated upon fluxes. Just like trade and financial flows have modulated the global economy up to date, "the most significant growth in cross-

[22] According to Nieborg and Helmond (2019, p.202), the "dual logic of platform expansion and decentralized data capture is understood as 'platformization', which emphasizes not only how a platform's technical design and evolution are related but also how the infrastructural and economic ambitions of social media platforms are interconnected."

border flows now comes as data. (…) Some of these flows represent 'raw' data, while others represent high-value-added data products" (WEBER, 2017, p.397). Rich data countries have the early-mover advantage in certain technologies, highly depend on structured data, e.g., Artificial Intelligence (UNCTAD, 2017). China and the U.S., with immense populations, and permissive regulations concerning data collection, have important data sources and natural places for the emergence of Big Tech firms. Nonetheless, in China the data collected by Big Tech firms are controlled by the State and the Communist Party, whereas in the US only part of the data collected is shared with the State, depending on the strategic options of the corporation.

Big Tech firms exercise data power in two ways. First, they own specific technologies to collect high volumes of *structured data* (big data). Data is essential in training these firm's algorithms, in order to better understand their customers, adapting their products to specific consumer "needs". Platforms possess the "data infrastructure" (NIEBORG; HELMOND, 2019), which allows them to perform complex, high volume, and high-speed data processing. Second, equipped with big data, and with the technologies that allow complex data processing, Big Tech firms are the most prepared social actors to develop and commercialize disruptive technologies - such as AI, blockchain, Augmented Reality/Virtual Reality, among others. This is the case even considering that such technologies are, more often than not, also a result of public R&D investments, commonly achieved through government funding on basic research (MAZZUCATO, 2011). These features are analyzed below.

Social networks are basic devices for structured data collection. For Big Tech firms such as Twitter, Facebook and YouTube, the rule of thumb is simple: "information platforms depend on the consumer's willingness to trade their data in return for free usage" (CULPEPPER; THELEN, 2020, p.14). If the user accepts cookies (i.e., instruments for data collection in web browsers), data will be collected. To make this data transference more transparent, recent initiatives, such as EU's GDPR, require Big Tech firms to inform users about their cookies' policies. Yet, because of the *privacy paradox* (CULPEPPER; THELEN, 2020), this policy is normally very ineffective. The privacy paradox means that, while customers may answer in surveys that they "value privacy", in their actual behavior, customers will often exchange their data for low prices or greater convenience, or even just to access basic online services.

Specific technologies for data collection and processing abound, and can be translated as data infrastructure. Considering "data infrastructure as socio-technical systems implicated in the creation, processing, and distribution of data" (NIEBORG; HELMOND, 2019, p. 199), examples include: APIs, SDKs, plugins, languages and other tools which facilitate "platform's programmability" (ibidem). The politics of data centers - from their growing data-processing capacity to efforts towards energy efficiency (BELOGLAZOV et al., 2012) - illustrate another dimension of data infrastructure.

Besides the technology infrastructure for data processing, the second trait of data power is Big Tech firms' capacity to develop new technologies which, essentially, are dependent upon big data. Machine learning and AI are examples of technologies heavily dependent upon digital platforms' abilities to collect structured and large volumes of data. Big Tech firms have been collecting structured and large amount of data from their customers for decades now. By means of this strategy, these firms built and enhanced large structured datasets. The U.S. does not have regulations as restrictive as the European GDPR, resulting in faster developments in machine learning compared to the EU. Independent of formal regulations, Chinese platforms are always strictly monitored by the State and Communist Party. We can thus say that the U.S. platforms have more data power than their EU counterparts, and the Chinese State much more data power than the others. Data power not only means processing capacity, but also the freedom to collect large amounts of data and use it as raw material for the creation of new technologies.

4.4. Filling a Gap in IPE Research

This chapter introduced an original typology for Big Tech corporate power. As "platform politics are becoming increasingly difficult to separate from global politics" (GORWA, 2019, p.5), debates about platform power have growing relevance in IR and IPE. However, Big Tech firms are still under-theorized in these disciplines (MENDES, 2021; ATAL, 2020; CULPEPPER; THELEN, 2020). Thus, this chapter's objective was to help fill this gap in the literature.

The four-fold platform power typology developed here included: network power, infrastructural power, information power, and data power. *Network power* is the ability to create and maintain a concise group of actors together in a digital community. This is achieved by a perception of freedom and empowerment platforms grant to their users, besides a "politics of prestige" that allows Big Tech firms to increase the agency and visibility of certain actors in their networks. Eventually, network power may transform platform firms into monopolies, mainly as a result of economies of scale. *Infrastructural power* is characterized by a certain financial capability, which enables such firms to acquire and mature (scale up) prominent start-ups through M&A investments. But it is also a system of services, material structures, codes of conduct, and business models, with the central purpose of fostering other businesses to growth (under Big Tech firms' ownership). *Information power* entails two features. It is the effective orchestration of public opinion towards relevant directions for Big Tech firms' business aspirations and/or social intent, but it also means a strategic use of information to improve these firms' business models. *Data power* was conceptualized here as the custody over computing technologies which allow high volume/high-speed data processing. This notion signifies power over the development of data-centric technologies, such as AI and machine learning, due to early-mover advantage (i.e., Big Tech firms are currently the most competent firms to collect and process big data and use it to develop new digital technologies).

With this power typology, I address three specific gaps in current IPE. First, as stated by Gorwa (2019, p.8), "keeping corporations accountable became a pressing global governance problem", but so far, few IPE scholars have attempted to conceptualize accountability models for Big Tech firms (ATAL, 2020, CULPEPPER; THELEN, 2020). Hopefully, the power typology I developed here will provide a contribution in this direction.

Second, "for free-market enthusiasts, reputational devices contribute to making the sharing economy a near perfect market, where participants have access to almost fully disclosed information on the other parties (…) punishment by the crowd takes the form of 'public shaming', meanwhile, digital economies become 'reputation economies', where 'reputation functions as a kind of capital' and measure of value for participants" (LANGLEY; LEYSHON, 2016, P.20). Notions of network power and information power developed here help analyzing the problems identified by Langley and Leyshon (2016), by clarifying some social risks ingrained in Big Tech businesses.

Third, "platforms constitute 'regulatory structures' that dictate the terms of several types of interactions—between workers and employers, buyers and sellers, clients and contractors, creators and viewers, and advertisers and consumers. This networked mode of market domination suggests that many traditional measures of a firm's "size" are not refined enough for assessing platform dominance. Indicators such as market capitalization and market share are relevant, of course, but may understate their degree of power (RAHMAN; THELEN, 2019, p.179). In this vein, the power typology presented here may clarify additional instances of platform power. This framework may be handy for policy makers and platform regulators.

PART III

Climate Change and the Low-Carbon Vested Interests of Alphabet, Amazon, Apple, Meta

CHAPTER 5

The Politics of Big Tech Decarbonization: Sustainability Reporting and Climate Commitment at Alphabet, Amazon, Apple, Meta

5.1. Climate Change Becomes a Big Tech Corporate Endeavor

Part I and II of this dissertation were theoretical, aiming to explore climate change, digitalization, and Big Tech multinationals through IR and IPE conceptual lenses. The present chapter introduces Part III of the dissertation, which is essentially empirical. In this introductory chapter of Part III, I perform four case studies on the intersections between Alphabet, Amazon, Apple, and Meta and climate politics. As explained in the introduction of the dissertation, my analysis draws on various data sources, including sustainability reports, newspaper articles, participant observations, and in-person interviews in California. The final result is an empirical narrative, which I shall present hereafter. Importantly, my narrative is presented in a storytelling style to reveal the complexity ingrained in Big Tech corporate behavior in addressing climate change.

In July 2015, Kate Brandt was appointed as Alphabet's (known as Google until October 2, 2015)[23] Chief Sustainability Officer (CSO), after a stellar career start at the U.S. Federal Government. Upon completing her master's degree (Cambridge) and her bachelor's degree (Brown) both in International Relations, the smiley, blonde, Californian-native executive started working for the Women for Obama campaign in 2008. Following, she became part of the Obama-Biden transition team, which granted her a job position in the Obama administration. As her first post in the White House, Brandt was an energy-policy analyst at the Office of Energy and Climate Change. Then she was promoted as a senior advisor at the U.S. Department of Energy. Eventually, after another promotion, in 2014 she became the first U.S. Chief Sustainability Officer, in charge of leading sustainability tactics across the federal government's 360.000 buildings, 650.000-vehicle fleet, and US$ 445 bi in annual goods and services purchases (STAFF, 2019).

After a little more than a year as the U.S. top sustainability officer, Brandt decided to switch to the private sector. And she opted for Alphabet. Hired as a Lead for Sustainability, she was quickly promoted to CSO again. According to her LinkedIn profile[24], in her current position she "*partners with Google's data centers, real estate,*

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[23] In the process of restructuring by which Google became Alphabet Inc., Google and all its subsidiaries were put under Alphabet's umbrella. All sustainability and climate reports analyzed in this dissertation refer to the multi-business enterprise (Alphabet), including but not limited to Google. Nonetheless, Google is by far the largest of Alphabet's subsidiaries. Thus, the majority of Alphabet's environmental and climate impacts (and commitments) come from Google.

[24] The profile is available here: https://www.linkedin.com/in/katebrandt/ Accessed January 20, 2022.

supply chain, and product teams to ensure the company is capitalizing on opportunities to strategically advance sustainability and the circular economy." In this description, Brandt's business-as-usual approach to sustainability is crystal clear. Let's analyze why.

Brandt's fast-paced career to the top illustrates her values (marketization[25], competitiveness, ambition) as the firm's sustainability leader: maximize sustainability outputs and capitalize on "green" business opportunities.

Besides the introduction to her LinkedIn, a recent talk she gave at the Stanford School of Earth, Energy & Environmental Sciences further clarifies Alphabet's approach to sustainability (STANFORD, 2017). At the beginning of her talk, Brandt shared information on several climate and sustainability policies at the firm-level across key dimensions: renewable energy, machine learning & AI, cloud computing, big data & geo mapping, circular economy, and cities[26]. She talked about these initiatives with excitement and joy, as any business-oriented leader would do. But the limits of Alphabet's sustainability approach became evident in the second part of the talk, the Q&A session.

For most questions Brandt had a business-as-usual answer at the tip of her tongue. When asked about how she compared her work at the U.S. government and at Alphabet, she was adamant about the importance of large governments and global corporations taking a leadership position on sustainability, because they can drive change by leading by example. Later, when asked about how Google defines running with 100% renewables, she observed that for all electricity the company uses globally, from offices to data centers, it purchases the same amount of renewable energy. Indeed, the firm is carbon neutral[27] since 2007 and, since 2017, its global operations are run with 100% renewable energy, achieved through large power purchase agreements (PPA)[28]. By 2030, Alphabet pledged to power all its operations with 100% carbon-free energy, without renewable energy certificates to offset fossil-fuel generated power (ALPHABET, 2021a; THE GUARDIAN, 2021).

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[25] Marketization means: a) the exposure of an industry or service to market forces, or b) the conversion of a national economy from a planned to a market economy. Brandt's marketization value is in line with (a). She defends environmental services to become a new source of business activities for Alphabet. Source: https://www.lexico.com/en/definition/marketization Accessed January 20, 2022.

[26] These initiatives will be further discussed in the course of this chapter.

[27] Carbon neutrality means having a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks.

[28] A power purchase agreement (PPA), or electricity power agreement, is a contract between two parties, one which generates electricity (the seller) and one which is looking to purchase electricity (the buyer). The specific PPA format used by Google will be discussed later.

However, the flaws of the firm's sustainability approach soon became evident in Brandt's talk. Upon being asked three crucial questions about the firm's environmental and climate strategies, the CSO was just not convincing. Given that the bulk of the revenues comes from advertising, a curious student asked if Google selects the firms it advertises for based on their environmental commitment, e.g., excluding large polluters from its portfolio, or subsidizing firms that operate sustainably. Brandt didn't say no, but simply replied: "great suggestion!" The main takeaway from this is that Alphabet is not interested in stopping advertising for environmentally-damaging customers, as long as they keep bringing important revenues.

Another man in the audience questioned what is Alphabet's position on national carbon pricing[29]. Brandt said that the firm does not have an official position on this issue. Instead, the firm considers what is the role of large energy-purchasers like Alphabet in driving renewable power buying and policies that unlock more of that. Indirectly, Brandt suggested that Alphabet would not lobby strongly as regards carbon pricing — a position I will discuss later. As a matter of fact, Alphabet doesn't lobby much with respect to climate change (THE GUARDIAN, 2021) — not even close to big Oil & Gas (O&G) companies. This is problematic because Alphabet has enough financial capital to really make an impact in advancing progressive climate policy in the U.S. Thus, I consider this a case of *climate non-commitment* by omission. As I will discuss later, Alphabet (and other Big Tech firms) does not spend much lobbying for climate policy because it has other "big shoes to fill." Other salient policy issues much more "dangerous" for the business in the short-term, such as data privacy and regulation.

Finally, a third student was curious about what Alphabet is doing to leverage sustainability in developing countries. The short answer for that was: *not much*. Politely, and again super corporate smiley, Brandt told the audience that the firm makes sure its sustainable technologies are globally available and open access. Accordingly, some of Alphabet's products are *freely* available to everyone and can have equal applicability both in the global North and South. But we know that at least the first part of her answer is false. Google, for instance, profits from big data collection by most of its *free* products such as Gmail, Google Maps, Google Nest, and others (ZUBOFF, 2019). In essence,

[29] Thirteen U.S. states have adopted marked-based approaches to reduce GHG emissions, including California, where Alphabet is headquartered. Carbon-pricing policies at the state-level have been operating since 2009 across the country, and states adopting carbon pricing represent 1/3 of the U.S. GDP. Source: https://www.c2es.org/content/market-based-state-policy/ Accessed May 3, 2022.

Brandt's "green corporate" speech is a recent trend across Big Tech firms, as we discuss hereafter.

Two other women lead sustainability initiatives at Apple and Amazon. But before telling their stories and how they approach sustainability and climate change, it is worth taking a note on women in these Big Tech firms. In 2019, Alphabet had 26,1% of women in leadership positions, whereas 31,6% of its global workforce was female (STAFF, 2019). In 2021, these figures didn't change much: 28,1% of women in leadership and 32,5% in Alphabet's total global workforce (ALPHABET, 2021b). At Apple, global figures from 2020 showed 31% of women in leadership positions, and 34% female representation in the firm's overall workforce, i.e., all positions regardless of the hierarchic level (APPLE, 2021a). As for Meta's global workforce in 2020, 35,5% of its leadership positions were occupied by women, whereas women represented 36,7% of the total workforce (META, 2021a). Amazon has shown the highest level of parity: 44,6% of women employed across its global workforce in 2020. Despite that, consistent with the "glass ceiling" metaphor, according to which "women are extremely under-represented in top management and professional positions in all countries" (ACKER, 2009, p.199), at Amazon the percentage of women employees declines as the hierarchic level ascends, as illustrated by figures across the following corporate areas: field & customer support: 48,5% of employees are women; corporate offices: 31,4% are women; people managers: 29,3% are women; senior leaders: only 22,1% are women (AMAZON, 2021a). Given these numbers, it is impressive that, at Alphabet, Amazon, Apple, and Meta, 75% (3 out of 4) of these firms have a woman at the top Sustainability position.

Big Tech firms are known for mostly employing STEM (Science, Technology, Engineering, and Mathematics) graduates, and research shows that women are still consistently under-represented in these fields (KAHN; GINTHER, 2017). So, it is not a surprise that, at Apple, for instance, out of the 18 top executives[30], only 5 (28%) are non-STEM — 2 of them with a bachelor's degree in Business, 2 in Literature, and 1 in Economics. Another *non-surprise* is that there are only 5 women amongst those 18 top executives: 2 with a Business undergraduate degree, 1 natural scientist, and 2 engineers. Lisa Jackson, one of those 2 women engineers, specifically deserves our attention.

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[30] Their profiles are available, as of January 2022, at: https://www.apple.com/leadership/ Accessed May 3, 2022.

Lisa Jackson completed her B.A. (Tulane University) and her M.A. (Princeton) both in Chemical Engineering, after which she worked a couple of months for an environmental non-profit organization (NGO). But then she switched to the government sector — where she would spend the next 24 years of her working life. According to Jackson herself, her "entire career has been dedicated to the environment and to human health" (JACKSON, 2021).

In 1987, she joined the U.S. Environmental Protection Agency (EPA) as a staff-level engineer. Very competent, she progressively climbed the career ladder until she became director. After 16 years at the EPA, working at the agency's regional office in New York, in 2002 she joined the New Jersey Department of Environmental Protection (DEP) as a commissioner. While working for the EPA and the DEP, Jackson would lead several initiatives regarding: hazardous waste cleanup projects, land use management, water supply, monitoring and stewardship. This led her to acquire enormous experience managing environmental issues both technically and in leadership positions across various government spheres.

In December 2008, Jackson took another major step in her career: Barack Obama officially designated her as the Administrator of the EPA - the top executive position in the agency. The EPA is only behind of NASA in number of scientists and engineers; thus, it employs huge brain power to deal with environmental issues. For the next 4 years, Jackson would lead the most important environmental agency in the U.S.

Of course, this top-nudge position provided her with valuable knowledge about the political dynamics and business-government affairs at the federal level. Aligned with her environmental expertise, this new position would make her an unvaluable leader to any organization dealing with business-government relations. "As Administrator, she focused on reducing greenhouse gases, protecting air and water quality, preventing exposure to toxic contamination, and achieving environmental justice by expanding environmental outreach to underserved communities and communities of color" — says her description at the World Economic Forum website[31]. Environmental and racial justice would be added to her managerial skills. And, as we see below, Apple took advantage of that new expertise.

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[31] World Economic Forum, Profile of Lisa P. Jackson (Vice-President, Apple). Available at: https://www.weforum.org/people/lisa-p-jackson Accessed May 3, 2022.

Apple hired Jackson in 2013 to serve as the firm's vice president (VP) of Environment, Policy, and Social Initiatives. By now, one interesting pattern calls the attention: both Kate Brand (CSO of Alphabet) and Lisa Jackson (VP of Environmental and Social issues at Apple) had accumulated enormous experience in the government sector prior to joining these firms. Needless to say, these women are valuable leaders for these Big Tech firms, particularly because their experience allows them to think of the best strategies (exploring environmental policy loopholes) to influence or circumvent U.S. environmental policies and regulations.

Besides the top environmental leader, Jackson would become the head of a) the Racial Equity and Justice Initiative (REJI), to which Apple recently committed to pledge US$ 100-million in projects across the U.S. (APPLE, 2021b), and b) Government affairs and public policy, which, as a consequence, has made her c) responsible for all lobby efforts at Apple (KURSON, 2015).

REJI is an interesting project as regards racial justice, but its connections with Apple's sustainability initiatives are blurry. Jackson made history as the first African American woman to become EPA's Administrator. Moreover, at Apple she would be the only black person in the leadership board (those top 18 executives I mentioned earlier). Because Apple is currently willing to diversify its leadership, both in terms of gender and race, Jackson has both the personal and professional background to oversee this effort.

REJI aims at tackling systemic injustices faced by communities of color. It includes "the Propel Center, an innovation and learning hub for Historically Black Colleges and Universities (HBCUs); an Apple Developer Academy to support coding and tech education for students in Detroit; and a venture capital funding for Black and Brown entrepreneurs." The central idea is "to help build the next generation of diverse leaders" (APPLE, 2021b, p.1). This is a reasonable initiative and there is reason to believe the firm is serious about it: out of the four firms I investigate in this dissertation, Apple has a higher percentage of Black and Latino employees than Alphabet and Meta, although it stands behind Amazon — certainly because of the low-paying jobs in packaging and delivery, which employ a high number of Blacks and Latinos at this firm. More information on racial justice in these firms will be provided later.

As Apple's head of government affairs, Jackson's political approach and personal history are definitely more aligned with the Democratic Party. While in New Jersey, she "worked effectively with both parties" but "her efforts to impose stricter environmental standards were not always welcomed by the business community"

(KURDON, 2015). As EPA's Administrator, she became even more aligned with the center-left — under the leadership of Obama. But she would also face challenges in managing government relations at Apple. Managing a multinational's government relations area is not an easy task since it involves both domestic and international affairs.

In 2020, for example, the U.S. Attorney General has requested Apple to unlock two encrypted iPhones belonging to the perpetrator of a shooting at a naval base in Pensacola, Florida. This has had a strong public repercussion because, to do so, Apple needed to develop a software that would weaken every iPhone's security. This would lessen current cybersecurity protocols, diminishing the barriers for the surveillance of millions of iPhone users (VESTEINSSON, 2020). Of course, this was a challenging situation for Apple, which, eventually, denied to attend to the government request, claiming that it "would set a disturbing precedent" (NADEAU, 2020). In essence, because political pressures (e.g., regarding cybersecurity, surveillance, data privacy, social justice, labor regulation, etc.) are becoming more diversified as Apple gets larger, Jackson's environmental specialization might end up turning out as a limitation to managing such a broad range of issues for business-government relations.

At the global political level, a more challenging landscape lies ahead. In 2019, Russia approved the so-called "law against Apple," which requires the firm to pre-install a set of applications on all iOS devices, including iPhones, commercialized in the country. Because of Russia's overall control of its tech ecosystem, these apps might easily provide the government with data as regards citizens' location, finances, and private communications (NADEAU, 2020). Although initially the firm has expressed resistance to this policy, since April 2021, and until it withdrew from the country in March 2022, all iPhones and other iOS devices sold in Russia have started to abide by this law. All devices had an additional setup step, which prompted users to install a list of apps from Russian developers (NEWMAN, 2021). As a result, the country was able to collect citizen's private data without direct user permission.

This sets a dangerous precedent for Apple, and other tech giants, that different authoritarian countries may follow. In this case, Apple's bending the rules for Russia not only gave the country the opportunity to promote apps that it can surveil and control but also allowed the government to manipulate the national tech market. Governments have the authority to (and sometimes should) manipulate their national markets when they do so with a reasonable purpose, e.g., to enhance the national competitiveness of certain industries, or to create production capacity in strategic sectors

— but not when they manipulate markets to increase citizen's surveillance. Such types of international political issues are set to become more complex and common over time, not only regarding data privacy but also in terms of climate politics.

As for climate politics, a good indicator of commitment is how Apple lobbies as regards climate issues — at least at the U.S. federal level. Although lobby will be discussed in Chapter 6, at this stage some background information is handy. As the main executive in charge of lobbying activities, Jackson will likely not oppose regulations restricting GHG emissions since Apple's global carbon footprint is steadily shrinking since 2016. The firm's global emissions, per year, in million metric tons (MMT) of greenhouse gases (CO2e) were: 33.8 (2013), 34.2 (2014), 38.4 (2015), 29.5 (2016), 27.5 (2017) until it reached 22.6 in 2020. Emissions come mostly from product manufacturing (around 80% to 70% of total emissions), followed by product use (around 17%), and product transportation (around 4%).

Compatible with this trend, out of the Big Five tech giants (our four cases plus Microsoft), Apple devotes the lowest percentage of its lobbying expenditures to climate-related topics. Meta spends 6% of all lobbying activities to climate issues (which is already a small ratio), Microsoft (5%), Amazon (5%), Alphabet (3%), Apple (2%) (INFLUENCE MAP, 2021, p.20).

When it comes to climate lobbying, transportation electrification and supporting renewable energy are salient topics. Among our four cases, Amazon is vocal in both respects. Being publicly engaged as a climate leader is one of Amazon's core climate commitments, as recently stated by its head of sustainability — Kara Hurst[32]. From now on, I will introduce Amazon's lead sustainability officer, and discuss the firm's sustainability strategy.

Kara Hurst is VP & Head of Worldwide Sustainability at Amazon. With a double bachelor's degree in Urban Studies and in Political Science (both from Columbia) and a master's in Public Policy (Berkeley)[33], Hurst is the most publicly engaged sustainability leader amongst our four cases. In a YouTube search for her name, plenty of recent interviews pop up, considerably more than similar search results for Alphabet's

[32] Corporate sustainability at Amazon | Kara Hurst | Global Energy Dialogues. Stanford Energy, May 4, 2021. Available at: https://www.youtube.com/watch?v=TRqz8mmyvzI Accessed January 25, 2022.

[33] Information available in her LinkedIn profile, which is available here: https://www.linkedin.com/in/karahartnetthurst/ Accessed 25 January, 2022.

Kate Brandt or Apple's Lisa Jackson. This is indicative of Amazon's approach to environmental issues. To a higher degree than Alphabet and Apple (and Meta, as we shall see later), Amazon is publicly engaged to "lead by example" and to introduce strong "market signals" towards making, in the firm's view, businesses greener.

Hurst's speech doesn't let me lie. Amazon presents itself publicly as having high ambition regarding climate action: "*we launched The Climate Pledge to state our ambition level. To move from middle of the herd to leading. (...) We can really drive at solutions, and not be afraid to really take that leadership position (...) to be Net Zero in carbon by 2040. Hopefully we will inspire others to come with us*."[34]

Hurst was even more emphatic in a talk at Stanford: "*one of the biggest things we know that we need is truly a transformation of systems, a transformation of industries. We need to be sending those very strong signals collectively that we have a demand for products and services that will help us to decarbonize*."[35]

The Climate Pledge is Amazon's flagship climate commitment. My job in the next paragraphs is to explain why, although this initiative has some positive implications for tackling climate change, it falls short of truly addressing the climate crisis.

The Climate Pledge is a network and venture-capital program co-founded by Amazon in 2019 to be a "cross-sector community of companies, organizations, individuals, and partners, working together to crack the climate crisis and solve the challenges of decarbonizing our economy."[36] So far, it involves 217 businesses, across 26 industries, in 21 countries.

All signatories commit to three areas of action. First, regularly reporting GHG emissions. However, according to Pardilla (2021, p.1), "the pledge doesn't define how signers can go about this, although it encourages companies to use existing, robust greenhouse gas reporting standards like the Greenhouse Gas Protocol (GHG) (…) and to count both direct and indirect sources of emissions." Second, signatories must implement decarbonization mechanisms in line with the Paris Agreement through efficiency

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[34] Sustainability Q&A with Kara Hurst, Head of Worldwide Sustainability, Amazon. December 16, 2019. Available at: https://www.youtube.com/watch?v=-wY3of5m21g Accessed January 23, 2022.

[35] Corporate sustainability at Amazon | Kara Hurst | Global Energy Dialogues. Stanford Energy, May 4, 2021. Available at: https://www.youtube.com/watch?v=TRqz8mmyvzI Accessed January 25, 2022.

[36] More information on The Climate Pledge: https://www.theclimatepledge.com/us/en Accessed January 23, 2022.

improvements, renewable energy, materials reductions or other strategies. Third, signatories should neutralize remaining emissions with carbon offsets. The chief goal is that all signatories reach net-zero carbon by 2040, 10 years ahead of the Paris Agreement.

Two additional pieces of information help us understand the origins and potential of the Climate Pledge: who co-founded it with Amazon, and how much money is available. Amazon co-founded the Climate Pledge with Global Optimism[37], a social enterprise led by Christiana Figueres, which is a long-term climate leader and the former Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC), a position she held from 2010 to 2016. Global Optimism "builds partnerships and campaigns with leaders from various sectors, and catalyzes citizen's climate action."[38] This is evidence of the growing participation of global businesses in the multilateral architecture of climate governance, under the auspices of the UNFCCC.

As regards funding, the *Climate Pledge Fund* (US$ 2-billion for the development of technologies and services that reduce emissions and help preserve nature) and the *Right Now Climate Fund* (US$100-million in reforestation projects and climate mitigation solutions) make up the principal financial sources available, but there is no information regarding how much of that comes from Amazon alone. Recently, Jeff Bezos stated that the Climate Fund will invest in "visionary companies whose products and services can empower a low carbon economy" (STIFFLER, 2020).

In September 2020, the first five companies selected to receive investment were announced, although the specific figures each firm will receive were kept in secret. The firms are: 1) *CarbonCure Technologies*, a start-up that helps reduce the carbon emissions of concrete production, with which Amazon is collaborating in some of its own buildings construction; 2) *Pachama*, a firm that provides verification of the climate impact of forest restoration and conservation projects, with which Amazon partners to monitor and evaluate its carbon offsets initiatives; 3) *Redwood Materials*, specialized in recycling electric vehicles' (EVs) batteries and other e-waste, and reusing the components; 4) *Rivian,* from which Amazon is purchasing 100.000 EVs, to reduce the carbon footprint of its delivery fleet; 5) *Turntide Technologies*, a firm that specializes in building equipment for energy-use optimization in buildings. Interestingly, in addition to

[37] More information on Global Optimism here: https://www.globaloptimism.com/ Accessed January 25, 2022.

[38] Ibid.

receiving Amazon funding to scale their businesses, all these investee companies aim at helping Amazon itself to decarbonize. In a nutshell: these are important investments, and Amazon deserves credit for that.

Despite that, it is worth noting that the Climate Pledge fund of US$ 2 billion is well below the US$100 billion a year that rich nations promised in 2009 at COP 15 (Copenhagen) to channel to developing nations starting 2020, in order to help them with climate adaptation and mitigation. According to a *Nature* article, this was a broken promise because, as of 2020, this target was realistically "out of reach" (TIMPERLEY, 2020), and it was not met even at Glasgow's COP 26, after which the "pledges have been estimated to amount to US$96 billion a year by the end of 2022" (MORRIS, 2021).

Of course, it would be unfair to compare the amount pledged under the realm of the UNFCCC by all rich nations with the amount committed by a business-led climate initiative. The limitations of Amazon's climate initiatives are of a different nature.

The problems with the *Climate Pledge* start with its own description "*leading businesses committed to transformational action to protect the global economy from the disruptive risks associated with climate change*."[39] Accordingly, the goal of this initiative is to protect *the global economy*, not the climate or the environment.

From this perspective stem some public criticisms regarding Amazon's initiative. As stated in a recent Forbes article[40], Amazon's Climate Pledge might be no more than a Public Relations (PR) mechanism, to deflect from adequate progress in tackling climate change. In fact, from 2019 to 2020, the company's global emissions increased by 15%, and are expected to keep growing as the company expands its complex of businesses. Amazon has a growing business complex (remember chapter 3, when I analyzed how Amazon deploys what I called *network power* to enter new industries, including cloud computing, artificial intelligence, online streaming, film and television content) which culminates in a progressive growth in global emissions. In this scenario, a good PR campaign would be more than timely.

Experts say that the Climate Pledge falls short because it fails to tackle three core climate issues: it does not help decarbonize the firm's supply chain, shipping

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[39] https://sustainability.aboutamazon.com/about/the-climate-pledge Accessed January 26, 2022.

[40] Amazon's Climate Pledge Arena: Virtue Signaling Or A Game-Changer? *Forbes*, June 26, 2020. Available at: https://www.forbes.com/sites/prakashdolsak/2020/06/26/amazons-climate-pledge-arena-virtue-signaling-or-a-game-changer/?sh=1d9d7b7453f6 Accessed January 28, 2022.

operations, or the companies with which Amazon has collaborations (PARDILLA, 2021). Similar to Alphabet's approach of not trying to select its customers based on their environmental responsibility, Amazon has not announced any major strategies to reduce emissions from its supply chain (suppliers and customers). Meta did not make any such commitments as well. Shipping is also a big source of emissions. Although Amazon is buying 100.000 EVs, and online shopping has a lower carbon footprint than in-person shopping, only 50% of Amazon's shipping will be net-zero by 2030. Moreover, Amazon is not stimulating vendors of products in its platform to reduce their emissions, which could be done through partnerships that enforce this idea. The firm is not refusing to sell products with a high carbon footprint. If this was adopted as a corporate strategy, it would eventually incentivize sustainability and reduce emissions across its supply chain. But the firm did not opt for this yet.

Another issue regards Amazon's turbulent labor relations, which culminated in the rise of the Amazon Employees for Climate Justice (AECJ) network. The AECJ is an environmental advocacy group started by Amazon employees in September 2019, when more than 1.500 workers "walked off their jobs to raise awareness for climate change and called on the company and CEO to do more to tackle climate change" (THORBECKE, 2020). In 2020, around 400 of those AECJ members went public on a polemic blog post[41], providing their full names, job titles, and public statements pushing Amazon to do more to help tackle the climate crisis. Some believe the post was due to a job termination threat an Amazon worker suffered after speaking to the press about climate change and the firm (THORBECKE, 2020; CALMA, 2020). Amazon's official position to justify the job termination threat was that the employee was violating the firm's communications policy by talking to the press without consent.

In the blog post, employees spoke their minds about Amazon and its socioenvironmental impacts. "*Amazon participates in the global economy, where it has a substantial impact on many issues. Expecting its employees to maintain silence on these issues, and Amazon's impact on them, is really a reprehensible overreach*", stated a principal engineer. A senior business analyst wrote that: "*The science on climate change is clear. It is unconscionable for Amazon to continue helping the oil and gas industry*

[41] Amazon Employees Share Our Views on Company Business. *Medium*, January 26, 2020. Available at: https://amazonemployees4climatejustice.medium.com/amazon-employees-share-our-views-on-company-business-f5abcdea849 Accessed January 28, 2022.

extract fossil fuels while trying to silence employees who speak out." "I am weighed down by the knowledge that Amazon partners with the Oil & Gas industry despite its Climate Pledge. We must be climate leaders, not delayers", wrote a software development engineer (AMAZON EMPLOYEES, 2020).

In fact, AWS, Amazon's cloud computing business, actively pursues O&G customers with technology promising to improve the efficiency of oil discovery and extraction. Recently, British Petroleum stated it would migrate all its data to AWS cloud services (NICKELSBURG, 2020). In public statements, Kara Hurst said that such a partnership would help the O&G industry to shift to renewable energy (ANDROFF; TAVASSOLI, 2012; AMAZON EMPLOYEES, 2020). However, Amazon didn't ask nor enforced any requirements on climate commitment from the O&G firms it partners with.

Another software engineer was even more emphatic on his criticism: "*Amazon's outsized impact on the world requires an outsized commitment to our community, and we're not living up to that responsibility. When we attempt to dismiss, discredit, or silence people who ask us to do better — workers who have been injured keeping up with fulfillment center quotas, independent researchers who have called out bias in our facial recognition software, open source developers who have expressed concerns about AWS's impact on the tech community, or engineers and designers who have spoken out to push Amazon to increase its commitment to addressing the climate crisis — we blow opportunities to earn trust with our customers and cut ourselves off from valuable, actionable feedback. In defending the indefensible to our employees — our contracts with Palantir*[42]*, our marketing outreach to government agencies who let children die of preventable diseases in for-profit detention centers, our lobbying and PAC contributions to climate-denying, anti-LGBT, anti-refugee politicians whose agendas fundamentally contradict the values we claim to uphold as a company — we show that we're only interested in "diverse perspectives" when they don't threaten our bottom line*" (AMAZON EMPLOYEES, 2020).

This statement has a straightforward message from an insider: Amazon's climate actions would be *greenwash*. Or, as we discussed before, Amazon's climate

[42] In 2019, AWS employees circulated an internal letter demanding that Amazon should stop working with data-mining company Palantir and that it should take a stand against the U.S. Immigration and Customs Enforcement (ICE). Palantir is partnering with ICE to provide specialized services, and the ICE suffers from public allegations of human rights abuses as regards border patrol and controversial anti-immigration policies.

initiatives, such as the Climate Pledge, are likely a PR strategy to divert society's attention from the firm's rising global emissions.

But the blog post censured Amazon for other controversial practices. For example, stressful working conditions in the warehouses; the ambiguity of *Space* exploration through Blue Origin[43], a private spaceflight company owned by Amazon's CEO, and to which Bezos has stated that he will invest US$1-billion every year, instead of more concise climate action to protect the *Earth*; the support of unsustainable overconsumption; and the collaboration with ICE (U.S. Immigration and Customs Enforcement), accused of border patrol abuse and human rights violations. Thus, Amazon's own employees recognize the firm is failing in CSR, which leaves them (and us) skeptical about the depth of the firm's climate commitment.

Certainly, after my thorough research to write this dissertation, I have no doubt that Amazon's (and Alphabet, Apple, Meta) climate actions do not stem from a genuine concern with the Earth, the environment, or the climate. Their climate actions represent either a risk-deflection strategy (to face stricter climate regulation, or civil-society/customers sustainability demands), or a deliberate engagement in the profitable business horizon for green tech. Chiefly: Big Tech firms' climate action comes to protect the business or to make the business grow, not to tackle climate change (although this might end up being a consequence). Given this reality, a central objective here is to investigate if, *although the climate is not Big Tech firms' genuine concern*, their actions can have any positive spillovers in climate mitigation and adaptation.

The lack of genuine climate commitment becomes all too evident in our fourth case: Meta Platforms, Inc. (known as Facebook until October 28, 2021). Out of its 23 top executives[44], Meta has no sustainability, environment, or climate leader. While Alphabet has Kate Brand as Chief Sustainability Officer, Apple has Lisa Jackson as Vice-President of Environment, Policy and Social Initiatives, and Amazon has Kara Hurst as Vice-President and Head of Worldwide Sustainability, the top sustainability executive at Meta Platforms is only a director — Edward Palmieri. He responds to Rachel Peterson, Vice-President of Infrastructure. This gives us a hint about the firm's perception of sustainability: environmental matters have a secondary priority.

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[43] More information about Blue Origin here: https://www.blueorigin.com/ Accessed January 28, 2022.

[44] The full list of Meta's executives is available here: https://about.facebook.com/media-gallery/executives/ Accessed January 30, 2022.

Edward Palmieri is the Director of Global Sustainability at Meta/Facebook since July 2017, but has been working for the firm for 12 years. With a Juris Doctor degree (Catholic University of America — a low-ranking private university in Washington, D.C) and a bachelor's degree in Political Science (College of the Holy Cross, liberal arts college in Massachusetts), the lawyer does not specialize in sustainability. Rather, most of his career was devoted to privacy and regulation issues. At Meta Platforms, before joining the sustainability team, he served for over seven years "advising on US and international privacy laws, regulations, and industry practices." Previously to joining Facebook, he "started his legal career at a DC-based communications and tech law firm advising clients on privacy, telecom, and other regulatory matters," says his LinkedIn profile[45].

Palmieri's lack of experience with sustainability becomes crystal clear when we analyze a November 2020 speech that he gave upon being interviewed by *GreenBiz*. When asked how Meta Platforms, Inc. addresses environmental justice and layers it into the firm's own priorities, Palmieri replied: "*It is a really important part of sustainability. Environmental justice is something that is really close to all of us on the sustainability team here at Facebook because we know that real sustainable solutions, things that are going to help improve the climate health of the planet and also the lives of everyone living on it. Really, it must mean that we can't leave anyone behind. We need to look at solutions that are bringing everyone along and meeting people where they are, and driving forward in a way that is going to lift everyone up. So, as we think about ways to further decarbonize our value chain, we want to partner with those suppliers to help make sure that the experiences of the workers in those factories that are working to bring us all the materials we need to build the things that make our servers run and our infrastructure go, we want to make sure that it's a win for all of those folks as well. Additionally, we know that engaging with people that use our services around the world will be an increasingly important part of that puzzle. And we think there is a lot we can do in the coming years from that angle as well"* [46].

[45] Edward Palmieri LinkedIn profile: https://www.linkedin.com/in/ejpalmieri/ Accessed January 30, 2022.

[46] Edward Palmieri discusses Facebook's 2030 net zero goals and environmental justice initiatives, November 20, 2020. Available at: https://www.youtube.com/watch?v=-gGtEY6Csas Accessed January 30, 2022.

In this speech, Meta's Sustainability leader did not discuss anything solid about the firm's approach to environmental justice, leaving us in the dark regarding if the firm has any such initiative whatsoever. Making generic statements such as "*climate justice is a really important part of sustainability*" and "*it must mean that we can't leave anyone behind*", without examples or any contextual facts grounded in the firm's actions, Palmieri basically repeated commonsense sentences about environmental issues. The question is: can it become more superficial than that?

Yes, it can. Palmieri's empty words were matched by Meta's 2021 Sustainability Report (META, 2021b), where the terms "environmental justice" and "climate justice" are mentioned only once each, in the following contexts. First, "*we will prioritize carbon removal projects that (...) support local livelihoods and enable climate justice and equity*" (IBID., p.14). But there is no information regarding specific methods, policies or resources the firm will invest in this initiative. Second, "*we are committed to supporting climate solutions that take impacted communities and groups into consideration, advancing projects and partnerships that incorporate equity and justice*" (IBID., p.16). Yet, how and with whom such partnerships are being pursued are never cited in the report.

Finally, in the same report the company states that "*in 2020, we generated a total of 23 sustainability-related product ideas from our hackathons, ranging from biodiversity, environmental justice, and circularity*" (IBID., p.33). But none of these 23 product ideas is explained in the document. In sum, in its 2021 Sustainability Report, Meta treats environmental and climate justice vaguely, given that these terms are *simply there*, untied to any specific actions or corporate policies.

While climate justice is not a priority, information sharing as regards climate change seems to be more interesting to the firm. *The Climate Science Information Center* was launched by Meta in September 2020 in order to "connect people with science-based information from leading climate organizations."[47] The Center can be accessed as a Facebook timeline[48], with updated content in the form of news, charts, videos, photos and data regarding climate change. Initially, it was launched in France, Germany, the UK and

[47] The official launching video is available at:
https://www.facebook.com/Meta/videos/629713944400035/?t=43 Accessed February 1, 2022.

[48] Facebook Climate Information Center, Available at: https://www.facebook.com/climatescienceinfo

U.S., but as of February 2021 it was expanded to Belgium, Brazil, Canada, India, Indonesia, Ireland, Mexico, the Netherlands, Nigeria, Spain, South Africa, and Taiwan.

According to Meta's website, "the Center will feature facts, figures and data from the Intergovernmental Panel on Climate Change (IPCC) and their global network of climate science partners, including the UN Environment Programme (UNEP), The National Oceanic and Atmospheric Administration (NOAA), and the World Meteorological Organization (WMO)." [49] Another goal is to tackle climate misinformation. This is being pursued by partnering with climate communication experts from the George Mason University, the Yale Program on Climate Change Communication, and the University of Cambridge. These experts write in the climate "mythbursting" section of the platform.

Interestingly, upon launching the Center, the firm announced an additional climate commitment: to achieve net-zero carbon emissions *in its entire value chain* by 2030. Indeed, this is a step further in Meta's actions towards carbon neutrality, as the firm has achieved net-zero carbon emissions in its global operations in 2020, with a mix of 100% renewable energy and carbon removal mechanisms. In the same year, the company had 5.4 GW of wind and solar projects under contract[50].

The idea for the Climate Science Information Center came from Facebook's COVID-19 Information Center, which "connected 2 billion people to information from health authorities, with more than 600 million people clicks." [51]

But the creation of these information centers is closely tied to business interests. Actually, they make total business sense, as Facebook is facing a steady decline in user engagement for some years now. To tackle the problem, the firm is using corporate policies such as the creation of the climate Center and the COVID-19 Center to overturn the lack of user engagement and the decline in number of users (ROOSE, 2021). Facebook Climate Science Information Center is a strategy to explore climate change as a driver of user engagement, a source for more clicks. Similar to what had happened with COVID-19, climate change ended up becoming a revenue-driver.

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[49] Stepping up the fight against climate change, September 14, 2020. Available at: https://about.fb.com/news/2020/09/stepping-up-the-fight-against-climate-change/ Accessed February 1, 2022.

[50] Ibid.

[51] Ibid.

This goes in line with the fact the Big Tech firms multiplied their profits during the pandemic, particularly Alphabet and Microsoft (O'LOUGHLIN, 2021). The figures are astonishing. Apple earned US$ 21.7-billion between May-July 2021, almost doubling the US$ 11.2-billion it earned in the same period of 2020. By August 2021, Alphabet had already earned revenues 166% higher than its total revenues from the entire year of 2020. Between May-June 2021 the firm reported a net income of US$ 18.5-billion, almost three times the amount of US$ 6.96-billion it earned during the same timeframe in 2020. Facebook reported earnings of US$ 10.3-billion between May-June 2021, whereas the revenues for the same period in 2020 were US$ 5.2-billion. Likewise, Amazon's revenues between May-June 2021 were US$ 7.8-billion, compared to US$ 5.2-billion in the same period in 2020 (CLARCK, 2021).

As we approach the end of this section, a question remains: why the three firms (Alphabet, Apple, Amazon) that have a woman at the top sustainability position *seem to be* more climate-committed than the firm that has a man leading these initiatives (Meta)? Would gender parity increase climate sensibility or, in other words, would firms more committed to diversity and inclusion be also more devoted to tackle climate change? If that is true, besides gender, would this extend to more racially diverse firms? The following section explores these questions in depth.

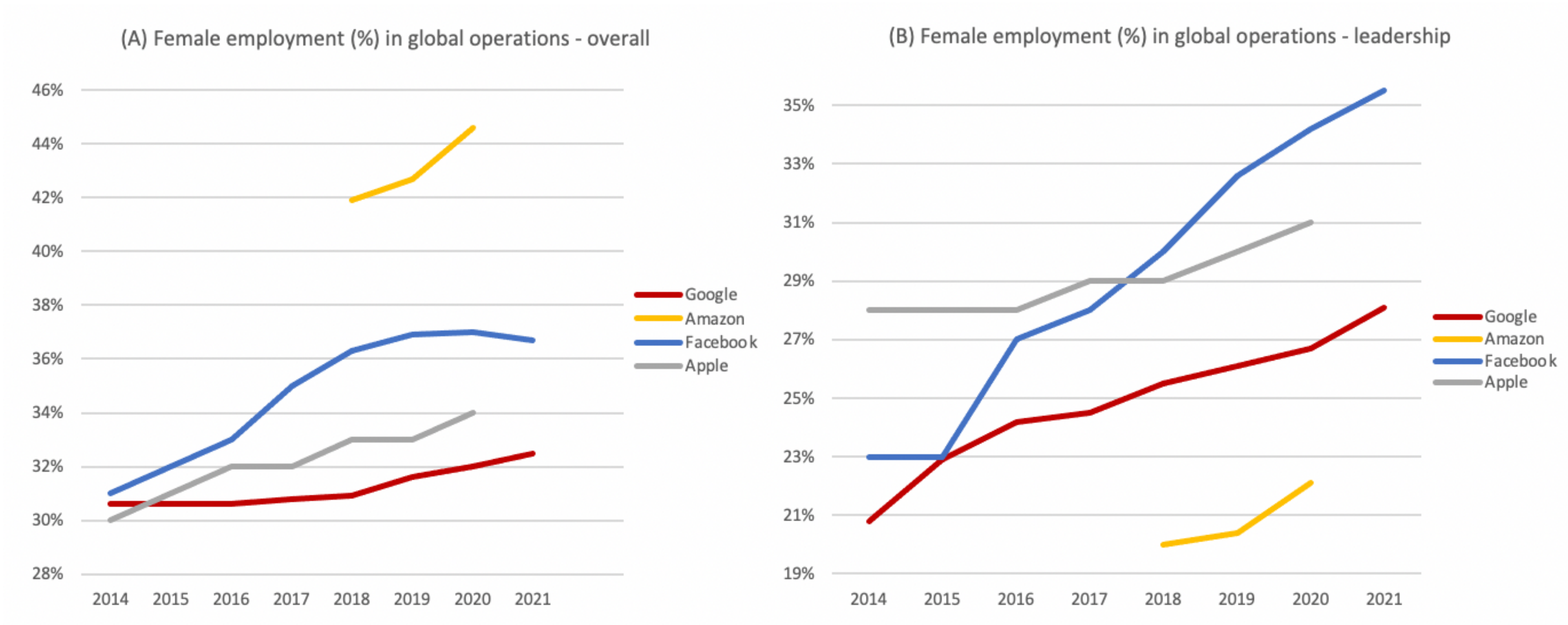
5.2. Do Big Tech Firms Support Climate Justice, Gender and Race Diversity?

Is having women as leaders positively correlated with better environmental performance and climate action? Business literature says yes. In a survey including all Fortune 500 (a sample of the biggest U.S. firms by annual revenue) CEOs and boards of directors, Glass et al. (2016) investigated the effects of gender parity on environmental performance. They found that gender mixed firms are more effective in pursuing environmentally friendly strategies. Similar results were found in Australia, where Galbreath (2011) observed that having women on the executive board increases enforcement of ethical business conduct. "Because of their relational abilities, women on boards are more likely able to engage with multiple stakeholders and respond to their needs, resulting in an avenue for demonstrating social responsiveness" (ibid., p.17). An international cross-country comparison corroborates these results. "In countries with a higher proportion of boards of directors with at least three women, the levels of CSR reporting are higher" (FERNANDEZ-FEIJOO et al., 2013, p. 351).

In order to check if this is true in our four Big Tech firms, I used data from recent reports on Inclusion & Diversity from Alphabet (2021b), Amazon (2021a), Apple (2021a), and Meta (2021a) to create Figure 8. In Figure 8 (A), I demonstrate that, between 2014 and 2021, the percentage of female employees in global operations had a consistent increment across all 4 firms. Amazon is the most gender diverse, with 44,6% of female workers across its global operations. But remember: this is mostly low-paying jobs in delivery and customer support. Unfortunately, Amazon's most recent data available on this matter only covers the period 2018-2020. Among the other 3 firms, Meta/Facebook evolved the most, going from less than 31% of women in its global operations in 2014 to 36,7% in 2020, although it had a slight decrease in 2021. Alphabet and Apple did not evolve much, and their percentage of women employees represented between 32-34% of their global operations in 2020.

The picture changes considerably when we analyze female representation in leadership posts, as presented in Figure 8 (B). Meta/Facebook is the most gender mixed firm, with 35,5% of its leadership posts occupied by women as of 2021. Although Meta/Facebook is the most advanced firm in this criterium, with 35,5% of women in leadership, gender parity is still a faraway reality. The bright side is that this evolved from around 23% of women leaders in 2014, so there has been some progress. The runner up is Apple, with 31% of women in leadership positions in 2020, compared to 28% in 2014. Although Alphabet presented a considerable evolution, from around 20% of women in leadership in 2014 to 28,1% in 2021, it is still behind Meta and Apple. But the worst position is occupied by Amazon, with only 22,1% of women in leadership in 2021.

Figure 8. Female workforce in Leadership at Alphabet/Google, Amazon, Meta/Facebook, Apple



Source: Prepared by the author, based on data from: Alphabet (2021b); Amazon (2021a); Apple (2021a); Meta (2021a).

Note: lines for Google, as well as for Facebook, reflect the number of employees in the holding companies (Alphabet, Meta), not only the subsidiaries (Google, Facebook). I keep the labels Google and Facebook, though, because previous to the creation of Alphabet (Oct 2015) and Meta (Oct 2021), numbers of employees represented only Google and Facebook.

Although the top sustainability executives are women in 3 out of our 4 cases, their CEOs are all men. In their boards of directors, as of February 2, 2022, the picture was the following. Meta: 6 men (60%) and 4 women (40%), total of 10 board members[52]. Alphabet: 9 men (82%) and 2 women (18%), total of 11 board members[53]. Apple: 6 men (67%) and 3 women (33%), total of 9 board members[54]. Amazon: 6 men (86%) and 1 woman (14%), total of 7 board members[55].

Thus, when it comes to female representation, these 3 indicators (% of women in global operations, % of women in leadership, and % of women on board composition) allow us to affirm that *Meta is the most gender mixed* firm, whereas *Amazon is the least gender mixed*. However, let's remember from the previous section that, amongst our cases, Facebook/Meta is (until the present moment of our analysis) the least climate committed firm. Thus, although it is the most gender-mixed, Meta is the least climate committed, suggesting that climate action and gender parity do not necessarily go in line.

But this picture becomes considerably more complex when we analyze racial diversity. Actually, racial diversity and racism are topics in which one of our cases is very vocal: Apple. In its 2021 EGS Report, Apple CSO Lisa Jackson stated that "systemic racism and climate change are not separate issues, and they will not abide separate solutions" (APPLE, 2021d, p.9).

Echoing these preoccupations, a recent paper from Sovacool et al. (2022) asked the question: "to what extent are low-carbon technologies, and their associated behaviors, currently equitable?" These authors show that low-carbon innovations are not automatically fair, just or equitable. Actually, green innovations can even introduce new inequalities. For instance, in the U.S., household solar photovoltaic panels diffusion is characterized by inequitable trends shaped by race, space (urban versus rural adoption), income, and class. In 2019, close to 70% of all U.S. households adopting solar panels were white and had a median income of $ 113.000/year, whereas the median income for all U.S. households was $ 64.000/year. In California, the picture was better.

[52] This data is available here: https://investor.fb.com/leadership-and-governance/default.aspx

[53] This data is available here: https://abc.xyz/investor/other/board/

[54] This data is available here: https://www.apple.com/leadership/

[55] This data is available here:
https://www.sec.gov/Archives/edgar/data/1018724/000119312510164087/dex991.htm

Hispanic/LatinX[56] and White families were responsible for around 40% of the total solar panel adoption each (ibid.). In sum, across the U.S., white rich people are those who most likely can afford clean technologies.

Besides the sociodemographic, income, and ethnic characteristics of those who adopt clean technologies, Mohai et al. (2009) present additional indicators of environmental and climate justice. Conceptually, environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with regard to public (laws, regulations, and policies) or private (industrial production, commercial operations) activities that affect the environment. No particular group of people should be forced to bear a disproportionate share of negative environmental externalities that any of those activities could cause (ibid., p.407).

Across industrial activities, examples of environmental injustice abound, for instance: distribution of environmental contaminants, poisonous residues, waste disposal facilities, or nuclear test sites in predominantly black and/or poor areas; global exports of garbage containers to developing countries and small islands; exposure to pesticides by farmworkers, which are usually poor people; natural resources extraction such as mining in poor regions with low or no rule of law; deforestation in indigenous peoples who usually lack knowledge or power to protect their territories; to name a few.

Climate change on its own is considered a type of environmental injustice given that the countries who will suffer the most (developing countries) contributed disproportionately less to the amount of CO2e present in the atmosphere, which was historically generated by industrial activities of rich developed countries.

Climate and environmental justice are a complex topic in these Big Tech firms because, simply, they are MNCs. This means that, in order to check their environmental justice behavior, their activities would have to be traced not only internally (firm-level) and locally (Silicon Valley and Seattle), but also at the state (California and Washington), national (U.S.), and international level (all subsidiaries and commercial offices globally). In sum: the analyst would have to evaluate environmental injustice dynamics across these firms' global value chains. This is a very complex task, impossible to be completed in a doctoral project.

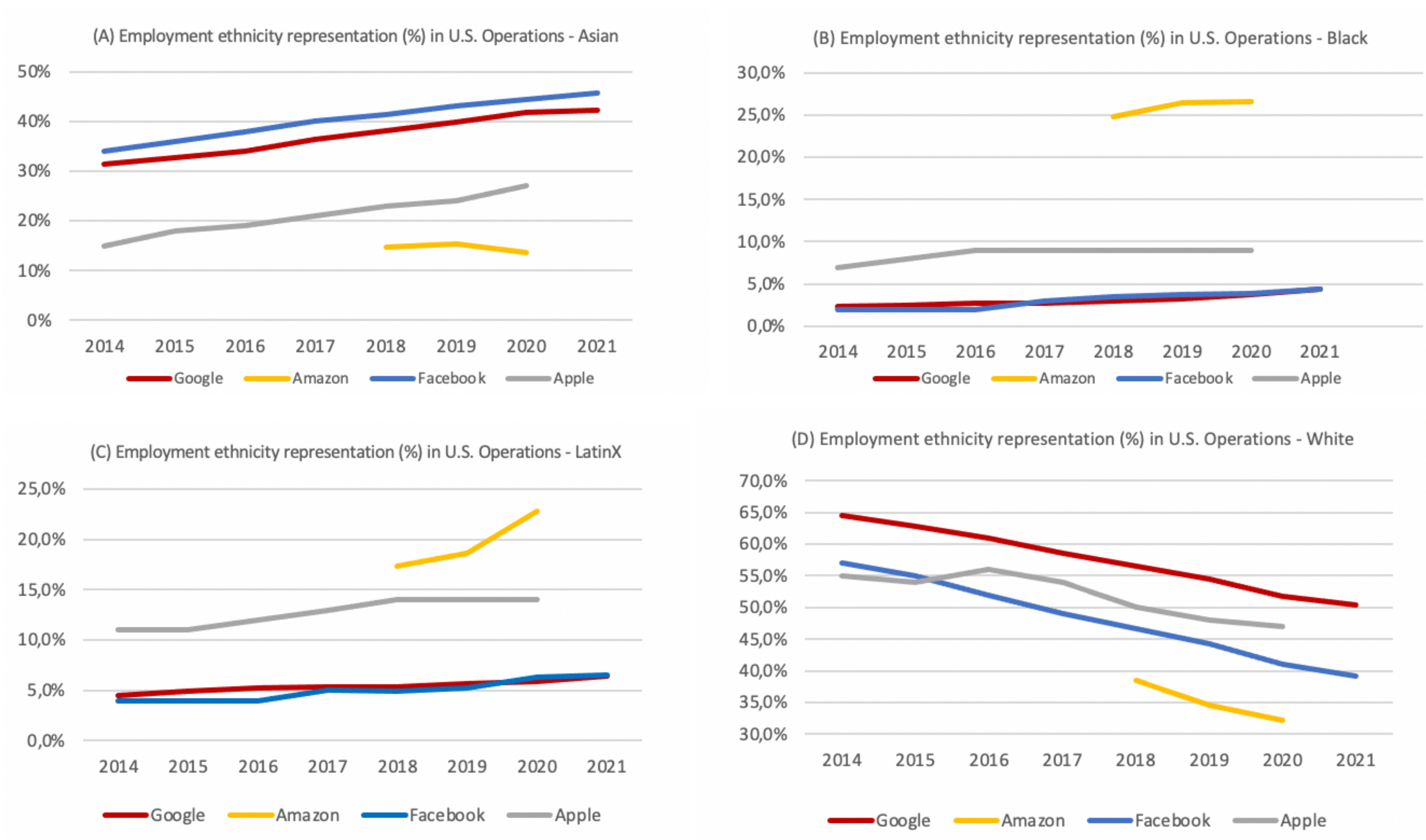
[56] I will use the inclusive language every time I refer to the Latina(o) community, adopting the expression LatinX. In fact, all Big Tech firms I am studying use this expression in their Diversity & Inclusion reports.

To address part of this analytical challenge, I decided to (1) Map the ethnicity of these firms' employees, as I understand that *the decision to become more racially diverse might indicate a higher likelihood of climate justice and commitment*; (2) Check climate justice laws and regulations at the state level (California and Washington) to analyze the requirements which these firms are legally bound to follow, even though in Chapter 6 business-government relations will be analyzed in depth; and (3) Synthesize the most likely sources of climate injustice across these firms' value chains, focusing on e-waste generation and disposal, raw materials, energy and water consumption.

Therefore, I created **Figure 9** to demonstrate how racially diverse are these firms' employees in their U.S. operations. Figures 9A to 9D show, respectively, the evolution in percentage of employees in U.S. operations with Asian, Black, LatinX, and White ethnicity.

Let's start by Figure 9D. The curves reveal that the percentage of White employees is shrinking since 2014 across all these firms. Amazon had around 32% of White employees in 2020, a considerable decline from almost 40% of White workforce in 2018. Being the least White is likely to be a result of the low-paying jobs characterizing Amazon, because we know people of color are often those who perform low-paying jobs, especially in the U.S. On the opposite side we have Alphabet, which is still predominantly White across its U.S. operations, with 50% of White employees in 2021, compared to almost 65% in 2014. Although predominantly White, the percentage of Caucasians at the firm is decreasing over time. Apple and Meta are somewhere in the middle. While Facebook presented a considerable decline from 57% of White employees in 2014 to less than 40% in 2021, Apple presented a modest variation, going from 55% of White employees in 2014 to 47% in 2020, according to the most recent numbers available.

Figure 9. Employees’ ethnicity background in U.S. Operations at Alphabet, Amazon, Apple, Meta



Source: Prepared by the author, based on data from: Alphabet (2021b); Amazon (2021a); Apple (2021a); Meta (2021a).
Note: lines for Google, as well as for Facebook, reflect the number of employees in the holding companies (Alphabet, Meta), not only the subsidiaries (Google, Facebook). I keep the labels Google and Facebook, though, because previous to the creation of Alphabet (Oct 2015) and Meta (Oct 2021), numbers of employees represented only Google and Facebook.

Figure 9A reveals interesting variations in the percentage of Asian employees across these firms. By far, Alphabet/Google and Meta/Facebook have the highest percentages of Asian employees in all years considered, but Meta is always positioned ahead. At Alphabet, the evolution was from around 30% of Asian employees in 2014 to more than 40% in 2021. Meta had around 35% of Asian employees in 2014 and 46% in 2021. That is to say: across their U.S. operations, Meta had more Asians (46%) than Whites (40%) in 2021, whereas Alphabet had more Whites (50%) than Asians (40%) in the same year, thus being primarily White.

Still considering Figure 9A, Apple and Amazon presented a noticeable variation in the percentage of Asian employees, the former having more such employees. Asian employees in Apple's U.S. operations were 15% in 2014, and in 2021 this number grew to 27%. Amazon had 14,6% of Asian employees in 2018, but only 13,3% in 2020, being the only firm where the percentage of Asians actually decreased from 2018 to 2020.

Figure 9B showcases the representativeness of the Black workforce in these firms. The 3 firms that are heavily focused on advanced computer technologies (Apple, Alphabet, Meta) employ less that 10% of Black workers, which is not a surprise, since the literature shows that Black people are consistently underrepresented in STEM careers in the U.S. (GRAF; FRY; FUNK, 2018). In Alphabet and Meta, the percentage of Black employees is below 5%. Amazon has around 24% of its workforce composed of Black people, mainly because, as we stated before, these are mostly low-paying jobs.

Finally, Figure 9C reveals a similar picture regarding LatinX representation in these firms. At Alphabet and Meta, employees with LatinX ethnicity make up around 5% in their U.S. operations, even though there has been a recent and slight upward trend, as in 2021, when both these firms employed around 6,5% LatinX workers. As of 2020, Apple employed around 14% LatinX workers in its U.S. workforce. LatinX workers represented 23% of total employers in Amazon's U.S. operations in 2020.

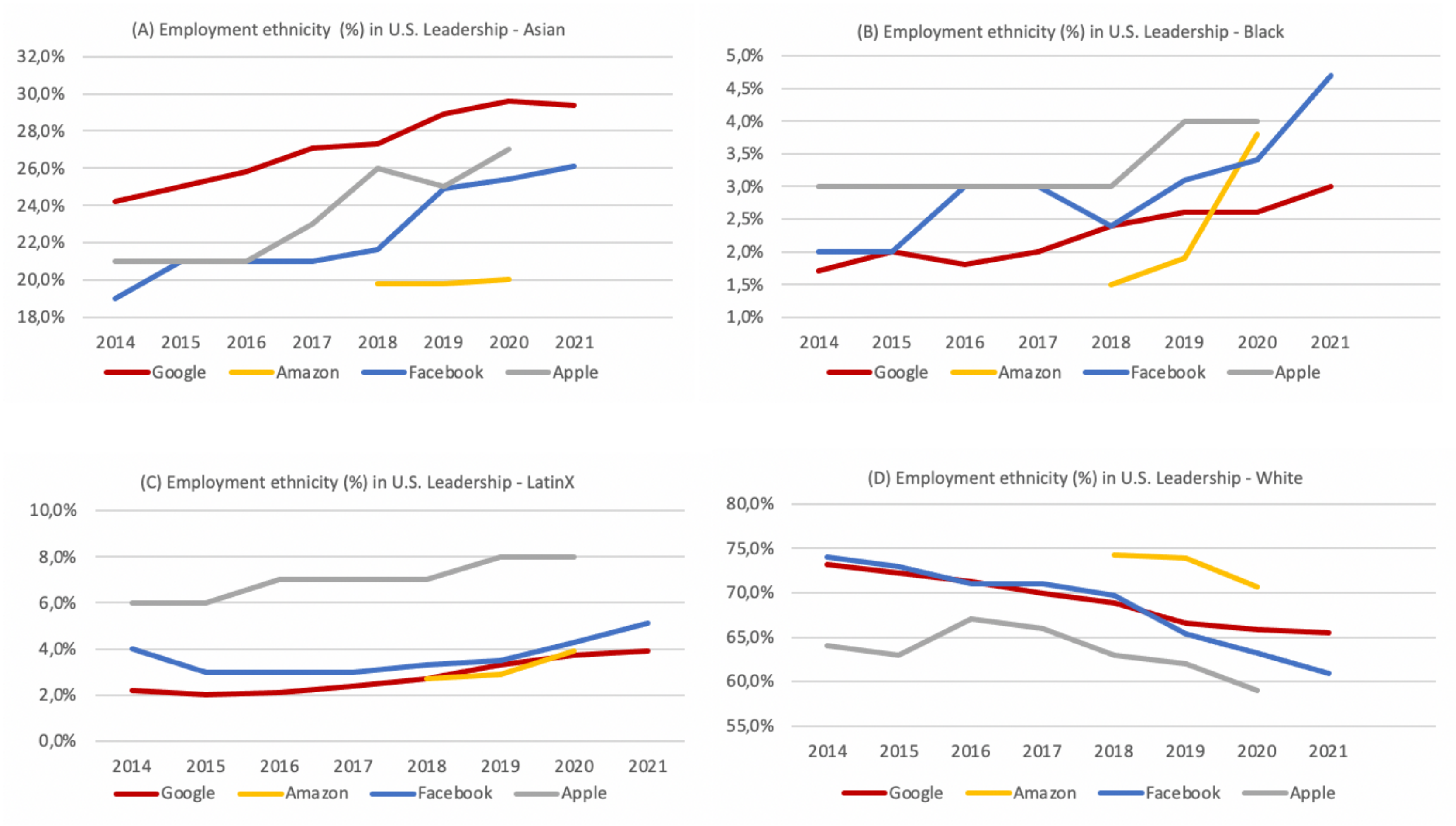
Another indicator of social justice regards the ethnic representation of corporate leaders. In order to explore this issue, I developed **Figure 10**. It illustrates employees' ethnicity in U.S. leadership positions at Alphabet, Meta, Amazon, and Apple. *Leadership positions include: managers, directors, VPs, and CEOs*. In other words, in their Inclusion & Diversity reports, these firms congregate managers, directors, VPs, and CEOs as "leadership positions." Thus, in the following analysis, I will call employees in leadership positions simply "managers", to simplify my analysis.

Starting by Figure 10D, which shows the percentage of White workers in leadership positions across these firms, we find the expected: White employees still represent the vast majority of leadership positions across all four firms. Apple is the firm with the least-White leadership, as we find that in 2021 59% of its managers were Caucasians. Amazon presents the most-White leadership, with 70,7% of Caucasian managers in 2021, although this represents a slight decrease from 74,3% in 2018. Both Alphabet and Meta had around 74% of Caucasian managers in 2014, whereas the former evolved to 65,5% of White managers in 2021, and the latter to 60,9% in 2021. But, essentially, all 4 firms are still mostly led by White managers, regardless of their gender.

Figure 10A shows that in 2021 almost 30% of Alphabet's managers were Asian, being far ahead of the runner up, Apple, with 27% of Asian managers in 2020. Meta had 29,4% of Asian managers in 2021, whereas Amazon had 20%. One interesting fact is that the percentage of Asians in leadership is rising across all these firms. At Meta, for instance, the percentage grew the most, going from 19% in 2014 to 29,4% in 2021.

Figures 10B and 10C reveal that, in all these Big Tech firms, the percentage of Black managers has always remained below 5% in the period from 2014-2021, although some of them seem willing to increase these numbers. As regards LatinX managers, their percentage has also remained below 5% in this period for all firms except for Apple, which had 8% of LatinX managers in 2020. Needless to say, these figures are awfully low and definitely not representative of the U.S. labor market.

Figure 10. Employees' ethnicity background in U.S. Leadership at Alphabet, Amazon, Apple, Meta



Source: Prepared by the author, based on data from: Alphabet (2021b); Amazon (2021a); Apple (2021a); Meta (2021a).

Note: lines for Google, as well as for Facebook, reflect the number of employees in the holding companies (Alphabet, Meta), not only the subsidiaries (Google, Facebook). I keep the labels Google and Facebook, though, because previous to the creation of Alphabet (Oct 2015) and Meta (Oct 2021), numbers of employees represented only Google and Facebook.

5.2.1. Laws and Policies Regarding Climate Justice in California and Washington

What about environmental and climate justice laws at the state level, in California (where Alphabet, Apple and Meta are headquartered) and in Washington (where Amazon is headquartered)? Alphabet, Apple, and Meta are subject to California's environmental justice law[57], enacted in 2009, when other 41 U.S. states had policies on environmental justice (MOHAI et al., 2009, p.422). In 2021, The California Environmental Protection Agency (CalEPA) approved the Preliminary Designation of Disadvantaged Communities[58], a bill detailing criteria to identify disadvantaged communities for targeting funds within the California Climate Investments program, based on geographic, socioeconomic, public health, and environmental hazard indicators.

Another important piece of legislation was introduced in 2021, the AB-585-Climate Change: Extreme Heat and Community Resilience Program[59], which focuses on resilience and adaptation with a climate justice perspective. This law aims at providing disadvantaged Californian communities in hot agricultural regions with "community resilience centers, including hydration stations, cooling centers, clean air centers, respite centers, community evacuation and emergency response centers, and similar facilities to mitigate the public health impacts of extreme heat and related climate change impacts on local populations" (ZIMMERMAN, 2021).

While California has pieces of legislation on environmental justice for more than a decade now, the state of Washington, where Amazon is headquartered, only approved a similar piece of legislation in April 2021. Washington policymakers passed the Healthy Environment for All (HEAL) Act, a bill requiring six state agencies (Agriculture, Ecology, Health, Natural Resources, Commerce, and Transportation) to embed environmental justice into their strategic plans (WONG, 2021).

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[57] California's environmental justice program can be reached at: https://calepa.ca.gov/envjustice/, whereas the full text of the climate justice law can be accessed at: https://codes.findlaw.com/ca/government-code/gov-sect-65040-12.html. Accessed February 6, 2022.

[58] The document can be read in full here: https://calepa.ca.gov/wp-content/uploads/sites/6/2021/10/2021_CalEPA_Prelim_DAC_1018_English_a.pdf. Accessed February 6, 2022.

[59] The bill can be read here: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220AB585. Accessed February 6, 2022.

As regards climate governance more broadly (without a specific focus on climate justice), California was the first U.S. state to approve a climate law. The AB-32-California Global Warming Solutions Act[60] was approved in 2006 and is considered a landmark in the state's history. "AB 32 was the first program in the country to take a comprehensive, long-term approach to addressing climate change." Its central goal — push California to reduce its GHG emissions to 1990 levels by 2020 — was achieved in 2016, four years before the target (HAMBLIN, 2018).

In 2021, California approved a new bill, the AB-1395-The California Climate Crisis Act[61], with an even more ambitious goal at the state level: "to achieve net zero GHG emissions as soon as possible, but no later than 2045; achieve and maintain net negative GHG emissions thereafter, and to ensure that by 2045, statewide anthropogenic GHG emissions are reduced to at least 90% below the 1990 levels."

Following California's footsteps, in 2021 the state of Washington approved its Climate Commitment Act (CCA)[62], "establishing a comprehensive program to reduce carbon pollution and achieve the greenhouse gas limits set in state law." The program will start in January 2023. Chiefly, it proposes cap-and-invest projects, criteria for emissions-intensive trade-exposed industries (EITEs), and recommendations on reporting emissions. Furthermore, it includes clauses requiring agencies allocating funding from CCA to report their progress toward environmental justice, and expands air quality monitoring in overburdened communities (those more susceptible to wide fires).

Interesting to observe is the concept of emissions-intensive trade-exposed industries (EITEs), sometimes called energy-intensive trade-exposed industries. Roughly, 85% of U.S. emissions come from three sectors of the economy: power plants, transportation, and large industrial facilities. Among large industrial facilities we have EITEs, a category of "core industries, primarily manufacturing, that release large amounts

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[60] The bill can be read here: https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006

[61] The bill can be read here: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220AB1395#:~:text=This%20bill%2C%20the%20California%20Climate,2045%2C%20statewide%20anthropogenic%20greenhouse%20gas. Accessed February 7, 2022.

[62] The bill can be read here: https://lawfilesext.leg.wa.gov/biennium/2021-22/Pdf/Bills/Session%20Laws/Senate/5126-S2.SL.pdf. Accessed February 7, 2022.

of GHG emissions and face significant national or global competition for their products [63].” O&G firms and Big Tech firms do not qualify as EITEs.

In sum, these four Big Tech firms are headquartered in climate progressive states, which recently have moved towards incorporating environmental and climate justice into their state policies and legislations. This is an important factor affecting intra-firm climate strategies and the path towards a low-carbon transition, at least for operations within these states. Moreover, because leaders and decision-makers at Alphabet, Amazon, Apple, and Meta are mostly located either in California or in Washington, these states’ pro-climate constituencies might as well influence these leaders towards climate commitment. Nonetheless, as we see below, these firms have considerable environmental externalities, complexifying the analysis of their actually existent commitment.

5.3. Raw Materials, Water, Energy, and e-Waste in Big Tech Value Chains

Environmental externalities in Big Tech firms’ value chains abound. Scholarship on environmental violations caused by U.S. high-tech firms date back to at least 20 years ago. For instance, one of the first books to survey environmental issues in California’s electronics industry was *The Silicon Valley of Dreams: environmental injustice, immigrant workers, and the hi-tech global economy* (PELLOW; PARK, 2002).

In this book, David Pellow and Lisa Park (2002) examined environmental racism within the context of immigrant workers and historical colonialism to diagnose that people of color and immigrants were disproportionally more exposed to chemical pollution and toxins released by the nascent high-tech industry in Silicon Valley in the 1960s. In their research, these authors found that, in Silicon Valley’s tech industries, such as microelectronics, exposure to toxins and other work hazards relies on unstable or temporary labor markets, characterized by gender, race, and class segregation. Gendered injustices were mapped in the targeted recruitment of female Asian workers for low-paying jobs. The region is also characterized by a century-long low-paying agricultural system reliant upon the labor of indigenous peoples, Mexican and Chinese immigrants, revealing that *environmental (in)justice includes components of race and class*.

[63] Emissions Intensive Trade Exposed industries (EITEs). Available at: https://ecology.wa.gov/Air-Climate/Climate-change/Reducing-greenhouse-gases/Climate-Commitment-Act/Emissions-Intensive-Trade-Exposed-industries. Accessed February 11, 2022.

More recently, in *Digital Rubbish: a natural history of electronics* (GABRYS, 2011), Jennifer Gabrys makes the case for tracing environmental contamination across all production stages of the global electronics value chain. Gabrys is one of the few scholars in the Humanities that has devoted her career to study what she calls *ecologies of the digital*, or *electronic environmentalism* (GABRYS, 2014). Remember Chapter 1, where I observed that sustainable computing is almost exclusively studied by STEM scholars, especially Engineers and Computer Scientists. Being a rare exception, the University of Cambridge Sociology professor has investigated, for over two decades now, the particular ways in which the digital industry uses energy, the contribution of electronic waste (e-waste) disposal to environmental contamination, energy consumption in cloud computing, and other topics in digital environmentalism.

In her book, Gabrys reminded us that, although digital technologies are apparently immaterial, they nonetheless have *substantial remainders*. By-products of the digital include fossils (or skeletons) of hardware and electronic devices that have stopped being used, being then discarded. The global production of e-waste is growing at an astonishing speed. “In 2019, the world generated 53.6 million metric tons (Mt) of e-waste, an average of 7.3 kg per capita. The global generation of e-waste grew by 9.2 Mt since 2014 and is projected to grow to 74.7 Mt by 2030” (FORTI et al, 2020, p.13). But globally only 25% of the waste of electric and electronic equipment (WEEE), another designation for e-waste, is recycled, which means that the majority of these residues are global hazards (BABU et al., 2007). A considerable portion of global e-waste is recycled in unregulated facilities, with high risk of toxin exposure to the recyclers, which are mostly women and children (PERKINS et al., 2014). Moreover, while e-waste represents only around 2% of U.S. trash in landfills, it represents 70% of the overall toxic waste.[64]

Raw materials extraction is another environmental externality in Big Tech value chains. In particular, rare-earth elements (REE), or rare-earth metals, are critical components in hi-tech industries. REE are used in the production of rechargeable batteries for electric and hybrid cars, advanced ceramics, computers, wind turbines, catalysts in cars and oil refineries, monitors, TVs, lasers, fiber optics, and superconductors[65]. Roughly

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[64] 11 Facts about e-waste. Available at: https://www.dosomething.org/us/facts/11-facts-about-e-waste. Accessed February 11, 2022.

[65] Explainer: China's rare earth supplies could be vital bargaining chip in U.S. trade war, *Reuters,* May 29, 2019. Available at: https://www.reuters.com/article/us-usa-china-rareearth-explainer/explainer-chinas-

85% of the global supply of REE comes from China, and this is a source of growing turmoil in the global semiconductors market, driven by the risk of dependency on a single producer country, which frequently pushes prices up in the global market[66]. Recently, China founded a "new rare-earth giant" state-owned enterprise called *China Rare Earth Group*, which reveals a strategic interest of this country to controll a crucial resource for the global digital economy. On top of that, mining environmental issues, such as the exploitation of rural communities, and toxic byproducts of extraction, are common in REE exploration, mostly located in developing countries such as China, Vietnam, Brazil, and South Africa. Adding to that, recycling methods for REE are still limited (MASSARI; RUBERTI, 2013).

In her e-waste ethnography, some of the fossils Gabrys (2011) uncovered were microchips — and their production — in Silicon Valley. Beginning in the 1960s, the microchip industry emerged in the region with pioneer companies like Fairchild Semiconductor International Inc., Intel, Raytheon, and IBM. Nowadays, along those pioneers, semiconductor firms headquartered in the region include: NUVIA, Alien Technology, Atmosic, SiFive, Presto Engineering, Celera, Universal Semiconductor, SK hynix, Infineon, GCT Semiconductor, GlobalFoundries, to name a few[67].

One by-product of this thriving industry was the transformation of Silicon Valley in *the highest Superfund site in the United States.* Santa Clara county (where most of Silicon Valley is located) bears no less than 23 toxic Superfund sites, more than any other county in the U.S.[68] In 2016, the U.S. states with the most Superfunds were New Jersey (113 sites), California (97 sites), and Pennsylvania (95 sites). Superfund sites are abandoned waste locations, whose methodology for identification was established by the Comprehensive Environmental Response, Compensation and Liability Act (1980), under

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rare-earth-supplies-could-be-vital-bargaining-chip-in-u-s-trade-war-idUSKCN1T00EK. Accessed February 21, 2022.

[66] China Set to Create New State-Owned Rare-Earths Giant. *Wall Street Journal*, Dec 3, 2021. Available at: https://www.wsj.com/articles/china-set-to-create-new-state-owned-rare-earths-giant-11638545586. Accessed February 21, 2022.

[67] 16 Silicon Valley Microchip Companies Engineering the Foundation of Global Tech. Available at: https://www.builtinsf.com/2020/02/14/silicon-valley-microchip-companies. Accessed February 14, 2022.

[68] The Superfund Sites of Silicon Valley, *New York Times*, July 2018. Available at: https://www.nytimes.com/2018/03/26/lens/the-superfund-sites-of-silicon-valley.html. Accessed February 14, 2022.

the auspices of the EPA. The EPA also oversees cleanup efforts of these sites. In sum: Silicon Valley alone responds to ¼ of all Superfund sites from California.

Local institutions such as the Silicon Valley Toxins Coalition (SVTC) and The Santa Clara Center for Occupational Health (SCCOSH) are important civil society organizations to monitor and act in order to oversee Superfunds' clean-up, and reduce workers' environmental vulnerabilities in the region. The SCCOSH was founded in the 1970s by three health and labor rights women activists. Since then, his body has organized various campaigns regarding workers' rights advocacy, occupational safety, and health training in Silicon Valley electronics industries.[69] The SVTC, by its turn, was founded in 1982 in response to the suspicion that leaks at manufacturing sites for IBM and Fairchild Electronics were causing health issues in nearby Silicon Valley homes.[70]

These facts inform us that the manufacture of electronic components, such as semiconductors, generates acute chemical pollution. Gabrys (2011, p.25) explains how toxic waste from microchip production came to accumulate in Silicon Valley. "During and after production, many of these chemical compounds were stored in underground tanks made of metal and fiberglass. These tanks eventually leaked into the surrounding soil and groundwater. When the contamination was detected in the 1980s, it was revealed that tens of thousands of gallons of solvents had been leaking over a span of 10 to 20 years. Beneath the prosperous surface of Silicon Valley were plumes of poisoned groundwater that stretched over three miles long and 180 feet deep."

The microchip value chain is labor and natural resources intensive. For the completion of a microchip, which usually takes 2 years, 200 workers, chemicals, gas, and other materials are mobilized in more than 300 production phases. To produce a single 2g microchip, 1.3Kg of fossil fuels and other materials are required. Overall, 99% of the materials used are discarded during a typical microchip manufacture (ibid., p.26).

In these manufacturing facilities, workers use a vest popularly known as "bunny suits." But these garments intend not to protect the workers, but the purity of the microchips. Many workers are women of color and low-paid immigrants. Also, as Gabrys' (2011) research shows, there is growing scientific consensus that microchip

[69] Santa Clara Center for Occupational Health (SCCOSH) and Silicon Valley Toxics Coalition (SVTC) Collection. Available at: https://scholarworks.sjsu.edu/speccoll_archives/128/. Accessed February 14, 2022.

[70] Ibid.

production generates health hazards to assemblage line workers, ranging from cancer to birth defects.

Although Alphabet, Amazon, Apple, and Meta are not microchip manufacturers, electronic devices such as optic fibers, computer networks, semiconductor chipsets, and smartphones are an essential component of their value chains. As a consequence, the indirect environmental externalities of these *digital materials* cannot be detached from Big Tech firms' operations. But how is e-waste, raw-material extraction, and environmental pollution addressed in these firms' environmental reports?

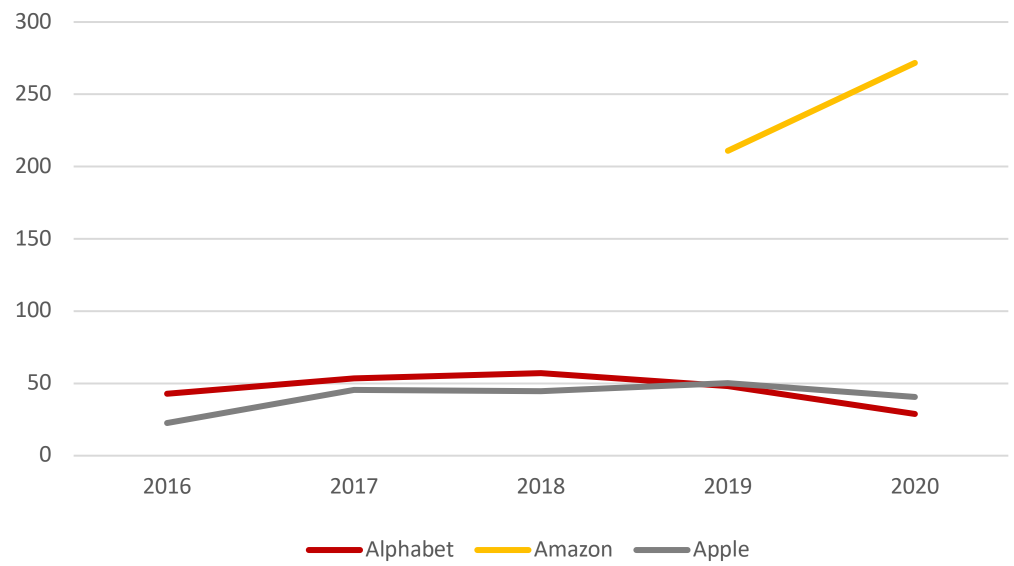
In the next pages, I analyze some environmental key-performance indicators (KPIs) for Alphabet, Amazon, Apple, and Meta. The KPIs I selected were those regarding the most environmentally harmful externalities: a) Total Waste Generated (in Metric Tons (MT), i.e., 1 MT = 1.000Kg); b) Water Withdrawal (in Million gallons, i.e., 1 gallon = 3,79 liters); and c) Electricity Use in global operations and in the U.S. (in MWh). The data was collected in these firms' most recent Environmental Reports. When data was not available in such reports, I looked for data in trustworthy secondary sources.

The waste generated in global operations in these 4 firms varies considerably. Data on solid waste is published in Alphabet (2021a), for the years from 2016-2020. Amazon's Environmental Reports do not disclose the total amount of waste generated. However, secondary sources provided me with this data, although only for 2019 and 2020. In 2019, Amazon produced 465 million pounds of waste,[71] an equivalent to 210.920 MT. According to Business Insider[72], in 2020 this amount increased to 599 million pounds of waste, the equivalent to 271.701 MT, a 29% increase from the previous year. Apple's (2021c) most recent Environmental Report provides historical volumes of waste generated from 2016-2020. Meta is the only firm that did not provide such data, and unfortunately, I did not find it in secondary sources. **Figure 11** illustrates the amount of waste generated in these firms' global operations (including their U.S. operations).

[71] How Much Does Amazon and E-Commerce Contribute to Plastic Pollution? Waste 360, Jan 13, 2021. Available at: https://www.waste360.com/plastics/how-much-does-amazon-and-e-commerce-contribute-plastic-pollution Accessed February 15, 2022.

[72] Business Insider: Amazon waste in 2020. Available at: https://www.businessinsider.com/amazon-created-599-million-pounds-of-plastic-waste-2020-report-2021-12. Accessed February 15, 2022.

Figure 11. Waste Generated (thousand metric tons) in global operations - Alphabet, Amazon, Apple



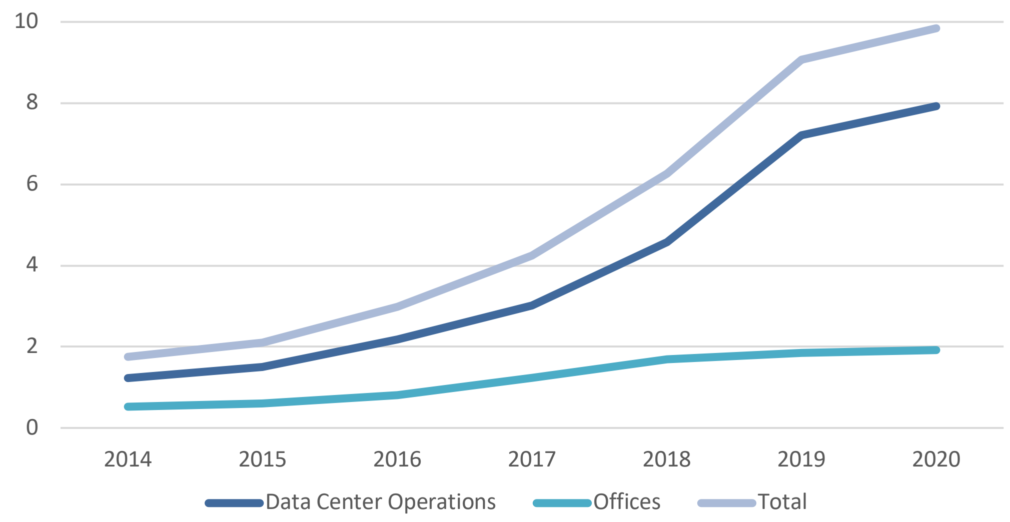
Source: Prepared by the author, based on data from: Alphabet (2021a), Amazon (2021b), Apple (2021c). Information for Meta was not available online nor in Environmental Reports.

Alphabet and Apple produce roughly 50 thousand metric tons of waste per year since 2016, but there has been a recent downward trend since 2018 for Alphabet, and since 2019 for Apple. On the other hand, Amazon produced 4x more waste than these two firms in 2019, and almost 6x in 2020. Additionally, Amazon's global waste production increased 29% from 2019 to 2020. Business Insider[73] observed that, only in 2020, 23,5M pounds of plastic generated by Amazon entered the world's oceans.

Water withdrawal is another important environmental externality of Big Tech firms, because their data centers are huge water consumers (for cooling purposes). Meta's water withdrawal illustrates that well. Between 2014-2020, the total amount of water consumed was multiplied by 5. Although part of this growth is due to the water consumed in offices, the vast majority of this growth is due to data centers, as we can see in **Figure 12**. In this firm, around 95% of the water used every year is employed to cool data centers. Unfortunately, the Environmental Reports of the other firms do not disaggregate this type of information, preventing me to perform cross-firm comparisons regarding this KPI.

[73] Ibid.

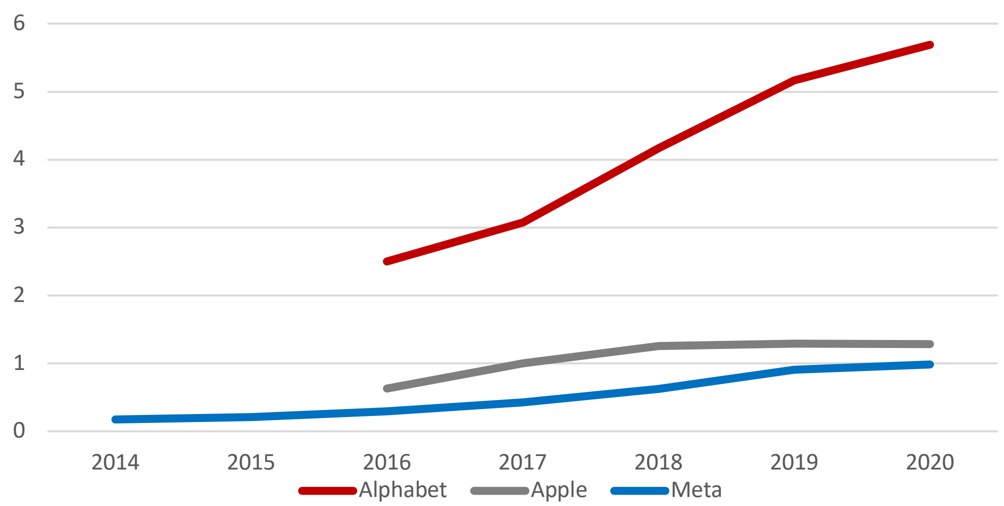
Figure 12. Water Withdrawal (in hundred million gallons) in global operations - Meta



Source: Prepared by the author, based on data from: Meta (2017) and Meta (2021b).

Although only Meta provides disaggregated information on the amount of water used for cooling data centers, Alphabet and Apple provide the total volume of water withdrawal per year, as we see in **Figure 13**. By far, Alphabet is the largest water consumer amongst these three firms, a growing trend over the years. From around 2,5 thousand million gallons in 2016, the firm's water consumption evolved to almost 6 thousand million gallons in 2020 — a growth of 230% in 4 years.

Figure 13. Water Withdrawal (thousand million gallons) global operations - Alphabet, Apple, Meta.



Source: Prepared by the author, based on data from: Alphabet (2021a), Apple (2021c), Meta (2017), Meta (2021b). Information for Amazon was not available online nor in Environmental Reports.

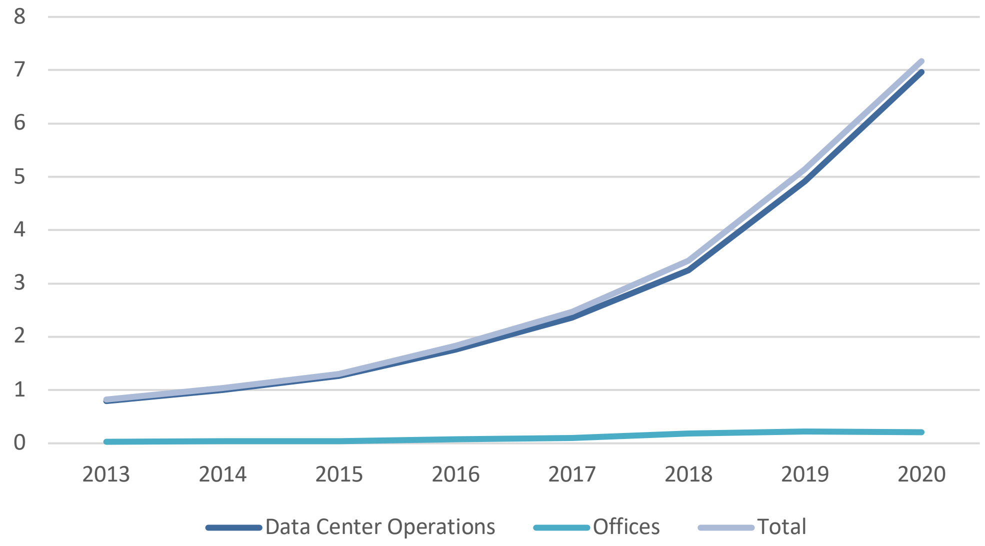
Apple and Meta present similar levels of water withdrawal. But whereas Apple has shown a plateau-like curve from 2018-2010 (no growth in the amount of water consumed), Meta has progressively increased the amount of water it consumes. Considering these two firms, Apple consumed more water in all years from 2016-2020.

When it comes to electricity use, these firms present important variations. Similar to the lack of transparency regarding data on water withdrawal, Amazon does not provide any information of how much energy is consumes per year. Bryce (2021, p.1) touched upon this point, highlighting that "all of the other big technology companies that dominate our digital lives — Alphabet, Apple, Facebook, and Microsoft — publish annual reports which detail their carbon footprints, electricity use, and overall energy consumption. But Amazon … won't reveal how much energy it uses."

In fact, Amazon's Environmental Reports are, by far, the least transparent in terms of environmental KPIs, when put in comparison with the other 3 firms. Alphabet (2021a), Apple (2021c), and Meta's (2020) recent Environmental Reports have very detailed appendixes, which disclose historical data on Electricity Use, Water Withdrawal, Waste Consumption (except for Meta), Renewable Energy, and GHG Emissions. However, Amazon only provides information regarding its GHG emissions, neglecting all other KPIs. Interestingly, Amazon's 2021 Environmental Report has 138 pages, whereas Alphabet (2021a) has 16 pages, Apple (2021c) has 105 pages, and Meta (2021b) has 53 pages. Meaning: the firm with the most extensive Environmental Report provides the least transparent information. Thus, Amazon has the lowest quality environmental reports amongst our cases.

Meta provides discrete data on electricity use in offices and data centers, as illustrates **Figure 14**. The vertiginous growth in electricity consumption, from less that 1 million MWh in 2013 to more than 7 million MWh in 2020, is mostly due to data center operations. But, while data centers are responsible for growing electricity use, Meta's offices are slightly decreasing the use of electricity since 2019.

Figure 14. Electricity Use (in million MWh) in global operations - Meta

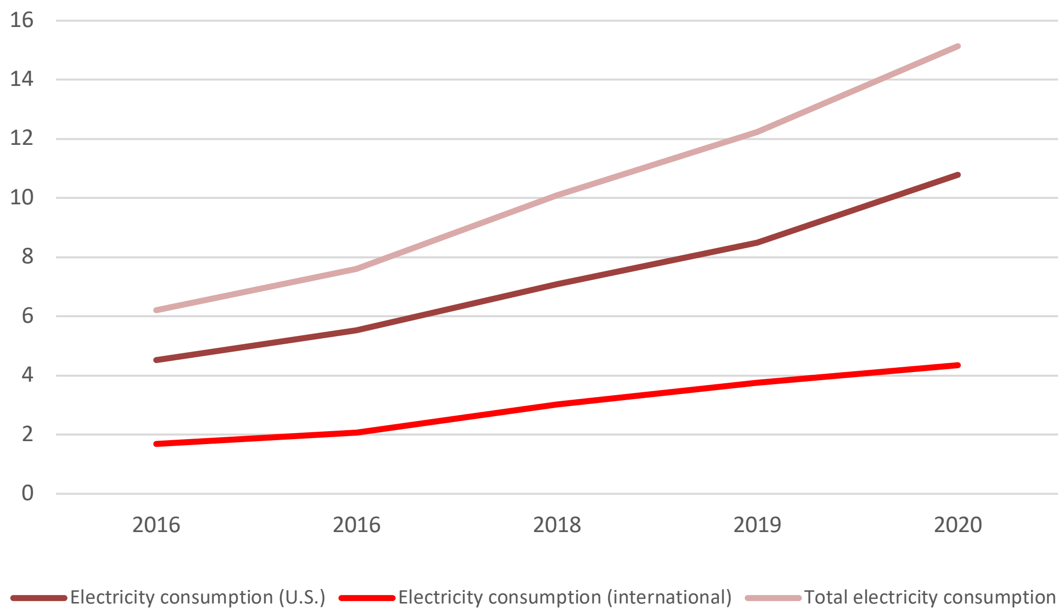


Source: Prepared by the author, based on data from: Meta (2017) and Meta (2021b).

Besides comparing energy consumption in offices and data centers, Figure 14 is relevant for an additional reason. It helps us evaluate climate strategies at the firm level. In fact, not only Meta, but the other firms dedicate several pages of their Environmental Reports describing strategies for reducing energy use and the carbon footprint of their offices. However, as Figure 14 shows, offices represent a very small portion of Meta's total electricity consumption. If this applies to the other firms (i.e., if Alphabet, Apple, and Amazon also consume much less energy in their offices than in their data centers globally), it makes sense to observe that, *by emphasizing in-company strategies to reduce their offices' energy use, these Big Tech firms are diverting the focus from more relevant (and challenging) actions for reducing energy use in data centers and global operations (i.e., their value chains)*.

While Meta is the only firm that provides disaggregate information on the electricity use in offices and data centers, Alphabet is the only one that specifies electricity use in the U.S. and internationally. **Figure 15** illustrates these numbers from 2016 to 2020.

Figure 15. Electricity Use (million MWh) in U.S. and foreign operations - Alphabet



Source: Prepared by the author, based on data from: Alphabet (2021a).

Total electricity use for Alphabet is centrally driven by their U.S. operations. In 2020, for instance, 71% of the total electricity used by this firm was employed in the U.S. Additionally, this percentage remained almost constant through all years from 2016 to 2020. We can interpret this pattern by evaluating the global data center infrastructure of Alphabet. Please, take a look at **Table 8**.

Table 8. Locations of all Data Centers, U.S. and Globally - Alphabet, Amazon, Apple, Meta

Firm	United States	Global	Total
Alphabet[74]	Berkeley County, South Carolina Council Bluffs, Iowa The Dales, Oregon Douglas County, Georgia Henderson, Nevada Jackson County, Alabama Lenoir, North Carolina Loudoun County, Virginia Mayes County, Oklahoma Midlothian, Texas Montgomery County, Tennessee New Albany, Ohio Papillon, Nebraska Storey County, Nevada	SOUTH AMERICA Quilicura, Chile EUROPE Dublin, Ireland Eemshaven, Netherlands Frederica, Denmark Hamina, Finland Middenmeer, Netherlands St. Ghislain, Belgium ASIA Changhua County, Taiwan Singapore	23 data centers
Amazon[75]	Virginia (38 data centers) San Francisco, CA (8 data centers) Seattle (8 data centers) Oregon (7 data centers)	SOUTH AMERICA Brazil (6 data centers) EUROPE Dublin (7 data centers) Germany (4 data centers) Luxembourg (3 data centers) ASIA-PACIFIC China (9 data centers) Japan (12 data centers) Singapore (6 data centers) Australia (8 data centers)	116 data centers
Apple[76]	Maiden, North Carolina Mesa, Phoenix, Arizona Reno, Nevada Prineville, Oregon Waukee, Iowa	EUROPE Viborg, Denmark Aabenraa Kassø, Denmark Athenry, Ireland ASIA Hong Kong Guizhou, China Ulanqab City, China	11 data centers
Meta[77]	Altoona, Iowa DeKalb, Illinois Eagle Mountain, Utah Forest City, North Carolina Fort Worth, Texas Gallatin, Tennessee Henrico, Virginia Huntsville, Alabama Kuna, Idaho Los Lunas, New Mexico Mesa, Arizona New Albany, Ohio Newton, Georgia Prineville, Oregon Sarpy, Nebraska	EUROPE Clonee, Ireland Odense, Denmark Luleå, Sweden ASIA Singapore	19 data centers

[74] Alphabet - Discover our data center locations. Available at: https://www.google.com/about/datacenters/locations/ Accessed February 21, 2022.

[75] Amazon Web Services (AWS) Data Center Locations Globally. Available at: https://www.sdxcentral.com/articles/news/wikileaks-publishes-the-location-of-amazons-data-centers/2018/10/ Accessed February 21, 2022.

[76] Apple data center locations. Available at: https://baxtel.com/data-centers/apple#datacenter-map Accessed February 21, 2022.

[77] Meta Data Centers. Available at: https://datacenters.fb.com/#locations Accessed February 21, 2022.

Source: Developed by the author.

Table 8 shows all data centers owned by Alphabet, Amazon, Apple, and Meta, as of 2022, and their respective locations, both in the U.S. and internationally. As I have observed previously, if all these firms follow a similar pattern as Meta, data centers represent the major driver of electricity use. Then, we could make a direct correlation between number and size of data centers and the total amount of electricity use. The number of data centers varies considerably from firm to firm. Apple has the lowest amount, with 11 data centers, 5 in the U.S., 3 in Europe, and 3 in Asia. On the opposite side is Amazon, with a total of 116 data centers only in its Amazon Web Services branch. The total number of data centers owned by the firm is not disclosed. Meta has a total of 19 data centers (only 4 outside the U.S.), and Alphabet has a total of 23 (9 outside the U.S.). Considering data center locations, Apple has the largest comparative international footprint (54% of its data centers abroad), Amazon has the second largest international footprint (47% of its data centers abroad). Following we have Alphabet (39% of data centers abroad), and then Meta (21% of data centers abroad).

Some insights from these figures are noteworthy. AWS's global data center infrastructure alone is larger than that of the other three firms combined! Unfortunately, Amazon does not disaggregate information on total electricity use by its data centers, preventing me from making the correlation regarding number of data centers vs. total electricity use, or comparisons with the other firms. A recent WikiLeaks report[78] have observed that Amazon, the largest cloud provider in the world, is notoriously secretive about the precise locations and number of its data centers.

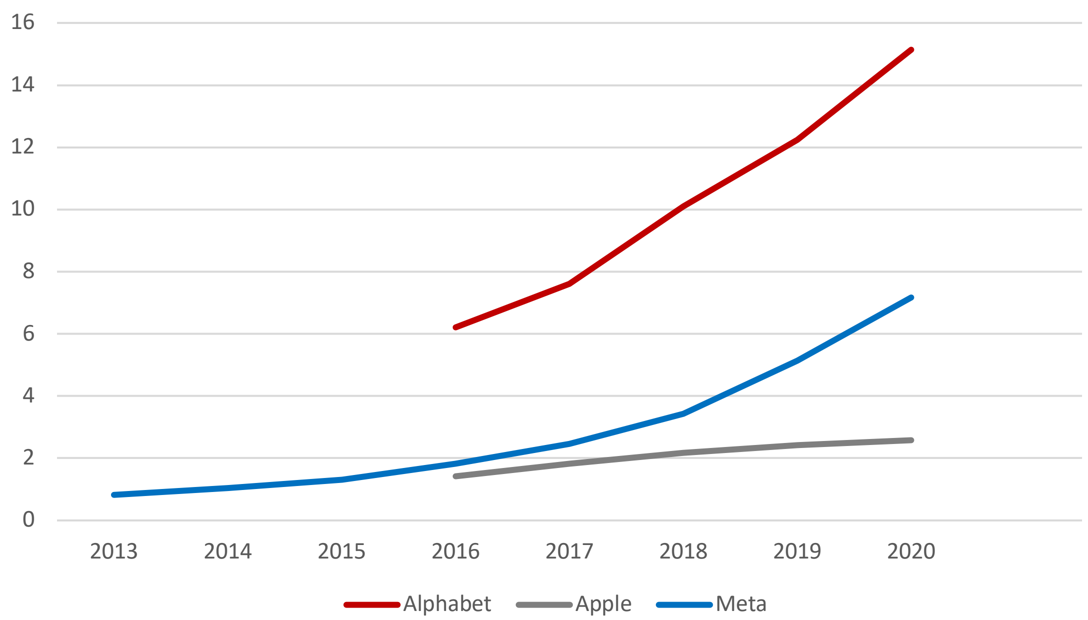
Although Amazon does not disclose total electricity use, the other 3 firms do. **Figure 16** illustrates these figures. Accordingly, if we compare Table 8 with Figure 16, an interesting correlation stands: the larger the number of data centers, the largest the electricity use. Apple, with the least number of data centers, consumes the least amount of electricity globally. Meta has more data centers and consumes a larger amount of electricity. Alphabet, which pursues the largest number of data centers out of these 3 firms, also consumes the largest amount of electricity. Because this correlation holds, it

[78] Amazon Atlas, October 11, 2018. Available at: https://wikileaks.org/amazon-atlas/. Accessed February 21, 2022.

makes sense to state that Amazon consumes much more energy than the other three firms. Yet, figures for Amazon regarding this indicator were not publicly disclosed.

Although Alphabet (23 data centers) and Meta (19 data centers) have a very similar number of data centers, electricity use by the former is much higher. In 2020, Alphabet consumed 2x more energy than Meta in global operations. Therefore, data centers alone cannot explain this energy use pattern. However, these firms do not disclose other sources of electricity use besides offices (and only Meta discloses this disaggregate data) and data centers. This is a strong limitation of these Environmental Reports, which prevents us from understating why, despite having a similar number of data centers, Alphabet and Meta consume so disproportionate amounts of electricity.

Figure 16. Electricity Use (million MWh) in global operations - Alphabet, Apple, Meta



Source: Prepared by the author, based on data from: Alphabet (2021a), Apple (2021c), Meta (2017), Meta (2021b). Information for Amazon was not available online nor in Environmental Reports.

In this section, I evaluated some environmental externalities of these Big Tech firms, based on data from secondary sources and their Environmental Reports. Although environmental footprints vary considerably, at this stage, we can make some empirically informed statements. Out of the 4 firms, Amazon has the largest operations, which makes it the most environmentally damaging firm in terms of water consumption, electricity-use, and global emissions (as I will demonstrate in the following section). Although Meta and Alphabet have a similar number of data centers (considering both those located in the U.S. and abroad), Alphabet consumes 6x more water and 2x more electricity than Meta, pointing to the necessity of considering their environmental externalities beyond data centers, even though large portions of their water withdrawal and electricity use are indeed due to data centers.

Apple discloses high-quality Environmental Reports since 2011. These documents are objective, comprehensive, certified by authorities such as the Fraunhofer Institute for Reliability and Micro-integration, and ISO 14001. Such certifications are attached as appendixes to Apple's Environmental Reports. On the other hand, Alphabet started disclosing Environmental/Sustainability reports in 2016, Meta stated releasing similar documents in 2017, and Amazon only in 2019. Importantly, Alphabet also discloses pretty comprehensive and objective reports, whereas Meta, and especially Amazon, provide extensive but lower-quality documents. In Amazon's case, the Environmental Report presents much information on what the company is doing to reduce its environmental footprint but fails to disclose numbers and indicators about what this footprint actually is. Thus, Amazon's Environmental Reports are the least transparent.

Apple has only 11 data centers globally, the lowest amount across these firms, which culminates in a comparatively lower level of water withdrawal (only higher than Meta), and the lowest level of electricity-use out of the 4 firms. As of 2020, Apple used 2 million MWh of electricity, whereas Meta consumed more than 7 million MWh, and Alphabet used more than 15 million MWh globally. Amazon did not disclose this data.

Nonetheless, figures for Apple do not include the environmental externalities of its contract manufacturers (the producers of electronics, such as the iPhone) — although GHG emissions for these contract manufacturers are disclosed as Scope 3. Thus, the actual environmental externality of Apple's value chains is cloudy — and likely to be much larger than the figures I presented here. This is also the case for Amazon, which is secretive about numbers illustrating its environmental impacts in terms of water withdrawal, energy consumption, and waste generated, although it discloses total GHG emissions (all the four cases do so), as I analyze from now on.

5.4. Big Tech Firms' Global CO2e Emissions: The Carbon Footprint of Alphabet, Amazon, Apple, Meta

The methodology involved in these firms' emissions calculations and reporting comes from The Greenhouse Gas Protocol (GHG Protocol). This protocol, also called *Corporate Accounting and Reporting Standard*, was developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The WRI is a global research non-profit organization headquartered in Washington, D.C., which operates with funding from, among others, the MacArthur Foundation. The WBCSD, by its turn, is a CEO-led organization (i.e., this is a private corporation) of over 200 international firms, whose origins date back to Rio 92, and is headquartered in Geneva, Switzerland. The GHG Protocol in the most widely accepted methodology for corporate carbon accounting.

The GHG Protocol establishes a standardized framework to measure and manage GHG[79] emissions. In this methodology, Scopes 1, 2 and 3 emissions are defined. Scope 1 covers direct emissions from owned or controlled sources from the corporation. Scope 2 covers indirect emissions from the generation of purchased electricity, steam, heating, and cooling[80]. Importantly, "renewable energy generates minimal Scope 2 emissions, whereas burning fossil fuels to produce electricity releases CO2e and other GHGs into the atmosphere" (APPLE, 2021c, p.12). Thus, Scope 2 emissions decrease as renewable energy use increases. Thus, if a company is running with 100% renewables, its Scope 2 emissions are zero. Scope 3 emissions include all indirect emissions that occur in a company's value chain. Table 2 summarizes these three scopes.

Table 9. Emissions from Scope 1, 2, and 3 - GHG Protocol methodology

Scope 1 (Owned Sources)	Scope 2 (Energy)	Scope 3 (Value Chain)

[79] Greenhouse Gas Protocol: About us. Available at: https://ghgprotocol.org/about-us Accessed February 26, 2022.

[80] Briefing: What are Scope 3 emissions? *The Carbon Trust*, Available at: https://www.carbontrust.com/resources/briefing-what-are-scope-3-emissions Accessed February 26, 2022.

Fuel combustion Company vehicles Fugitive emissions Offices (owned facilities) Data centers (assemblage and repair) Networking infrastructures	Purchased electricity, heat, steam, and cooling, i.e., emissions generated in the production of all purchased energy sources	Purchased goods and services Business travel Employee commuting Waste disposal Use of sold products Transportation and distribution (up- and downstream) Investments Leased assets and franchises

Source: Developed by the author, based on information from The Carbon Trust[81]

When analyzing Table 9, two aspects must be noticed. First, data centers emissions are Scope 1. However, this includes emissions in the assemblage and repair of data centers, but not their electricity use. Emissions generated in the production of the electricity consumed in data centers are Scope 2. Even though such emissions occur in the operations of the utility firms that provide such electricity, these emissions are accounted as Scope 2 in these Big Tech firms' emissions inventories.

Second, emissions in transportation and distribution (of people and products) in Big Tech firms' operations are accounted as Scope 3. This includes emissions both upstream the value chain (transportation and distribution in the supply-side, i.e., all suppliers of raw materials extraction, and other suppliers that feed Big Tech firm's operations), and downstream the value chain (the demand side, i.e., all products and services transported to customers, be they firms or individuals).

Important to observe (and I have stated this before, in the introduction of this dissertation) is that I am analyzing GHG emissions from Alphabet Inc. (not only from Google), from Meta Platforms Inc. (not only from Facebook), Amazon, and Apple. As stated by Alphabet itself in its 2021 Environmental Report, "the majority of our environmental data covers Alphabet Inc. and its subsidiaries, including Google. All reported data is global and annual unless otherwise specified" (ALPHABET 2021a, p.10). This also holds true in the case of Meta. In fact, Facebook was rebranded as Meta Platforms Inc. only recently, in October 21, 2021. Therefore, all Environmental Reports released so far refer to Meta's entire businesses. Thus, all environmental KPIs I analyzed in this dissertation refer to Alphabet and Meta, not only Google and Facebook.

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[81] Ibid.

Additionally, as regards methodology, the emissions I will analyze here are *market-based emissions*, not location-based. According to the WRI, "the location-based method reveals what the company is physically putting into the air, and the market-based method shows emissions the company is responsible for through its purchasing decisions. Both pieces of information tell an important story about the company's carbon footprint and carbon reduction strategy."[82]

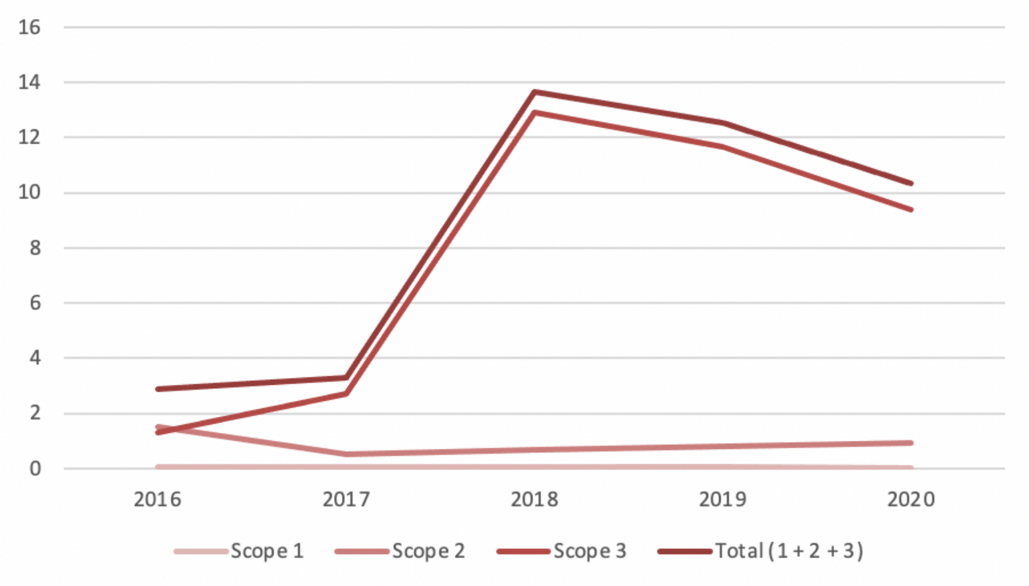
Basically, some years ago companies could choose if they would calculate their emissions from their local power grid (the location-based method) or look to contracts with their electric utilities (the market-based method). The current GHG Protocol guideline requires that companies use both methods. However, in this dissertation I chose to analyze market-based emissions because, *in their Environmental Reports, these firms only disaggregate Scopes 1, 2, and 3 emissions in market-based terms*. Thus, such a method allows me to perform a more thorough intra-firm and inter-firm comparative analysis.

Figure 17 provides information on Alphabet emissions by scope, between 2016 and 2020. Since 2017, the majority of Alphabet's emissions are Scope 3 (emissions from its value chain). For example, in 2020, Scope 3 represented 90,8% of total emissions. Scope 2 represents the second largest source of emissions, but far smaller than Scope 3. In 2020, Scope 2 emissions (indirect emissions from the generation of purchased electricity) represented only 8,83% of the total. Scope 1 emissions (which includes emissions from owned sources) represented only 0,37% of the total.

As we have seen before, data centers are the largest source of electricity consumption in these firms. So, why, although data centers are responsible for almost all electricity used by these firms, scope 1 emissions (which include data centers) represent so little? This is due to the accounting methodology. Emissions from all electricity consumed (including the electricity used to power these firm's data centers) are Scope 2, which represented 8.83% of Alphabet's emissions in 2020. Therefore, in carbon inventories, Data Center emissions, when represented as scope 1, do not include the related emissions from the generation of the electricity used to power them, but only emissions from data center assemblage and repair, which are indeed very low.

[82] Scope 2: Changing the Way Companies Think About Electricity Emissions, *World Resources Institute*, January 20, 2015. Available at: https://www.wri.org/insights/scope-2-changing-way-companies-think-about-electricity-emissions February 28, 2022.

Figure 17. Global Emissions, in Million Metric Ton CO2e, 2016-2020 - Alphabet



Source: Prepared by the author, based on data from: Alphabet (2021a).

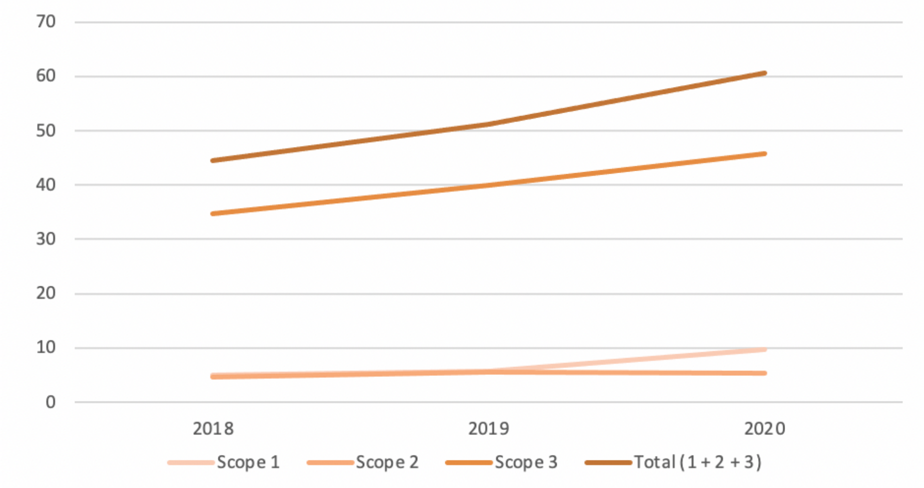
Figure 17 provides additional information. Alphabet's total emissions are decreasing since 2018, despite the fact that scope 2 emissions (from energy use) are growing. In section 4.5, when I discuss decarbonization policies and technologies in these Big Tech firms, we will understand why total emissions are shrinking at Alphabet.

Although Alphabet's total emissions are decreasing, this is not the case for other Big Tech firms. At Amazon, for instance, emissions are growing steadily. **Figure 18** illustrates Amazon's scope 1, 2, and 3 emissions from 2018 to 2020. As we can see, Scope 3 represents the vast majority of the firm's emissions. In 2020, 75,4% of total emissions were Scope 3 (value chain), whereas 16% were Scope 1 (direct emissions), and only 8,7% were Scope 2 (energy). From this data, we can extract important information.

First, scope 2 emissions are decreasing. Because this category represents emissions from purchased energy, we can assume that global electricity consumption in Amazon's internal operations (not considering the supply chain) is shrinking, although the firm does not disclose electricity consumption numbers. Moreover, under the Climate Pledge, Amazon is promising to power all its operations with 100% renewable energy by 2025, thus committing to reduce Scope 2 emissions to zero (AMAZON, 2021a, p.124).

Second, Scope 1 emissions (from owned or controlled sources) are growing, and represented 16% in 2020, whereas for all other Big Tech firms analyzed here, this category of emissions is close to zero, and decreasing. For example, in Alphabet, Scope 1 represented 0,37% of total emissions in 2020. However, Amazon's Scope 1 emissions grew by 67% from 2019 to 2020. Why are Amazon's Scope 1 emissions growing?

Figure 18. Global Emissions, in Million Metric Ton CO2e, 2018-2020 - Amazon



Source: Prepared by the author, based on data from: Amazon (2021a).

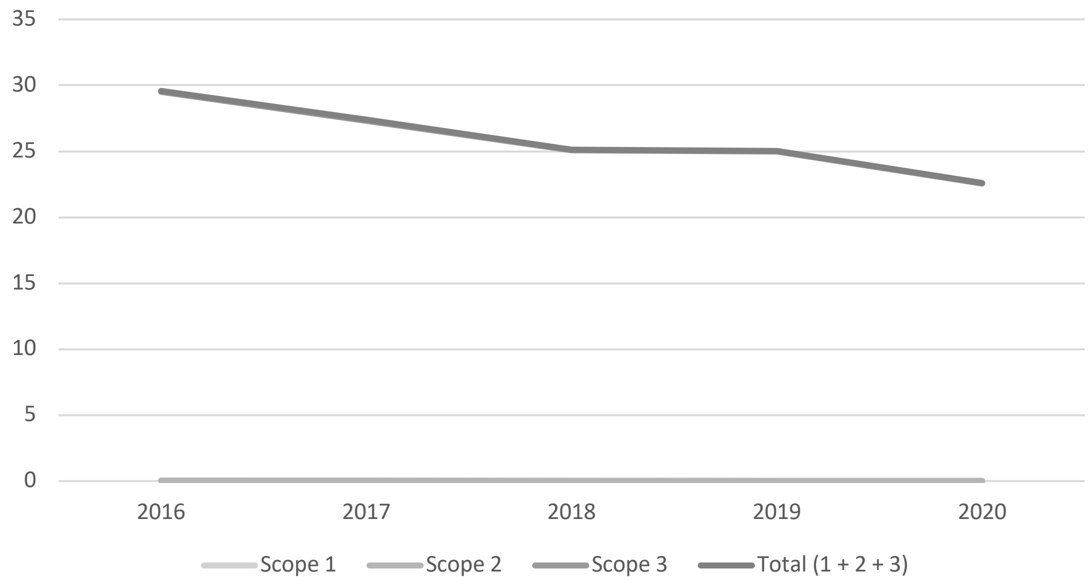
Crucially, because Amazon's own facilities (e.g., offices and warehouses), delivery fleet (estimated in 400,000 drivers worldwide, 40,000 semi-trucks, 30,000 vans, and around 70 planes[83]), and network infrastructure (AWS alone has 116 data centers globally and an estimated infrastructure of between 2,8 million and 5,6 million servers) is huge and growing. So, emissions from direct infrastructure, owned by the firm, are growing essentially because such infrastructure is getting larger as the firm expands its global operations. Scope 3 emissions (from its supply chain) are also growing.

Apple Inc.'s overall emissions are heading in the opposite direction. **Figure 19** highlights this firm's shrinking emissions from 2016 to 2020. The curves from Scope 3 and total emissions basically overlap. In fact, Scope 3 emissions represented 99,8% of

[83] "Amazon is now shipping cargo for outside customers in its latest move to compete with FedEx and UPS," *CNBC*, September 4, 2021. Available at: https://www.cnbc.com/2021/09/04/how-amazon-is-shipping-for-third-parties-to-compete-with-fedex-and-ups.html Accessed February 26, 2022.

total emissions every year, from 2016 to 2020. On the other hand, both Scope 1 and Scope 2 emissions are either zero or close to it. How that can be explained?

Figure 19. Global Emissions, in Million Metric Ton CO2e, 2016-2020 - Apple

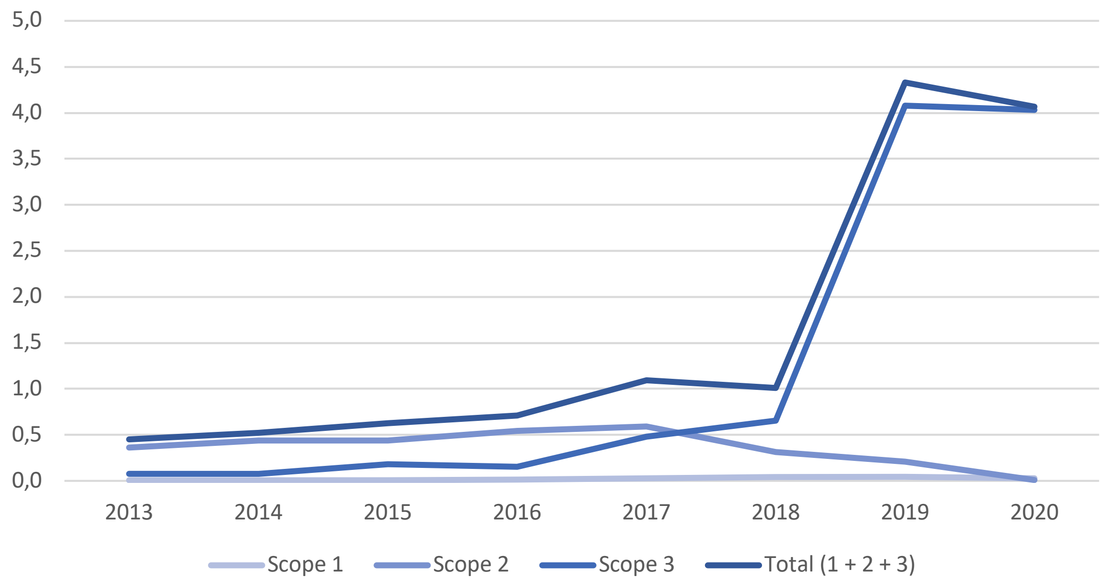


Source: Prepared by the author, based on data from: Apple (2021c).

Zero or close-to-zero Scope 1 and Scope 2 emissions are explained by Apple itself in its 2021 Environmental Report. "Since 2011, our Scopes 1 and 2 emissions have declined by 73 percent, and (in 2020) *we had zero scope 2 electricity-related emissions for the second year in a row*. Even as our business grew, our work to drive energy efficiency and transition to renewable energy reduced our footprint—avoiding over 4.6 million metric tons of emissions, the equivalent of taking almost 1 million cars off the road for a year. We've addressed our remaining Scope 1 emissions through nature-based solutions" (APPLE, 2021c, p.14). These nature-based solutions will be explained in detail in section 4.5, but mainly include reforestation and regenerative agriculture projects. In sum, although in 2019 and 2020 the business kept growing, Apple had zero Scope 2 emissions because it managed to offset energy-related emissions with renewable energy purchase.

In the case of Meta, something similar is happening. Scopes 1 and 2 emissions are shrinking, even though neither of these categories reached zero yet. **Figure 20** presents Meta's annual emissions by scope, from 2013 to 2020. Scope 3 emissions grew from 2018 to 2019, and decreased slightly from 2019 to 2020.

Figure 20. Global Emissions, in Million Metric Ton CO2e, 2013-2020 - Meta



Source: Prepared by the author, based on data from: Meta (2017), Meta (2021b).

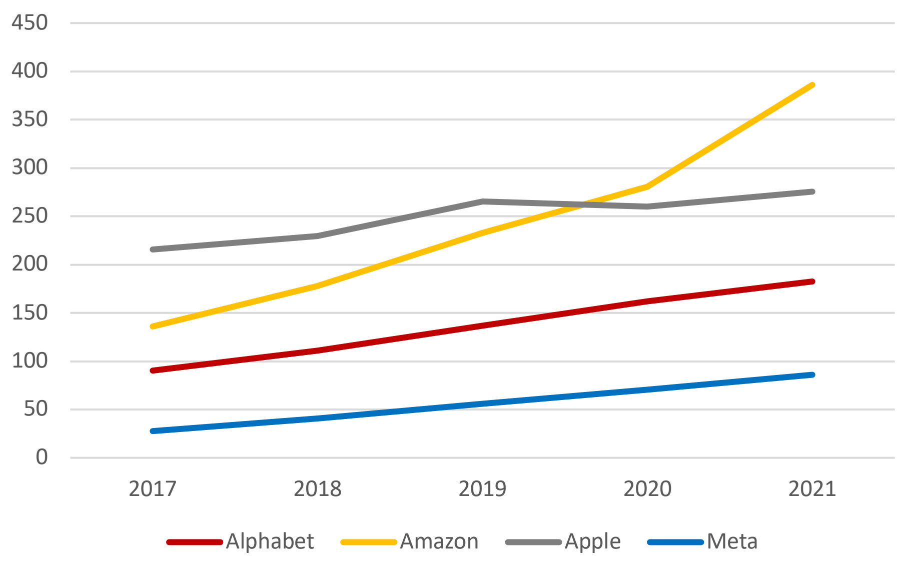
The first interesting thing we notice in chart 20 is the inflection point in which total emissions drastically change from only around 1 MM Ton CO2e in 2018 to almost 4,5 MM Ton CO2e in 2019. According to Meta (2021b), this occurred because, although the firm reported some categories of Scope 3 (business travel, employee commute, and construction) since 2015, only in 2019 full Scope 3 categories started to be reported.

In 2020, Meta's Scope 1 emissions were 0,71% of the total, and Scope 2 represented 0,22% of the total. In other words, Scopes 1 and 2 combined represented less than 1% of total emissions. This means that Meta's value chain (Scope 3) represents practically all of the firm's emissions (99,07%). How these numbers can be interpreted?

In September 2020, Meta (which was still Facebook) launched the document "Facebook's Net-Zero Commitment" (Meta 2020). On page 1, the firm made the following statement: "in 2020 and beyond, Facebook will achieve net zero GHG emissions for our global operations (scopes 1 and 2)." Nonetheless, as we have seen in the previous paragraph, this was not achieved, as in Meta (2021b), which reported emissions for the whole year of 2020, Scopes 1 and 2 emissions represent close to 1% together. Although this is very close to zero, net-zero on these two categories was not achieve yet. The 2020 Environmental Report, which is the most recent such document release by the firm, was launched in June 2021. Moreover, Meta (2020, p.1) commits to reach net-zero GHG emissions across its value chain (Scope 3), but only in 2030.

Figure 21 and **Figure 22** are comparisons of, respectively, annual revenues and GHG emissions for Alphabet, Amazon, Apple, and Meta, encompassing the period 2017-2021 for revenues, and at least the period from 2018 to 2020 for GHG emissions.

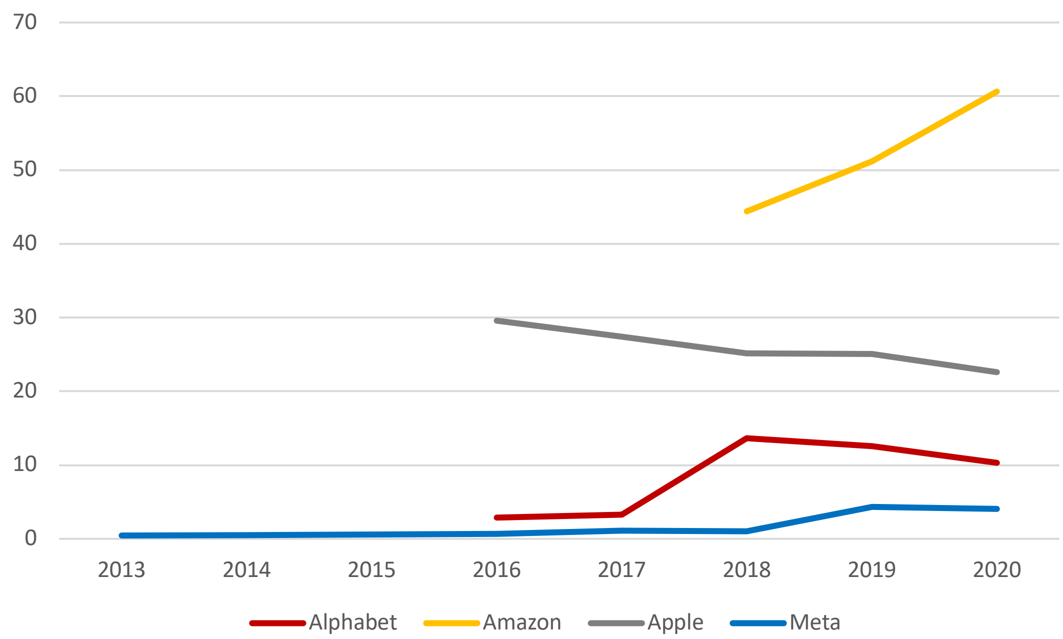
Figure 21. Annual Revenues, in Billion US$ - Alphabet, Amazon, Apple, Meta



Source: Prepared by the author, based on consultations in the Fortune 500 annual lists, which are available at: https://fortune.com/fortune500/2018/search/ Accessed February 28, 2022.

Chart 21 is relevant to understand their carbon footprint in a nuanced perspective. This chart reveals the constant growth in revenue streams for all four Big Tech firms. Amazon had the largest total revenue in 2021 (US$ 386 Billion), followed by Apple (US$ 275 Billion), Alphabet (US$ 182 Billion), and Meta (US$ 86 Billion). Nonetheless, in 2020, when Covid-19 hit the world, Amazon presented an important inflection point in its revenue stream, with a steeper positive inclination. Despite also increasing their revenues during the pandemic, Alphabet, Apple, and Meta presented only a linear revenue growth. But how are revenues associated with GHG emissions? Did emissions grow at the same pace as revenues? **Figure 22** highlights comparative GHG emissions for these four firms.

Figure 22. Global Emissions, Million Metric Ton CO2e - Alphabet, Amazon, Apple, Meta



Source: Prepared by the author, based on data from: Alphabet (2021a), Amazon (2021b), Apple (2021c), Meta (2017), Meta (2021b)

Comparing Figures 21 and 22, we observe that, although revenues are growing for all firms, GHG emissions are shrinking for 3 (Alphabet, Apple, Meta). Thus, it is safe to state that *business growth does not necessarily means more emissions*. Of course, as we will understand better further in the chapter, emissions are shrinking not because these firms in fact emit less (in material terms), but because of carbon offset strategies.

What else can we conclude from Figure 22? Firstly, the firms whose core-business is software (Alphabet and Meta) have lower emissions than those whose core-business is electronics manufacturing (Apple) or ecommerce/logistics (Amazon). Of course, as I have stated before, these firms are multi-business enterprises. Thus, they operate in different industries, e.g., Amazon with AWS, whose core-business is cloud computing, which brings it closer to Alphabet and Meta. Therefore, as these Big Tech firms transform over time, entering new business sectors, their emissions patterns might as well change.

Figure 22 also reveals that, as of 2020, Meta had the lowest carbon-footprint (4,07 million metric ton CO2e), followed by Alphabet (10,33 million metric ton CO2e), Apple (22,60 million metric ton CO2e), and Amazon (60,64 million metric ton CO2e). Put differently, in 2020 Alphabet emitted 2x more carbon than Meta; Apple emitted 2x more carbon than Alphabet; and Amazon emitted 3x more carbon than Apple. Thus, in 2020 Amazon had a much larger carbon footprint than the other 3 firms combined! More importantly, emissions are decreasing for 3 firms (Alphabet, Apple, Meta), but, for the heaviest emitter (Amazon), emissions are growing.

In the following subsection I explore in detail the sources of such emissions. By disaggregating the different sub-categories that constitute Scope 3 (the bulk of these firms' emissions), I will highlight what exactly is driving emissions reductions at Alphabet, Apple, Meta, and what are the sources of increasing emissions at Amazon.

5.4.1. Scope 3 Emissions: The Carbon Footprint of Big Tech Value Chains

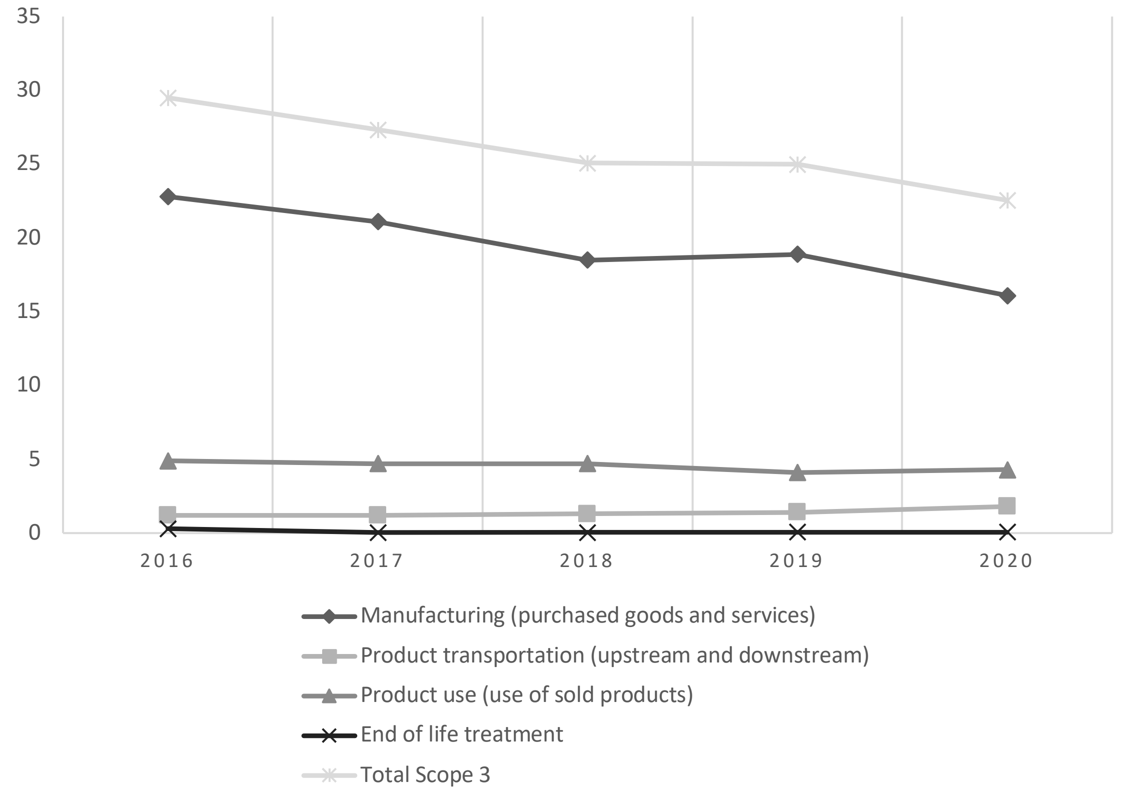
In this section, I analyze the portion of Alphabet, Amazon, Apple, and Meta's emissions coming from their value chains. Because these firms use the GHG Protocol methodology, information is disclosed in a similar pattern across the four firms' Sustainability Reports, allowing me to perform both intra-firm and inter-firm analyses.

Starting with Apple, **Figure 23** displays this firm's Scope 3 emissions from 2016 to 2020. As we have seen before, Scope 3 represented 99,07% of total Apple's emissions in 2020. But what are the sub-categories included in these emissions?

Manufacturing of purchased goods and services represented the bulk of Apple's emissions across these years. In 2020, manufacturing represented 71% of Scope 3 emissions. Following, we have product use (e.g., all iPhones, iPods, iTunes, MacBook, Apple Watches, etc.) as the second largest driver of Scope 3 emissions (19%). So, the manufacturing and use of such devices account for 90% of Apple's value chain emissions.

Product transportation, both in the supply side (raw materials) and in the demand side (finished products delivered to customers), represents only 8% of the firm value chain emissions, whereas end of life treatment (recycling and disposal of products) accounts for roughly 0,3% of Scope 3 emissions.

Figure 23. Emissions in Value Chain (Scope 3), MM Ton CO_2e, 2016-2020 - Apple



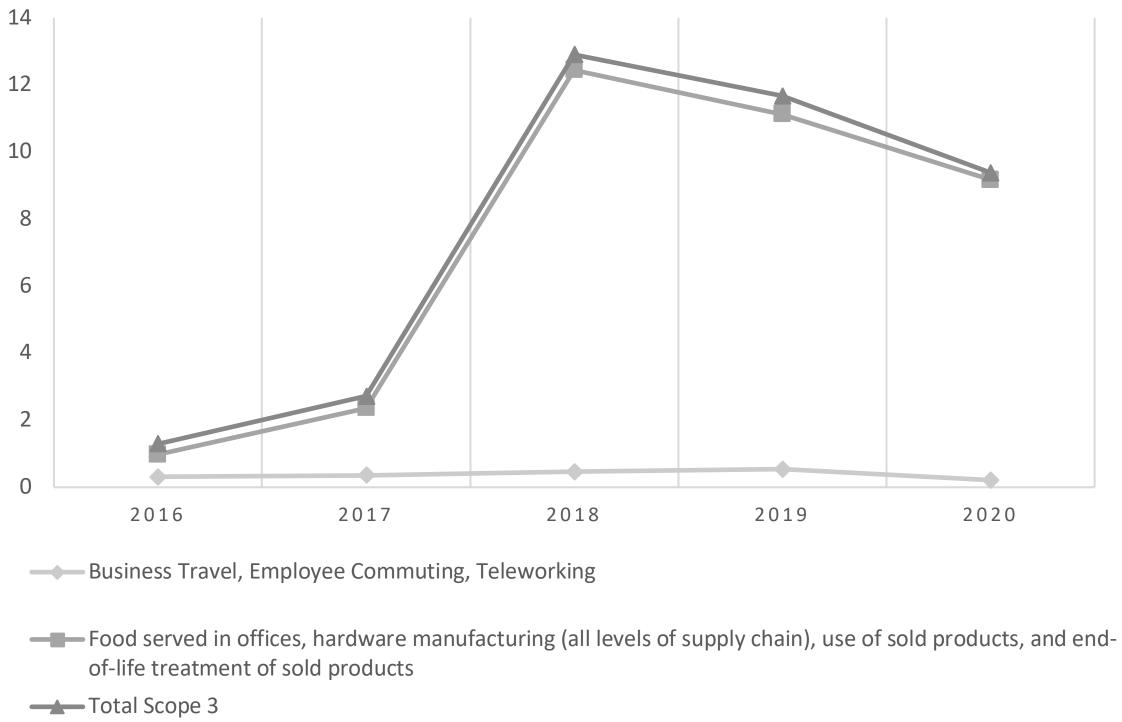
Source: Prepared by the author, based on data from: Apple (2021c).

Figure 24 illustrates Alphabet's Scope 3 (value chain) emissions. According to its most recent Environmental Report, "in 2018, to align with industry best practices for Scope 3 reporting, we extended our reporting boundaries to include emissions associated with food served in our offices, hardware manufacturing emissions beyond Tier 1 suppliers (full upstream to the point of extraction), use of sold products, and end-of-life treatment of sold products" (ALPHABET, 2021, p.13). Thus, Figure 24 includes aggregated emissions from all these sources.

In 2020, business travel and employee commuting approached zero, while teleworking emissions increased. Hence, in 2020, business travel, employee commuting, and teleworking accounted for 2,3% of total Scope 3 emissions from Alphabet.

The bulk of the emissions came from the category that combines food served in offices, hardware manufacturing (all levels up- and downstream the supply chain), use of sold products, and end-of-life treatment of sold products. Unfortunately, the company does not disaggregate these different categories as Apple does. Thus, Apple's report is more transparent regarding this KPI.

Figure 24. Emissions in Value Chain (Scope 3), MM Ton CO2e, 2016-2020 - Alphabet



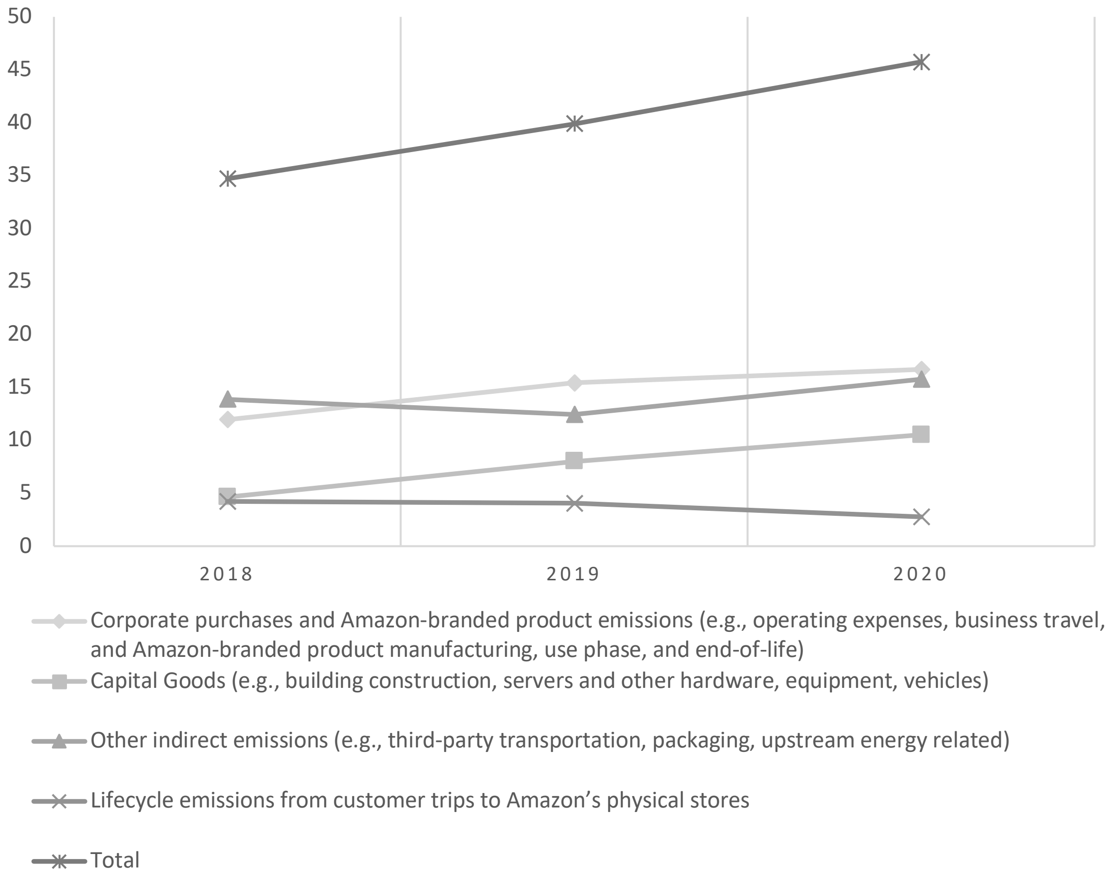
Source: Prepared by the author, based on data from: Alphabet (2021a).

Amazon reports Scope 3 emissions in a more transparent manner than Alphabet does, as we can observe in **Figure 25.** In 2019 and 2020 the slight majority (36,5%) of these emissions came from corporate purchases and product emissions (e.g., operating expenses, business travel, and Amazon-branded product manufacturing, use, and end-of-life treatment).

Roughly 34,5% of Scope 3 emissions came from other types of indirect activities, such as third-party transportation, packaging, and the upstream energy related to these activities. The third largest emitting category were Capital Goods (23%), such as building construction, servers and other hardware, equipment, and vehicles. This category is growing steadily since 2018.

Finally, lifecycle emissions from customer trips to Amazon's physical stores accounted for 6% the firm's value chain (Scope 3) emissions. Figure 25 details how these different categories evolved since 2018. We can observe that only lifecycle emissions from customer trips is decreasing, whereas emissions from all other sources are growing.

Figure 25. Emissions in Value Chain (Scope 3), MM Ton CO2e, 2018-2020 - Amazon

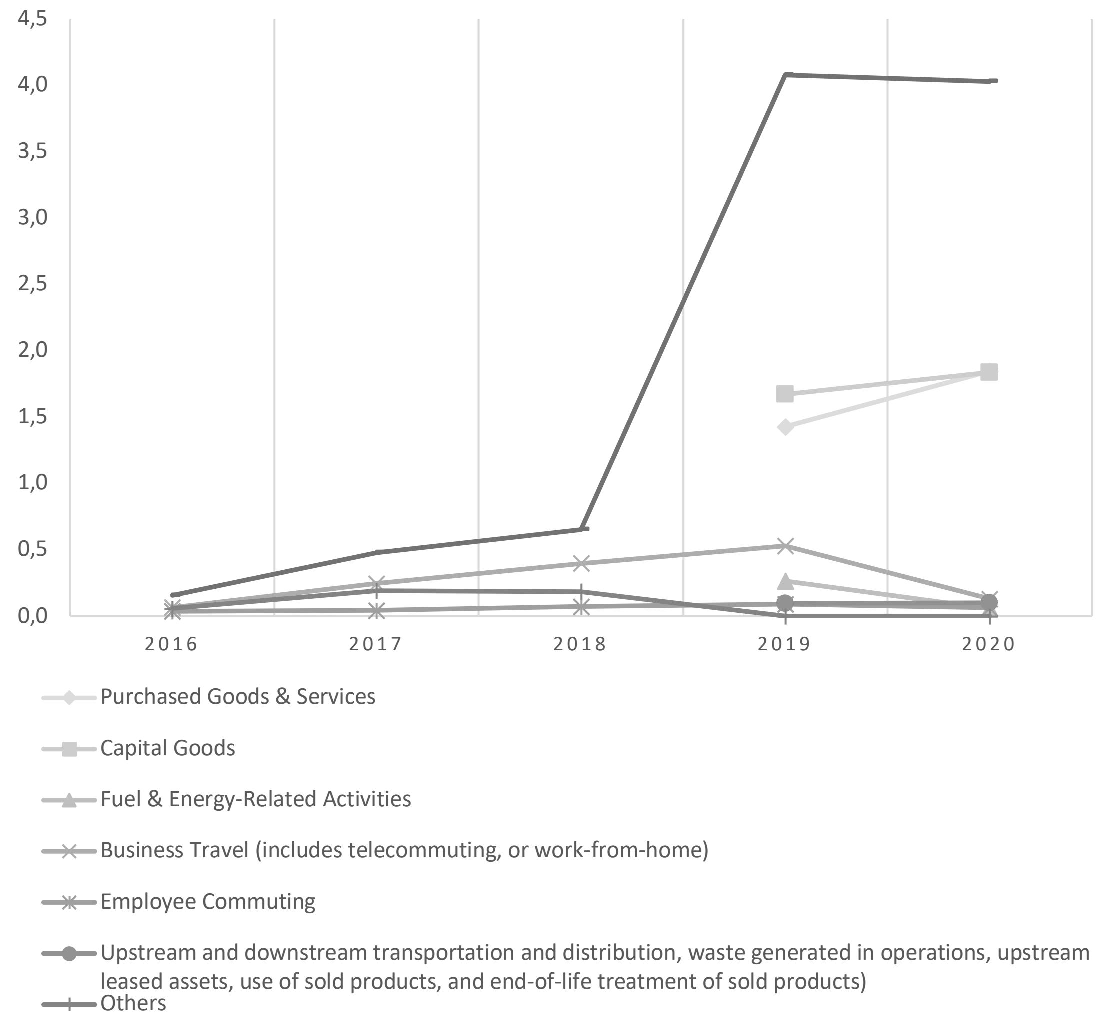


Source: Prepared by the author, based on data from: Amazon (2021b).

In the case of Meta, the picture became more transparent only in 2019, when complete Scope 3 emissions started to be disclosed. According to **Figure 26**, in 2020, purchased goods and services (45,8% of total emissions) and capital goods (45,6% of total emissions) represented practically the same portion of Meta's value chain emissions. These two categories alone totalize 91% of these emissions.

All other categories, which include fuel & energy-related activities (1,4%), business travel (includes telecommuting, or work-from-home) (3,2%), employee commuting (1,5%), upstream and downstream transportation and distribution, waste generated in operations, upstream leased assets, use of sold products, and end-of-life treatment of sold products (2,5%), represent a small portion of Meta's Scope 3 emissions.

Figure 26. Emissions in Value Chain (Scope 3), MM Ton CO2e, 2016-2020 - Meta



Source: Prepared by the author, based on data from: Meta (2021b).

To complete this section, in the next few paragraphs I discuss two climate change KPIs: Power Unit Effectiveness (PUE), which measures data center energy-efficiency, and Carbon Intensity. PUE is a relevant climate KPI when it comes to Big Tech firms because their core-business (large volumes of data processing) depends on Data Centers; thus, maximizing energy efficiency in these infrastructures is crucial.

PUE is an indicator I discussed in Chapter 1, and it is relevant for Big Tech firms because it helps monitoring data centers' energy efficiency. Nonetheless, Amazon and Apple do not disclose PUE, even though, amongst our cases, Amazon has the largest amount of data centers. In fact, Apple justified not disclosing PUE numbers: "the building operations and cooling emissions (PUE) associated with our collocated data facilities are beyond our operational control and therefore these emissions are not included in our report" (APPLE, 2021a, p.67).

Table 10 illustrates the evolution in PUE for Alphabet and Meta. Visibly, these numbers are pretty similar, and did not evolve much since 2016. In PUE, the closest to 1,00, the more energy-efficient data centers are. As table 10 illustrates, Alphabet and Meta have very similar data centers in terms of energy-efficiency. Actually, according to recent news[84], Big Tech firms have some of the most energy-efficient data centers on the planet. This is confirmed by Table 2, highlighting PUE values very close to 1,00.

Table 10. Evolution in PUE indicator for Alphabet and Meta, 2016-2020

	2016	2017	2018	2019	2020
Alphabet	1,12	1,11	1,11	1,10	1,10
Meta	1,10	1,10	1,11	1,11	1,10

Source: Prepared by the author, based on data from: Alphabet (2021a), and Meta (2021b).

Carbon intensity is another relevant climate change KPI. It is measured in emissions per unit of revenue or per full-time employee. In Alphabet and Amazon's Environmental Reports, carbon intensity metrics are based on the combined gross global Scope 1 and Scope 2 emissions. **Table 11** presents these metrics for Alphabet and Amazon, the only two firms that disclose this indicator. As we can see, Alphabet's carbon intensity per unity of revenue was 20x smaller than Amazon's in 2020. This ratio was pretty much constant since 2018, when Amazon started releasing this KPI.

What does such a KPI mean? It means that Alphabet generates much more revenues than Amazon per ton of CO2e emitted. Therefore, Alphabet is more carbon

[84] Big data centers are power-hungry, but increasingly efficient, *D.W. Akademie*, January 24, 2022. Available at: https://www.dw.com/en/data-centers-energy-consumption-steady-despite-big-growth-because-of-increasing-efficiency/a-60444548 Accessed March 8, 2022.

efficient, being capable to generate more wealth than Amazon per ton of CO2e emitted in the atmosphere. In 2020, for example, for each million dollar of revenues Alphabet generated, it emitted 5,21 tons of CO2e, whereas Amazon needed to emit 102,7 tons of CO2e (20x more) to generate the same million dollar.

Table 11. Carbon Intensity per unit of revenue (tCO2e/ million US$) Alphabet and Amazon

	2016	2017	2018	2019	2020
Alphabet	17,6	5,19	5,47	5,32	5,21
Amazon	-	-	128,9	122,8	102,7

Source: Prepared by the author, based on data from: Alphabet (2021a), and Amazon (2021b).

Apple does not disclose numbers on carbon intensity, and Meta only discloses carbon intensity per FTE (Full-time equivalent) employee. Interestingly, besides carbon intensity per revenue, Alphabet also releases carbon intensity per FTE. **Table 12** illustrates this climate KPI. Accordingly, Alphabet has a much larger carbon intensity per FTE than Meta. Neither Apple nor Amazon disclose data as regards this KPI.

This is an interesting climate KPI because it allows us to balance these firms' social benefits (number of jobs) with their harmful environmental externalities (carbon emissions). One way to interpret these numbers is the following: the larger the carbon intensity per FTE, the more the social benefit a firm generates is canceled by its negative impacts on the environment. Accordingly, Meta has more positive implications to society and the environment (combined) than Alphabet does, given that Meta's carbon intensity per full-time employee is extraordinarily smaller than Alphabet's. How can we interpret Table 12, in simple terms? One way is the following: in 2020, for each employee Alphabet had it emitted 7,49 tCO2e, whereas in the same year Meta emitted 0,000012 tCO2s (considerably less) for each full-time employee.

Table 12. Carbon Intensity per FTE Employee (tCO2e/FTE), Alphabet and Meta

	2016	2017	2018	2019	2020
Alphabet	23,4	7,6	8,36	7,96	7,49
Meta	0,0003	0,00029	0,00015	0,00008	0,000012

Source: Prepared by the author, based on data from: Alphabet (2021a), and Meta (2021b).

Tables 11 and 12 are interesting tools to help us compare carbon intensity at Alphabet, Amazon and Meta. In terms of revenues generated per emissions, Alphabet performs better than Amazon. In terms of number of employees per emissions, Meta performs much better than Alphabet. Unfortunately, Apple did not disclose these KPIs.

These different interpretations of carbon efficiency (for instance, Alphabet can be considered carbon efficient, as Table 11 shows, but can also be considered carbon inefficient, as Table 12 illustrates, depending on the indicator used) point to the necessity of comparing different carbon intensity KPIs across firms before reaching a conclusion as regards how (and to what extent) these companies impact climate change.

The next section continues this debate, but now with a different perspective. Whereas sections 5.2 to 5.4 explored some social, environmental, and climate externalities of these firms, section 5.5 highlights their strategies to cope with (reduce) these externalities. I focus on actions these firms are taking to develop low-carbon technologies, green their data centers, and invest in renewable energy infrastructures. Some of these initiatives might be positive in terms of mitigation and adaptation, but in my analysis, I also highlight limitations and side effects of these climate actions. Also, while so far, I have conducted my analysis of these firms in an integrated manner, in section 5.5. I analyze each firm individually.

5.5. Climate Commitment and Vested Interests: Low-Carbon Technologies, Green Data Centers, and Renewable Energy Investments

A note is necessary here, before I continue my analysis. From now on, and until the end of the dissertation, I will frequently use the concept of *vested interests*. This is thus a central concept in this dissertation. But, what do I mean by *vested interests*?

In Political Science, there are many definitions for the term. But here I adopt Terry Moe's (2015, p.287-288) interpretation, which he draws from institutional theory: "Vested interests arise in all government institutions, in all countries of the world, because *certain people and groups benefit from what the institutions do or make possible* - for example, through the services they provide, the supplies they purchase, or the jobs they fund. *The classic vested interests are business firms.* In the United States, insurance and pharmaceutical companies have vested interests in the health care system because their revenues are deeply rooted in the way the system is organized. Defense contractors have vested interests in the governmental defense programs that generate funds for the weapons systems, airplanes, vehicles, and satellites that their firms produce. Agribusinesses have vested interests in government programs that bolster their prices, give them subsidies, and thus raise their incomes and reduce their risks. *In all capitalist systems, whatever the variety, businesses get woven into the fabric of government in countless ways, wedding their interests to the institutions they are part of.*"

My analysis does not focus only on how Big Tech firms express their interests in the U.S. federal government or in California and Washington state governments, in order to influence climate or energy policies (e.g., though lobby), but also how their vested interests are ingrained in international organizations (e.g., the UN and its agencies, such as UNFCCC) and business coalitions (e.g., Amazon's climate pledge), by framing their low-carbon digital technologies as necessary and crucial to tackle climate change.

From Political Economy, I adopt Espen Moe's (2010, p.1732) interpretation of *vested interests*, based on his theorization on structural change, long-term economic growth and development. Accordingly, "technology, economics, and politics constitute a triangle, with all sides of the triangle capable of preventing structural change from occurring" (MOE, 2010, p.1731). To develop his theorization, Moe (2010) draws on two arguments: 1) one from Joseph Schumpeter ("different time periods have been characterized by different growth sectors" and "core industries and technologies that have been particularly important for growth and prosperity through different historical epoch"); and 2) one from Mancur Olson ("Olson understands how structural change is a thorny process that routinely meets with resistance from *vested interest* groups. As an economic sector becomes economically prosperous, it typically also acquires political influence. Institutional stability leads to institutional rigidity, as *vested interests* seek to preserve the institutional status quo that served them in the past.") (IBID, p.1732).

According to these insights, the notion of *low-carbon vested interests* that I adopt in this dissertation focuses on how Big Tech firms will likely:

(i) look for support from government (national and state-level) and from International Organizations, thus exercising political influence, towards the diffusion of their low carbon digital technologies
(ii) frame such technologies as good for society, not for their business
(iii) use their monopolistic advantages to prevent the growth of competitors in low carbon technologies (e.g., buying green startups)

(iv) manifest in international political and transnational business arenas their intent to scale-up low-carbon digital technologies

Now, I test these propositions for Alphabet, Amazon, Apple, and Meta, based on their low-carbon technologies, green data centers, and renewable energy investments.

5.5.1. Alphabet Inc.

In New York City is located the headquarter of Sidewalk Labs, a subsidiary of Alphabet founded in 2015. This company is emblematic when it comes to Alphabet's vested interests in the development of climate-smart technologies.

Sidewalk Labs is a start-up firm that aims to improve urban infrastructure through technology, and tackle issues such as cost of living, efficient transportation, and energy usage.[85] In tackling these urban problems, the firm's goal is to make cities more sustainable. Sidewalk Labs also works as a venture capital platform, by investing in other green tech start-ups.

This case is relevant to help us understand the politics of green tech at Alphabet. In this effort, some questions are crucial. Which climate-smart technologies is Sidewalk Labs developing, and how successful are they? How Alphabet/Sidewalk Labs are connected with the concepts of "sustainable smart city" and "climate smart city"? What are the *vested interests* behind Alphabet's subsidiary called Sidewalk Labs?

Sidewalk Labs has five technology products up to now. The first is called *Delve*. Delve is a software that supports real estate building, helping construction engineers to integrate financial and energy models with site constraints in order to make more sustainable buildings.

Mesa, another product from Sidewalk Labs, is a toolkit to be installed in commercial buildings. This is a set of sensors that help to cut energy costs and, by doing so, reduces emissions. These sensors automatically control space's energy use based on real-time inputs, like tenant occupancy, and optimizing for energy savings.

Pebble is a third technology. It uses real-time data to help city managers to administer parking and curb spaces, but is not directly related with energy efficiency or

[85] For more information, take a look at the company's website, available at: https://www.sidewalklabs.com/about Accessed March 7, 2022.

emissions reductions. Nonetheless, because this technology targets city management more broadly, its direct customers are urban planners and local government officials. Thus, *Pebble* is a technology with an inherent policy interface.

Two other products complete the list of Sidewalk Labs technologies: Mass Timber and Affordable Electrification. *Mass Timber* proposes to develop timber materials for sustainable construction (let's remember that the cement industry is responsible for 8% of global CO2e emissions). *Affordable Electrification*, still under development, is a project in which Sidewalks Labs is partnering with utility companies to build a software that matches clean energy use with each customer's monthly budget.

What can we conclude from Alphabet's vested interests in these climate-smart technologies? Out of these five technologies, four of them (Delve, Mesa, Pebble, and Affordable Electrification) are heavily based on data collection. This means that, although such technologies may help tackle climate change, data privacy issues must be considered a side effect of "tackling climate change" through these technologies. Additionally, such technologies were set to be applied in cities, strategic sites when it comes to climate governance (recent UN statistics highlighted that 70% of global CO2e emissions comes from urban spaces). Thus, data privacy and global urbanization are two phenomena of interest for Alphabet when it comes to the firm's climate strategy focusing on the development of related products and services.

Besides these climate-technologies (whose efficacy, sustainability impact, and scale are yet to be seen), Sidewalk Labs was responsible for a very controversial project, which ended up being discontinued. This was a sustainable smart city initiative, the *Quayside project* in Toronto. This project started in 2017 and would cost over one billion dollars. It proposed "to transform a slice of Toronto's waterfront into a high-tech utopia." [86] Moreover, "Sidewalk Labs' plan was to spend $1.3 billion on mass timber housing, heated and illuminated sidewalks, public Wi-Fi, and a host of cameras and other sensors to monitor traffic and street life."[87]

This project suffered severe criticisms and opposition from city residents. Community opposition was based on data privacy concerns, resistance regarding urban profiteering by tech giants (in this case, Alphabet), and the opacity of Alphabet's plans.

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[86] Alphabet's Sidewalk Labs shuts down Toronto smart city project, May 7, 2020. Available at: https://www.theverge.com/2020/5/7/21250594/alphabet-sidewalk-labs-toronto-quayside-shutting-down Accessed March 7, 2022.

[87] Ibid.

Visibly, this initiative suffered from a lack of citizen participation, which has been repeatedly demonstrated in political science literature as essential for the success of smart cities (see, for instance, Hollands, 2014).

The official statement of Sidewalk Labs CEO Dan Doctoroff explaining the suspension of the project pointed that it was financially non-viable. He cited the economic uncertainty borne by the Covid-19 crisis as an additional cause for the termination. One thing he did not mention was the strong citizen opposition to the project, based on concerns ranging from data-privacy to criticisms of the megalomaniac (and lucrative) ambitions of Alphabet. Needless to say, Alphabet (and other Big Tech firms) are not interested in educating users and consumers about the side effects (and hidden costs) of their "smart" technologies, as Zuboff (2019) has empirically demonstrated.

This short case informs us that climate technologies are not only technical artifacts. They represent a political agenda, which needs citizen engagement to work out. Climate-smart technologies, such as the ones proposed by Alphabet's subsidiary Sidewalk Labs, are not just market products and services. They are political initiatives by default, because they aim at transforming public realities (cities and their public spaces, the environment and the climate). So, this illustrated that my argument regarding low-carbon vested interests was correct, since Alphabet look for government support (Toronto's municipal government), thus exercising political influence, towards the diffusion of one of its low carbon digital technologies (a climate-smart city project).

However, these types of technologies might not be simply "sold" or "bought", rather they should be politically negotiated in a democratic process, since they propose interventions that will end up affecting us all — not only these firms' customers. Even when a private consumer buys, let's say, Sidewalk Labs' *Mesa* devices, which are physical artifacts to control energy-efficiency at home, this consumer's private behavior will indirectly affect climate conditions (a public good) for all of us.

This leaves us with a critical political economy question: can we make *private* green technologies work to protect the *global public good* which is the climate?

This inquiry can be segmented into three considerations, posed by the following questions: 1) How can we assure that, once available on the market and proved to work in climate change mitigation/adaptation, these technologies will be made available according to *climate justice* principles so that everybody has access? 2) Since climate technologies should be developed for the public good, is it fair to invest *public resources* (e.g., financial capital from government, big data from cities, etc.) in order to help these Big Tech firms to create, improve, and scale-up such climate technologies? 3) How can we hinder these technologies, developed by Big Tech giants, from being protected by *intellectual property rights* (similar to what happens with Big Pharma firms, developers of important drugs, but which are protected by long-lasting patents, preventing them from benefiting the majority of the population), thus becoming useless to save the climate, since only rich people, or those who can afford such technologies, might end up having access? (I will come back to these questions at the final section of this chapter).

From now on, I will concentrate on specific climate-smart technologies developed at Alphabet. It is not feasible to make a comprehensive analysis of all climate technologies the firm is developing, thus, in the following paragraphs, I will discuss only the most relevant.

Alphabet 2021 Sustainability Report (regarding operations for the year 2020) disclosed environmental KPIs considered strategic. Such indicators are segmented in: 1) Efficiency of Data Centers (energy use, GHG emissions, and waste generated); 2) Advancing Carbon-Free Energy (renewable energy use, investments, and GHG emissions); 3) Creating Sustainable Workplaces (certifications, waste, commuting); 4) Building Better Devices and Services (GHG emissions, recycling materials, energy, and waste); and 5) Empowering Users with Technology (products, tools, and incentive programs) (ALPHABET, 2021a, pp.4-9).

Accordingly, this report signals that Alphabet is improving the sustainability of its operations. For example, between 2011-2020, the firm reduced its carbon intensity per unit of revenue by 87%. In the same timeframe, it reduced by 63% its Scope 1 and Scope 2 emissions combined. In 2020, the firm matched 100% of the electricity consumption of its operations with renewable energy purchases.

Besides, in 2020 Alphabet reached a 71% landfill diversion rate for waste from its offices globally. Waste diversion means diverting waste from landfills through recycling and by reducing waste generation. Additionally, in 2020, more than 400 cities worldwide were using the *Environmental Insights Explorer*, a tool that provides policymakers with data to help reduce emissions.

If we compare these achievements with Alphabet's five-year sustainability strategy (2020-2025), which is focused on three key pillars: "accelerating the transition to carbon-free energy and a circular economy; empowering everyone with technology; and benefiting the people and places where the firm operates" (IBID., p.2), we observe that the firm has achieved relevant sustainability results. Of course, these improvements are mostly in internal operations, but they are still far from making a large impact on the firm's value chain.

Three policies and technologies at Alphabet will provides us with another illustration of the firm's climate actions (climate-smart technologies, Google Nest technologies, and renewable energy purchase power agreements).

Alphabet launched innovative climate technologies on October 6, 2021, in an official statement in the format of a 25:18 minutes YouTube video[88], where CEO Sundar Pichai introduced these innovations. Figure 27 (A) showcases Pichai while he introduced the "dragon scale skin", a new type of solar panel that integrates solar and geothermal energy. A prototype of the "dragon scale skin" coves the roof of the tent behind Pichai, in Figure 27 (A). This tent is located in the firm's campus in California. The roof is covered in more than 50 thousand solar panels, which resemble the scale of a dragon. Details on the shape of these innovative solar panels can be seen in Figure 27 (B).

Figure 27. Climate-Smart Technologies introduced by Alphabet in 2021

(A) CEO Sundar Pichai introduces Alphabet's new climate-smart technologies

Source: Image treated by the author, extracted from the YouTube video available at Alphabet (2021c).

[88] "Google Sustainability | Helping every day be more sustainable with Google." Alphabet, October 6, 2021. Available at: https://www.youtube.com/watch?v=MbHuSHGZf5U&t=6s Accessed March 8, 2022.

(B) “Dragon scale skin”, a more energy efficient solar panel created by Alphabet

Source: Image treated by the author, extracted from the YouTube video available at Alphabet (2021c).

(C) Alphabet Headquarters showcasing a building with a “dragon scale skin” rooftop

Source: Picture taken by the author during field research in California, March 9, 2022.

Figure 27 (C) was taken by me in March 2022, while I was conducting field research in California. It showcases a building where we can see the rooftop covered by

Alphabet's "dragon scale skin" solar panels. A drive across the campus revealed that this is only one of several buildings whose rooftops were covered by these new solar panels.

Below the rooftop of these buildings, it is set up the largest geothermal pile system in North America, underneath the "dragon scale skin." This pile system draws energy from the earth, in order to fulfill the energy needs of the building while the sun is set. This integration is what actually makes the "dragon scale skin" a climate innovation.

Additional climate-smart technologies were introduced in the same video. For example, "ecofriendly routes" available on Google Maps, starting in the U.S. October 6th, 2021, and in Europe in 2022. Alphabet is also developing AI systems to support cities to optimize the energy efficiency of traffic lights. This is a project related to the concept of climate-smart city, previously discussed. Another example is the "tree canopy insights", which combines AI and aerial imagery to help cities see the tree canopy coverage, helping them in planning tree planting projects.

Additionally, Alphabet introduced sustainable products and functionalities in the areas of Travelling, Shopping, and Investment. On October 6, 2021, the firm started to display carbon emissions on the Google Flights search engine. This feature is accessible globally, and allows customers to choose their flights based on the amount of carbon emitted. Still regarding travelling, when searching for hotels on Google, the webpage displays when the hotel has made minimum commitments to sustainable practices through a badge next to the hotel's name. It shows a list of the sustainable practices adopted (e.g., waste reduction, energy efficiency, and water conservation measures). Alphabet joined the Travalyst Coalition to create an open model to calculating the carbon impact of travels booked online. The model promises to bring standardization across the industry in order to provide a reliable measure to calculate the carbon footprint in the travel industry.

When customers use Google Search to look for home appliances, the engine will automatically prioritize stores and products that have sustainable impacts on society, helping users to narrow the search for more sustainable options.

Finally, when using Google Finance[89] to investigate a given company, the website will display the path towards sustainability the company has taken, so that users will be able to choose greener and more sustainable firm to invest in.

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[89] Google Finance is a website that provides real-time market quotes, international exchanges, financial news, and analytics to help users make more informed trading and investments

With these initiatives, Alphabet aims at achieving 100% of all offices and data centers operating 24/7 on locally sourced carbon-free energy by 2030. The firm has already achieved 67% carbon-free energy usage across its data centers (whereas in 2019, it was 61%). It has also launched US$ 5,75Bi in sustainability bonds in 2020, of which US$ 3,4Bi will be allocated on projects such as new clean energy agreements, and the construction of certified office spaces. Lastly, the firm will support around 500 cities to reduce 1GT of GHG emissions annually by 2030, providing tools that help measuring emissions, prospect the solar energy, and monitoring air quality (ALPHABET, 2021a).

These actions suggest that my proposition that Big Tech firms will frame their climate-smart technologies as good for society, not for themselves, makes sense. The enthusiastic (marketing-savvy and optimist) tone adopted by Pichai in the video where he introduced Alphabet's recent climate innovations illustrates my argument.

Another branch of sustainable technologies is Google Nest, particularly the *Nest Thermostat* and its new feature called *Nest Renew*. The Nest Hub was launched in 2018 (and updated as Nest Hub Max in 2019), as a smart home device. This computer can be used as digital picture frame, speaker, kitchen TV and smart home controller (thus, it rivals Amazon's Alexa)[90]. One of these smart home devices is Nest Thermostat. According to *Tech for Humans*, Alphabet's Thermostat "can control your heating and hot water automatically. In just a week, the thermostat will learn how warm or cold you like your home throughout the day. When you're at home, it will raise the temperature, and when you go out, it will turn it down, ultimately saving you energy." [91]

In October 2021, Nest Renew was launched, aiming to provide advanced features for the Nest Thermostat. This new feature is a mix of IoT and smart home technology to help householders to adjust the use and sources of energy in their homes. "Nest Renew can match the estimated fossil fuel electricity your home consumes with clean energy from US wind and solar plants, helping to support the growth of clean

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[90] Google is always listening. Now it's watching, too, with the Nest Hub Max, *The Washington Post*, September 9, 2019. Available at: https://www.washingtonpost.com/technology/2019/09/09/google-is-always-listening-now-its-watching-too-with-nest-hub-max/ Accessed March 10, 2022.

[91] What Is Google Nest and How Does it Work? Available at: https://www.lifewire.com/nest-home-automation-products-4159765 Accessed March 10, 2022.

energy." [92] The Nest Renew is in its early stage, and so far it is being rolled out only by invitation to specific customers.

These climate-technologies tell us that Alphabet perceives climate change as a business opportunity. *If technologies such as the Nest Thermostat and Nest Renew are strategies so that Alphabet can profit from climate change, why would the company be interested in helping solve the problem?* As I previously observed: by framing climate change as a technical issue (instead of a more complex political and economic challenge), Alphabet's new technologies can be interpreted in at least two ways. First, the company is aware that climate change will not be solved soon, so, it makes sense to invest in products and technologies whose future demand will only grow. Second, while the firm's interest is to sell climate-smart devices, thus guaranteeing a new source of revenues in a warming world, the market strategy adopted frames Alphabet as an actor "supporting a clean energy future" that will keep doing (or selling?) more to address climate change.[93] I perceive this as a *bluewashing*[94] strategy.

It is also worth discussing renewable energy strategies at Alphabet. The firm is cited by the World Resources Institute (WRI) as a good example of renewable energy adopter. "In going beyond the Scope 2 quality criteria and focusing on impact, Google prioritizes contracts that support new energy built on the grids where their data centers operate. They frame these criteria as: a) Bringing new sources of green power on the grid, rather than sourcing renewables from built or operating projects; b) Buying power from within the same grid regions as its data centers; c) Creating a positive impact on the industry by providing capital for renewable energy project developers, who use the cash flow from one project to finance the next, thereby expanding the industry." [95]

Based on the WRI's view, Alphabet's renewable energy policies are centered upon two things. First, the so-called *criterion of additionality*. Alphabet (2013, p.2) summarizes this criterion as: "a renewable energy purchase is additional if it has an effect

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[92] More information about this technology is available at: https://nestrenew.google.com/welcome/ Accessed March 10, 2022.

[93] Ibid.

[94] Bluewashing is a term used to describe deceptive marketing that overstates a company's commitment to responsible social practices.

[95] Scope 2: Changing the Way Companies Think About Electricity Emissions, *World Resources Institute*, January 20, 2015. Available at: https://www.wri.org/insights/scope-2-changing-way-companies-think-about-electricity-emissions Accessed February 28, 2022.

in the real world, be it direct or indirect. A direct effect would be causing a new renewable project to be built. An indirect effect would be increasing demand for renewable energy such that market pressures are able to encourage new investment."

What does that mean, in simpler terms? It means that Alphabet's Power Purchase Agreements (PPA) aim not only at providing renewable energy "rights" to the firm (so it can offset carbon emissions), but they also aim at helping the renewable energy industry to grow. Cases in which Alphabet catalyzes renewable energy projects are the following, disclosed in the document: *Google's Green PPAs: what, how, and why* (ALPHABET 2013):

Case A) "There is a company that wants to build a renewable energy project, but they need a reliable customer to help them make the project financially sound. In this scenario, signing up would spur the development of additional renewable power." (ALPHABET, 2013, p.2) Alphabet would, then, prioritize these types of incipient plants to partner in its PPAs.

Case B) "Perhaps a company does own an operating wind project, and is known to be a serial developer of renewable energy projects. They use the cash flow from one project to finance the next or to convince investors that they have bankable income. (Alphabet) would consider the power from this wind farm as additional since they have confidence that the proceeds will be used to finance additional renewable power" (ibidem). In this case, Alphabet would prioritize buying renewable energy credits from these types of incumbents that are demonstrably investing in expanding their operations.

Besides the criterion of additionality, a second principle that guides Alphabet's renewable energy investments is the use of *Renewable Energy Credits* (RECs). Alphabet buys its energy from Utility companies, and, as such, the firm has no control over where the Utility gets its power. Also, in several markets (including the locations where Alphabet has most of its data centers), there is no provision for users to buy their own power directly from a renewable energy generator.

Under these circumstances, Alphabet buys its electricity directly from renewable project developers using PPAs. Because Alphabet is not able to use this renewable energy directly in its data centers (which are normally located far away from wind and solar farms), it sells this energy near the location of the renewable energy company. In this process of selling, Alphabet receives RECs and keeps them so that no one else can claim credit for the green aspect of the purchase. Then, the firm uses these

RECs to offset the carbon emitted in the production of the fossil fuel energy used in its data centers.

RECs are "papers", just like debentures[96], being considered a financial commodity. Thus, because RECs are a tradeable commodity, Alphabet could simply buy RECs on the market, not directly from renewable energy firms.

Yet, Alphabet opted to use PPAs because, as I observed before, the firm claims it wants to help the renewable energy industry to grow. "In a PPA, Google is agreeing to buy all the power from a project for many years. Google has, in effect, totally accepted the power price risk that the project owner would otherwise face—instead of taking the risk of selling into the power market on a short-term basis, Google is providing the seller with a guaranteed revenue stream for 20 years" (ALPHABET, 2013, p.4). Basically, Alphabet helps renewable energy firms to cope with the risk of operating in such a new (and risky) type of business.

Although Alphabet's vested interests behind this type of support for renewable energy is hard to decipher, most likely the firm uses these initiatives as a PR and CSR strategy, to build a public image of sustainable business. Now let's discuss the case of Amazon.

5.5.2. Amazon.com

In the beginning of this chapter, I discussed one of Amazon's climate initiatives: the Climate Pledge. This initiative is both a multi-business network, gathering around 217 firms committing to stronger climate action, and a venture capital investment fund, through which Amazon invests in firms whose core businesses is developing market devices and services to cope with climate change. We have seen that this initiative is at the core of the firm's PR strategy towards becoming a leader in climate action. But, are there other relevant policies and technologies at Amazon aiming to tackle climate change? If so, how helpful are they? What are the firm's vested interests with such technologies? These questions animate this sub-section. Amazon's 2020 and 2021 Sustainability Reports (AMAZON, 2020, 2021b) will guide my analysis.

[96] A debenture is a security issued by corporations, representing debt, which assures its holders the right of credit against the issuing company.

Amazon's 2020 Sustainability Report was officially named *All In: Staying the Course on Our Commitment to Sustainability*. This document highlighted four areas for climate action: Sustainable Operations; Circular Economy; Packaging and Products; and The Cloud. I discuss each of these areas in the following lines.

As we have seen before, Amazon's operations are by far the most waste-intensive and CO2e emissions-intensive compared to the other three companies. This means that its operations are challenging to decarbonize. In particular, Sustainable Operations includes greening data centers and renewable energy investments, central concerns for any meaningful discussion on decarbonizing Big Tech.

In effect, in its Sustainable Operations commitment, Amazon (2020, p. 21) committed to deliver 50% of shipments with net zero carbon by 2030. Nonetheless, this is still a distant target from 100% net-zero shipment, that would be a truly aggressive commitment. In terms of sustainable transportation, in order to meet the target of net-zero carbon by 2040, the firm aims at: electrifying its transport fleet, maximizing the efficiency of current vehicles, and use alternative, less carbon intensive delivery methods.

Amazon's warehouses (which include fulfillment centers, sortation centers, and delivery stations) are also a huge source of emissions. In order to decarbonize these infrastructures, in 2020 the firm began an in-depth study of its operations buildings in order to transition these facilities to net-zero carbon (ibid., p.26).

Data center sustainability is another concern. AWS (subsidiary where almost all Amazon's data centers are located) has several initiatives to increase water use efficiency and reduce the use of drinking water for cooling data centers. But, differently from Alphabet, who adopts a KPI for data center efficiency (energy use, GHG emissions, and waste generated), Amazon did not release data center efficiency KPIs, such as PUE, in its 2020 report.

When it comes to the Circular Economy, a statement summarizes what the company was doing in 2020: "minimizing waste, increasing recycling, and providing options for customers to reuse, repair, and recycle their products — sending less material to the landfill and more back into the circular economy loop" (AMAZON, 2020, p. 28). In terms of recycling, the firm is "developing new recycling infrastructure, inventing recyclable packaging materials, and investing in initiatives that support the recycling industry across the U.S." (ibid., p. 29).

Concrete examples of policies in this regard include: a) investment of $10 million USD in the *Closed Loop Infrastructure Fund*, in order to finance recycling and circular economy infrastructure in North America; b) *Amazon Second Chance*, a program that aims at providing information on how to trade in, recycle, or repair Amazon devices and products, how to recycle Amazon packaging, and how to find open-box and refurbished devices (there is a specific webpage — https://amzn.to/amsc — where Amazon customers can find information on these programs); c) partnerships with NGOs such as *Feeding America* and *Good360* to donate surplus inventory and distribute products to communities in need across the U.S.

In the area of Products and Packaging, similar to what the firm is doing as regards the Circular Economy, initiatives are centered upon minimizing waste, reducing packaging materials, and incentivizing recycling of these packages. For example, the *Frustration-Free Packaging (FFP)* program encourages "manufacturers to package their products in easy-to-open packaging that is 100% recyclable and ready to ship to customers without additional Amazon boxes" (ibid., p. 33). Amazon also uses machine learning algorithms to match products with the right packaging choice, in order to minimize the amount of packaging. Partnerships with networks such as the *Sustainable Packaging Coalition* (SPC) increment the firm's actions in this area.

Regarding The Cloud, Amazon (in particular AWS) is investing in cloud efficiency by reducing data centers' emissions, water consumption, and investing in R&D to find ways to make these infrastructures more sustainable.

So far, according to the firm, relevant results have been achieved. First, AWS's infrastructure is 3,6 times more energy efficient, and performs the same task as an average enterprise cloud with 88% less carbon emissions (AMAZON, 2020, p.42). Of course, these numbers are disclosed by the firm itself, so there is no practical way to verify how exactly the firm got this number. As we have demonstrated before, Amazon does not disclose much data on its environmental and carbon footprints, thus it has a lower-quality sustainability report than the other three firms. Additionally, different from Apple, who discloses third-party certifications of the quality of its environmental reporting by authorities such as the Fraunhofer Institute for Reliability & Micro-integration and ISO 14001, and from Alphabet, who is certified by ISO 50001 (energy management systems) and has the UL 2799 certification (landfill waste diversion validation), Amazon does not disclose any such certification. Nonetheless, Amazon's carbon footprint reporting is externally certified by Apex, an environmental auditing third-party firm.

Another sustainability program is *Amazon Sustainability Data Initiative* (ASDI). Basically, "ASDI works with scientific organizations like NOAA, NASA, the

UK Met Office and Government of Queensland to identify, host, and deploy key datasets on the AWS Cloud, including weather observations, weather forecasts, climate projection data, satellite imagery, hydrological data, air quality data, and ocean forecast data. These datasets are publicly available to anyone. In addition, ASDI provides cloud grants to those interested in exploring the use of AWS' technology and scalable infrastructure to solve big, long-term sustainability challenges with this data" (AMAZON, 2020, p.45).

It is important to highlight that none of these commitments were modified in a meaningful way in the firm's 2021 Sustainability Report: *Further and Faster, together* (AMAZON, 2021b). Perhaps the only thing that was more emphasized in this new report was the commitment to be carbon neutral by 2040 — which, by the way, is the central goal of the Climate Pledge. The company is taking five actions to fulfill this promise: deploying 100,000 custom electric delivery vehicles by 2030; US$2 billion to support the development of green businesses (the Climate Pledge Fund, which I analyzed in section 4.1.); investing US$100 million in reforestation projects and climate mitigation (the Now Climate Fund, which I also analyzed before); and promising to power its operations with 100% renewable energy by 2025 (ibid., p.12-13).

A final goal of this sub-section is a brief analysis of Amazon's Renewable Energy strategies. The firm is very vocal about what it is doing in this regard, and there is even a webpage[97] where this type of information is disclosed.

Amazon's chief goal in this area is powering its operations with 100% renewable energy by 2025 — of course, this is mostly with PPAs, which counterbalance the actual use of fossil-fuel energy. Yet, in 2020 the firm became the world's largest corporate purchaser of renewable energy, reaching 65% renewable energy across its operations. This means that 65% of all energy consumed across Amazon's global business (U.S. and abroad) is offset with carbon credits.

Investments in renewable energy projects go beyond the U.S. For example, in 2021 the firm made its largest renewable energy investment ever, in a wind project in the Netherlands. It is planned to start operations is 2024, and part of the electricity generated (380MW) will be bought by Amazon to power its operations in Europe.

[97] Amazon: renewable energy. Available at: https://sustainability.aboutamazon.com/environment/sustainable-operations/renewable-energy?energyType=true A Accessed March 17, 2022.

The numbers involved in the firm's Renewable Energy projects are huge. "As of June 2021, Amazon has 232 solar and wind projects across the globe. These projects have a combined capacity to generate 10,000 megawatts (MW) and deliver 27 million megawatt hours (MWh) of energy annually. These projects helped power the 24 million MWh of electricity consumed by Amazon in 2020 and led to a 4% reduction in our carbon emissions from purchased electricity from 2019 to 2020" (AMAZON, 2021b, p.26).

Amazon buys new renewable energy beyond the existing grid mix through three strategies: a) off-site contracts for wind and solar (PPAs), b) on-site rooftop solar installations, and c) green tariffs, with local utilities that result in new renewable energy projects being added to the grid. According to the WRI, a green tariff is "a price structure, or an electricity rate, offered by a local utility and approved by the state's Public Utility Commission that allows eligible customers to source up to 100% of their electricity from renewable resources."[98]

As we approach the end of this sub-section, a question remains: what do Amazon's climate actions mean to the political economy of decarbonization more broadly? After analyzing this firm's public commitments and reports, my conclusion is that, although Amazon is not developing climate-technologies, as Alphabet does, the company is doing a relatively good job in incentivizing the renewable energy industry. In this case, similarly to Alphabet, a core objective is to help renewable energy providers to emerge, thrive, and grow. This doesn't seem to be only a PR strategy: this corporate policy seems to be really incentivizing the renewables industry. This is because Big Tech firms, as well as any firm with a decarbonization strategy, need renewable energy providers so that they can negotiate PPAs and buy emissions rights (carbon offset mechanisms). Therefore, helping the renewable energy industry to expand is a key contribution from Amazon, although this cannot be decoupled from vested interests (the firm will need renewable energy providers sooner or later, depending on the speed of the adoption of climate and renewable energy policies).

The politics of decarbonization in the ICT sector is influenced by how firms such as Amazon manage to increase data center energy-efficiency, firstly, in their own operations, and subsequently, propelling efficient data center models across the industry,

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[98] Utility Green Tariffs, Available at: https://www.wri.org/initiatives/utility-green-tariffs#:~:text=A%20green%20tariff%20is%20a,their%20electricity%20from%20renewable%20resources. Accessed March 17, 2022.

as Meta does. In this case, Amazon's initiative regarding data centers efficiency (besides developing less waste-water-carbon intensive models) is another interesting step taken by the firm. The Carbon Pledge (although indissociable from being a PR strategy) is another relevant initiative, as I pointed out before, because it helps *mainstreaming climate change* mitigation across global businesses. Additional vested interests and the political engagement of Amazon regarding climate policies will be further analyzed in Chapter 6.

5.5.3. Apple Inc.

An element differentiates Apple's climate-smart technologies and policies from the other three firms: Apple is the most vocal when it comes to *climate justice*. This is not only because it has a *black woman* as CSO (Lisa Jackson, whose story I told before), but because the firm is not shy to make commitments and investments to tackle climate change and racism, which Apple considers intertwined problems. And there is reason to believe the firm is making a genuine claim on these commitments.

One such commitment was raised in Apple's 2021 ESG Report: "To ensure that our work to protect the planet also helps advance equity, Apple has launched an *Impact Accelerator for Black- and Brown-owned businesses*. The Accelerator expands access to opportunity in sectors like renewable energy, carbon removal, and recycling innovation. We are making investments in these sectors to help fight systemic barriers impacting communities that are disproportionately affected by environmental issues like climate change" (APPLE, 2021d, p.9). This is a part of the *Racial Equity and Justice Initiative (REJI)*, which I discussed in the introductory section of this chapter. Apple aims at investing US$100 million on REJI.

Although noteworthy, the use of a business-driven strategy to tackle structural racism might not be welcome by critical political economists and sociologists, because in essence, such strategy deploys the very moral precepts that helped create racism (ambition, competition, profit maximization) in order to tackle it. Isn't that a paradox?

Apple managed to become carbon neutral since 2020, adopting a "policy of stages" in its efforts towards low-carbon development. What does that mean? It means that the firm's initial goal was to decarbonize itself, i.e., become carbon-neutral in its entire operations (stores, data centers, corporate facilities, business travel, and employee commuting), which was achieved in 2020. Subsequently, after becoming carbon neutral, the firm adopted a more ambitious goal: investing in clean energy around the world. As a result, Apple's 10-year climate roadmap encompasses five strategies.

First, *low-carbon design*. This means reducing the carbon intensity of products using low-carbon materials, recycled metals such as aluminum, and reducing the product energy-use (which represents 19% of the firm's total emissions).

Second, *energy efficiency*. Using less energy in product manufacturing (representative of 70% of the firm's total emissions) is a central goal. But other policies include: renovating and retrofitting older locations, designing new facilities with energy efficiency in mind, and working with local utility firms on energy efficiency strategies (ibid., p.8). Additionally, the *Supplier Energy Efficiency Program* helps suppliers that use significant amounts of energy to reduce their energy use. Yet, Apple is not clear, in its sustainability and ESG reports, which strategies are being deployed to help improve energy efficiency across these suppliers.

Third, *renewable electricity*. The firm has made investments in renewable energy generation. "In total, Apple-created renewable energy account for 90% of the renewable electricity our facilities use" (APPLE, 2021d, p.8). Renewable Energy Projects as of 2020 included: "more than 180 megawatts of solar power in Virginia, and outside of Reno, Nevada, as well as 130 megawatts of wind power near Chicago, and in Viborg, Denmark. In total, Apple-created renewable sources account for (…) around 1.5 GWh currently in use and another 30 MWh under contract" (APPLE, 2021c, p.20).

Fourth, *direct emissions abatement*. In this area, the firm aims at reducing emissions by means of technological solutions through emissions abatement or switching to low-carbon fuel. For example, Apple has "helped fund R&D for ELYSIS, a technology that eliminates direct GHG emissions from aluminum smelting. And also started to use ELYSIS aluminum in production of the 16-inch MacBook Pro" (APPLE, 2021d, p.9).

Fifth, *carbon removal*. To help remove carbon from the atmosphere, the firm invests in nature-based solutions that restore forests, wetlands, and grasslands, which are carbon sinkers. In this effort, Apple is partnering with Conservation International and Goldman Sachs, and plans to invest $200 million through the Restore Fund. This fund aims to remove 1 million metric tons of CO2/year in its pilot phase (IBID., p.10).

These five branches of climate action make up what the firm calls "carbon roadmap." This term is used both in the 2021 ESG report and in the 2021 Sustainability Report. Accordingly, from 2021 until 2030 the company will progressively offset its carbon emissions, until it reaches net-zero by 2030.

When it comes to Apple's 2021 Sustainability Report (APPLE, 2021c), climate change occupies pages 9 to 28, a space that represents almost 20% of the 105-pages document. What does that signal? It seems to signify that the firm is committed to, at least, bring climate change centerstage in its sustainability and environmental corporate strategies. It also means that climate change acquired such a dimension on politics and society that the tech market, exemplified here by Apple, could not afford to leave it behind. In sum, climate change is the most emphasized environmental issue in Apple's 2021 EGS and Sustainability reports.

Another aspect to observe is Apple's main highlights on climate action. According to Apple (2021c): the firm aims to become carbon neutral in its entire operations by 2030; the Restore Fund, which will invest up to US$200m in natural climate solutions; and more than 100 suppliers committed to 100% renewable electricity.

Yet, when it comes to climate-smart technologies, Apple's initiatives are shy. The only clean technology emphasized is the support for direct carbon-free aluminum smelting through the ELYSIS technology, as I mentioned before (IBID., p.11).

Beyond that, what is Apple doing in terms of greening its data centers and renewable energy policies? The next paragraphs summarize these dimensions.

Greening data centers is an explicit corporate policy. In 2020, Apple Data Centers used 1.7 billion kWh of electricity, and "100 percent of that came from clean, renewable sources including solar, wind, biogas fuel cells, and low-impact hydro power (…)". Additionally, the firm builds its own "renewable power projects and work with utilities to purchase clean energy from locally obtained resources" (APPLE, 2021c, p.76).

So, Apple managed to keep data centers running with 100% renewable electricity, even under circumstances of continuous business growth. As we have seen before, Apple has only 11 data centers in total, the least amongst our cases. Thus, the firm's efforts to "green" all its data centers do not account for such a huge effort in a comparative perspective.

Finally, Apple is deploying different Renewable Energy strategies across its business operations. In 2011, the firm became the first non-energy company to build its own utility-scale solar PV project in the U.S. Apple used the Public Utility Regulatory Policies Act (PURPA) to structure solar PV, biogas, and micro-hydro projects in the states of Oregon and North Carolina, thus contributing to future deployment of the PURPA in these states, thus helping to propel the industry of renewable energy generation.

5.5.4. Meta Platforms, Inc.

Previously, I observed that Meta is performing poorly (most likely, the worst performer out of our four cases) as regards environmental and climate action. Starting by its Director of Global Sustainability, Edward Palmieri, who does not specialize in environmental matters, the company does not portray a strong image of climate activism (contrary to what Amazon tries to do). One of the few explicit strategies to cope with climate change, the *Climate Science Information Center*, is basically a revenue and profit-driven initiative. Full-reporting from scope 3 emissions only started to be disclosed in 2019, and between 2019 and 2020 emissions were practically steady, while firms such as Alphabet and Apple managed to reduce their emissions in this timeframe.

In this sub-section, I take this background as a warning to analyze climate technologies, data center sustainability, and renewable energy projects at Meta Platforms. Along with secondary sources, two chief documents guide my analysis: Facebook's Net-Zero Commitment (META, 2020) and the 2021 Sustainability Report, regarding the operational year of 2020 (META, 2021b).

A bold statement opens the first document aforementioned: "Facebook is committed to helping solve the climate crisis and is aligning with the latest science on what is necessary to transition to a zero-carbon future. We will be helping to *scale existing technology* and the *development of new solutions* that will reduce greenhouse gas (GHG) emissions and remove carbon from the atmosphere" (META, 2020, p.2, *italics mine*). So, the firm highlights a commitment to the development of climate technologies. Meta aims at developing not only technologies for emissions reduction, but also carbon removal technologies (which can include geo-engineering). As we will see later, the firm is also developing technologies for climate adaptation, although focused on internal operations.

Although the corporation is explicit about the fact that il *will* (future tense) advance climate technologies, how genuine are such statements? Do we have indications that such commitments will materialize? If so, will such technologies represent a relevant change in the firm's trajectory in tackling climate change?

Renewable Energy initiatives seem to have been materialized in Meta's sustainability strategy. "Our renewable energy commitments are leading to the construction of over 5,400 megawatts (MW) of new solar and wind power plants globally until 2030" (IBID., p.3). What does this mean, in comparative terms? In 2020, the firm consumed more than 7 million MWh of electricity. Thus, 5,400 MWh from new renewable energy projects does not account for much of the firm's consumption. In other words: this is a shy commitment.

Another concern is the Circular Economy. The firm commits to "evaluate materials with lower carbon impacts, building repairability and recyclability principles into design processes, extending the life span of our hardware, and continuing to ensure responsible end-of-life management" (IBID., p.3). Yet, these are basically the same initiatives that other firms are pursuing, as previously discussed. For example, Amazon adopts a policy of waste management, recycling, and sending less waste to landfill (end-of-life management), which are pretty much the same as Meta.

Nonetheless, one initiative at Meta is more emphasized than in any other of the three cases: the *Responsible Supply Chain* program. "We partner with suppliers to build capacity on data reporting and to support on-site energy assessments that identify energy reduction opportunities to improve environmental performance" (IBID., p.3). In other words, all Meta suppliers receive technical support from the firm in order to increase the reliability of their analytics regarding sustainability data, which might end up helping these other companies on planning emission reductions.

Additionally, *carbon removal projects* are emphasized as a policy already materialized. "Projects and technology that remove carbon from the atmosphere can serve as a bridging mechanism toward long-term decarbonization. We recognize that some of our emissions will be very difficult to reduce by 2030, and we will support projects that remove carbon equal to the emissions we are not able to reduce by then" (IBID., p.3). For instance, in 2019, the firm "purchased *carbon credits* totaling more than 100,000 metric tons of CO2e, which supported carbon removal projects, such as forest conservation" and planting more forests (META, 2020, p.4).

Meta's approach in 2020 and beyond is to prioritize two types of carbon removal initiatives: beginning with *nature-based solutions* (e.g., projects on reforestation and regenerative agriculture), and to enable emerging *climate technologies*. Geoengineering technologies for carbon removal were not disclosed in the firm's sustainability reports.

Meta (2020, 2021b) discloses a set of climate technologies linked to *big data* and *analytics*. These include the Climate Information Center (previously discussed), some data science tools useful for climate action, and the Climate Conversation Map (which will be discussed in a moment). Hyperefficient data centers complete this list, and I will discuss them later. Criteria to select carbon removal projects are set by the firm 2021, including: a) additionality[99]; b) design for permanent impact; c) alignment with social and environmental co-benefits; d) alignment with climate justice and equity; e) quantification using recognized standards; e) assurance by an accredited third-party verifier.

Another approach pursued by Meta is that of *climate resilience*. The firm defines climate resilience as “adapting to and addressing challenges and risks caused by climate change and any relevant disruptions to supply, operations, and users” (META, 2021b, p.10). Climate resilience is a concept that did not appear in any other of the three firms reports - although all of them have ome policies for climate adaption. According to Meta (2020, p.4), it will invest in “strengthening resilience and adaptability to climate-related hazards and adaptability to natural disasters while helping to build resilient and equitable communities.” As the firm expands its operations, it is taking an integrated approach to resilience across climate, water, and biodiversity.

An example of climate resilience action was explained in Meta’s Net-Zero Commitment report: “by the end of 2020, we will have contracted water restoration projects at 2/3 of our high water stressed data center locations. As a result of these efforts, we have helped restore landscapes and rivers that increase wetlands and fish and wildlife habitat, as well as increase resilience to floods and droughts and help protect endangered species” (META, 2020, p.4). Nonetheless, results in terms of scientific and technical reports evaluating the effectiveness of these initiatives are necessary, particularly those produced by third-party verifiers. So far, this commitment is still a promise.

Another initiative at Meta regards *climate action through data science*. The firm “partners with nonprofits, businesses, and communities to help share information about the impacts of climate change and harness the strength of our platforms to drive climate action. (…) People have raised over US$ 89 million through Facebook Fundraisers to combat climate change and support environmental protection since we introduced *charitable giving tools* on Facebook in 2015” (IBID., p.5).

These tools to collect donations at Facebook can work through two different avenues: 1) Nonprofits can collect donations through their Nonprofit Facebook Page, or

[99] “In a climate change mitigation context, additionality is generally used to mean net greenhouse gas (GHG) emissions savings or sequestration benefits in excess of those that would have arisen anyway in the absence of a given activity or project” (VALANTIN, 2012, p.2).

2) Supporters collect donations on a nonprofit's behalf.[100] The firm has a dedicated set of tools and information on its webpage to help fundraisers collect money for their causes, including climate change and environmental projects.

In addition, the *Climate Conversation Map*[101] is "a tool that helps partners understand more about how climate conversations develop" (ibid., p.5). What does that mean? The map is a tool that "provides information to help others advance climate action, including important *data and insights* into how conversations on the topic retreat and flow throughout the world and over time. These maps provide organizations with a way to visualize the rate of engagement with climate-related news in various regions."[102]

The map portrays climate information, such as surveys and thematic maps, with a global, national, and local focus. This means that users can access information related to climate change and its connections with health, disaster, economic opportunities, gender, population, and several other search terms. In addition, on a similar page titled "Data for Good", Meta provides information and analytics on other relevant topics, such as COVID-19. These dashboards are open access; thus, I consider this a materialization of climate commitment with the use of data.

Yet, the impacts of these initiatives are not only hard to measure but likely to be small on the broader context of climate mitigation/adaptation. After all, information does not necessarily mean action.

Let's discuss Meta's data centers sustainability. We have already seen that Meta has 19 data centers in total. Although each of them is a building on its own (several mainframes assembled together), the firm has less data centers than Alphabet (23) and AWS (116). Is this relatively low number of data centers a hindrance or a bonus for making them more sustainable? What are the climate impacts of Meta's data centers?

The firm has some of the most energy-efficient data centers in the industry. "We are proud to design and operate some of the most sustainable data centers in the world. (…) we have worked to minimize our impact by incorporating design elements

[100] Tools of Collect Donations on Facebook. Available at: https://www.facebook.com/business/learn/lessons/tools-to-connect-donations-on-facebook Accessed March 20, 2022.

[101] The map can be accessed here: https://dataforgood.facebook.com/dfg/visualizations

[102] New Climate Conversation Map provides insight to help global organizations drive climate action. Meta, April 22, 2020. Available at: https://tech.fb.com/hyperefficient-data-centers/ Accessed March 20, 2022.

and construction practices that prioritize resource efficiency and clean energy" (META 2021b, p.35). Indeed, as Table 2 shows, the PUE measures for Meta are excellent (very close to 1,00, which would mean the maximum efficiency). Nonetheless, Alphabet has similar PUE measures. Unfortunately, Amazon and Apple do not disclose these numbers, preventing me to perform comparisons. Meta also commits with powering its data centers with 100% renewable energy, plus saving energy and water through efficient designs (IBID., p.35).

As regards the Circular Economy, Meta "explored strategies to reduce the environmental impacts linked to construction activities and building materials like concrete and steel." In 2020, the company began piloting the use of electric construction equipment. Let's remember that the circular economy aims ate reducing material waste, and incentivizing circularity and recycling policies. Because Big Tech firms have an *apparent immateriality* (they deal with *data* and *information*, non-material subjects per se), very few are engaging with the circular economy. But, amongst our cases, all firms have stated some type of commitment in this regard, even Meta and Alphabet, the least material out of the four cases. Apple (with huge manufacturing operations) and Amazon (which uses several materials, from packages to delivery fleets) have obvious reasons to strongly incorporate the concept of circularity into their operations.

It is noteworthy to highlight the institutional influence Big Tech firms, such as Meta, have on propelling sustainable data centers across the industry. "We work closely with industry organizations and experts to help shape the industry's standards for high-performance data centers. We continue to collaborate with the United States Green Building Council to shape design and construction standards and best practices" (IBID, p.38). This initiative highlights the political power of these firms in advancing the climate and sustainability agenda in the ICT sector.

One case illustrates Meta's strategy regarding green data centers. "Through our Open Compute Project (OCP), we connect with other leading technology innovators to exchange products and designs around data center infrastructure and hardware with an open-source community. In 2020, the OCP Incubation Committee, a working group dedicated to establishing the foundational and operational aspects of the OCP, outlined key strategies to enable greater circularity within the data center industry" (IBID., p.39).

Let's close this section exploring Renewable Energy strategies at Meta, in a comparative perspective with the other three firms. Meta Platforms do not invest much in this area, compared to the other three cases. While Meta's *Renewable Energy Projects* are heavily concentrated in the United States (5,4GW of contracts), only a few projects are located in Europe (330 MW of contracts), and in Asia (160 MW of contracts) (META, 2021b). In comparative terms, Apple had a total of 1,5 GW of renewable energy projects in use as of 2020, and more 30 MW under contract (APPLE 2021c). Alphabet had much higher investments: 55,000 GW of contracts (in total) as of 2020 — it is not a surprise that Alphabet was the world's largest *annual corporate purchaser* of renewable energy in 2020. To complete the list, Amazon had a total of 27,000 GW of renewable energy contracts across the globe in 2020. In sum: Alphabet and Amazon are global powerhouse investors in Renewable Energy projects, whereas Apple and Meta have almost insignificant investments in this area, compared to the other two corporations.

Yet, Meta managed to "increase the operating portfolio of wind and solar to over 2.8 GW spanning 15 U.S. states, Europe, and Asia" (META, 2021b, p.17). Additionally, the firm is "supporting new projects and approaches that increase access to renewable energy, as well as add renewable capacity to the grids that support our data centers" (IBIDEM). Meta also works directly with local utilities around the U.S. to establish new *green tariffs* that enable other companies and customers to access renewable energy, and has established six new tariffs in the U.S (META, 2021b, p.17)

What does this all mean to the politics of decarbonizing Big Tech firms? Has Meta had any meaningful impact on the global political economy of climate change?

No, and yes. As we have seen in this section, most of Meta's sustainability strategies regarding climate technologies, renewable energy, and green data centers aim at decarbonizing the firm's internal operations. Apart from that, strategies aiming at a broader societal effect focus exclusively on sharing data and information on climate change - mostly through Facebook. Thus, even when the firm shares information and data in order to "help solve" the climate problem, it profits from expanding users' engagement. So, vested interest of profiting from climate change are clear.

Yet, there is an aspect of Meta's behavior that has a potential for truly contribute for the transition towards a low-carbon future. This is the fact the firm is a global powerhouse in the tech sector. So, when Meta stands publicly emphasizing the importance of tackling climate change, this represents a market signal for other firms, which might become inclined to move in a similar direction, i.e., start coping with climate change. This is a process that I previously called *mainstreaming climate change*. Yet, is mainstreaming climate change "good" or "bad" for solving the problem? Will Big Tech firms help fix the climate crisis? These questions animate the final section of this chapter.

5.6. When Big Tech CEOs Prophecy they are Gonna "Save the Climate"

I started this project on Big Tech firm's climate action, focusing on Alphabet, Amazon, Apple, and Meta, not because I believe these firms are helping solve the climate crisis, but because global corporations have become central players in the politics of climate change. Corporations might be drivers for the world's transition to a low-carbon future. And, among global firms, Big Tech are the world's most powerful, considering their market capitalization.

The UN "Emissions Gap Report 2020" (UN, 2020) observed that 15% of global CO2e emissions come from the 1% richest people in the world, which naturally include our Big Tech founders and CEOs. Therefore, *I understand that these business elites have not only the means, but the moral responsibility to help solve the climate crisis, contributing to solving the problem in the same proportion of their wealth*. But it does not mean that these business elites are doing anything meaningful to solve the problem, as I observe in this section.

There is still little information on what type of agency giant tech firms have on international climate politics. Are the CEOs from Alphabet, Amazon, Apple, and Meta committed to tackle climate change? Do these businessmen use their wealth, brain-power, material and technological capabilities to advance low-carbon transitions? Why does it matter to the politics of climate change more broadly?

This final section of the chapter is dedicated to exploring these questions. While I do not ambition to answer them, I will at least pinpoint some elements that might help us understand these firms' motivations, vested interests, and impacts on global climate governance. To do so, I need, at first, to go beyond my four cases, including the climate action of two additional firms and their founders/CEOs: *Tesla* and *Microsoft*. While I do not develop an in-depth climate profile of these firms (as I did previously for Alphabet, Amazon, Apple, and Meta), I will focus on their engagement in the political economy of climate change as well as in global climate multilateralism. After a brief discussion of these two firms, I conclude the chapter by analyzing my four cases' CEOs.

Back in 2016, when I was a master's student at the Coppead Graduate School of Business in Rio de Janeiro, I attended a course on "Strategy and Innovation." The final project of this course had to do with a future scenario planning analysis for a firm of our choice. My team and I selected Tesla. Following, we engaged on weeks of discussions in order to understand the values and business model of the firm, so we could apply the scenario planning tool to "predict" its future. Scenario planning is a powerful tool to analyze firm behavior, and consists of choosing two analytical axes (let's say, *x* and *y*) which indicate key uncertainties for the firm, with a variation (let's say, *positive* and *negative*). The idea is to build a 2x2 matrix, where each quadrant represents a possible future, with different arrangements of x and y, varying according to a positive or negative inclination. We did this exercise for Tesla, and our conclusions were noteworthy.

Our analysis revealed that transformations in the *mobility sector* and the growth in the *renewable energy industry* are driving forces (and key market uncertainties) for Tesla. The first dimension is actually the reason why the company was founded in 2003: to demonstrate that electric cars could be better than fuel-powered cars, or, in other words, to prove that eclectic vehicles (EVs) can achieve high performance and zero emissions simultaneously. To achieve this, Tesla decided to invest in the renewable energy sector. Differently from what Alphabet, Amazon, Apple, and Meta are doing on this area (chiefly, investments in renewable energy plants), Tesla develops and sells batteries for a) EVs, and b) to store energy from renewable generating sources, such as wind and solar plants. With this strategy, the firm managed to grow globally (today it operates in more than 30 countries), and has built a wide net of superchargers, free spots where EV owners can recharge their cars[103]. So, it is fair to say that Tesla is somehow helping to grow the renewable energy industry.

Yet, to understand Tesla's market behavior and vested interests regarding energy and climate, we must investigate what motivates Elon Musk, Tesla's famous CEO. With a double bachelor's degree in Economics and Physics from the University of Pennsylvania, the South-African business magnate incorporates climate change as a driving force across its businesses. Climate activism in Tesla is an explicit corporate strategy. In my view, despite explicit corporate and private interests, Tesla might have positive spillovers for decarbonizing society more broadly. Let's understand why.

Besides EVs and battery products, Tesla has entered the renewable energy sector. SolarCity was founded by Tesla in 2006, and ten years later it became a whole new business area: *Tesla Energy*. In its current configuration, beyond Tesla Motors (with subsidiaries across 14 countries) and Tesla Energy, the business conglomerate includes

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[103] More information about the firm is available at: https://www.tesla.com/ Accessed April 4, 2022.

SpaceX, Neuralink, The Boring Company, DeepScale, and Tesla Grohmann Automation.[104] Tesla Energy is the most strategic subsidiary in terms of climate, because it signals that it is not only a carmaker: it wants to be known for helping solving the climate crisis.

Musk is promoting climate activism in several social, political, and academic circles. While it is not easy to decipher the deep reasons why Musk is so "preoccupied" with climate change (Is this for self-promotion? Is this just because, as we have seen, climate change became a profitable new business?), he has been promoting climate activism in various arenas.

One example was a talk he gave in 2016 at The Sorbonne, in Paris, summarized in a 12-minute YouTube video[105], highlighting crucial aspects of his view. First, Musk repeats that we will face, sooner or later, the "end of the fossil fuel era". Thus, we need to advance a transition towards a low-carbon economy now (in close resemblance with the Sustainability Transitions literature). Clearly, Tesla operates in 2 sectors (energy and mobility) out of the 4 sectors most strategic for the world's sustainability transition (energy, mobility, agriculture, natural resources/biodiversity use), which are also some of the most challenging sectors to decarbonize because of deep incumbent interests (LOORBACH et al. 2017). So, Tesla operates in two fundamental industries for climate change mitigation.

In order to transition to what Musk calls a "sustainable energy future", corporations, governments, and civil society need to act now. Yet, we know that this is not happening in the speed we need, thus, the sustainable energy transition is delayed. Musk points a reason for that: "*the reason that the transition is delayed, or is happening slowly, is because there is a hidden subsidy on all carbon-producing activity*."[106]This subsidy, according to him, stem from the fact thar carbon-emitting activities are not taxed. The costs of climate change to society, which stem from carbon-emitting industries, is not being paid by heavy-emitting firms. And the net result is 51 Gt of carbon per year into the atmosphere (GATES 2021).

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[104] List of Tesla Motors subsidiaries globally: https://www.sec.gov/Archives/edgar/data/1318605/000119312511054847/dex211.htm Accessed April 4, 2022.

[105] Elon Musk's Unbelievably Simple 12-minute Killer Break Down on Climate Change, May 31, 2016. Available at: https://www.youtube.com/watch?v=xKCuDxpccYM Accessed April 4, 2022.

[106] Ibid.

To overcome the challenge, Musk asked the audience: "*what can we do about it?*" Answering his rhetorical question, he pointed out three things. First, talk to the politicians, asking them to enact carbon tax laws; second, talk to friends about it, to increase society's pressure towards carbon taxing; and third, fight the propaganda from the carbon industry.

This is of course very simplistic, as Musk fails to pinpoint other challenging areas for a low-carbon transition, particularly those involving corporations. For instance, to contribute to decarbonizing the economy, firms should engage in lobbying in favor of stronger carbon legislation (as only few companies do), reducing their own and their supply chain emissions, decreasing dramatically the total energy and natural resources they consume, reducing waste generation across their value chains, avoiding investing in countries that are destroying the carbon budget like China and India, and stopping "doing business" with major polluters. Musk doesn't even scratch these challenges in his talk, signaling to an overfocus on carbon-pricing as a silver-bullet solution. This framing is very limited to help solve the climate problem, although carbon pricing is indeed a necessary (yet incomplete) part of the solution.

Although Musk's view on climate solutions seems too simplistic, some of his businesses have had important spillovers for the low-carbon industry, particularly galvanizing EV adoption. Although Tesla didn't pioneer the EV sector, Musk was a trailblazer because he managed to "forge the first functioning marketplace for an EV"[107]. Thus, he was crucial to make EVs be considered as a viable market product. While there is no practical way to measure Tesla's impact on the growth of EVs, it has provided strong market signals towards decarbonizing the mobility sector back when EVs were little discussed. An important (yet indirect) consequence, or driver, for Tesla, was the proliferation of EV-promoting laws across the world.

For example, in the U.S., some pieces of legislation promoting EVs include the Advanced Technology Vehicles Manufacturing Loan Program (2007), the Zero Emissions Airport Vehicle and Infrastructure Pilot Program (2012), the Alternative Fuel and Advanced Vehicle Technology Research and Demonstration Bonds (2009, 2010, 2012), and the Freight Efficiency and Zero-Emission Vehicle Infrastructure Grants

[107] Elon Musk bio, available at: https://www.crain.com/?portfolio=elon-musk Accessed April 4, 2022.

(2015)[108]. Similar policies were created in countries in China, European Union, Norway, Japan, and others across Asia and Europe.

Of course, we cannot attribute these laws and policies to Musk nor to Tesla. But it is undeniable that the firm and its CEO played a role in pushing EVs and the corresponding regulations. But I am not trying to suggest that firms, such as Tesla, are the causes of the emergence of EVs, because it depends on other types of incentives, laws and regulations. In fact, governments are the main responsible for EV adoption and growth, through policies such as "subsidies, large-scale charging infrastructure funding, and restrictions on registrations of combustion-engine vehicles" (CMS, 2016, p.6), just like China is doing. Nonetheless, as market forces catalyze EV-adoption and customer demand growth, this for sure pressures governments to adopt more and stronger EV policies, laws, and regulations. These reinforcing cycles (market forces and government policies towards EV adoption) are essential for a low-carbon transition. Yet, so far, "cohesive regulatory frameworks for EVs are not yet well-established" (CMS, 2016, p.7).

Besides EVs, Elon Musk has propelled competitions, such as The X PRIZE Carbon Removal Competition (THE X PRIZE, 2021), which uses market principles (inter-firm *grow or die* competitions, venture capital, innovation, entrepreneurialism) to propel what I call *the business of climate change*. One of my interviewees created a green tech startup just to compete in Tesla's X PRIZE Carbon Removal Competition. The company name is *Pull to Refresh*[109], and it aims to tackle climate change with an interesting approach. In 2022 I interviewed, in California, one of the founders of this start-up, and she explained how the business works, citing the X PRIZE competition:

> *In order to capture and sequester huge amounts of CO2, we are using solar-powered robots to grow Giant Bladder Kelp, a kind of algae which is very efficient in absorbing CO2 at high sea. Our start-up launched different carbon removal solutions a year ago. But we opted to grow Kelp in the ocean because economically it is really feasible. So, we are building autonomous boats and we will put them to sink Kelp to the deep sea at scale. We are almost finishing with our first prototype and collecting a lot of data from that. The first round of the X PRIZE competition is scheduled to Feb 1st,*

[108] All these programs, and others, are introduced and explained here: https://afdc.energy.gov/fuels/laws/ELEC?state=US Accessed April 4, 2022.

[109] The start-up webpage has more information on how it plans to tackle climate change: https://pulltorefresh.team/#approach Accessed April 4, 2022.

> *2022. We will report what we have done so far, and what is our busines plan, in order to compete for 1M dollars (10 teams will win this amount). We are starting to have conversations with other Big Tech corporations to sell our idea (INTERVIEWEE_08[110]).*

The XPRIZE is a "a non-profit organization that designs and hosts public competitions intended to encourage technological development to benefit humanity", founded in 1994 by Peter Diamandis, so, not directly linked to Elon Musk. However, in April 2021, Musk and the Elon Musk Foundation launched The X PRIZE Carbon Removal competition in the X PRIZE Platform. "XPRIZE Carbon Removal is a US$100M four-year global competition that invites innovators and teams from anywhere on the planet to create and demonstrate solutions that can pull carbon dioxide directly from the atmosphere or oceans. To win the grand prize, teams must demonstrate a working solution at a scale of at least 1000 tones removed per year; model their costs at a scale of 1 million tons per year; and show a pathway to achieving a scale of gigatons per year in future, as validated by a third party" (THE X PRIZE, 2021, p.1).

In comparative terms, the US$100 million Elon Musk is investing in the X PRIZE Carbon Removal Competition equals Amazon's *Right Now Climate Fund* (US$100 million in reforestation projects and climate mitigation solutions), part of Amazon's Climate Pledge. Yet, it is not even close to *the Climate Pledge Fund* (US$2 billion for the development of technologies and services that reduce emissions and help preserve nature), which is also part Amazon's Climate Pledge.

Regarding global climate multilateralism, Musk often participates in meetings organized by the World Economic Forum, COPs, UNFCCC, The Global Compact, among others. For instance, as of April 2022, Tesla Inc. was one of the 1326 signatory companies of the Business Ambition for 1.5°C commitment[111], an initiative of the Global Compact. Out of our four cases, only Meta is a signatory of the Business Ambition for 1.5°C commitment. Let's remember that the Global Compact is a pact under the U.N. auspices in which all signatories commit to adopt sustainable and socially responsible policies, and to report their implementation.

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[110] A complete list of interviewees and respective codes is provided next chapter.

[111]"Business Ambition for 1.5 C: Join the visionary corporate leaders." Available at: https://www.unglobalcompact.org/take-action/events/climate-action-summit-2019/business-ambition/business-leaders-taking-action Accessed April 4, 2022.

Other relevant environmental and climate business councils are the World Business Council on Sustainable Development (WBCSD) and the World Resources Institute (WRI). Tesla does not participate in the WBCSD, not does Meta, but, interestingly, Alphabet, Amazon, and Apple are WBCSD members. When it comes to the WRI, member companies are not disclosed in its website, so, I didn't find information as regards Tesla or my four cases' participation. In Chapter 6, I will use the global governance approach to further scrutinize Big Tech firms' participation in multilateral climate initiatives.

From now on, let's discuss another relevant Big Tech firm in terms of climate change: *Microsoft*. The founder, Bill Gates, is probably the tech personality who most strongly advocates for climate action. After reading several papers, books, and news articles about Big Tech firms and climate change, I dare to say that Gates is the most committed climate supporter out of the tech magnates I have surveyed in this thesis.

Bill Gates has been advocating and publishing on climate change as a side-project of the Bill and Melinda Gates Foundation (GATES 2021). In 2021 he announced at COP26 in Glasgow that he is investing US$315 million in new funding to support vulnerable farmers as they adapt to climate change. Microsoft leads the US$1 billion Breakthrough Energy Ventures fund. And Gates has proposed a US$ 1 billion Climate Innovation Fund, designed to encourage the development of new carbon reduction and removal technologies, resembling Amazon's Climate Pledge. Bill Gates has also contributed to the promotion and funding of a new generation of nuclear reactors (small, decentralized, and much safer) and the funding of some geoengineering projects. In the next few paragraphs, I will discuss each of these initiatives in more detail.

Despite being published just a year ago, *How to Avoid a Climate Disaster* (GATES 2021) has made some impact, accumulating 150 citations on Google Scholar. This book presents Gate's view on the solutions to tackle climate change. As I discuss below, he adopts *a techno-social approach to fighting climate change*. He advocates in favor of reducing global poverty (and for that we need development and, thus, more energy) while simultaneously fighting climate change.

The Bill and Melinda Gates Foundation concentrates on three issues: global health, development, and U.S. education, meaning that climate is not central for the Foundation, but a personal parallel project for Bill Gates. While the relationship between energy and development became clear to him as he traveled to many poor countries, particularly in Africa, as part of his work at the Foundation, Gates initially was not convinced about climate change, because all the solutions for the problem involved curtailing carbon emissions, thus, energy, so, according to his view, blocking development. However, things changed in 2006, when former Microsoft colleagues started to invest in NGOs on energy and climate, which inspired him to learn more about climate change. According to himself, "I read the reports issued by the Intergovernmental Panel on Climate Change (IPCC), the UN panel that establishes the scientific consensus on this subject" (GATES 2021, p.11). Gates tells this story at the introduction of his book.

Over the years, he became convinced of three things: 1) to avoid a climate disaster, we have to *get to net-zero* (i.e., remove more carbon than the amount we emit into the atmosphere); 2) we need to deploy the tools we already have, like *solar and wind*, faster and smarter; and 3) we need to create and roll out *breakthrough technologies* that can take us the rest of the way (IBID., p.12).

To reach global net-zero CO2e emissions, Gates defends a conjoint strategy of investments in *Renewable energy* and the development/adoption of *Climate-smart technologies* (for mitigation and adaptation), which are, as we already know from section 5.5, the central strategies adopted by Alphabet, and, on a lesser degree, by Amazon, Apple, and Meta. But, how is Gates contributing to fighting climate change through Microsoft and the Gates Foundation?

Microsoft pledged to become not even carbon neutral (reaching net-zero emissions), but *carbon negative* by 2030, removing more carbon from the atmosphere than it emits. Additionally, by 2050 the firm promised to remove enough carbon to make up for all emissions from its electricity consumption since it was founded, in 1975[112]. To achieve this, Microsoft has been contributing to the development of *climate-smart technologies*, mainly funding start-ups.

In 2020, the firm created a US$1 billion *Climate Innovation Fund*, which aims to "loan money and take equity stakes in ventures to encourage the development of new environmental innovations"[113] over the years of 2020-2024. The firm will use four criteria for selection investment recipients: sustainability initiatives, market impact, technological advances, and climate equity (related to the issue of climate justice).

[112] "Microsoft pledges to be 'carbon negative' by 2030, launches $1B Climate Innovation Fund", *GeekWire*, January 16, 2020. Available at: https://www.geekwire.com/2020/microsoft-pledges-carbon-negative-2030-launches-1b-climate-innovation-fund/ Accessed April 7, 2022.
[113] Ibid.

Back in 2016, a similar fund had been put forward under the Microsoft leadership: the US$ 1 billion *Breakthrough Energy Ventures*, which received a second round of US$ 1 billion investment in 2021. Different from the Climate Innovation Fund, which is an individual initiative from Microsoft, the Breakthrough Energy Ventures includes 20 "ultra-wealthy tech and business leaders from around the globe, including Jeff Bezos, Richard Branson, LinkedIn co-founder Reid Hoffman, Alibaba's Jack Ma, and Michael Bloomberg"[114].

Breakthrough Energy Ventures' goal is to advance a low-carbon transition through innovation, helping to escalate the green tech industry. It will fund some 40-50 startups, focusing on the trickier green technologies in development, including climate-friendlier steel and cement production, long-haul transportation, and carbon capture technologies. "Startups already backed by the fund are working on climate-smart technologies including batteries, fusion reactors, biofuels, geothermal power, the next-generation nuclear energy, cleaner fertilizer, and alternative protein sources"[115]

Interestingly, a "patient capital" approach is adopted, so that investments are made over a 20-year period, as opposed to the conventional venture capital approach that looks for returns on investments within 5 years. This is very central, and basically opposes the neoliberal approach to venture capital which prioritizes short-term returns (thus, Breakthrough Energy Ventures financial strategy resembles developmentalism, which prioritizes long-term strategic investments). *From this example, we can conclude that: climate-smart technologies, being a risky and uncertain type of investment, needs patient forms of capital, just like heterodox economists (e.g., Mariana Mazzucato) defend.* Isn't that a paradox that market-liberal businessmen now advocate for and defend heterodox measures in order to scale up low-carbon technologies?

Current venture capital and investment banking models are a hindrance for green technologies to emerge and grow because, as we all know, financial markets and investors, particularly in rich democracies such as the U.S. and Europe, still largely prioritize short-term returns. Nonetheless, low-carbon technologies need patient forms of capital, because they are risky businesses.

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[114] "Gates-led Breakthrough Energy Ventures raises another $1B for investing in climate innovation", *GeekWire*, January 19, 2021. Available at: https://www.geekwire.com/2021/gates-led-breakthrough-energy-ventures-raises-another-1b-investing-climate-saving-innovation/ Accessed April 7, 2022.

[115] Ibid.

Also central to Breakthrough Energy Ventures is that the startups need to make the case that *they can scale up to size that cut at least 500 MMT of annual* CO_2 *emissions — about 1% of global emissions*.[116] This is clearly a very ambitious goal.

Similar to Tesla and Meta (but not Alphabet, Amazon, Apple), Microsoft is one of the 1326 companies signing the UN's *1.5-degree Business Ambition Pledge*, the most recent initiative of the Global Compact. This initiative basically aims to "introduce business-based cooperation on climate change, committing to take practical actions, such as setting GHG emission reduction targets"[117].

Different from Bill Gates and Elon Musk, the CEOs of Alphabet (Sundar Pichai), Amazon (Jeff Bezos), Apple (Tim Cook) and Meta (Mark Zuckerberg) are not engaged with climate change on a personal level, although their firms invest in climate technologies, renewable energy, and green data centers (as we have seen previously). Among these four CEOs, Jeff Bezos is probably the most vocal in terms of climate change, with obvious "vested interests" for doing that (e.g., deflect public attention form Amazon's rising emissions), as I have discussed before. Next, I concentrate on briefly analyzing these CEOs-led climate initiatives.

The Chan Zuckerberg Initiative (CZI), a philanthropist organization founded in 2015 by Zuckerberg and his wife, Priscilla Chan, pledged US$ 44 million in funding for solutions to climate change on February 2022. Previously, in 2021 the CZI had invested US$ 23 mi for the development of carbon removal technologies, plus US$ 10 million to the Breakthrough Energy Ventures. [118] More than half of this US$ 44 million investment will go to a UCLA research project which is developing an electrochemical process for cutting CO2e emissions from cement production (which represents 8% of global CO2e emissions, 4x more than global civil aviation). The UCLA project will also invest part of the CZI funding in a technology to remove carbon dioxide from seawater (oceans absorb 25% of global CO2e emissions, making seawater more acid, which generates serious environmental problems). The other half of the 2022 CZI investment

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[116] Ibid.

[117] "Join the Campaign for Our Only Future", *UN Global Compact*, June 2019. Available at: https://www.unglobalcompact.org/take-action/events/climate-action-summit-2019/business-ambition Accessed April 9, 2022.

[118] "Chan Zuckerberg Initiative announces tens of millions in funding for climate tech", *The Verge*, Feb 10, 2022. Available at: https://www.theverge.com/2022/2/10/22927245/chan-zuckerberg-initiative-millions-funding-climate-tech-carbon-removal Accessed April 7, 2022.

will fund a chemical start-up called *Twelve*, which is trying to develop products made with CO2e captured from the atmosphere. Thus, we can be sure of one thing: Mark Zuckerberg is investing in relevant carbon removal technologies (nonetheless, the success of such initiatives is yet to be seen).

While Meta's climate investments in 2021 and 2020 (a total of US$ 77 million) are not even close to Amazon's Climate Pledge (US$ 2 billion), Jeff Bezos' Earth Fund (US$ 10 billion**)**, or Bill Gates' initiatives (US$ 2 billion, including the Breakthrough Energy Ventures), they are closer to what Elon Musk is investing in its X PRIZE Carbon Removal Competition (US$ 100 million). Importantly, Meta is investing more money in a university research project than in start-ups, which is the mainstream type of Big Tech investments regarding climate technologies.[119] Again, as I have stated before, *Big Tech firms will not make climate investments if they do not foresee future revenues and financial returns*.

Indeed, when it comes to Alphabet's CEO Sundar Pichai and his personal position on climate change, he has recently stated that Big Tech firms' fight against climate change "is about more than climate change — it's also a recruitment tactic. If you don't do this correctly, you won't be able to attract talent."[120] As younger generations have become more aware of climate change and the challenges of living in a warming world, Big Tech giants (which have always been *dream firms* to work, thus able to hire the best employees in very competitive selection processes) such as Alphabet know that it will not be able to hire the best employees without a clear sustainability strategy. With this business-as-usual approach, Sundar Pichai does not have any personal stakes on climate change. He is far from being a climate activist.

Larry Page and Sergey Brin, Google's founders, also do not demonstrate strong climate activism. But in 2014 they left the lobbying group *American Legislative Exchange Council* over its links to climate change denial. In 2019, Page and Brin have also organized a secretive meeting in Italy - including personalities such as Barack

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[119] Ibid.

[120] "Google CEO says companies that fail to go carbon-free will lose the talent war", *Business Insider*, Oct 18, 2021. Available at: https://www.businessinsider.com/google-ceo-big-carbon-free-companies-recruit-better-talent-2021-10#:~:text=Google%20CEO%20Sundar%20Pichai%20said,Pichai%20told%20Bloomberg's%20Mark%20Bergen. Accessed April 8, 2022.

Obama, Prince Harry, and Leonardo DiCaprio - to discuss climate change. Yet, results such as investments or goals stemming from this meeting were not disclosed.

Amazon's Jeff Bezos is of course trying to look like he cares about climate change, as he is the richest person on the planet, and Amazon's global emissions are rising. In 2020, he announced the US$10 billion Bezos Earth Fund, funding 16 groups working on climate change (including WWF, The American Forest Foundation, The Natural Resources Defense Council, etc.) with a total US$790 million. Yet, this is less than 0.4% of his $194.4 billion net worth[121], revealing that Bezos is committed to fighting climate change, but just up to a certain amount.

Apple CEO Tim Cook has no clear climate activism beyond business-as-usual opinions in public conversations, such as his discourse summed up below, at the 2020 Climate Ambition Summit, stressing that leaders of nations and companies around the world have a "burden to act" to address climate change:

> *This year, Apple has accelerated our progress. We became carbon neutral for our worldwide corporate emissions. Already, we're helping 95 of our supplier's transition to 100% renewable energy, a number we continue to grow. We've unveiled a plan, unrivalled in its ambition, to achieve carbon neutrality for our entire supply chain and product usage by 2030 — 20 years before the goal set by the United Nations. (...) The choice between the bottom line and the future of our planet is a false one, and each new green innovation offers the proof. This is no time for changes of the margins. Together, we can transition to a carbon-neutral economy and usher in a new era of inclusive opportunity. This is a moment for ambition, cooperation, and leadership (Apple CEO Tim Cook, 2020).* [122]

Tim Cook talks in the name of Apple, but does not state his own beliefs regarding climate change. When Cook states, in the above-cited speech, that "*the choice between the bottom line and the future of our planet is a false one*", he tries to defend that the *profits-above-all logic*, typical of private firms, is congruent with genuine climate action and environmental protection. This is not only a misleading view, but also a very naïve (or, most likely, deliberate) framing in order to paint Apple as a "green" firm.

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[121] "What The World's Richest People Are Doing to Fight Climate Change", *Forbes*, April 22, 2021. Available at: https://www.forbes.com/sites/sofialottopersio/2021/04/22/what-the-worlds-richest-people-are-doing-to-fight-climate-change/?sh=4be97b0a2a39 Accessed April 8, 2022.

[122] Climate Ambition Summit 2020. Available at: https://www.climateambitionsummit2020.org/ Accessed April 8, 2022.

Yet, let me clarify something. As I stated before, although I do not consider Big Tech CEO-led climate initiatives negative, I question their real impact in terms of climate change mitigation and adaptation. As I have demonstrated throughout this chapter, Big Tech firms climate impact is very difficult to measure (mainly because these initiatives are quite recent). Thus, the success of such initiatives is still a future promise. Moreover, Big Tech firms' initiatives (and their CEO's "activism") have benefitted the firms in a greater extent than the climate or the environment. These firms have proposed techno-centric solutions to fighting climate change, but some experts caution against this much emphasis on technology as a silver bullet solution for the problem. Public policy needs to be a driving factor. We already have green technologies available that only need to be ramped up[123]. So, the idea that only "disruptive technologies" will solve climate change is a misleading framing that chiefly attends to Big Tech firms' market aspirations.

On top of that, some environmentalists are concerned about how climate-smart technologies might negatively affect communities and the environment. Corporate tree-planting as a carbon removal strategy has faced criticism, in part because tree farms and forests can easily release CO2 back into the atmosphere if not maintained. That's why environmental activists continue to press Big Tech firms and their billionaire philanthropists to do more to curb their own pollution and take responsibility for how their platforms influence the climate crisis.[124] Furthermore, most of these Big Tech firms did not adopt comprehensive policies to green their value chains. Alphabet and Meta do not include refusing ads from fossil fuel companies and lobbyists, nor strongly engage in stopping fake news and climate mis-information on their platforms, although they have recent initiatives in this direction (e.g., Facebook's Climate Science Information Center). However, these are incipient efforts, whose effectiveness in terms of fighting climate change is yet to be seen.

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[123] "Gates-led Breakthrough Energy Ventures raises another $1B for investing in climate innovation", *GeekWire*, January 19, 2021. Available at: https://www.geekwire.com/2021/gates-led-breakthrough-energy-ventures-raises-another-1b-investing-climate-saving-innovation/ Accessed April 7, 2022.

[124] "Chan Zuckerberg Initiative announces tens of millions in funding for climate tech", *The Verge*, Feb 10, 2022. Available at: https://www.theverge.com/2022/2/10/22927245/chan-zuckerberg-initiative-millions-funding-climate-tech-carbon-removal Accessed April 7, 2022.

CHAPTER 6

Business-State Relations for Low-Carbon Transitions: Big Techs Firms' Vested Interests on Climate Change

6.1. Political Economy Insights on Business-State Relations

Let me start the chapter by providing some theoretical insights on business-States relations, so we can better understand the forces that might influence Alphabet, Amazon, Apple, and Meta to act more (or less) on climate change, as well as their low-carbon vested interests.

What does the recent literature on business-State relations has to say about the political role of firms? What does this literature say in terms of climate change and low-carbon transitions? And about business-State relations and their impact on the emergence of green tech businesses? Here I survey contemporary IPE literature on the business-State nexus, in order to observe, in the subsequent sections, how this relationship occurs when Big Tech firm's "act" in the global (multilateral), national (USA), and local (California) climate policy arenas.

Scherer et al. (2006) observed that the role of business as simply a "profit-maximizing" entity has been put into question. Empirically, as corporations intensify their activities in various governance arenas (issue-areas), concepts such as Corporate Social Responsibility (CSR), "corporate citizenship", ESG, and "republican business ethics" have, in some few cases, materialized beyond greenwash, inasmuch as businesses started to exercise functions that previously were exclusively performed by the State. This not only blurred previously more established distinctions between public and private authority but also generated new issue-areas in which States and corporations dispute over the legitimacy of their activities. Of course, the issue-area of interest here is climate change.

Maha Atal (2018) provided insights on business governance in different issue-areas. In *When Companies Rule: Corporate Political Authority in India, Kenya and South Africa*, Atal investigated the Reliance oil refinery in India, the Del Monte pineapple plantation in Kenya, and the Lonmin platinum mine in South Africa, to find out that, when firms govern (in these extractive industries and agriculture issue-areas), they are motivated by one or more of the following factors*: i) utopian visions of the society their governance can deliver; ii) a desire to counter resistance to business operations from labor, community groups, or other stakeholders; or iii) internal bureaucratic power struggles which take governance policies as a site of conflict*. Importantly, *private firms' governance achieves legitimacy not only based on the material quality of company-provided services and infrastructure, but also based on their normative content*. Indeed, "workers, communities and regulators respond to the ideological motives expressed in company governance" (ibidem.).

Yet, we cannot simply generalize Atal (2018)'s findings, because, as Brewer (1992, p.295) observed, "business-government relations vary systematically across issue-areas in their interactions and outcomes." Thus, in climate politics, private governance models might differ from extractive industries and agriculture issue-areas, but can also vary across different geographies, scales, and time, as Atal (2018) correctly diagnosed.

The concept of CSR illustrates mechanisms regarding how corporate political authority materializes. Scherer et al. (2006, p.523-524) observed that the limits of CSR are challenging to define. Yet, although fair allocation of responsibilities is an intricate task, it will depend upon *i) the nature of the relationship between firms and the citizens whose rights/territories are violated by corporate activities, and ii) the firm's capacity to remedy the problem.* But Scherer et al. (2006) do not hide their positive view on firms' progressive engagement on issue-areas beyond their business.

To give us more nuances about the risks of firm's political engagement, Scherer and Palazzo (2011) emphasized the distinction between instrumental CSR and political CSR. In *instrumental CSR*, the main political actor would be the State, there would be a high degree of separation between the political and the economic spheres, in a hierarchical governance model, which is focused on the nation-state. This is the more traditional approach to CSR, which has been central until recently. Yet, currently, political CSR would stand out.

In *political CSR*, political actors would encompass not only the State, but also civil society and corporations. There would prevail a low degree of separation between the political and the economic spheres, in a fragmented mode of global and multilevel governance. "*Business firms have started to assume social and political responsibilities that go beyond legal requirements and fill the regulatory vacuum in global governance*" (ibid., p.899). This is happening both in rich democracies and in countries with weak democracies, proto-political systems, or fragile rule of law. Unfortunately, these authors do not dig deep into the complex political and economic implications of private governance, which was, of course, intensified since the emergence of neoliberalism (1990s), when corporatist logics have become mainstream in Western societies.

These insights will be particularly important in section 6.2., when I explore Big Tech firm's political engagement in the multilateral arena, observing how these firms use Environmental, Social, Governance (ESG) indicators to make climate pledges, and how they advance climate commitments in global forums, such as UNFCCC and COPs, where State leaders, global businesses and civil society meet to discuss climate change.

Concerning green tech business, the literature points the State as central. When investigating the role of the State in fostering green innovation in Germany and in the U.S., Gordon (2019, p. 571) found that "innovation policy is flexible and adaptable to each context, but the active role of the State stands out in both countries." Malkin (2020) has observed that Susan Strange's concept of productive power can be divided into four subcategories: i) centrality in global value chains, ii) market power, iii) ownership of assets, and *iv) technological standard-setting.* China's rise in intellectual property protection and commercialization, global value chain, as well as standard setting and competition policy are signs that the country possesses latent productive power, that might strengthen its position in the international system with the backdrop of US-China global competition. This is an important insight when it comes to the low-carbon technological standard-setting capacity, because it allows us to *compare how Chinese and U.S. Big Tech firms are adapting and entering the low-carbon/green tech industry.* I consider (for the simplification of my analysis) Big Tech firms as representative of their home States, thus operating is a cooperative dynamic with their host-countries in order to "conquer" green tech markets.

This logic makes sense, because, as Milner and Solstad (2021, p.545) have demonstrated, "government policies to promote technology adoption are related to concerns about rising international competition. *A competitive international system is an important incentive for technological change*." China-US rivalry in the international system might have positive implications for the development and adoption of low-carbon technologies, including those developed by Big Tech firms. States have an interest in helping to promote Big Tech firms (whose headquarters are located in their jurisdiction) in the global arena, inasmuch as these firms represent their home countries' global power.

In section 6.3., I use these insights to demonstrate the relationship between governments and Big Tech firms' investments in fostering low-carbon businesses in California/Silicon Valley. To do so, I use original data from 6 months of field research I conducted in California, between September 2021 and March 2022, where 9 in-depth interviews and 12 participant observations on green tech workshops were performed.

More recently, a set of critical IPE authors, particularly from the Netherlands and the UK, have been discussing the complexity of the disputes between States and corporations in the international system. Among them, Babic, Fichtner, and Heemskerk (2017) theorization is important for a series of reasons.

First, in accordance with my own view (MENDES 2021), these authors observed that IR is still a very limited discipline when it comes to analyzing the structural corporate power in international politics. Consequently, for Babic et al. (2017, p.21), "there is a sizable literature that investigates states versus markets, but astoundingly little scholarly work in IR and IPE that moves beyond the broad concept of markets and investigates its actors." IR still neglects studying MNCs, central market actors.

Second, business-State connections must be better understood as a network of actors and their relations. Thus, social network analysis and similar methods must be used to clarify such complexity. Yet, IR and IPE literature is meager when it comes to this type of research, with rare exceptions (see DE GRAAF 2020; BABIC, BERNARDO, AND HEEMSKERK, 2019; SEABROOKE AND YOUNG, 2017).

Third, as of 2016, the global top 100 States and corporations, considering the revenues of states (mainly taxes collected) and the revenues of corporations, comprised 29 countries and 71 corporations (IBID, p.9). Apple alone already has greater revenues than Belgium, Mexico, or Switzerland. Global corporations have thus become large socio-economic organizations on their own. Despite this fact, several authors observe that state-centrality is still hard to overcome when considering activities such as interstate military relations, diplomacy, and norm-setting.

I also use these insights in section 6.3., when I explore how Big Tech firms lobby in the climate policy arena, thus observing how powerful is their influence in policy development in this issue-area.

6.2. Big Tech Stakes on Climate Multilateralism: ESG and Global Business Councils

In 2005, the UN Principles for Responsible Investment (PRI)[125] promoted the "Who Cares Wins" conference. This conference "brought together institutional investors, asset managers, buy-side and sell-side research analysts, global consultants and

[125] The PRI is an investor initiative in partnership with UNEP Finance and the UN Global Compact. Currently, the PRI has 1600 members representing assets of around US$70 trillion. More information is available at: https://www.unpri.org/about-us/about-the-pri Accessed April 14, 2022.

government bodies and regulators to examine the role of environmental, social and governance (ESG) value drivers in asset management and financial research."[126] After the conference, a document called "Who Cares Wins" (UN PRI, 2005) was disclosed.

Previously, Socially Responsible Investment (SRI) principles were a common CSR practice (mostly used as a PR strategy, thus being simply greenwash) of "avoiding investments in companies that produce or sell addictive substances or activities (like alcohol, gambling, and tobacco) in favor of companies that are engaged in social justice, environmental sustainability, and alternative energy/clean technology."[127]

However, since the "Who Cares Wins" conference, ESG principles started to be reported by firms, banks and investment funds globally, adopting a different perspective for corporate environmentalism. "The difference between SRI and ESG lies in the fact that *investing based on ESG criteria is considered to make financial sense* as well and is not solely tied to a moralistic stance against unethical businesses."[128] Some (not exhaustive) ESG indicators[129] are presented next.

Environmental indicators include metrics for the conservation of the natural world. Examples are: Climate change and carbon emissions; Air and water pollution; Biodiversity; Deforestation; Energy efficiency; Waste management; Water scarcity.

Social indicators are related to consideration of people and relationships, such as workers-firms' relationships, those involving data-privacy, labor standards, inclusion and diversity policies. Indicators in this sense are: Customer satisfaction; Data protection and privacy; Gender and diversity; Employee engagement; Community relations; Human rights; Labor standards.

Governance has to do with ethical standards for running a company, such as corruption avoidance, lobbying, board composition and executive salaries (typical *Corporate Governance* topics). Examples include: Board composition; Audit committee; Bribery and corruption; Lobbying; Political contributions; Whistleblowers schemes

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[126] International Finance Cooperation, "Who Cares Wins 2005 Conference Report: Investing for Long-Term Value". Available at: https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_report_whocareswins2005__wci__1319576590784. Accessed April 14, 2022.

[127] Socially Responsible Investment. Available at: https://www.investopedia.com/terms/s/sri.asp. Accessed April 14, 2022.

[128] History of ESG Investments. Available at: https://medium.com/blue-sky-thinking/history-of-esg-investments-629a96c7ebcf Accessed April 14, 2022.

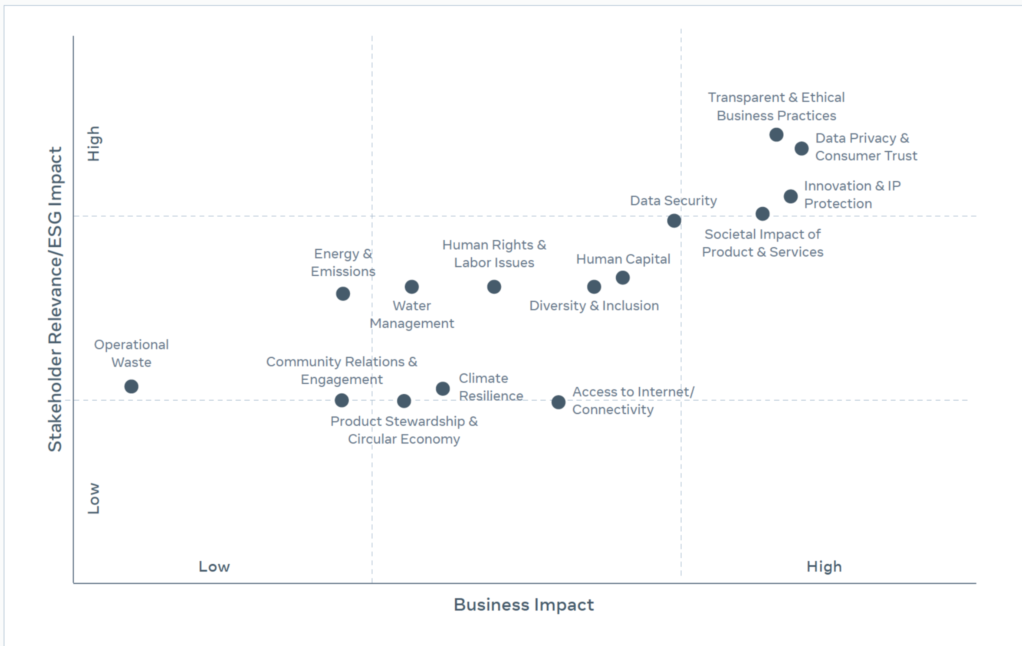
[129] CFA Institute. "What is ESG Investment". Available at: https://www.cfainstitute.org/en/research/esg-investing Accessed April 14, 2022.

Nonetheless, in spite of the novelty of ESG, critical political economists consider its principles as a new form of greenwash, whose real impacts in terms of protecting the environment and advancing a low-carbon economy are limited.

I now proceed to evaluate how these ESG principles appear in our Big Tech firms' latter sustainability reports. I looked for specific mentions to "ESG" across these documents. While all these firms make reference to "Environmental" and "Social" indicators, thus indirectly reporting their progress in ESG, 2 out of my 4 Big Tech firms do not make any reference to the term "ESG". This is the case of Alphabet (2021a) and Amazon (2021b), who do not make a single mention to ESG in their Sustainability Reports. On the other hand, Apple and Meta have incorporated ESG.

Meta (2021b, p.8) highlights key ESG priorities, which are summarized in Figure 27. What can we infer from this figure in terms of Meta's approach to climate change? **Figure 28** shows two indicators of interest for our analysis: Energy & Emissions and Climate Resilience.

Figure 28. Meta Platforms Inc., Priority ESG topics



Source: Meta (2021b, p.8).

The first indicator (Energy & Emissions) is considered by Meta of low-business impact. Thus: the firm states that it is little affected by its CO2e emissions, which are indeed the lowest amongst our four Big Tech firms, as I have demonstrated in Chapter 5. This indicator suggests that Meta is little affected by its energy consumption, which is roughly half the energy consumed by Alphabet globally, but 3x more than what Apple consumes. This might explain why Meta has invested the least in Renewable Energy projects if compared to the other three firms. This proves that, because Energy & Emissions is an indicator of low business impact, the firm is not acting strongly to improve such indicator, although it is considered by the firm itself *of mid to high stakeholder/ESG* relevance (i.e., this indicator has a high environmental and climate impact). As expected, Meta aims to minimize the impact of climate change on the business, but does not engage with climate change mitigation, which impacts society but not directly the firm.

The second indicator (Climate Resilience) is considered of *mid to low* business impact, but of *low relevance for its stakeholders*. Effectively, Meta does not report much action on this area. What the firm does to advance climate resilience is just the basics: "we developed a climate resilience toolkit with checklists and key questions for each type of physical risk to help develop resiliency plans. Teams also conduct tabletop exercises to practice responses to disruptive extreme weather events" (META, 2021b, p. 15).

In terms of ESG, Apple is the most vocal. In 2021, the firm disclosed a report to highlight its actions on this area: *Environmental, Social, Governance Report 2021* (APPLE 2021d). This 64-page document is just a few pages shorter than Apple's 2021 Sustainability Report (APPLE 2021c). Nonetheless, as regards energy and climate, the ESG report simply repeats the firm progress as stated in its Sustainability Report. The document repeats the 5 pillars of the firm's strategy to fight climate change (low-carbon design, energy efficiency, renewable electricity, direct emissions abatement, and carbon removal, as I discussed in chapter 5). It also repeats the firm's strategy to minimize natural resources consumption.

To sum up in brief, these Big Tech firms have not yet engaged strongly with ESG. While Alphabet and Amazon do not even cite ESG in their recent Sustainability Reports, Meta reports ESG progress but fails to disclose environmental/climate action with regards to ESG. Apple disclosed a specific ESG report, but this document simply repeats information from its 2021 Sustainability Report. *Nonetheless, although limited, Apple is the more engaged with ESG.*

Big Tech firms go beyond ESG, focusing their engagement in three types of multilateral forums (strictly economic forums, sustainable business forums, and climate forums). I include as strictly economic forums the World Economic Forum, UNCTAD, and the B20 Business Summit, whose recent edition was held in Italy in 2020 (B20 BUSINESS SUMMIT 2021). How climate change is treated in these forums? How have our Big Tech firms participated in these events? Have these firms pledged their climate commitments on these global arenas?

UNCTAD launches many reports each year, some connected to sustainability. UNCTAD's 2022 Financing Sustainable Development Report[130] simply didn't state anything regarding climate change or the role of corporations in contributing to fight the problem (or to make it worse). Furthermore, UNCTAD's 2019 Digital Economy Report[131] analyzed Amazon, Alphabet, Apple, and Meta in terms of their role on global digitalization, but did not connect these firms to sustainability or climate change. In fact, climate change was not cited even once, demonstrating the complete disconnection between digitalization and climate change in these UNCTAD documents.

The World Economic Forum has a different approach to climate change, which I would call more engaged. This organization's climate initiatives are summed up as follows: "The World Economic Forum is committed to supporting global efforts in the private and public sectors to limit global temperature rise and stave off disaster. We aim to work with leaders to increase climate commitments, collaborate with partners to develop private initiatives, and provide a platform for innovators to realize their ambition and contribute solutions."[132]

This is of course a private sector-led institution, whose activities aim to protect and propel businesses, not to fight climate change as a central purpose. This "green business" logic is aligned with Alphabet, Amazon, Apple, and Meta positions (as I analyzed in chapter 5), which, essentially prioritize their businesses, not climate or the environment. In my research, I didn't find any explicit connection between the World Economic Forum and Alphabet, Amazon, Apple, Meta to advance climate mitigation or adaptation efforts.

In 2020, Business leaders from G20 countries (B20) stated that a central goal is to "underline the importance of clean energy transitions which (…) promote

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[130] UNCTAD Annual Report 2021: Reducing inequality. Available at: https://unctad.org/webflyer/unctad-annual-report-2021-reducing-inequality Accessed April 16, 2022.

[131] UNCTAD Digital Economy Report 2019. Available at: https://unctad.org/system/files/official-document/der2019_en.pdf Accessed April 16, 2022.

[132] World Economic Forum Climate Change. Available at: https://www.weforum.org/topics/climate-change Accessed April 16, 2022.

international technology cooperation, (…) address present and future energy needs, reduce global emissions and enhance adaptation to climate change thus enabling the achievement of the 2030 Agenda" (B20 BUSINESS SUMMIT 2021, p.37). Nonetheless, how B20 members approach these goals is never mentioned in the document. Interestingly, in the List of B20 participants, out of our 4 Big Tech firms, only Alphabet is a member, which means that Apple, Amazon, and Meta do not participate in this multilateral business fora.[133] Additionally, within B20, Alphabet's central priority is "ICT and Innovation", whereas only 13 companies state that "Green Growth" is their priority, including Bosch, Rodhia, and Samsung. Beyond the excerpt quoted above, climate change is never discussed nor cited in this B20 report.

But how climate change is approached by global business councils focused on sustainability, namely Global Compact, the World Resources Institute (WRI), and the World Business Council on Sustainable Development (WBCSD)? Of course, I expect climate change to be a central concern in these forums. And this is indeed the case, although the role of Big Tech firms in advancing climate change mitigation/adaptation is blurry in these conferences. Let's understand how.

Global Compact's recent *Business Ambition for 1.5°C* campaign managed to congregate 1.145 firms, representing around US$ 23 trillion in market capitalization, across 53 sectors and 60 countries, pledging (promising, but this is not legally-binding) they will "achieve net-zero emissions before 2050 and halt global temperature rise to 1.5°C."[134] Other areas of activity for the Global Compact include i) *innovation through leadership* (creation of business clubs, such as the Just Transition Think Lab, the Ocean Stewardship Coalition, to become leaders in certain environmental issue-areas), and ii) *scaling globally* (Science Based Targets initiative, which proposes business standards to achieve net-zero; the UN Global Compact Academy, which offers e-learning courses on climate change; and recently the Business Ambition for 1.5°C campaign).

Politically, the Global Compact defends that "the G7 must lead from the front in driving climate action on science-based net-zero targets."[135] Thus, this UN-backed

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[133] B20 List of Participants. Available at: https://www.b20businesssummit.com/press/participants. Accessed April 16, 2022.

[134] UN Global Compact: Climate Change. Available at: https://www.unglobalcompact.org/what-is-gc/our-work/environment/climate Accessed April 16, 2022.

[135] Ibid.

business coalition advocates for rich countries to act more emphatically (and rapidly) to fight climate change. There is no mention to Big Tech firms across the Global Compact documents and website.

The WRI (which I analyzed in chapter 5) is a global research non-profit organization headquartered in Washington, D.C., which operates with funding from, among others, the MacArthur Foundation. It was responsible for the development of the widely used (and perhaps the most important) GHG reporting standard in the world, The GHG Protocol. Alphabet, Amazon, Apple, and Meta follow the GHG Protocol as their reporting methodology, revealing that the WRI has a relevant indirect impact for these firms in their low-carbon transition.

The WBCSD is a CEO-led organization (i.e., this is a private corporation) of *204 global companies*, whose origins date back to Rio 92, and is headquartered in Geneva, Switzerland. As regards climate change, the WBSCD has three working lines.

First, *Climate Action and Policy*. In this first segment, "Climate Policy Working Group members meet regularly to shape key messages, share insights and plan for events to bring the voice of business, and topical issues today include Paris Agreement implementation and ambition, carbon pricing and Science-Based Targets (SBTs). As a registered UNFCCC observer, the group provides yearlong access to negotiations, most importantly the annual Conference of the Parties (COP)."[136]

Second, *Natural Climate Solutions*. In this segment, the WBCSD works with Nature4Climate (NGO which specializes in building partnerships between governments, civil society, businesses and investors in order to protect, restore and fund nature-based solutions for climate change) to push member-companies to invest and raise their voices politically in favor of these climate solutions.

Third, the SOS 1.5, a project which "aims to support companies from all sectors to stay within the 1.5°C safe operating space", basically providing consulting services for helping firms to devise low-carbon business strategies.

What about our Big Tech firms' relationship with WBCSD? As we have seen in chapter 5, *Amazon, Apple, and Alphabet/Google (but not Meta) are members of the WBCSD*. Nonetheless, specific engagement of member firms in the aforementioned initiatives are not provided in any of the WBCSD documents analyzed here. So, I am not

[136] WBCSD Climate Action and Policy. Available at: https://www.wbcsd.org/Programs/Climate-and-Energy/Climate/Climate-Action-and-Policy Accessed April 16, 2022.

equipped to analyze in depth which role Alphabet, Amazon, Apple, and Meta play at WBCSD in terms of their climate action.

Alphabet, Amazon, Apple, and Meta have also been participating in the UNFCCC, although they were not officially present at COP 26 in Glasgow. The list of participants[137] of COP26 demonstrates that neither of these four Big Tech firms sent representatives to participate in the event. However, it doesn't mean that they didn't have an indirect participation.

On October 26, 2021 (5 days before the start of COP 26), Ruth Porat (Alphabet's Chief Financial Officer) published a note[138] highlighting how the firm would help COP26 to reach its goals. "We'll livestream the activities through YouTube and Google Arts and Culture, helping COP26 expand the reach of its digital channels", wrote the executive. Beyond that, I found nothing else on what role Alphabet played at COP26.

Although Amazon and Apple did not participate in the event, they joined other companies, such as Bank of America, Bain & Company, BCG, Volvo, Nokia, Salesforce, Airbus, Delta Air Lines, and United Airlines, to announce, at COP 26, a joint commitment "*to create a market for emerging low-carbon technologies*."[139] This new business club, called *First Movers Coalition*, is a partnership of the World Economic Forum and the first U.S. climate envoy, John Kerry. Consistently with the previous sub-section, where I highlighted some theoretical developments that emphasize the emergence of corporate authority in various governance issue-areas *beyond their business*, at the announcement of this new climate coalition, the World Economic Forum Representative, Antonia Gawel, stated that: "*we won't solve (climate change) only with governments. We won't solve it only through private action. We need kind of both, and we need collaboration between the two*."[140]

The *First Movers Coalition* aims to incentivize low-carbon technologies (including sustainable aviation fuels, zero-emission heavy-duty vehicles, near-zero

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[137] COP 26, Provisional list of registered participants. Available at: https://unfccc.int/sites/default/files/resource/PLOP_COP26.pdf Accessed April 18, 2022.

[138] Alphabet Sustainability (Ruth Porat), "Bringing COP26 to people everywhere", 26 Oct., 2021. Available at: https://blog.google/outreach-initiatives/sustainability/google-cop26-2021/ Accessed April 18, 2022.

[139] Fast Company, "Apple, Amazon, and others band together at COP26 to create a market for low-carbon technologies", April 11, 2021. Available at: https://www.fastcompany.com/90693502/apple-amazon-delta-cop26 Accessed April 18, 2022.

[140] Ibid.

emissions steel, and EVs) in order to make them commercially viable. This is in fact essential for low-carbon transitions. The coalition will work across 8 industrial sectors, 7 of which (steel, cement, aluminium, chemicals, shipping, aviation, and trucking) account for 34% of global CO2e emissions. The eighth sector is direct air capture, essential for the development of carbon-removing technologies.[141] As we have seen before, only the cement industry accounts for 8% of global CO2e emissions. Hence, because these sectors are core for a low-carbon transition, I consider the *First Movers Coalition* an important initiative. But we have yet to see its results.

As regards Meta, its biggest role at COP 26 had to do with tackling climate misinformation. The year of 2021 marked the highest amount of climate misinformation online, but only 3,6% of climate misinformation is fast-checked, according to Stop Funding Heat, a climate civil society group[142]. During COP 26, Meta's VP of Global Affairs & Communications, Nick Clegg, observed that the firm is "expanding the Climate Science Center to more than 100 countries to connect more people with factual resources from leading climate organizations", and is launching "the Green Boost, a new sustainability training program to help small businesses reduce their carbon emissions and grow sustainably"[143].

In the same post, the VP stated that Meta wants to "play its part by helping people find accurate, science-led information while also tackling misinformation."[144] During COP 26 (October 31, 2021 to November 12, 2021), Meta also acted with a live studio at the event itself where the firm's representatives hosted a series of conversations with leading voices on climate change. Besides, they launched a podcast series called *Climate Talks*, and a live-streaming called *Say It with Science*, on Facebook Live, covering health and climate change. On Instagram, the firm launched a series called *Our*

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[141] Live Mint, "COP26: Amazon, Apple, Mahindra join coalition to drive zero-carbon tech demand", Nov 5, 2021. Available at: https://www.livemint.com/companies/news/cop26-amazon-apple-mahindra-join-coalition-to-drive-zero-carbon-tech-demand-11636106148734.html Accessed April 18, 2022.

[142] Euronews, "COP26: 'Staggering scale' of climate misinformation on Facebook revealed in new report", Available at: https://www.euronews.com/next/2021/11/05/cop26-staggering-scale-of-climate-misinformation-on-facebook-revealed-in-new-report Accessed April 18, 2022.

[143] Meta at COP 16, "Our Commitment to Combating Climate Change", Nov 1, 2021. Available at: https://about.fb.com/news/2021/11/our-commitment-to-combating-climate-change/ Accessed April 18, 2022.

[144] Ibid.

Planet in Crisis, featuring stories of activists and organizers who are dedicated to take action in their local communities [145].

6.3. Vested Interests in Big Tech Firms' Support of Low-Carbon Transitions

In September 2021 I arrived in the Silicon Valley, California, to conduct field research with respect to Alphabet, Amazon, Apple, and Meta, in order to understand their approach to climate change and their participation on the development of low-carbon industries in the region. Unfortunately, these firm's executives and employees were very resistant to my contact when I invited them to participate in interviews. Hence, I decided to complement these firms' Sustainability Reports and newspapers articles with interviews and participant observation in online workshops organized by third-party actors (i.e., non-related to the firms) with knowledge about these firms and the green tech sector in California. **Table 13** summarizes data on the 9 interviews and 12 participant-observations I conducted.

[145] Ibid.

Table 13. Research Interviews and Participant-Observation in California, Sep 2021 - Mar 2022

INTERVIEWS				
CODE	Organization	Interviewee	Date/Duration	Topics discussed
INTERVIEWEE_01	Alphabet	Software Engineer	October 4, 2021 (1h04 min)	Alphabet's approach to climate change, ESG and low-carbon technology
INTERVIEWEE_02	CCL	Chapter Leader (CCL-Santa Cruz)	October 26, 2021 (35 min)	Citizens Climate Lobby (CCL) and its approach with Silicon Valley businesses
INTERVIEWEE_03	Private consultant	Data and Software Engineer (consultant)	October 27, 2021 (30 min)	Sustainability and climate change ICT sector and Big Tech firms
INTERVIEWEE_04	NextEra Energy Res.	Senior Data Scientist	October 27, 2021 (35 min)	Sustainability and climate change ICT sector and Big Tech firms
INTERVIEWEE_05	Sustainable Energy Inc.	Director of marketing and international development	November 2, 2021 (1h30 min)	Sustainability and climate change ICT sector and Big Tech firms
INTERVIEWEE_06	City College of SF	Professor and researcher in Engineering	November 9, 2021 (50 min)	Sustainability and climate change ICT sector and Big Tech firms
INTERVIEWEE_07	Business Climate Leaders	Engagement Director	December 10, 2021 (1h)	Sustainability and climate change ICT sector and Big Tech firms
INTERVIEWEE_08	Pull to Refresh, Inc.	Business development analyst	December 17, 2021 (30 min)	Low-carbon tech start-ups ecosystem in California
INTERVIEWEE_09	Business Climate Leaders	Co-Leader (IT Sector)	January 4, 2022 (1h)	Sustainability and climate change ICT sector and Big Tech firms
EVENTS (participant observation)				
CODE	Organization	Title	Date/Duration	Topics discussed
EVENT_01	Meta	Meta's product manager	October 4, 2021 (30 min)	The Engagement Lifecycle of a Facebook Product
EVENT_02	ClimateLink	Adding Electric Vehicles in California	October 10, 2021 (1h30)	Introduction of EVs in California and the USA
EVENT_03	CCL	Monthly Meeting - Alameda Chapter	October 10, 2021 (2h)	Civil society lobbying on climate change in California
EVENT_04	Meta	Meta's product manager	October 15, 2021 (30 min)	Use of AI in Human-Computer Interactions at Facebook
EVENT_05	Climate Mobilization	Facing the Climate Emergency	October 20, 2021 (1h30)	Civil society role of fighting the climate crisis
EVENT_06	ClimateLink	Online Happy Hour	November 3, 2021 (1h)	Civil society role of fighting the climate crisis in California
EVENT_07	CCL	Monthly Meeting - Silicon Valley North Chapter	November 10, 2021 (1h30 min)	Civil society lobby on climate change in California
EVENT_08	CCL	Study Group	December 6, 2021 (1h)	Oceans and climate change
EVENT_09	Amazon	Amazon's product manager	December 13, 2021 (30 min)	Characteristics of Amazon Inc.'s supply chain
EVENT_10	CCL	Study Group	January 3, 2022 (1h)	Climate Justice in California
EVENT_11	CCL	Monthly Meeting - Silicon Valley North Chapter	January 10, 2022 (1h30 min)	Civil society lobby on climate change in California
EVENT_12	CCL	Study Group	March 7, 2022 (1h)	Agriculture and climate change in California

Source: Author's research notes

Notes: CCL: Citizens Climate Lobby

In this section, I trace political movements and vested interests ingrained in Big Tech firms' support for low-carbon transitions in California/Silicon Valley. To do so, I use empirical data as summarized in Table 1. Central questions I try to answer here are: a) how Big Tech firms participate in sectorial (ICT) business and trade associations to accommodate climate change demands? b) How Big Tech firms influence local (California) and national (U.S.) green tech industrial growth? c) What are Big Tech firms' vested interests in participating in low-carbon transitions? d) How these firms lobby as regards energy and climate policy?

6.3.1. Tech Industry Trade Associations and How they "Fight" Climate Change

Recently, we have witnessed the emergence of business associations to fight climate change. On this matter, one interviewee was emphatic: "if you want to understand business action in climate change beyond greenwash you really have to come across what those business associations are doing" (INTERVIEWEE_09). A good example is the *We Mean Business Coalition*. This is a partnership of 3.326 firms and 7 non-profits, committed to "halve global emissions by 2030 in line with a 1,5 °C pathway."[146] The initiative aims to "accelerate an inclusive transition to a global net-zero economy by 2050."[147]The *We Mean Business Coalition* is interesting because of the following: *it is an association of business associations*. Which means that the coalition brought together the WBCSD (I have already discussed it before), the Carbon Disclosure Project (CDP, which I introduced in chapter 5), the BSR (association of experts in sustainable business), Ceres (NGO founded by global businesses), The B Team, The Climate Group, and CGL Europe.

One interviewee observed that: "some of the business responses (to climate change) came from the *We Mean Business Coalition*. This includes a number of declarations signed stating that businesses are also in the Paris Accord" (INTERVIEWEE_07). The coalition partners on a secondary level with climate organizations such as C40, Global Optimism, WWF, and the Global Compact. This is a generalist type of coalition, so I couldn't "detach" how tech firms, and Big Tech in particular, exercise agency within it to advance issue-areas such as climate change.

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[146] We Mean Business Coalition. Available at: https://www.wemeanbusinesscoalition.org/about/ Accessed April 25, 2022.

[147] Ibid.

Business, industrial, and trade coalitions focusing on the ICT sector are more central for Big Tech firms. In terms of California and Silicon Valley, the most vocal tech trade associations, that might lobby to tackle climate change, are "the Silicon Valley Leadership Group, TechNet, the Information Technology Industry Council (which recently created a climate change subgroup), American Sustainable business Network and the Climate Leadership Council" (INTERVIEWEE_09). Interviewee_09 provided me with this list of business/trade tech associations of relevance in the region. Hereafter, I survey how these networks intersect climate change. Do Alphabet, Amazon, Apple, and Meta participate in these tech trade associations? Do these industrial associations propose to tackle climate change? How?

The *Silicon Valley Leadership Group (SVLG)* adopts climate change as a backdrop for its actions. "Since our founding in 1977, the SVLG has worked to develop, promote, pass and implement policy initiatives that benefit our members, their employees and the Bay Area."[148] Alphabet, Amazon, Apple and Meta are active members of this initiative, whose majority of members are tech firms headquartered in Silicon Valley. In 2020, the SVLG has expanded its policy goals, making climate a priority. "We learned that many of us can work from home effectively, reducing road congestion and carbon emissions. California and the US must actively work on all aspects of climate change. The approach must be comprehensive, from reducing carbon emissions through resiliency projects for communities impacted by flooding, fires, mud and other consequences of our changing climate."[149] So, it aims to advance both climate mitigation and adaptation.

Accordingly, the SVLG lobbies to approve environmentally progressive legislations in California and at the federal level. On energy and climate, top policy priorities include: "the climate crisis; water supply reliability; infrastructure improvement; and reliable, high-quality, environmentally responsible and competitively-priced energy."[150] The SVLG has been effective in supporting the approval of many such legislations, including: the California Air Resources Board zero-emissions airport shuttle rule, to accelerate the deployment of zero-emission shuttle buses (2019); the Senate Bill

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[148] Silicon Valley Leadership Group. "About us." Available at: https://www.svlg.org/about-us/ Accessed April 26, 2022.

[149] Ibid.

[150] Silicon Valley Leadership Group. "Climate & Energy". Available at: https://www.svlg.org/climate-energy/ Accessed April 26, 2022.

(SB) 100, establishing Zero-carbon energy Supply by 2045; the Assembly Bill (AB) 1796, which requires "a landlord to approve a tenant's request to install an EV charging station at a rent stabilized property, with the tenant paying the costs of the station and installation", the AB 3232, which "requires the State Energy Resources Conservation and Development Commission, by January 1, 2021, to assess the potential for the state to reduce the emissions of GHGs from the state's residential and commercial building stock by 40 percent below 1990 levels by January 1, 2030", and the AB 398 on Cap-and-Trade, which extends the "cap-and-trade program through 2030. Cap-and-trade helps provide market certainty for the clean energy economy to flourish. Additionally, the program serves as a model to other states, the federal government, and other countries."[151]

Another tech association of relevance is *TechNet*, a national network of tech CEOs and senior executives that promotes the innovation economy in the U.S. It focuses on IT, e-commerce, the sharing and gig economies, advanced energy, cybersecurity, venture capital, and finance, by advancing public policies and private sector initiatives at the federal, state, and local levels.[152] How these sub-sectors connect with climate change through the lenses of this business association? TechNet has some energy and climate initiatives, but all stemming from one area: *clean energy technology development*. TechNet is not clear, however, about which laws and policies in terms of climate change it supports, as I did not find any such information online in its website. While the explicit interests of TechNet are to promote innovation (not necessarily green) and competitiveness (typical U.S. values), few climate change references were found in this network's website.

The *Information Technology Industry Council (ITI*) is a global business association of tech firms, headquartered and mainly focused on the U.S. It "promotes public policies and industry standards that advance competition and innovation worldwide." Its approach to climate change is blunt, and can be analyzed in 2 dimensions: multilateralism and decarbonizing the ICT value chain.

In the first dimension, "ITI strongly supports international cooperation and partnership on addressing climate change, and welcomed the US's re-entry into the Paris Agreement of UNFCCC and support the UN 2030 Agenda for SDGs as part of climate

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[151] More detailed information on these bills and others supported by the SVLG are available at: https://www.svlg.org/climate-energy/ Accessed April 26, 2022.

[152] TechNet, "Our story". Available at: https://www.technet.org/our-story/ Accessed April 26, 2022.

change solutions and social equity."[153] Let's remember that under the Trump administration, the U.S. was the first nation in the world to formally withdraw from the Paris Agreement, on November 4, 2020.[154]

ITI's political enforcement of climate multilateralism is complemented by specific ICT industry-related decarbonization strategies, reproduced in the excerpt below:

> For its advocacy, ITI is focused on addressing both the industry's footprint – direct carbon emissions and impacts from the ICT industry – and handprint – carbon reductions in other sectors enabled by the ICT industry.
>
> Addressing Industry's Footprint: Direct Carbon Emissions and Impacts from the ICT Industry
>
> To address industry's climate footprint, ITI recommend that U.S. policies – both for government and industry – reflect mandatory targets that meet or exceed recommendations by the Intergovernmental Panel on Climate Change (IPCC). Further, ITI supports government investment in clean technologies, infrastructure, and programs, such as:
>
> - Utilities generating 100% zero-carbon electricity and other energy commodities.
> - Energy efficiency standards for new homes and commercial buildings.
> - Development of energy efficient products.
> - Accelerated electrification of the energy system, especially in buildings and transportation segments and resilient infrastructure
> - Incentives, including tax incentives, to promote rapid development and deployment of clean and efficient energy technologies.
> - Initiatives that draw carbon dioxide out of the atmosphere, including biological efforts and emerging technologies.

[153] ITI Climate Change. Available at: https://www.itic.org/policy/environment-sustainability/climate-change Accessed April 26, 2022.

[154] BBC News, "Climate change: US formally withdraws from Paris agreement". Available at: https://www.bbc.com/news/science-environment-54797743 Accessed April 26, 2022.

- Public-private partnerships in technology development and education.
- Elimination of regulatory and market barriers to the deployment of emissions reduction technologies and low-carbon energy.
- Increased funding and research to support communities to advance climate resilience and adaptation

Addressing Industry's Handprint: Carbon Reductions in Other Sectors Realized by the ICT industry

To address the climate impact of other industries utilizing ICT industry tools, also known as *industry's handprint*, ITI advocates for prioritization and investment in areas such as:

- ICT-enabled efficiency and decarbonization solutions the help to reduce the climate footprint of other sectors of the economy.
- Smart grids, artificial intelligence (AI), intelligent transportation systems, electrification, smart manufacturing, building management systems, smart cities, the internet of things (IoT), and Blockchain solutions to increase efficiency throughout the economy.
- Policies that promote the role of ICT in reducing the footprint of other segments of the economy.[155]

The aforementioned concept of *industry handprint* is very important. The NGO *Digital Climate* observed that "handprint is the role of our technology in helping other sectors (and ours too of course) reduce their carbon footprints. The concept of a handprint is much newer. And while other industries can claim some handprint impact (aluminum, for example, can help the auto industry reduce weight and thereby improve fuel economy), the ICT industry probably is unique in the breadth and extent of its handprint impact."[156]This discussion connects with Chapter 1, where I evaluated ICT's global CO2e emissions, i.e., the carbon footprint of the ICT sector, and observed that this sector has an enormous potential to help decarbonize other sectors of the economy,

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[155] ITI Climate Change. Available at: https://www.itic.org/policy/environment-sustainability/climate-change Accessed April 29, 2022.

[156] Digital Climate. "Handprint vs. Footprint". Available at: https://www.digitalclimate.io/new/89egciqhu51ohwyxen5qzirztrq7mm Accessed April 29, 2022.

because of the wider process of digitalization of global value chains. This is encompassed by the concept of *industry handprint*.

Another tech business group is The Semiconductor Industry Association, which adopts some initiatives to fight climate change: reporting and reducing emissions of perfluorinated compounds (PFCs), which it does since the 1990s; reduction in energy used in manufacturing, with total reduction of electricity consumption in the sector's operations by 34% between 2001 and 2015; and improving the energy efficiency of semiconductors. It is important to state that The Semiconductor Industry Association is a trade association and lobbying group founded in 1977 to represent the U.S. semiconductor industry, and it is headquartered in Washington, D.C.[157]

The *American Sustainable Business Network (ASBN*)[158], which focuses on sustainability more broadly, and the *Climate Leadership Council (CLC)* (which is a bipartisan non-profit organization that advocates for a carbon fee and dividends policy that would tax carbon emissions and refund all the money to North-Americans)[159] are engaged with climate change more thoroughly than the previous trade associations. Because of space limitations, and because these networks are not explicitly focused on the ICT sector, I will not discuss their initiatives in detail here.

To finish this section, and to illustrate some vested interests of tech firms in fighting climate change, now I discuss some interviews and participant observation I conducted at Citizens Climate Lobby (CCL) in California.

CCL is "an international grassroots environmental group that trains and supports volunteers to build relationships with their elected representatives in order to influence climate policy."[160] I interviewed the leader of the "Santa Cruz Chapter" (INTERVIEWEE_02)[161], and 2 members of the CCL branch which deal directly with businesses: *Business Climate Leaders* (BCL) (INTERVIEWEE_07 and INTERVIEWEE_09).

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[157] The Semiconduction Industry Association. "Semiconduction industry to continue action on climate change". Accessed April 29, 2022.

[158] American Sustainable Business Network. Available at: https://www.asbnetwork.org/ Accessed April 29, 2022.

[159] Climate Leadership Council. Available at: https://clcouncil.org/ Accessed April 29, 2022.

[160] Citizens Climate Lobby. Available at: https://citizensclimatelobby.org/ Accessed April 29, 2022.

[161] CCL calls "chapters" the regional groupings of members to joint periodically to discuss their movements and coordinate actions

Although the CCL Santa Cruz has many businessmen as members, chapters closer to the Bay area were more engaged with tech people. Accordingly, at "Silicon Valley North Chapter, they have many connections to big businesses, and Big Tech firms" (INTERVIEWEE_02). Therefore, in addition to interviews, I conducted 6 participant-observation in online events from the Silicon Valley North Chapter. I also became an active member of the "Study group" of CCL Silicon Valley North chapter, and I am an active member until nowadays.

The next paragraphs illustrate how Silicon Valley tech firms are not so influenced by CCL. One of the interviewees told me how BCL (Business Climate Leaders) approach Silicon Valley firms to talk to them about climate policy, in order to convince them to back (many times through lobbying) climate-friendly climate policy. Nonetheless, these meetings are often secretive, not many tech people engage in such meetings, and results in terms of convincing them to back climate policy are meager:

> *We worked together to try to make them (Silicon Valley firms) endorse carbon climate policies. We bring policy experts from CCL, talk about the bill, in the end these firms give a lot of support, but so far, they were not able to get these companies' executives to support or endorse climate laws. A couple of companies have been involved. Those meetings are very confidential with these companies from Silicon Valley* (INTERVIEWEE_07).

This interviewee continued, observing that the main goals of CCL in approaching business people from Silicon Valley firms is to convince them to back the federal laws on carbon pricing. CCL main line of lobby in the U.S. is to help craft and approve legislation that would put a price on carbon emissions, as was reiterated several times across EVENT_03, EVENT_07, and EVENT_11. Nonetheless, as stated below, Silicon Valley tech firms do not provide up front support for climate policymaking:

> *These firms are quite willing to group with other companies, their peers. In order to make advocacy statements about the importance of fighting climate change. But when it comes to specific legislations and endorsement, they have not done much. The reason that they express is that they do not want to take a winner, before the final version of the carbon pricing bill emerges. They say that would rather "keep their powder dry", they wait until the final version of the law emerges. It falls way short of what I would like to see. They lobby more*

regarding taxes, and issues related to their specific businesses (INTERVIEWEE_07).

In addition to that, BLC (the business branch of CCL) is the biggest subdivision (in terms on number of members) of CCL, which beyond BCL has branches like the Study Group, the Communications/Events Teams, etc. According to an interviewee (see excerpt below), the main goal of BLC is helping the network to convince businesses to back lobbying in order to approve the Carbon fee and dividend proposal. The Carbon fee and dividend works as follows: "carbon fees are proposed fees collected for the cost of burning fossil fuels; the dividends are the fees collected (minus administrative costs) and returned to Americans to spend as they see fit."[162]

> *BCL is the largest action team within CCL. (…) Our whole mission is to tap into the voice of business to support CCL main policies acts (federal price on carbon), The main proposal now is the Carbon fee and dividend* (INTERVIEWEE_07).

Nonetheless, in addition to INTERVIEWEE_07 and INTERVIEWEE_09 statements that business groups at Silicon Valley are not very engaged to back climate policy, a software engineer from Alphabet was even more emphatic, questioning the effectiveness of the firm in "fighting" climate change.

> *I lost my hope that any company will help solve the climate problem. The incentives have to come from the Government. For instance, even Tesla, which tries to be environmentally-friendly, is actually contributing for us to have more cars, but we all know that public transportation is actually better for the climate* (INTERVIEWEE_01).

What do these Interview excerpts tell us about the vested interests of tech businesses in "fighting "climate change? It is important to compare the discourse and *apparently strong climate action* promoted by tech trade and business associations such as the SVLG, TechNet, ITI, the Semiconductor Industry Association, and the ASBN with

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[162] CCL, "How Carbon Fees and Dividends Work". Available at: https://citizensclimatelobby.org/basics-carbon-fee-dividend/#:~:text=Carbon%20fees%20are%20proposed%20fees,spend%20as%20they%20see%20fit. Accessed April 29, 2022.

the *actual resistance of Silicon Valley tech businesses to back climate policies*, as identified by BCL and by CCL. This means that, considering tech businesses from Silicon Valley (our Big Tech firms included), *on-the-ground climate action* is meager, whereas under the protection walls of their official webpages, these firms often say they are doing much to fight climate change. The truth is that they are actually doing little. It is hard to deny that, with the exception of some climate initiatives from Alphabet, Amazon, Apple, Meta (but whose positive effects are not yet proved since they are quite recent initiatives), most of these firms adopt business-as-usual environmental/climate strategies, focusing on protecting their businesses, or looking for new business opportunities. Bottom line is that such initiatives are still mostly greenwash.

6.3.2. Three Types of Low-Carbon Vested Interests

One of Alphabet's software engineers provided me with inside-information about how climate change in framed by the firm. Accordingly, as long as the manager approves, Alphabet employees can work part-time helping climate NGOs to develop services or solutions for climate change. Internally, part-time work in green tech development, even though it might not be related to the core of the employee's activities, is also a possibility. There is even an internal group to share information on climate change: the *Greenglers*. According to Interviewee_01, "their mission is to focus on internal behavior as regards sustainable actions." According to this interviewee, the dynamic occurs as follows:

> *There are internal projects where we (Google employees) can decide to embark in: some of them can be about developing a technology, for instance, about climate change mitigation/adaptation, that can help NGOs, or some third-party actor working on climate change. The company allows you do part of your working time to help on that. If you manager approves it, Google will approve it as well. So, you devote part of your working time to help these tech projects regarding climate change, environmental or social issues* (INTERVIEWEE_01).

As I observed in the last section of Chapter 5, Alphabet's CEO Sundar Pichai is specific about the importance of "being green" to attract the best young professionals, since the labor market is progressively more sensible to issues such as sustainability and climate change. The strategy illustrated in the above except is the materialization of what the firm is doing to attract *climate-aware* young professionals, making them feel they are somehow fighting climate change while working for Alphabet. This is an interesting new dimension of Greenwash, by which the firm paints itself as a climate leader when it is actually using climate action as a strategy to attract climate-aware professionals.

Alphabet "*is helping business customers like Whirlpool, Etsy, HSBC, Unilever and Salesforce develop solutions for the specific climate change challenges they face. Unilever is working with the power of Google Cloud and satellite imagery through Google Earth Engine to help avoid deforestation in their supply chain*" [163] This piece of discourse was given by Ruth Porat, Alphabet's CFO. This informs us about a second dimension the firm's vested interests in fighting climate change: climate action will happen when these firms foresee business opportunities.

One interviewee was emphatic about the drivers of Big Tech firms' climate action: "I think businesses are not motivated by discourse; they will be motivated by business opportunities" (INTERVIEWEE_09). What does that mean? It means that policy discourse, and even civil society pressures, if not aligned with regulations and business opportunities, will not drive firms to act on climate change. In this respect, another interviewee observed that regulation is more effective than civil society pressure:

> *Regulations (e.g., carbon pricing, carbon taxing, cap and trade, etc.) are very important. Otherwise, companies will only act on climate change because of PR and Greenwash. I don't know about pressure from the public. Public incentives might work, but I don't know to what extent* (INTERVIEWEE_08).

Another type of vested interests regarding climate change is materialized when firms attempt to influence society about the "positive climate impacts" of their business and products/services. This happens, for example, when governments and citizens use Alphabet's products such as Google maps to help fight and control fires, which have become more frequent in regions of California due to climate change.

> *Last year there was many wildfires in California: the way it affected Google's business is that the firm has Google maps, which provides*

[163] Alphabet Sustainability CFO (Ruth Porat), "Bringing COP26 to people everywhere", 26 Oct., 2021. Available at: https://blog.google/outreach-initiatives/sustainability/google-cop26-2021/ Accessed April 18, 2022.

tools that could help locate where the fires were happening. The firm was helpful to local people. In the long-term people will need more information as regards these environmental effects. We (Google) have the responsibility to help others on how to navigate these catastrophic events (INTERVIEWEE_01).

As the above excerpt illustrates, such low-carbon tech products are framed as a matter of "responsibility" Google has before society. But is that really what the firm envisions? Based on my research and on the previous two arguments as regards low-carbon vested interests (climate action will happen in order to attract climate-aware employees; or because of business opportunities), a third type of vested interest is the attempt to influence society as regards the relevant social role of the corporation, for instance, regarding climate change.

Firms gain much from having society (citizens/customers) on their side. Customers "convinced" that the firm has a positive influence on the environment/climate are more prone to buy the firm's products/services. Moreover, climate-aware customers will pay premiums for low-carbon products, thus, bringing more revenues for the firm.

Thelen (2019) has found that firms-citizens coalitions are becoming frequent in the political economy of U.S. and European countries. Such coalitions are influencing local and national policies in order to favor business firms, and this is a core trait of the platform economy. So, firms-citizens coalitions will help firms approve legislations favoring their businesses, including the approval or denial of climate laws.

It is interesting to observe that these three low-carbon vested interests are not necessarily adopted in order to protect Big Tech business from climate change, but to make such businesses profit from climate change. "My personal belief is that droughts in Silicon Valley have zero effect on those firms. Because Big Tech firms are quite new firms, they had time to install their data centers in safe regions" (INTERVIEWEE_03). This means that Big Tech firms from Silicon Valley do not need to invest much in climate adaptation. Big Tech firms' climate action in California is more a matter of business opportunity, to strengthen the public perception of their "beneficent" role, or to attract climate-aware employees than a matter of hedging these businesses from the consequences of climate change. At least in California, it does not seem that global warming will have a direct impact on Big Tech firms' operations. Of course, this does not necessarily apply to their offices and data centers located elsewhere.

What about the other three firms, besides Alphabet? One interviewee worked for more than 20 years in the tech sector in Silicon Valley, so he has a long-term perspective on the environmental practices of these firms. According to him:

> *In terms of greenwash, (...) my personal opinion is that Google is serious. But I think Microsoft is the most serious in favor of climate change mitigation. Apple is probably next, after Google. But for Apple, climate change is a secondary priority. Amazon is purchasing green vehicles, but they are not as serious as the others. Facebook is in the bottom. If anybody is greenwashing, this is Facebook* (INTERVIEWEE_09).

This opinion gives us nuances about the different levels of "greenwash" of these Big Tech firms. Microsoft, as I analyzed on Chapter 5, is the most climate-aware, and I believe this is genuine. Bill Gate's *How to Avoid a Climate Disaster* is proof that he has a genuine concern with the climate crisis, although he believes that technology is the central part of the solution, thus attributing a smaller role to other variables. Alphabet and Apple would act on climate change more genuinely as well, whereas Amazon and Meta would be greenwashing. This goes in line with my empirical results. Based on my analysis, out of the four Big Tech firms I studied, Apple does the most concise climate action (the least greenwash), whereas Alphabet comes next, and then Amazon, and finally Meta, which is actually not doing much to face climate change.

6.3.3. Lobbying Towards Energy and Climate Policy

Let's start this final section, about the climate lobbying of Big Tech firms, with a warning: there is no official information about the amount of money these Big Tech firms spend on climate change policy. This is in line with one of the interviewees:

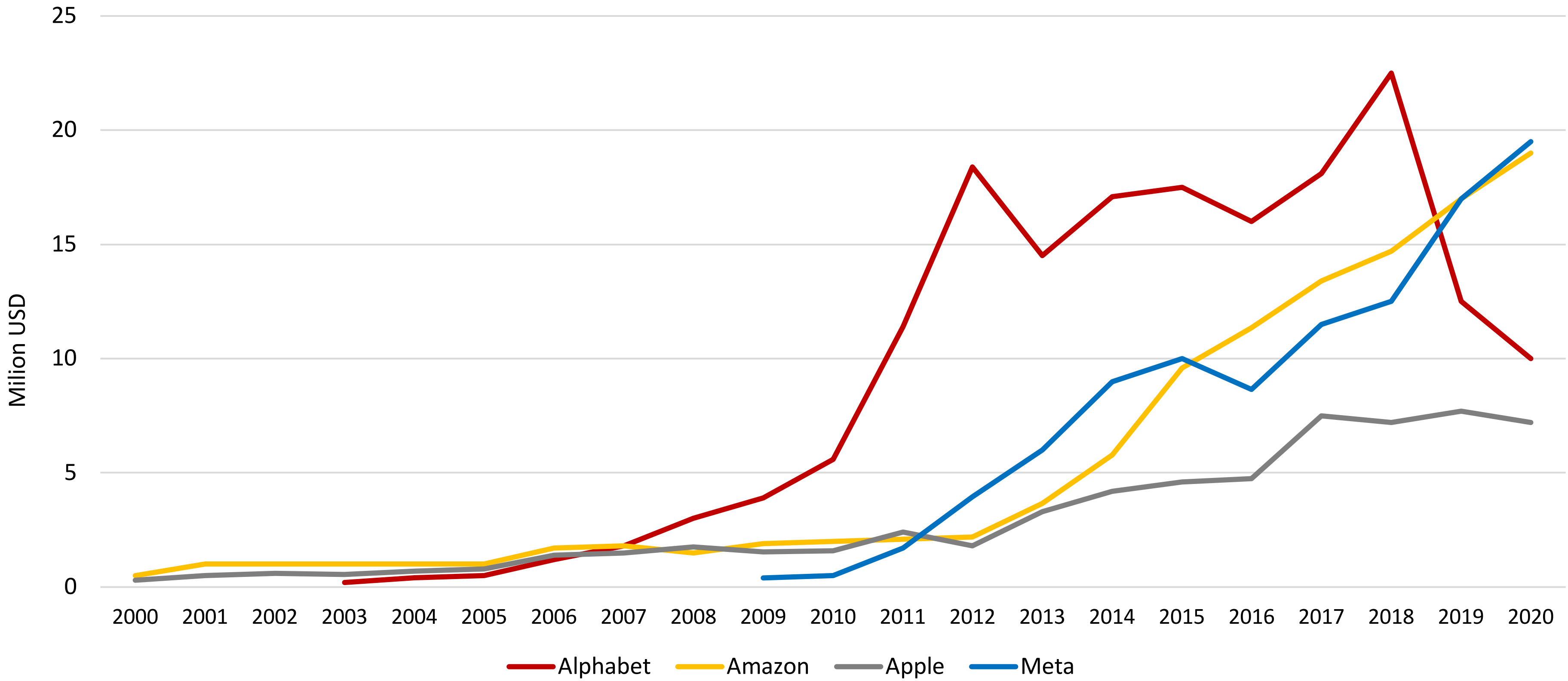
> *The amount of lobby (spent by Big Tech firms) is hard to find. They keep this information private. They spend more money on policies to help their specific businesses. If companies are really serious about backing significant climate action, they should sign firmly support the Build Back Better, the Biden recovery plan. But this plan will increase taxes on corporations, so many businesses will not back it up* (INTERVIEWEE_07).

He refers to the Build Back Better plan, which includes "USD 555 billion in climate change investments," an important part of Biden's pledges to curb U.S. emissions in half from 2005 levels by 2030.[164] Nonetheless, information on climate lobby is indeed very scarce, particularly from trustful sources.

To help me solve this problem, another interviewee observed that "Open Secrets is the only website I know that provides lobbying information on all sectors, and this might include ICT. (…) My perception in general is that ICT firms do not do a lot of lobbying as regards climate change. If they do, this is their second or third priorities" (INTERVIEWEE_09) Therefore, I visited the Open Secrets website and collected the available information on Lobbying spending by Alphabet, Amazon, Apple, Meta. This information is provided on **Figure 29**. As we can see, this is general data lobbying spending. Therefore, the website does not provide specific figures on the percentage or amount of money that goes to lobbying regarding climate and energy policy.

[164] CNBC, "House Democrats urge Biden to pass climate change portion of Build Back Better", Feb 1, 2022. Available at: https://www.cnbc.com/2022/02/01/democrats-urge-biden-to-pass-climate-change-part-of-build-back-better.html Accessed April 18, 2022.

Figure 29. Lobbying Expenditure by Alphabet, Amazon, Apple, Meta from 2000 to 2020 in million USD



Sources: Chart developed by the author, based on data from Alphabet (2022a, 2022b), Amazon (2022), Apple (2022), Meta (2022).

Notes: such data was collected in the website of Open Secrets, Federal Lobbying (https://www.opensecrets.org/federal-lobbying). Until 2014, numbers for Alphabet refer to Google's lobbying spending.

How then can we grasp which issue-areas are of interest for Big Tech firms lobbying? The same interviewee observed that:

> *The IT sector advocates and lobbies government for things that are specifically of their interests. Historically ICT-US Government relations have been good relationships. But nowadays, this is becoming more contentions because there are some important points of controversy such as Monopoly, Data Privacy, Data Security, etc. This is why I do not think these firms advocate strongly on climate change policies, because they have bigger problems to handle* (INTERVIEWEE_09).

These companies lobby as regards more salient issues for their core-business, such as data privacy, laws against monopolies (as many Big Tech firms are considered to exercise monopolistic competition, an illegal and anticompetitive corporate behavior), data security, misinformation, and health issues generating in online platforms and social media. In 2020, Alphabet, Amazon, Apple, Meta, and Microsoft spent collectively USD 61 millions on issues including: international tax policies, copyright reform, and content policy.[165] Amidst these many topics which affect the core business of Big Tech firms, climate change is not expected to be priority when it comes to lobbying. On top of that:

> *Silicon Valley Leadership group paid for a study focused on measuring the impact of carbon pricing in Silicon Valley businesses. If there is a price on carbon, increasing the costs of emissions, how much this will affect these businesses? The conclusion of this study was that carbon pricing will affect them in less than 1%* (INTERVIEWEE_09).

This is a sign that carbon pricing will not negatively affect Silicon Valley businesses. Thus, Big Tech firms from Silicon Valley have no direct incentives to oppose stricter climate legislation. These evidences support the hypothesis that Big Tech firms will not lobby in favor or against climate legislation. Although, as I said before, there is no data to back this proposition. Yet, in the next lines I triangulate information from these

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[165] Grist, "Big Tech says it wants to solve climate change. Its lobbying dollars say otherwise", June 28, 2021. Available at: https://grist.org/politics/big-tech-says-it-wants-to-solve-climate-change-its-lobbying-dollars-say-otherwise/ Accessed April 18, 2022.

firms' sustainability reports and newspapers articles in order to indirectly check this proposition.

According to Meta's approach to climate policy, the firm focuses on policies that "actively supporting the European Green Deal, the European Union's roadmap toward climate neutrality by 2050. We stand as a ready partner to the EU and European Governments in making the ambitions of the Green Deal a reality. (…) And, in the U.S., urging the new Biden administration to support ambitious climate policies to reach the U.S. Paris Agreement targets" (META, 2021b, p.12). This indicates that, according to Meta itself, it would strongly support pro-climate laws.

However, this is not the reality. "Between 2019 and 2020, just 4% of Apple, Alphabet, Amazon, Meta, and Microsoft's self-reported lobbying activities targeted climate-related policy at the federal level. In Europe, these companies do even less lobbying on climate" [166] This data was released in a 2021 report[167] by InflueceMap. According to this report, out of these Big Five tech giants, Apple devotes the lowest percentage of its lobbying expenditures to climate-related topics. Meta spends 6% of all lobbying activities to climate issues (which is already a small ratio), Microsoft (5%), Amazon (5%), Alphabet (3%), Apple (2%) (INFLUENCE MAP, 2021, p.20). On the other hand, Oil & Gas firms such as Chevron, Shell, ExxonMobil, ConocoPhillips, and BP spend an average of 38% of their legislative lobbying to climate-related policies between 2019-2020.

These are signs that Big Tech firms' low-carbon vested interests are market-based prospects for new business opportunities. Although these firms have put forward some efforts to fight climate change, their lobbying on pro-climate policies is meager.

[166] Grist, "Big Tech says it wants to solve climate change. Its lobbying dollars say otherwise", June 28, 2021. Available at: https://grist.org/politics/big-tech-says-it-wants-to-solve-climate-change-its-lobbying-dollars-say-otherwise/ Accessed May 1, 2022.

[167] InfluenceMap, "Are the Technology Giants Deploying Political Capital on Climate Change?" Available at: https://influencemap.org/report/Big-Tech-and-Climate-Policy-afb476c56f217ea0ab351d79096df04a Accessed May 1, 2022.

CONCLUSION

Corporate climate action is a complex political phenomenon. In order to understand it better, this dissertation aimed at clarifying some of the motivations, mechanisms, and interests of Big Tech firms when their business behavior, corporate strategies, productive operations, and socio-institutional relationships intersect climate governance. I selected the ICT sector because it is transforming society through a process of *digitalization*. Digitalization is the progressive use of digital technologies, platforms, social media, online content, smart devices, and data analytics in everyday life. This process has transformed Big Tech firms (the inventors of the most innovative digital technologies) in powerful agents in contemporary politics and society.

I started the dissertation by highlighting the global carbon footprint of the ICT sector. Recent statistics showcase that the sector accounts for roughly 2 to 3% of global GHG emissions. Nonetheless, recent forecasts attest that this participation is growing because digital technologies have become pervasive social artifacts. This means that the material components used to manufacture digital products are set to generate rising levels of e-waste, consume more water and energy, thus generating rising levels of emissions.

Rising emissions in tech and Big Tech firms comes mostly from the energy used in data centers. These are data processing units, which account for much of these firm's environmental impacts. Additionally, software and algorithms, although have an apparent immateriality, generate substantial environmental externalities. Optic fibers, computer networks, and chemical elements (e.g., rare earth elements, employed in the manufacturing of tiny pieces such as semiconductors, key components of the ICT industry) not only consume growing amounts of electricity, but also generate e-waste and consume growing amounts of water. When it comes to new technologies such as AI, energy usage and emissions grow exponentially, because computer models need to work non-stop in order to train machine learning algorithms, in a perpetual cycle in search for improvement.

Alphabet (formerly known as Google), Meta (previously Facebook), Apple, and Amazon are global firms with considerable market power. Apple and Amazon are amongst the 10 largest corporations on the planet in terms of revenues. All four companies figure amongst the top 100 firms in the world by the same measure. In this dissertation, these firms are part of a new set of multinational corporations called *Big Tech firms*. I selected Alphabet, Amazon, Apple, and Meta as my empirical cases because they are the top 4 (top 5 if we add Microsoft) Big Tech corporations. Consequently, my goal was to map relevant climate change impacts, action, and vested interests as regards these firms.

As far as I am concerned, this is the first scholarly work that systematically proceeds to such an analysis. Thereby, this represents the component of originality of this dissertation.

We have seen that the relationship between multinationals and climate change has sparked scholarly interest since at least the 1980s, thanks to the contribution of trailblazer authors such as Peter Newell and Ans Kolk. Nonetheless, Big Tech multinationals have not yet been included in this literature. In this research, my findings were both theoretical (Part II) and empirical (Part III).

In Part II, I used my former business training to showcase, in Chapter 3, a brief marketing outline of these firms. I presented their main corporate strategies and business values, such as a push for innovation before profits. In Chapter 4, I created an original power typology for Big Tech corporations. By conceptualizing network power, information power, data power, and infrastructural power, I highlighted some challenges ahead of Big Tech firms' governance. Of course, this is a tentative typology, whose validity has yet to face peer-review scrutiny. Anyway, this exercise helped me to clarify how these firms behave, and what motivates them in terms of market and social goals. To my surprise, I found that these firms are more than simply profit-maximizing entities: Alphabet, Amazon, Apple, and Meta have become socio-political actors that are transforming society through logics of platformization, digitalization, and what I call a *low-carbon techno economy*. And this is by design, not by chance.

Part III is the largest part of the dissertation because it contains my actual case studies. It took me six months just to finish chapter 5, with its 100 pages! I started by telling the stories of Kate Brandt, Lisa Jackson, Kara Hurst, and Edward Palmieri, these firms' sustainability leaders. I built my narrative by arguing that these executives' personal traits and histories have much to do with the sustainability strategies of these firms. For instance, all of them have worked for the U.S. government or have degrees in politics. I interpreted this fact as these firms attempting to hedge against unexpected environmental policies. By knowing profoundly, and exploring, the U.S. policy loopholes, these executives are trained to help these firms avoid financial and reputational losses as regards environmental issues, such as climate change.

Chapter 5 also contains an extensive analysis of Alphabet, Amazon, Apple, and Meta's environmental and carbon footprints. I will not describe these numbers here. But it is important to highlight that these firms, except for Amazon, have been reducing their GHG emissions in recent years. As climate change becomes mainstream, these corporations face pressures from politics, society, and the market to neutralize their emissions. On top of that, this chapter demonstrates that these Big Tech firms (particularly Alphabet) have been developing climate smart technologies. Their goal is clear: they are repositioning their businesses in order to profit from climate change, although they already profit enormously from the digital economy.

Big Tech firms' CEOs promise to "save the climate" but they have clear vested interests: advancing their techno-utopic agendas (claiming that tech will solve the world's most challenging problems, such as climate change) while profiting from selling tech products and services along the way.

Chapter 6, the final of the dissertation, shifted the discussion to clarify the political economy of business state relations towards low-carbon transitions. I found out that these firms lobbying expenditures is growing, not because of climate policies, but because of salient issues for their core businesses, such as data privacy regulations. Additionally, I found that Big Tech firms' climate action occurs mainly because of three vested interests: 1) to attract climate-aware employees, 2) because of business opportunities related to climate products, services, and climate-smart technologies, and 3) to influence society as regards the beneficent role of the corporation. Big Tech corporate climate action has to do with framing these businesses as good for society and the environment, hiding on purpose their negative environmental externalities, some of which were stressed in this work.

These results add to existing literature on multinational firms' climate actions, thus contributing to IPE and IR. Because my study had a qualitative nature, it would be interesting to see other analyses of the climate behavior of Big Tech firms using different research designs, for instance, including quantitative or mixed methods. I believe my findings can be a reference for future studies in such directions.

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