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Sustainability Reporting in the ICT Industry

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“Master of Science”

supervised by
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Affidavit

I, **ING. BARBARA ANNA-MARIA KARLOVČEC, BA**, hereby declare

1. that I am the sole author of the present Master's Thesis, "SUSTAINABILITY REPORTING IN THE ICT INDUSTRY", 98 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted the topic of this Master's Thesis or parts of it in any form for assessment as an examination paper, either in Austria or abroad.

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Abstract

With the introduction of the Corporate Sustainability Reporting Directive (CSRD) and its consequent European Sustainability Reporting Standards (ESRS) the European Union aims to foster the awareness of sustainability even in corporate contexts. Potential and existing stakeholders and investors, civil society organizations or the public shall be informed about which impacts and opportunities associated with sustainability a company deals with. Adding to the companies´ reporting requirements, the CSRD aims to consider additional aspects, such as double materiality and a broader scope of enterprises. Moreover, by requiring a third party to audit and control the reports, the compliance of the firms is evaluated. Since the first reports of the CSRD will be submitted in 2025, affected firms are in the midst of preparations and reporting activities. Due to the novelty of the directive and the standards, open questions, assumptions, and speculations have come up. Hence, this research paper aims to identify such concerns and to evaluate them. In addition, the impacts and opportunities faced by ICT enterprises in Austria will be assessed.

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List of Abbreviations

AI	Artificial Intelligence
CSRD	Corporate Sustainability Reporting Directive
EFRAG	European Financial
EU	European Union
ESG	Environmental Social Governance
ESRS	European Sustainability Reporting Standards
GHG	Greenhouse Gas
ICT	Information and Communication Technology
NFRD	Non-Financial Reporting Directive
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
WEEE	Waste of Electrical and Electronic Equipment

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1 Introduction

In an ever-changing world and its fast-paced societies, advancement and progress seem to be inevitable. This holds true for various sectors and parts of today´s world. In particular, technological advancement moves at a rapid pace. The motto is, faster, easier, and more accessible. Accustomed to abundant choices, it is as though today´s society has grown entitled to aspire to having seemingly endless access to any resource, at any time and place. Nonetheless, however convenient, progress can be a double-sided sword. The Information and Communication Technology (ICT) sector is a major force among global industries. Its growth counts as one of the most rapid ones next to other sectors in the world (Wang, et al., 2024). While it is the driving impulse behind digitalization, it is having a drastic influence on many facets of our lives, as well as a detrimental bearing on the environment (Bieser, et al., 2023). ICT covers a broad range of technological instruments and resources used for information creation, sharing, and communication (Statistics, 2009, p. 120). This umbrella term encompasses all technical means utilized for processing information and facilitating communication. This comprises both computer and network hardware, as well as associated software (Eurostat, 2023). The importance and convenience stemming from the ICT industry are seemingly undeniable. However, there is two sides to any story. Due to the fact that ICT has established itself in vast areas of our daily lives, thereby having grown increasingly significant, people are becoming more conscious of its possible impact on the environment (Freitag, et al., 2021).With the adoption of the Non-Financial Reporting Directive (hereinafter referred to as NFRD) in 2014, the European Union made a major advancement in sustainability reporting. Furthermore, with these efforts, it encouraged the business sector to move towards enhancing sustainability (Fasan, 2024). Larger enterprises with more than 500 employees were compelled to reveal their impact on their environmental, social, and governance (ESG) in the form of so-called sustainability reports (Rakic, 2023). However, in 2021 due to inadequacies, the necessity for revision of the NFRD became apparent. Shortly after, the European Commission presented a draft of the Corporate Sustainability Reporting Directive (hereinafter referred to as CSRD) (Fasan, 2024). Superseding the NFRD, the new reporting directive was enforced on January 5th, 2023, and thereby subjected a vast additional number of companies, registered within the EU member states, to defer to its reporting requirements (European Commission, 2022). The number of companies obliged to

disclose sustainability reports thereby inclined from approximately 11,700 enterprises to 49,000 companies. Since the enforcement of the CSRD was enacted at the beginning of 2023, the actual application for it starts from January 1st, 2024, for companies that have been obliged to report under the NFRD already. These reports will be ready in 2025 (Fasan, 2024) . With the introduction of CSRD, the aim is to offer transparency and information on a company´s impact on humans and the environment. In particular, the purpose is to disclose this information to potential investors, consumers, and stakeholders (European Commission, 2022).

1.1 Problem Statement

With the introduction of the CSRD and its new reporting requirements, a vast number of newly affected companies, as well as formerly subjected companies must adapt to new standards and requirements. Due to the novelty of the CSRD and especially the ESRS, an existing research gap has been identified. Since companies in different sectors deal with individual topics and issues, the ESRS might pose independent opportunities or obstacles to them. This paper aims to examine the impact the CSRD has on the ICT industry. Furthermore, the objective is to gather whether there is an impact and the extent of implications that such companies potentially have. On account of the scope of this paper, the focus will be on ICT enterprises within Austria. In line with the above-mentioned aims and objectives, the following research questions have been established:

1. **How have ICT enterprises prepared for compliance with the CSRD? What were the key challenges in aligning?**

   In comparison to the NFRD, a significant additional number of companies is expected to report on their practices, and activities and disclose information on such. Due to the growing number of newly affected companies, the adaptation to such requirements was examined.

2. **What, if any, opportunities or obstacles do these companies identify in adopting sustainability reporting practices?**

As aforementioned, a multitude of enterprises are newly required to disclose their information according to the CSRD. This paper sheds light on whether such criteria introduced new opportunities.

1.2 Research Methodology

Taking into consideration the above-stated aims of this research paper, the findings were of qualitative use. For the purpose of this research paper, exploratory research was applied This form was supported by the fact that no proof or data had yet been gathered on the subject, as mentioned in earlier chapters. In the interest of obtaining a profound background knowledge on the matter of this research paper as well as supporting issues, a secondary source was utilized. To gather necessary data, facts, and information, a thorough review of available literature was conducted by using scientific publications, journals, internet publications, and statistics reports. Due to the nature of the topic, official institutional websites and files were assessed as well. This thorough collection and revision of sources acted as a profound base for the primary data collection. Primary data collection was required to answer research questions one and two, as the paper´s topic was rather new. Therefore, three structured interviews with industry experts in the field were undertaken by utilizing videoconferencing tools or meetings in person. Before meeting the interviewees, a structured interview guideline with the expected questions was shared and distributed to the respective individuals. In addition, everyone´s consent was acquired before the recording of the conversations. Although this paper´s topic is about the Corporate Sustainability Reporting Directive of the European Union, the scope of this paper was narrowed to the Austria region. The rationale supporting this range is attributed to the constraints imposed by time limitations and the specified requirements of the paper. Therefore, this research paper consists of collected data from a thoroughly conducted literature review, as well as primary data collection.

1.3 Structure of the paper

This research paper aims to give the reader a profound background knowledge of the topic, as well as an understanding of the current state of the art of the matter. Moreover, by diving into several other sub-topics of ICT, the objective is to provide a brief overview of how versatile, diverse, and sometimes unexpected ICT topics are, what these matters entail, and what their influence on our current society, respectively our daily lives, are.

In contemplation of giving the reader the necessary insight and background information to the paper´s topic, it begins with an introductory chapter. Thereby the treated matter is stated, as well as the current state of the art. Following this chapter, the research questions and aims are stated. However, prior to the research aims, the reader is succinctly led to the research questions and its targets. By providing profound background information, the aim is to hint the reader towards the matter, the issues, and the objectives of this research paper. Due to the provision of newly collected data, which was supported and facilitated by interviews, the state of the art for some ICT enterprises was assessed. The results and implications are illustrated within the last chapters to conclude this paper. To review the offered content, a summary and discussion conclude this paper. The discussion provides recent updates to the topics, press releases, etc.

2 Literature Review

The literature review of this research paper aims to provide a broader background knowledge as well as to present an overview of priorly conducted research related to this paper´s topic. Furthermore, while utilizing existing secondary literature, the status quo on pre-existing and current issues is exhibited. In order to gain a profound understanding of the matter, the literature review is fractioned into different parts. The first section lays out diverse definitions of frequently introduced formulations within this research paper. Due to the divergent available classification of terms such as sustainability, a comprehensive definition of such terms is laid out in this chapter. Additionally, to have a clear understanding of the differences and implications of carbon footprint, carbon emissions, and greenhouse gas emissions, these terms are defined as well within the first part. The consecutive division handles the available literature regarding Information and Communication Technology. In particular, the definition of the matter and its associated potentials, issues, and threats are laid out. Due to the subject matter of this paper, a strong emphasis is placed on environmental and sustainability-related topics. Attributable to the novelty of the matter, several perspectives and results of studies were included, despite the potential of a contradictory nature. The subsequent third part deals with divergent imposed directives of the European Union. To offer a comprehensive view of the entire subject, an inclusive mention of diverse directives, as well as hierarchical development is discussed. Apart from agreed-upon EU directives, international agreements are paid attention to, since oftentimes such agreements pave the way for further decisions on

international grounds. With the intent to shine a light on the below-mentioned aspects, openly available secondary literature, official statements, articles, and studies were researched online and utilized. Prior to the conduct of this literature review, the scope and availability of published data were assessed. A vast number of sources were obtainable due to open and free access. However, some information was only accessible after the explicit grant of access from the respective authors and co-authors. However, this was not always applicable.

2.1 Definition of frequently used terms

Sustainability

Nowadays, the noun 'sustainability', as well as its corresponding adjective 'sustainable' can be encountered in numerous contexts and situations, regardless of which language. These keywords are displayed on billboards, articles, and magazines and are even used in political campaigns. The strive for every aspect, product, and service to become sustainable is rising. It is seemingly used as an eyecatcher. Hans Carl von Carlowitz, (1645–1714) a former chief mining administrator from Germany transferred the idea of sustainability to forestry. According to Carlowitz, to implement sustainable action, only as much should be cut down in a forest as the forest can regenerate naturally in the foreseeable future. The principle of sustainability should therefore ensure that a natural system retains its essential characteristics in the long term. This approach laid the foundation for sustainable thinking and action (Lexikon der Nachhaltigkeit, 2015). The roots of the idea and term of sustainability reach far back into the past, researching for an official, agreed-upon definition it seemed as if the classification of this formulation is subject to interpretation. However, the United Nations Brundtland Commission agreed upon a definition in 1987. "Meeting the needs of the present without compromising the ability of future generations to meet their own needs." (United Nations, n.d.).

Greenhouse Gases

According to a definition of the UNFCC, a greenhouse gas is any gas, which absorbs infrared radiation in the atmosphere. There are several different greenhouse gases, which include but are not limited to, water vapor, Carbon dioxide (CO2), methane (CH_4), ozone (O3), etc. (UNFCCC, n.d.).

Carbon Emissions

The release of greenhouse gases and/or their precursors into the atmosphere over a predetermined region and period is referred to as emissions. Such. emissions of carbon dioxide, commonly known as CO2 emissions, are created when fossil fuels are burned. These emissions also include carbon dioxide released when solid, liquid, and gas fuels are consumed and when gas is flared (European Commission, n.d.). As mentioned in the chapters to follow, the unit of measurement for carbon emissions is metric tons of carbon dioxide-equivalent (MTCO2e), an industry-standard measure. This measurement considers multiple greenhouse gases, including carbon dioxide, methane, and nitrous oxide (AWS, 2024).

Carbon Footprint

To measure the implications of climate change on the environment, decisionmakers agreed on means to do so. Such measurements are best done by utilizing so-called footprint frameworks, as they grant a holistic approach and view of the matter (Harkiolakis, 2013). More particularly, a carbon footprint approximates the total among of greenhouse gases released throughout the manufacturing, processing, and selling of consumer products (Plassmann & Edwards-Jones, 2010).

Fiscal year

A so-called fiscal year consists of a 12-month time period, which is utilized by businesses and organizations to submit, evaluate, and report on financial accounts, budgets, and targets. Companies can choose the start of this time independently, as it does not have to begin with the traditional start of the year (The Economic Times, n.d.).

2.2 Information and Communication Technology

Searching for a commonly agreed upon definition for Information and Communication Technology proved to be more time-consuming than initially assumed. Although various varying understandings are accessible online, the following provides a thorough, however succinct explanation. The blanket term also stretches to entail the transmission, storage, and exchange of data. It circumscribes any technological device or application devoted to information and communication services. In conjunction with others, common usages, such as media, the internet, computers, telephones, and mobile phones come to mind. In

addition to hardware, also software and its related services are included in the term. Furthermore, ICT covers the technologies of satellite systems as well (International Telecommunication Union, 2014). Information and Communication Technology in this day and age has become a vital element of socio-economic growth. According to Faisal ICT can greatly influence sectors such as education, health, employment, living standards, and even income inequality. Furthermore, Faisal states that the easing of poverty, trade, energy consumption, and economic growth may depend to a degree on ICT (Faisal, et al., 2020). Considering its established potential to have both, positive and negative effects on global emissions, the ICT industry received a lot of attention in the context of climate change discussions. As Malmodin established, the ICT sector needed around four percent of the global electricity demand, which stands for one point four percent of the overall global greenhouse gas emissions four years ago, in 2020. These numbers apply to the duration of the usage of any ICT device. More than 50 percent of all greenhouse gas emissions were attributable to user devices. Nevertheless, for the usage stage, data centers and networks are in the lead (Malmodin, et al., 2024).

2.3 International Agreements and Directives

In line with the objectives to reach a more sustainable future and the net zero goal by 2050, the European Union implemented several different legislations to apply change and to attain these goals. A step in the right direction was taken with the enforcement of the Non-Financial Reporting Directive, which was adopted in 2014. The aim of the NFRD was for large companies based within the European Union to publish information on sustainability-related matters. The specifications under the NFRD targeted an inclined transparency regarding corporate activities. This directive thereby in addition granted stakeholders the potential of an improved view for a non-financial evaluation. Subsequently, these benefits led to better-informed decision possibilities for stakeholders, as well as opportunities for businesses to act more consciously (Cuomo, et al., 2022). In addition, the European Parliament decided on the adoption of the Sustainable Finance Disclosure Regulation (SFDR). This particular regulation mandates financial market participants and financial advisors to communicate and explain the identified degree of sustainability risks (European Commission, n.d.) Furthermore, the Capital Requirements Regulation (CRR) II was implemented, which aimed at regulatory disclosure for large credit institutions (Hummel & Jobst, 2024).

The latest directive, which was only decided on and adopted recently, is the Corporate Sustainability Directive (CSRD), which is set out to supersede the NFRD. Due to identified gaps, the European Union opted for another directive, closing such deficiencies, and requiring companies, which were subject to the NFRD beforehand, to report within these requirements.

3 Information and Communication Technology

The environment can be impacted by ICT in both beneficial and harmful ways. ICT use, manufacture, and disposal harm the environment. In addition, ICT activities are attributable to a rise in CO2 emissions that come from the generation of power (Higón , et al., 2017). Apart from the previously provided information about the ICT sector included in the Introduction chapter, this section aims to present and assess several different facets of the industry. It discusses the emissions of the ICT industry, including energy usage of data centers, challenges the sector faces, as well as opportunities and hopes placed onto the industry. There are public opinions concerning the negative effects of ICT usage, such as increases power consumption and more emitted greenhouse gases. However, according to Xiaoxi Zhang, the industry also aided in reducing greenhouse gas emissions due to enhanced productivity and decreased mobility (Zhang, et al., 2022). Among others, with this finding, it is evident that opinions among academics are still split on the subject. Some support the view that ICT has improved environmental quality, while others think it has led to serious ecological problems (Adebayo, et al., 2022). Nonetheless, ICT appears to be and remains a hot topic in relation to the environment, as it was established that ICT continuously positively contributes to greenhouse gas emissions. As aforementioned, the reliance on digital devices and services is steadily increasing, almost parallel are the concerns of a respective incline of greenhouse gas emissions. It was found that the ICT industry necessitated one point four percent of the global greenhouse gas emissions in 2020, while the portion of the carbon footprint remained approximately at the level of 2015. This makes up for 764 Mt CO2e total greenhouse gas emissions. Compared to the numbers of 2015 this is an increase of about five percent (Hummel & Jobst, 2024).

3.1 Environmental Impact

The ICT sector frequently earns criticism for its exponential rise in energy use. This stems from the fact that ICT devices have grown to be a necessity in today´s life. Due to this, a noticeable increase in energy demand in the manufacturing sector has been recognized.

In addition to this, the necessary electricity to generate power, any ICT device is a major contributor to the rise in CO2 emissions. This has a direct connection to both global warming and greenhouse gas (GHG) emissions (N'dri, et al., 2021). As demonstrated in the figure below, up until now only assumptions of the increase of greenhouse gas emissions due to the ICT sector have been made for the years 2015 and 2020. However, there is no official consensus on which technologies must be considered for the calculation of greenhouse gas emissions in ICT. Nevertheless, it can be stated that networks, user devices, and data centers constitute the main aspects. The studies, which have been used for this illustration are:

- Andrea & Edler: On Global Electricity Usage of Communication Technology: Trends to 2030. This study contained TVs and TV peripherals (Andrae & Edler, 2015).
- Belkhir & Elmeligi: Assessing ICT global emissions footprint: Trends to 2040 & Recommendations. This study did not include TVs (Belkhir & Elmeligi, 2018).
- Malmodin & Lundén: The Energy and Carbon Footprint of the Global ICT and E&M Sectors 2010–2015. This research included TV networks as well as other end-user devices and paper media (Malmodin & Lundén, 2018).

Carbon footprint estimates for the worldwide ICT sector in 2015

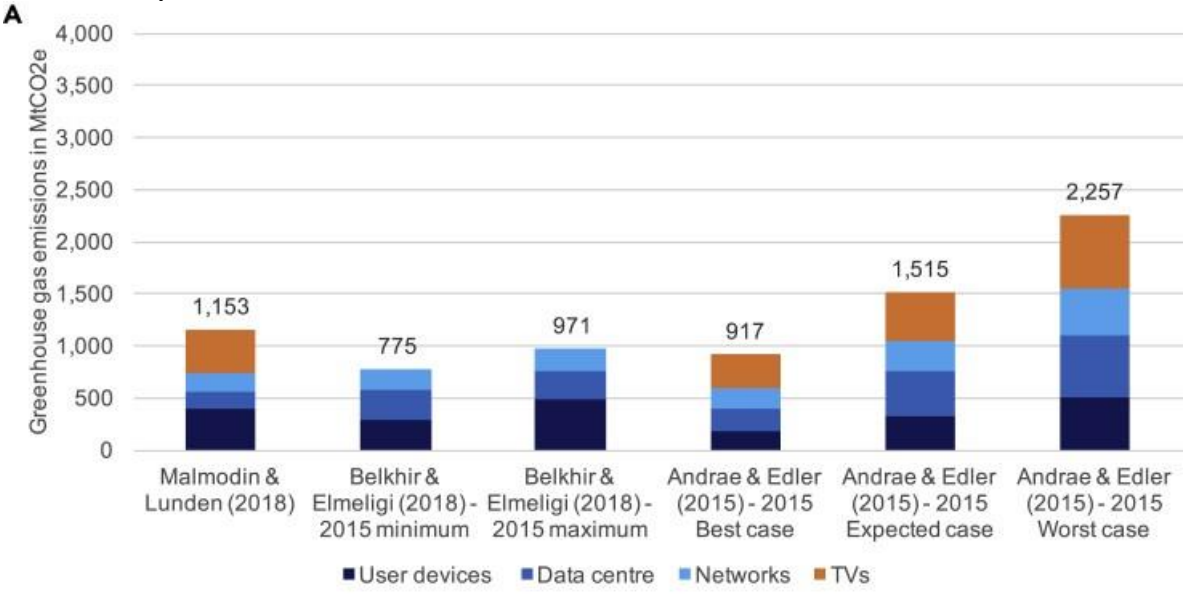

Figure 1: Carbon Footprint ICT 2015 (Freitag, et al., 2021)

Carbon footprint estimates for the worldwide ICT sector in 2020

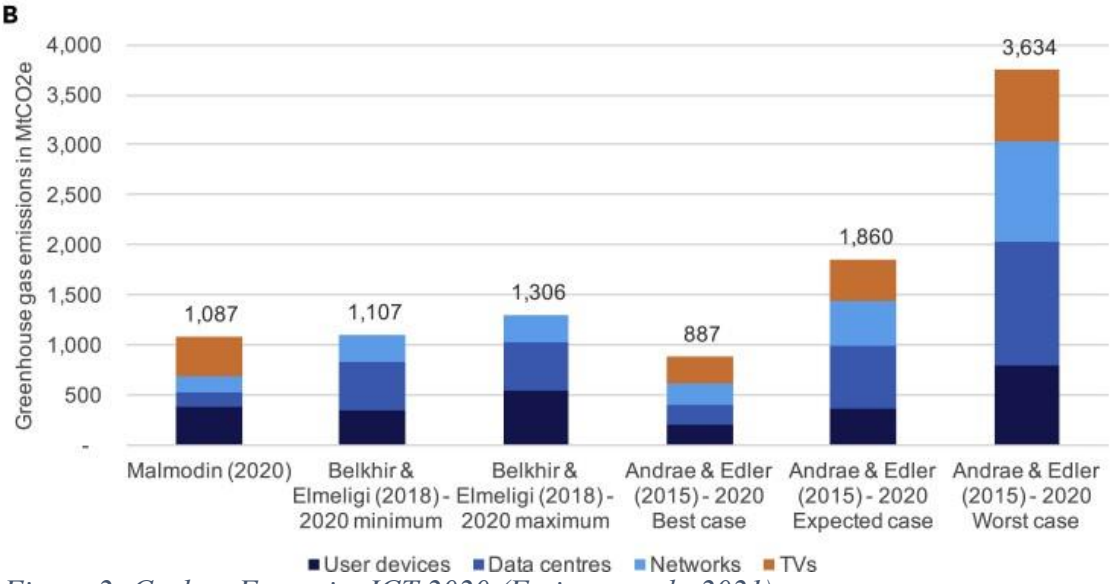

Figure 2: Carbon Footprint ICT 2020 (Freitag, et al., 2021)

In accordance with the research of Belkhir and Elmeligi, a comparison between the sections within the ICT sector, their growth, and respective greenhouse gas emissions has been established. Numbers for the years 2010 and 2020 are displayed side by side, demonstrating the relative GHG emission footprint. For 2020 it illustrates the increase of data center contribution to the greenhouse gas emissions of more than ten percent, while the percentage for phones has more than doubled (Belkhir & Elmeligi, 2018).

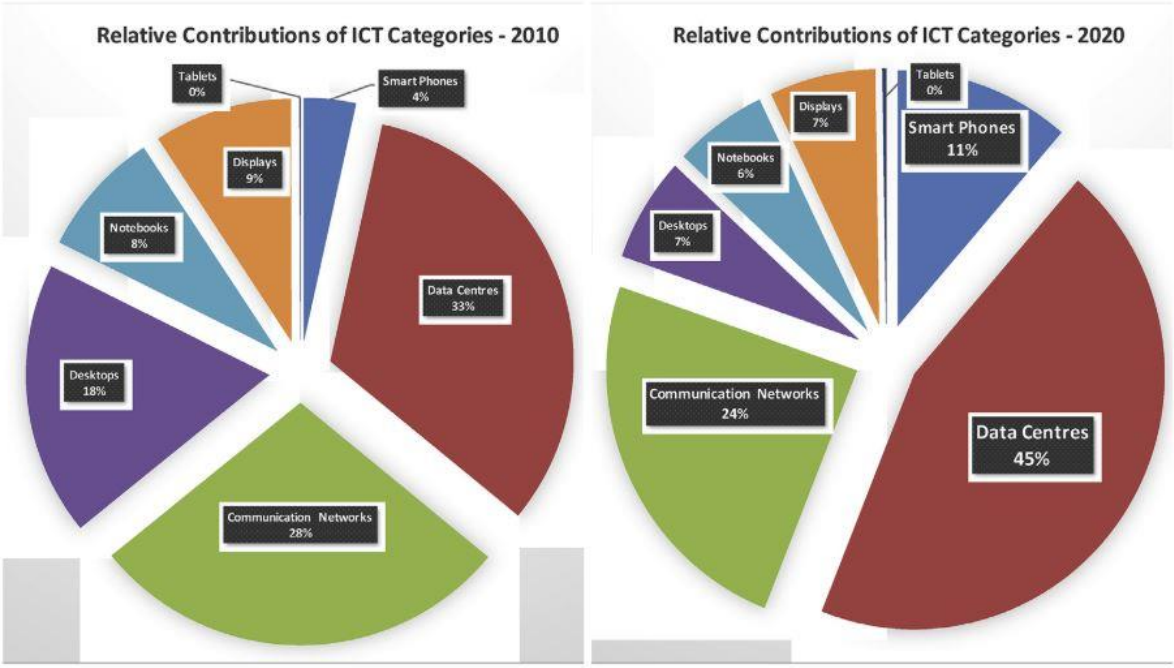

Figure 3: Relative Contribution ICT (Belkhir & Elmeligi, 2018)

Furthermore, emissions are emitted during the various stages before, within, and after the manufacturing processes of any ICT-related device. This commences with the extraction of raw materials required for the production involved in creating such a device, up to further process, assembling, etc. Emissions released continue to the delivery of finished goods to enterprises, sales point up until the end-user or customer. Moreover, to the physical processes, the operations within the ICT industry contribute in addition to further GHG emissions (Charfeddine & Umlai, 2023). Therefore, and expanded carbon footprint generated by emitted greenhouse gases (GHG) is attributable to the global ICT industry. In addition to the previously stated stages within the manufacturing process, also maintenance, as well as end-of-life emissions (e-waste), contribute to the emissions count (Freitag, et al., 2021). ICT emissions are further increased by so-called operational emissions from the ICT sector and the regular use of its goods and services. In addition, there are emissions from the ICT sector's operations, such as the energy used for routine tasks (like data centers) and maintenance, which includes end-of-life emissions from the disposal of ICT and other electronic waste (Charfeddine & Umlai, 2023). In addition, according to the European Framework Initiative for Energy & Environmental Efficiency in the ICT Sector, sending one e-mail generates four grams of CO2 emissions, while an e-mail with an attachment creates 50 grams of CO2 emissions. Furthermore, the ICT industry is accountable for eight to ten percent of energy consumption within the EU (ICT Footprint EU, n.d.).

3.2 E-Waste

The umbrella term E-Waste, also commonly known as WEEE (as waste of electrical and electronic equipment) defines discarded electrical or electronic appliances. Contrary to popular belief, encompassed within this term are not only ICT devices. Furthermore, E-waste includes larger home appliances, such as electric stoves and washing machines, computers, printers, and mobile devices of any kind. Moreover televisions, solar panels for non-commercial use, and smaller devices such as toasters and medical equipment (European Parliament, 2024). E-waste counts as the most rapidly growing type of waste and causing major concern globally (Ghulam & Abushammala, 2023) . High rising demand for consumer electronics, rapid technical advancement, and urbanization within the fast-paced society we live in are some of the contributors to the generation of E-waste over the last two decades. In addition, due to the increasing trajectory to follow short-lived trends, the need to change or upgrade electronic devices contributes further to the E-waste creation (Budd, et al., 2020). The improper disposal of such E-waste can have potential detrimental impacts on human health and the environment. The discarded devices consist of many different substances, some of which entail toxic pollutants. Improper waste disposal might lead to potential risks of these pollutants leaching into surfaces, soil, or groundwater or the airborne emission may be of threat to public health, animals, and the environment. Due to these factors, proper waste disposal is of utmost and increasing importance (Ghulam & Abushammala, 2023). E-waste is generated by different sources and sectors. In developing countries, however, such as China, India, or Nigeria (among others) the E-waste attributable to the ICT sector is inclining. This particular rise is subsequently causing inconveniences in waste management (Ilankoon, et al., 2018). Due to the very nature of the industry and its purpose, the ICT sector is dependent on electrical and electronic equipment. Such tools or products entail various substances and materials, with usually minor life spans. This may be due to new technologies or updates emerging rapidly. Although varying, single materials or components might be extracted by the appliance of proper techniques and further utilized. For instance, non-hazardous substances, such as glass, aluminum, etc. may be extracted and further put to use for different purposes. Hazardous materials, such as Mercury or Lead require a particular extraction method to be properly recovered and secured (Vishwakarma, et al., 2022).

To illustrate the extent of electronic waste, the overall amount of electrical and electronic equipment collected increased from 3.0 million tonnes to 4.9 million tonnes between the years 2012 and 2021. With an average of more than 15 kilos (kg) per inhabitant, Austria is the leader of the EU Member States in electronic waste collection. Closely followed by Finland with an average amount of 14.68 kg per inhabitant. Last on the ranking is Cyprus with 3.96 kg of collected e-waste per inhabitant (European Parliament, 2024; Perkins BS, et al., 2014).

3.3 Data centers

Fundamentally, data centers are extremely specialized spaces created to handle, distribute, and store enormous volumes of data. Such data ranges from emails, and financial transactions, to video streaming services (Wilson 2023). Hence, data centers are crucial premises for any digital service or devices dependent on connection, data, or information. However indispensable, such data centers are among the most intricate and energy-intensive buildings, due to their density of devices and their consequent complexity. Furthermore, such facilities contain a notably high concentration of ICT peripherals, such as servers, computers, media for data storage, network devices, and electronic accessories. In addition, data centers house infrastructure for power distribution, standby generators, and cooling systems which can be fans, air conditioning systems, cooling towers, and, among many others, also artificial lightning. Moreover, power supplies ensure a continuous power supply, which then consequently secures efficient cooling, lighting, etc (Balaras, et al., 2017). According to a study from Katal, data centers alone will use 2967 TWh of energy by the year 2030. This number increased up from 200 TWh in 2016. CO2 emissions rise because of the data centers' high-power requirements for operation (Katal, et al., 2022). More particularly, the energy usage can be partitioned into different categories. Commencing with the least consuming, auxiliary lighting accounts for three percent, while the distribution system attributes for ten percent, and the energy consumption of air-cooling credits about 37 percent. The remaining fifty percent of energy usage results from the ICT equipment. In order to combat such large numbers of energy consumption, larger enterprises transfer their data establishments to naturally favorable locations. In particular, this means that companies relocate their data centers to areas in colder climates, where the energy usage is lower due to advantageous natural circumstances, such as high latitudes in the Arctic zone. Favorable conditions in these cases are colder air, appropriate levels of humidity, and the availability of renewable

energy. All of which consequently eradicate the necessity of artificial cooling for the stored devices in data centers (Liu, et al., 2020). The Nordic region has grown over the last ten years to become a powerhouse for the European data center business. This trend seems to be continuously growing (Saunavaara , et al., 2022). According to a joint study by Jan C.T. Bieser and colleagues, 1.5 percent to 4 percent of the global GHG emissions are caused due to the ICT industry. The manufacture of end-user devices is the largest contributor to greenhouse gas emissions, and in accordance with Bieser, this trend is expected to continue as the number of devices and their GHG intensity rise (Bieser, et al., 2023).

In order to comprehend the severity and the impacts data centers have on emissions, the figure below fosters the visualization. Divided into different types, the greenhouse gas emissions of data centers are distinguished, among others, for cooling, heating, electricity, and indirect emissions. According to Kilgore, data centers were accountable for two point five to three point seven percent of the global greenhouse gas emissions in 2023 (Kilgore, 2024).

Figure 4: Globa GHG emissions sector (Kilgore, 2024)

3.4 Artificial Intelligence

The term AI, referring to Artificial Intelligence, is nowadays broadly and often used in media, news, and even academia. In both industry and academia, artificial intelligence and machine learning have grown increasingly popular (Richins, et al., 2021). With such

embedded smart technologies in our everyday lives, Artificial Intelligence is surely not a new technology, however an increasingly emerging one. By welcoming applications of AI, such as Siri (created by Apple), Cortana (by Microsoft) or Alexa (creation of Amazon), into our lives and homes, the technology paved its way to an almost indispensable daily digital assistant. Such digital helpers are utilized for carrying out basic personal tasks, replying to questions, as well as for further advanced requests (Brill, et al., 2019). Consequently, to these developments, among many domains within the ICT industry, Artificial Intelligence stands out with the greatest recorded growth. AI is said to bear the potential to significantly improve many facets of human life, ranging from smart cities and driverless cars to better healthcare and low-carbon economies (Technology Ireland ICT Skillnet, n.d.). Furthermore, the utilization of such technology in a professional context allows for reliance on non-human based skills. More efficiency based on faster decision-making can result in higher productivity, as well as profitability. Due to this, AI was noted to aid economic activity, among others, in field such as manufacturing, transportation and commerce (Sarker, 2022). Moreover, the possibility of AI tools being utilized for the mitigation, reduction and halting the climate crisis is being explored. At this moment, it seems to be an enormously compelling opportunity in regard to the climate change mitigation. In order for Artificial Intelligence to be utilized as a tool to combat the climate emergency, so-called Machine Learning techniques may be of use. Thereby a prediction on climate change, on national and international range could be made, as well as the provision of necessary policy recommendations to drive change related to emissions. In accordance with findings from a collaborative study by Microsoft and PWC, an integration of Artificial Intelligence into the context of environmental impact mitigation, presents a potential to reduce GHG emissions in a range of one point five percent to four percent. Within their research direct and indirect influences of AI to the improvement of GHG emissions for the environment are stated. Such direct applications of AI tools could potentially lead to effects such as a reduction of the GHG intensity, enhanced energy intensity in households and industry, as well as a change in energy mix for specific sectors (Taddeo, et al., 2021). Notwithstanding the aforementioned expectations and hopes placed onto Artificial Intelligence for the environment, AI seems to hold a dual role, as referred to by Payal Dahr. Apart from the before stated positive aspects of AI, the emerging technology itself stands to be a threat to the environment as well (Dahr, 2020). This is due to the fact that AI models are contributing positively (adding to the amount) the carbon emissions and air

pollution. According to a conducted study by the University of Massachusetts Amherst, larger AI models emit 626,000 pounds of CO2, which converted in the metric system, results in 283.442 tons of CO2 emissions (Strubell, et al., 2019). In accordance with Shaolei Ran and fellow research colleagues at the University of California, it was discovered that the training (fuelling the AI model with selected data in order to be able to promptly answer queries) of ChatGPT-3, an AI tool of OpenAI, utilized approximately 700,000 litres of freshwater in its data center. Furthermore, he distinguishes between onsite and offsite water consumption. Both together are then referred to as operational water consumption (Ren, et al., 2023). This main factor can be attributed to the training process, which necessitates a considerable energy amount that is subsequently converted into heat. To facilitate the maintenance of temperature control and the cooling machineries, a high amount of freshwater is needed (Mclean, 2023). Moreover, Ren et al, revealed that ChatGPT necessitates and consumes half a litre or 500 millilitres (ml) of water, which can be visualized as a small water bottle or two glasses of water, per ten to 50 requested queries (Ren, et al., 2023). Thereby contributing tremendously to its water footprint. In Figure 5 an estimation is depicted of how many numbers of Chat GPT-3 prompts would be needed to consume 500 millilitres of water. The reason the number of prompts differs is that the amount is depends on the location of where the AI model is hosted

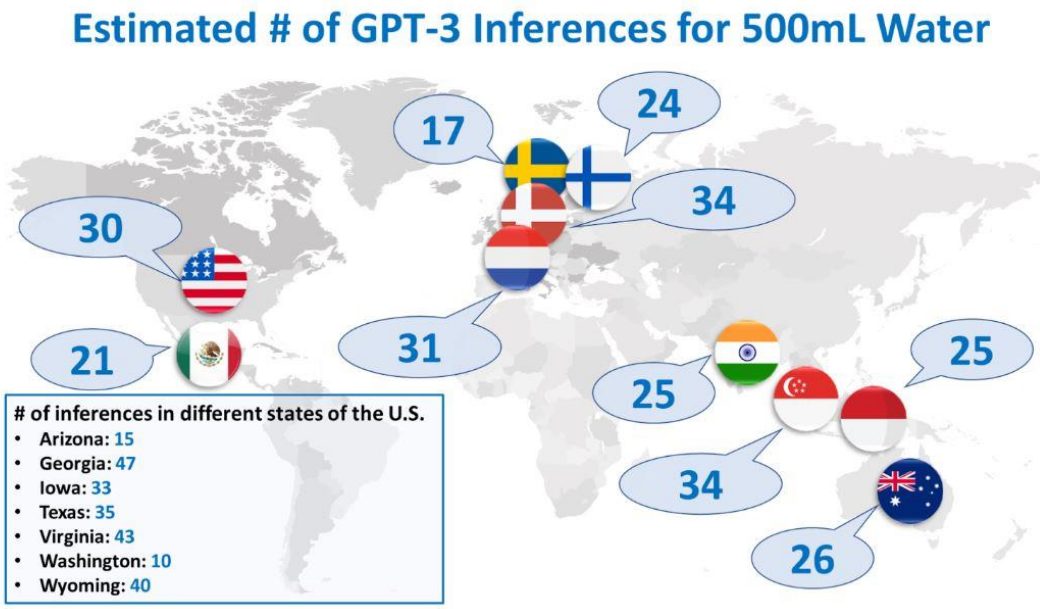

Figure 5: Water consumption GPT (Re, et al., 2023)

3.5 Cryptocurrencies

Crypto assets, digital currency or more commonly known as cryptocurrencies is the term used for digital assets, which were developed in order to be implemented as a form of

exchange, comparable to traditional money (Tredinnick, 2019). In 2020, ICT accounted for one point eight to two point eight percent of worldwide greenhouse gas emissions. According to a study from Allianz, under the assumption that the emission intensity of energy utilized remains constant, the ICT industry will account for 830 MT of CO2 emissions by 2030. And this is before the rise of cryptocurrencies like Bitcoin and Ethereum are considered, which take up to 240 terawatt-hours of power per year, more than Australia's total annual electricity usage (Zimmer & Holzhausen, 2023). Due to its role as a manner of digital exchange, it is furthermore completed through a solid encryption mechanism. Consequently, this process then regulates the number of stocks (Luu, et al., 2016). One of the most famous cryptocurrencies existing is Bitcoin, a peer-to-peer concept (an IT concept which allows two or more computer systems to connect, share and exchange resources without the need for a separate instance, like a server), created by Satoshi Nakamoto (Nakamoto, 2008; Ultimaco, n.d.). The primary intention behind the idea was to build a transaction system that was free of interference by any central or monetary influence. In addition, it was meant to be founded was founded on the base of a mathematical formula. The purpose and its point of persuasion is that payments can be made electronically in a secure, verifiable, and indisputable manner (Kayal & Rohilla, 2021). Despite the innovative and fresh approach cryptocurrencies brought to the world, their creation or generation requires knowledge, technology, and vast amounts of energy. The performance of a Bitcoin transaction necessitates a computer infrastructure, which contributes to the network by solving the cryptographic challenge. The contributor would then be rewarded for performing this Proof-of-Work (PoW) process, which is often referred to as mining. These computational units (miners) require a significant quantity of electrical power to function. Mining cryptocurrencies becomes economically viable when the value of the acquired cash reward exceeds the expenses of participation, resulting in a large increase in power usage. It is believed that around one million Bitcoin miners are operational, as of 2024, throughout the world (Carter, 2024). In order to assess the among of energy Bitcoin mining requires and the environmental footprints associated with it, the Cambridge Bitcoin Electricity Consumption Index (CBECI) was invented by the Cambridge Center for Alternative Finance (Cambridge Centre for Alternative Finance, 2023). On a global scale, 39 percent of Proof-of-Work mining is driven by renewable energy, whereas the remainder, which is around 61 percent, is fuelled by non-renewable energy sources, such as fossil fuels. Cryptocurrency mining, with its significant usage of fossil fuel energy, adds to global carbon emissions as well as resulting in its associated

environmental damages (Jones, et al., 2022). Irrespective of the source of energy utilized for bitcoin mining, its creation and transmission evidently bears a tremendous impact on the environment. According to statistics of Digiconomist, each Bitcoin transaction is estimated to have the same or even higher carbon footprint as over a million Visa transactions (Digiconomist, 2023). Nonetheless, it was found that the Bitcoin mining is heavily reliant on fossil fuels. As visible in the Figure five, 67 percent stem from fossil fuels, while 45 percent of coal constitute the biggest portion. In addition,16 percent of Hydropower make up the share of the largest renewable source of energy. However, it cannot be neglected that it has a large water footprint, due to experiencing losses because of evaporation and generally a larger land footprint than other renewable energy sources.

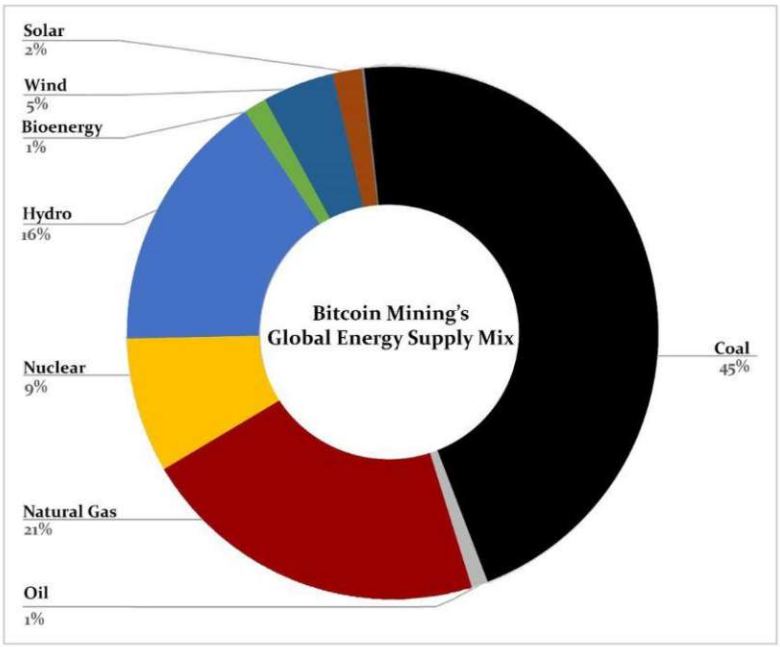

Figure 6: Bitcoin Energy Mix (Chamanara, et al., 2023)

The following figure demonstrates the electricity use of Bitcoin mining per country in Terrawatt-hours (TWh) from 2020 to 2021. The illustration shows that China, with a value of 73.48 TWh exceed the United States with a value of 32.89 TWh (Chamanara, et al., 2023).

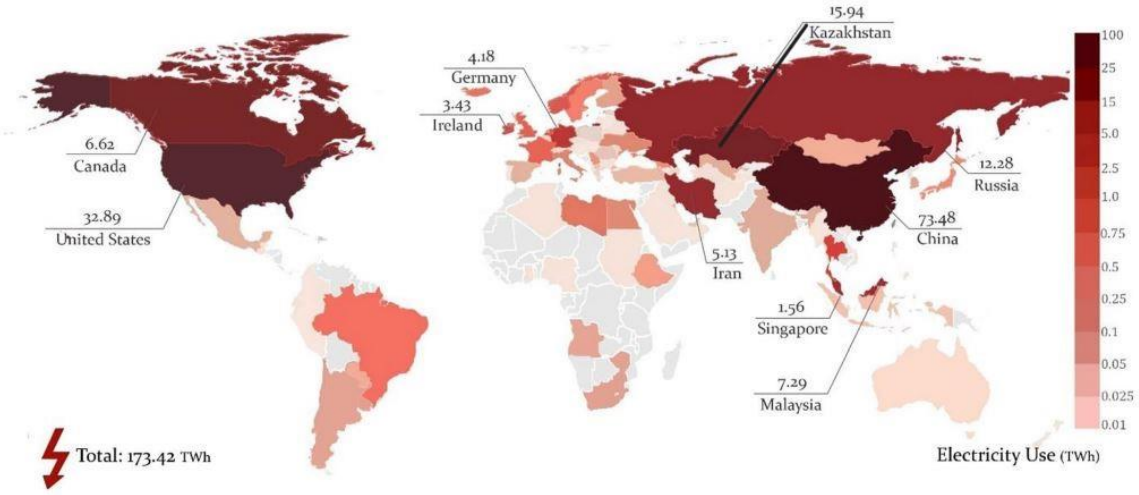

Figure 7: Bitcoin Electricity Use (Chamanara, et al., 2023)

In the research of Chamanara, a suggestion for counterbalancing the carbon footprint of China´s activities were proposed. In order to offset the emissions from 2020-2021, around two billion trees would have to be planted. This number would equal the size of Portugal, Ireland, or New York´s Central Park multiplied by 45,000. The following figure illustrates which nations are accountable for the biggest electricity use, carbon, water, and land footprint ranking from highest to lowest (Chamanara, et al., 2023).

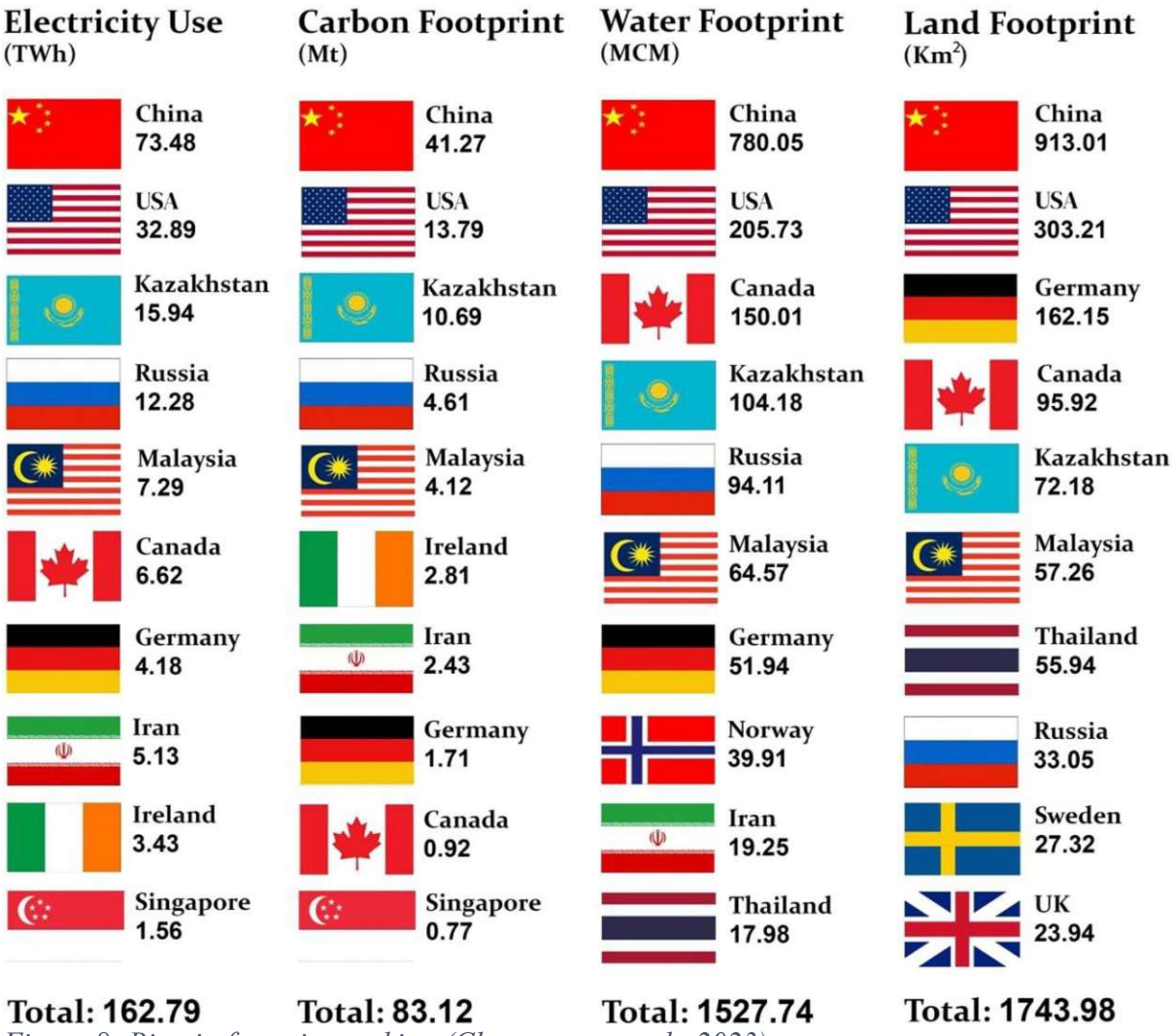

Figure 8: Bitcoin footptint ranking (Chamanara, et al., 2023)

3.6 Internet and Media

As discussed previously, many aspects of the ICT industry contribute to negative environmental aspects. In addition to this, it was identified that the Internet represents a major polluting number of two to four percent of global greenhouse gas emissions. These numbers are the same as for the aviation industry. The average person streams content for five hours a day, releasing up to one point fifty-seven million tonnes of CO2 emissions, equivalent to zero point fifty-seven billion tonnes per year (Lawrence, 2023). Furthermore, the Internet traffic has varying negative environmental implications and contributes to climate change determined by energy supply mix and efficiency. As internet users expand, so does the number of online services and apps they utilize as well (Obringer, et al., 2021).

4 International Agreements

For the purpose of following the hierarchical developments and to provide a common thread, the international agreements are discussed in their order of enforcement. Henceforth this part of the research paper first explains the background, content and purpose of the Kyoto Protocol are laid out. Following this cornerstone, the Paris Agreement and its purpose are defined. Lastly, the European Green Deal is described.

4.1 Kyoto Protocol

In 1992 countries joined the United Nations Framework Convention on Climate Change (UNFCCC), which acts as a framework for international collaboration to prevent rises in the average world temperature and the ensuing climate change, as well as to deal with effects that were by that point already unavoidable (UNFCCC, n.d.). Since then, 198 parties (countries) are part of the UNFCCC and are taking actions to withstand and improve the climate crisis (United Nations Climate Change, n.d.). In addition, an effort has been made to reach a consensus on actions that would stabilize atmospheric concentrations of greenhouse gases at a level that would stop the hazardous anthropogenic (human caused) interference with the climate system. In addition, the international scientific panel tasked with evaluating climate change, the Intergovernmental Panel on Climate Change (IPCC) contributed to the global aims. In order to reach the objectives of the UNFCCC, it was of utmost importance to limit the rise in the world's yearly average temperature to less than two degrees Celsius over preindustrial levels. However, the UNFCCC since has had trouble maintaining the global warming within the bounds set by the IPCC (Savaresi, 2015). In 1997, the UNFCC accounted for 160 countries. At this time, the parties agreed on and adopted the Kyoto Protocol, during the Conference of Parties (COP), which are held annually, was conducted in Kyoto, Japan. This protocol set legally binding emissions limits for industrialized nations on carbon dioxide and other greenhouse gases for the first time in history. Due to various political, economic, scientific, and legal challenges that are brought up by human-induced climate change, the Kyoto Protocol was formulated highly intricate (Breidenich, et al., 2017).

4.2 Paris Agreement

An international agreement on climate change that is legally binding and quite recent, is the Paris Agreement. The Paris Agreement was created and agreed upon during the COP21 in Paris, France. Overall, 196 parties adopted it, which led to its enforcement in

2016. Since the need was identified for such an agreement, its objectives cover the aim to restrain any temperature increase to one point five degrees Celsius, above pre-industrial levels. In addition, on the global scale to maintain an average temperature under two degrees Celsius. This is supported by the repeated statements of officials and scientists that it is of utmost necessity to keep global warming to one point five percent until the end of this current century. Backed by the IPCC, crossing the threshold of one point five percent degrees Celsius would inevitably lead to significant climate change implications and weather conditions. Droughts, heatwaves, and rainfall could be severely strong and its consequences as well. The emphasis within the Paris Agreement is put onto limiting global warming to the before mentioned threshold, as well as lowering greenhouse gas emissions significantly. In absolute terms, GHG emissions must decrease by 43 percent bs 2030 (UNFCCC, n.d.).

4.3 The European Green Deal

Since climate change and environmental degradation are existential threats to Europe and the world, the necessity to counter these threats is rising. Therefore, the European Commission introduced the European Green Deal (EGD) in 2019. In essence, the EGD is a comprehensive approach which encompasses different important policy areas (Sandri, et al., 2023). The transition to a modern, resource-efficient, and competitive economy is an urgent attempt to combat the increasing danger. Objectives to be pursued, in order to stand a chance in improving the status quo include the halt of net greenhouse gas emissions until the year 2050. Ultimately, the European Green Deal is striving towards achieving climate neutrality by 2050 (European Council, n.d.). Moreover, all 27 Member States cooperate in establishing an economy that achieves economic growth independent from resource consumption. All these goals are to be attained without leaving a place or person behind (European Commission, n.d.). Policy areas affected include energy-efficient construction, just transition, renovation interventions, clean and secure energy, biodiversity, a sustainable food system, fisheries and agriculture, sustainable industry, and smart mobility (Sandri, et al., 2023). In light of supporting these goals, the European Commission endorsed a series of further initiatives, legislations and directives. These initiatives are aimed to prepare the climate, energy, transport, and taxation policies for reducing net greenhouse gas emission by a minimum of 55 percent by the year 2030. These values, which are to be attained in six years have to be taken into comparison and consequently

into analysis with the pre-existing values from 1990 One of the initiatives supporting the EGD objectives further is the 'Fit for 55 package', compromising proposals aimed at revising and updating EU legislation. Furthermore, its additional aim is to implement new initiatives. Subsequently, the overarching target is to align EU policies with the climate goals agreed upon by the Council and the European Parliament. In order to pave the legal way for these proposals, the European Climate Change Regulation (in German Europäisches Klimagesetz) translates the political ambition to attain climate neutrality by 2050 into a legal commitment for the European Union and its Member States. By approving it, the EU and its Member States have pledged to reduce the net greenhouse gas emissions as previously mentioned. Covered by this rule, the provision of a timeline for emissions reduction through 2050 is required. Moreover, residents, firms and stakeholders must be granted transparency, as well as framework must be put in place to monitor and report progress. Lastly, the guarantee for an affordable and equitable green transition must be offered (European Council, n.d.).

5 ESG Reporting

This subsequent chapter addresses the subject matter of the reporting directives imposed by the European Union. More particularly, with over 2,400 ESG rules in place throughout the world, sustainability reporting or also referred to as ESG (Environmental, Social, Governance) reporting is becoming an increasingly important aspect of company compliance. The European Union, in particular, has been in the vanguard of this trend, enacting extensive ESG legislation with far-reaching consequences for corporations operating under its authority (Bernoville, 2024). In order to have a common understanding of what a directive is, the power and requirements it holds, this part of the research paper aims to describe the term. In accordance with the official definition of the European Union, a directive is a legislative act that specifies an objective that European Union Member States must accomplish. Nonetheless, each individual country holds the responsibility for developing their own laws in order to meet these aims (Directorate-General for Communication, 2022). Besides the, within this chapter, mentioned directives, some other fundamentally important ESG frameworks and standards are the Sustainable Finance Disclosure Regulation (SFDR), the Corporate Sustainability Due Diligence Directive (CSDDD) and the Carbon Border Adjustment Mechanism (CBAM) (Bernoville, 2024).

5.1 Non-Financial Reporting Directive (Directive 2014/95/EU)

In order to reach net zero by 2050 and to foster change for a sustainable economy, the European Union imposed several different legislations to support these objectives. In line with these aims, the European Parliament and the Council of the European Union adopted the Directive 2014/95/EU. Thereby the EU dedicated a directive aimed for disclosure of non-financial and diversity information, also commonly known as the Non-Financial Reporting Directive (hereinafter NFRD), in October 2014 (EUR-Lex, 2014). Companies registered in the EU Member States, falling under the diligence to report according to the NFRD, were required to include non-financial statements to their annual reports for the financial year ending on December 2017 or later (Cuomo, et al., 2022). After the adoption of the Single Market Act also known as the Accounting Directive (Directive 2013/34/EU) in 2011, the European Commission recognized the necessity for a directive providing a transparent view into social and environmental information by all enterprises of all industries. Similar to the Single Market Act, the NFRD was enforced for all the Member States (EUR-Lex, 2014). The expectation of the NFRD was that more transparency would make businesses more resilient and effective, in financial and non-financial terms. Increased data disclosure could eventually lead to more strong growth and employment, as well as increased confidence among stakeholders such as investors and customers. Transparent corporations are also consistent with long-term investment, as demonstrated by the impact assessment of Directive 2014/95/EU (European Commission, 2017a). Among the EU Member States, the NFRD mandated large, listed companies, banks, and insurance companies with more than 500 employees to release reports detailing and elaborating on their policies concerning various company-internal impacts. Social responsibility, treatment of the companies 'employees and adherence to human rights fall under these points. Furthermore, companies had to include information on their efforts against corruption and bribery, and the diversity within company boards considering age, gender, personal and professional background. Moreover, such enterprises were obligated to publish information on their business models, risk assessments, and key performance indicators etc. (Europäische Kommission, 2014).

In order to provide a similar ground for consistency and comparison, as stated within the NFRD, the Commission published non-binding reporting guidelines in 2017. These suggested standards were intended to help corporations meet their reporting responsibilities under the non-financial disclosure requirements of the time. The Commission aimed to

enable effective corporate reporting, as it is of the opinion that companies benefit of their provision of data transparency. The purported benefits include attracting new staff and lowering finance expenses. In general, it might be claimed that having more knowledge allows for better business judgments. Despite the fact that the NFRD compels previously mentioned companies to publish data on ample aspects, it grants these companies flexibility in their approach to do so. This autonomy allows for companies to report in a chosen manner. The guidelines were put forward as recommendations, which were not meant to increase administrative load drastically (European Commission, 2017a). Yet, as these guidelines were not mandatory, firms could choose which guidelines to adhere to. Typically, a company made this decision dependent on its business environment, or generally according to its specific circumstances. Due to a rather vague definition of the type of information, the degree of detail and the format of the data. The loose definition of the type of information expected to be published, the format of disclosure, and the missing instructions on the structure displayed a notable level of inconsistency. This intricacy posed challenges for those preparing the information and introduced ambiguity for users (EFRAG, 2021). Despite the fact that the adoption of the NFRD acted as a vital pathway for further enhancing Corporate Social Responsibility within the European Union, increasing concerns were raised. Stakeholders, investors, and civil society organisations gradually requested a regulated framework in regard to non-financial reporting. These requests are backed by the appeal for further and more detailed information on companies´ social and environmental actions and potential impact (European Parliament, 2021).

5.2 Corporate Sustainability Reporting Directive

Recurrent and persistent criticism of previously stated deficiencies of the NFRD led to a vital review of the NFRD. Flaws and inconsistencies concerning reliability and comparability were detected. Due to the profound revision of the directive, a proposal with improved key points was compiled. In June 2022 a provisional agreement of the Corporate Sustainability Reporting Directive (CSRD) was presented. Subsequently, the European Union decided on the adoption of the latest reporting directive aimed towards more sustainability and transparency in November 2022 (European Commission, n.d.; CSR in Deutschland, n.d.). The Directive requires enterprises to publish information on what they deem as risks and opportunities stemming from social and environmental issues. Furthermore, they are asked to share data on the effect of their company´s actions on the environment and people. Despite the primary intent of improving the established

shortcomings within the NFRD, the objectives placed onto the CSRD are also to aid investors, consumers, and other (potential) stakeholders in assessing their sustainability performance and intents. These goals are in line with the overall objectives of the European Green Deal (European Commission, 2023). The CSRD comes into full effect starting from fiscal years, which begin either on or after January first, 2024. Companies, already subjected to report under the NFRD, automatically are obligated to report under the CSRD as well. Following this time declaration, the first companies will have to publish their CSRD reports in 2025 (European Commission, n.d.). The latest imposed Directive is set out to supersede the NFRD not only in the numbers of subjected companies. However, the number of impacted firms expanded significantly. A bigger range of large enterprises, as well as publicly traded small and middle-sized enterprises (SMEs), will now be expected to report on sustainability. Some non-EU enterprises will also be required to declare if their revenues exceed EUR 150 million on the EU market. An exception to the mandated firms is listed micro-enterprises (European Commission, n.d.). In contrast to the NFRD, under which 12, 000 companies within the EU were required to disclose their information to, the CSRD requires 50, 000 firms to publish their data. This noticeable addition of enterprises is due to the fact that 40, 000 EU companies and 10, 000 non-EU firms will be subject to report (Holzheuser, et al., 2023). In addition, it introduces more detailed reporting requirements, such as the obligation to report in accordance with European Sustainability Reporting Standards (ESRS). Furthermore, with the adoption of the CSRD, the incorporation of sustainability information into management reports is laid out, as well as an external assurance requirement. Moreover, newly implemented with the CSRD is the requirement of digital tagging of reported information (Hummel & Jobst, 2024). The CSRD provides for a successive approach of the new reporting requirements. For companies with an existing reporting obligation under the Non-Financial Reporting Directive (NFRD), the adherence is planned for the annual report with becoming public in the year 2025. For the remaining undertakings will be affected by the new reporting criteria from 2026 or 2027. The following overview shows the exact scale of these.

- *Fiscal year 2024 to the 2025 annual report*
  Large companies with an annual average of 500 employees or more. Companies, matching these numbers are thus far already mandated to a reporting obligation under the NFRD.

- *Financial year 2025 to the 2026 annual report*
  Either all other large enterprises with 250 employees or more on an annual average, a balance sheet total of €25 million or €50 million turnover. Two of these three criteria must be met for a company to fall within the scope of the CSRD.

- *Fiscal year 2026 to the 2027 yearly report*
  Listed SMEs as well as small credit institutions and insurance enterprises. A company is classified as small or medium, if it meets two out of these three conditions, such as the total of the Balance sheet exceeds 350,000 Euro. The turnover exceeds 700,000 Euro or the number of employees accounts for more than ten.

- *Fiscal year 2028 to the 2029 annual report*
  Third-country companies with subsidiaries or branches in the EU. This only applies if the mark of EUR 150 million net sales in the EU is overtaken, within two years.

The graduate approach holds the benefit of providing for a transitional phase for companies before the full reporting obligation is entered into force (Denkstatt, 2023). As the novelty of the obligation and the overall topic can be identified by the application dates, this thesis stems from the freshly published obligations and requirements. For the case of uncertainty, whether an undertaking must comply with the CSRD or not, the following illustration is to aid with the evaluation process:

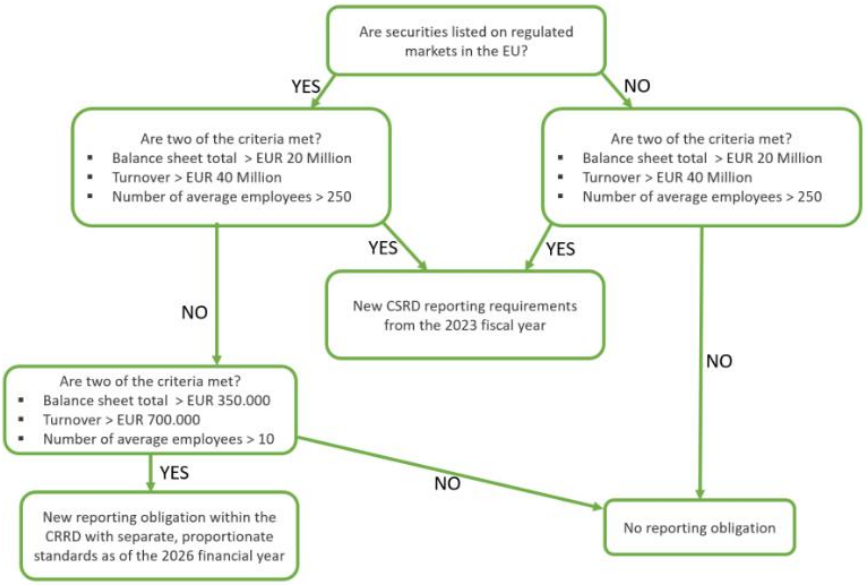

Figure 9: CSRD Compliance (Fuhrmann & Kerbl, 2022)

In order to clarify which other factors distinguish the CSRD from the NFRD and to emphasize its necessity, the most important altercations are:

- *Third-party auditing*
  Under the CSRD it is mandatory to consult a third-party auditor to check the reports. This may be an auditor or an independent assurance organisation.
- *Reporting Format*
  The NFRD allowed for a free choice of format, however, affected companies must provide their CSRD reports in XHTML format. The European Single Electronic Format (ESEF) sets to improve accessibility, analysis, and comparability of annual financial reports (European Securities and Markets Authority, n.d.).
- *Stand-alone report*
  Companies are mandated to submit their CSRD reports as a separate section in the management report.
- *Double Materiality (chapter 5.2.1)*

(AMF, 2024)

5.2.1 Double Materiality

The principle of materiality determines the subjects an enterprise must report on. The European Union regulation on non-financial disclosure defines materiality as a combination of financial and impact materiality, resulting in the term "double materiality" (DM) (De Cristofaro & Gulluscio, 2023). Due to this, companies are required to report on their implications on people and the environment, as well as in what manner social and

environmental concerns generate financial risks and possibilities for the organization (UN Environment Programme, 2024). More precisely, enterprises must include financial materiality in the materiality analysis according to the so-called 'outside-in' perspective. This ensures that an enterprise addresses factors which could impact their financial situation. Moreover, the impact materiality entails that the reports of an enterprise must consider the company's impact from the inside-out perspective, which refers to the aforementioned impact materiality. This approach grants an insight into the impact an enterprise has onto the outside world, not lastly in order for how (potential) investors, stakeholder and organizations to obtain a clear impression of a company's activities. In essence, the concept of double materiality is meant for companies to face their actual positive and potentially negative influence it might have onto the environment and society. In addition, almost simultaneously, external factors and their impacts on the company´s profitability are considered (Zauchner, n.d.). In order for a company to know what of their firm´s activities etc., is subject to materiality, a materiality assessment must be carried out. As notably mentioned, many times prior to this chapter, impacts, risks, and opportunities (IROs) are present throughout the ESRS and constitute a significant part of the standards. In particular, they allude to sustainability associated impacts, risks, and opportunities of a company. These three terms are to be identified and assessed by each undertaking individually, which is done by a double materiality assessment. The underlying reason for the necessity of such an assessment is simple. The objective of the materiality assessment is to constrain the content of the sustainability report to solely that which is pertinent to the users of the report and significant for the specific company. Taking into account the amount of information a firm shall disclose, a materiality assessment is crucial for a company to merely provide the required data, as well as to keep a structured overview. Due to the novelty, the particularity and amount of the ESRS required data, it is vital for a firm to assess its essential reporting areas. Ideally, this is done some time in advance (Wilhelm & Müller, 2023).

The following illustration depicts the essence of the term double materiality and the reason for its importance.

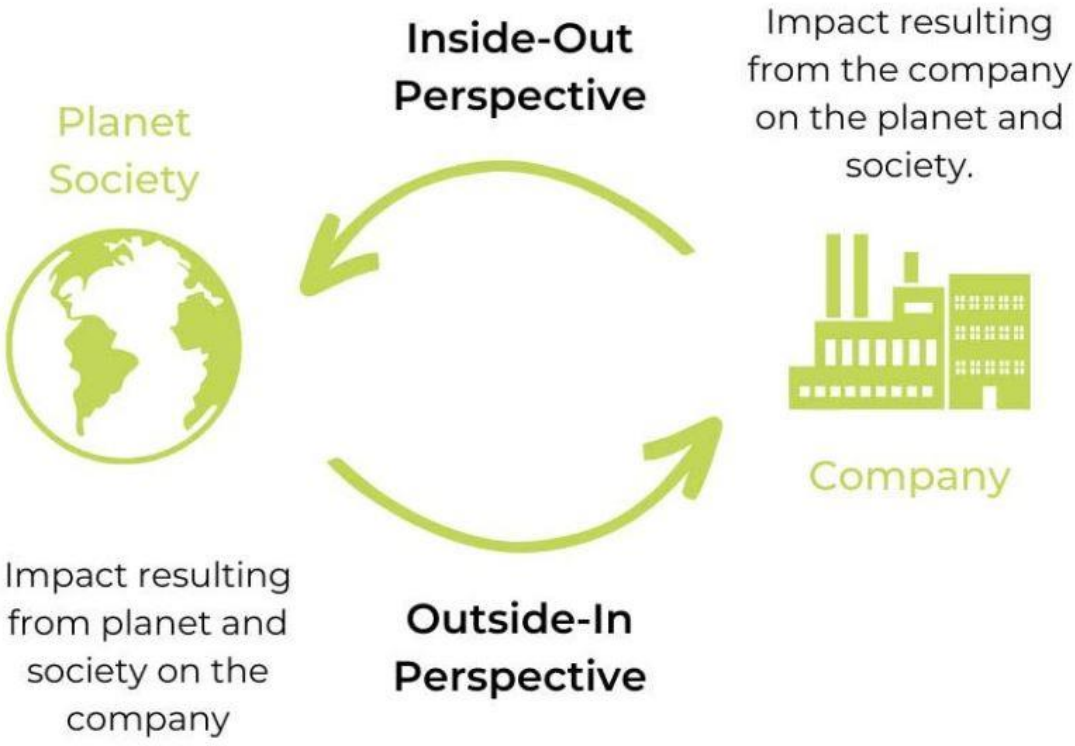

Figure 10: Double materiality (Soeder, 2023)

5.3 Taxonomy

Despite the fact that this paper is mainly focused on gradually expanding on the non-financial reporting requirements within the EU, the Taxonomy Regulation cannot be dismissed. Particularly since firms, which are in scope of the CSRD also are in scope of Article eight of the EU Taxonomy Regulation. Aiming to allocate funds toward sustainable initiatives, the 44 European Commission's "Action Plan: Financing Sustainable Growth" was unveiled in March 2018 and includes the EU Taxonomy Regulation (PwC, 2024). The regulation 2020/852 of the European Parliament and of the Council, was enforced on the 12 of July 2020. Its introduction paved the way for the creation of a framework for the facilitation of sustainable investment within the EU and simultaneously amended the regulation 2019/2088, which was formerly intended for sustainability associated disclosures within the financial services industry (Simmons & Simmons, 2020; European Union, 2020). The EU Taxonomy stands to be the primary regulated and extensive classification system emphasizing sustainable economic practices. Its aims pertain operation that account for as much as 80 percent of greenhouse gas emissions within the EU (Schütze & Stede, 2024). The regulation aids guiding direct investments into

economic branches needing it the most for the transition, in accordance with the European Green Deal objectives and the net zero targets for 2050. Nonetheless, despite the efforts of short-term and long-term objectives of the EU Green Deal, an essential task is to have a common understanding, not only of the targets but also of the definitions used to describe them. Due to this, the necessity for a classification system, the EU taxonomy or an action plan for sustainable growth increased (European Union, 2020a). Achieving equal competition and legal certainty for all enterprises conducting business within the EU is the goal of the EU Taxonomy Regulation and the Sustainable Finance Disclosure Regulation (SFDR). The following are the main objectives of both regulations, which adhere to the Green Deal's objective:

- Redirection of financial flows with an emphasis on sustainable investments
- Incorporation of sustainability into risk management
- Stimulating sustained economic activity and investment

Even though the Regulation is named "Taxonomy", it is not the same as the digital taxonomies found in financial reporting. An environmental sustainability classification system is offered by the EU Taxonomy. A portion of an organization's operations will be deemed eligible. And from those, those activities that satisfy certain standards will be considered EU Taxonomy aligned. Key performance indicators (KPIs) that show the proportion of an organization's operations that are taxonomy aligned must be reported by businesses. These KPIs are related to revenue, capital expenditure, and operating expenditure for non-financial enterprises. Depending on the kind of business, financial businesses will require different KPIs, but they usually try to give information on how much of an asset or source of income comes from sustainable activities. Businesses subject to the CSRD will have to submit their ESRS disclosures together with the EU Taxonomy declarations and KPIs. This is partly done to enable players in the financial markets, such investment managers, to reveal details regarding the sustainability of their investment products, whether they comply with the EU Taxonomy (PwC, 2024). The intent of the EU Taxonomy regulation is to categorize economic activities within the EU as sustainable, green, or environmentally friendly. Due to the priorly existing gap in relation to a proper definition of what such activities are, the Taxonomy regulation set out such definitions and explanations, thereby also providing a profound base to a common understanding. This is particularly important when it comes to companies and their

activities and how to classify them (EU-Taxonomy Info, n.d.). According to an official publication of the EU, the EU Taxonomy is "a classification system to establish clear definitions of wat is an environmentally sustainable activity." Furthermore, it is stated that the EU Taxonomy is a "tool to help investors and companies make informed investment decisions on environmentally sustainable activities for the purpose of determining the degree of sustainability of an investment." (European Commission, n.d.). Within the regulation, six environmental goals have been identified (EU-Taxonomy Info, n.d.).
The Taxonomy Regulation defined six objectives associated with the climate and environment:

1. Climate change mitigation
2. Climate change adaptation
3. Sustainable use and protection of water and marine resources
4. Transition to a circular economy
5. Control and prevention against pollution
6. Biodiversity and ecosystems protection and restoration (European Union, 2020b)

In addition, the Taxonomy Regulation also defines cross-cutting prerequisites, which aid enterprises to assess whether an activity is deemed sustainable or not. The first of these criteria is to have made a significantly great contribution to minimum one of the six priorly mentioned objectives. The second condition is to not materially impairing one of the remaining five environmental targets. Lastly, the third requirement is to respect the minimal safety precautions, as well as adhering to the technical screening standards specified in the Taxonomy Delegated Acts (European Commission, n.d.).

6 European Sustainability Reporting Standards ESRS

Due to the previously identified deficiencies entailed within former reporting directives, the Commission not only established the necessity to create a new directive. In addition, and with the purpose of avoiding formerly caused confusion, common reporting standards were created by the European Financial Reporting Advisory Group (EFRAG) (UN Environment Programme, 2024) . EFRAG serves as an impartial and consulting organization that receives most of its funding from the EU. Close collaboration among investors, businesses, other undertakings, auditors, and among others, academia, in order to develop such drafts. After modifications to the initial set of drafts of the ESRS, in 2023, a

consultancy meeting took place. Within this meeting, various EU organs and Member States representatives have been participating towards the drafts, respectively the final solutions. Among many others, the European Securities and Markets Authority, the European Environment Agency, the European Union Agency for Fundamental Rights, and the Platform on Sustainable Finance advised the Commission on this topic. Furthermore, to grant the public a chance to voice their concerns, the proposal of the ESRS was published in June 2023 for four weeks (European Commission, 2023) . The first set of the European Sustainability Reporting Standards (ESRS) was published in 2023. Those firms, which thus far are mandated to report under the Accounting Directive, are to follow the ESRS. The establishment of uniform standards aspires for firms within the EU Member States, which are subject to report, and now also to publish sincere and comparable information in reference to the enterprise´s sustainability and social practices (European Commission, 2023). The ESRS demands enterprises to submit thorough information on their sustainability performance, which might extend to the supply chain and the conclusion of the product life cycle. Mandatory ESRS indicators of both qualitative and quantitative character, as well as trustworthy information on the growth of a company's sustainability performance, lay a far larger burden on businesses than previously. This expansion places increased pressure on data management and current reporting structures and procedures, not least since the CSRD requires an electronic reporting format for sustainability data. As of May 2024, twelve ESRS standards have been released and are open to the public. The first published set of ESRS comprises two cross-sectoral standards and 10 topical standards. The cross-cutting standards are divided into ESRS 1, with a focus on more general requirements, and ESRS 2, foreseen for general disclosures. The ten topical standards are devoted to environmental, social, and governance (ESG) topics. Attributable to the new standards is the fact that the desired and required sustainability information, a company is mandated to report on, is laid out in a straightforward, divided into sections, and structured manner (Denkstatt,2023). Due to the complexity of the subject, the following illustration should serve to aid the explanation:

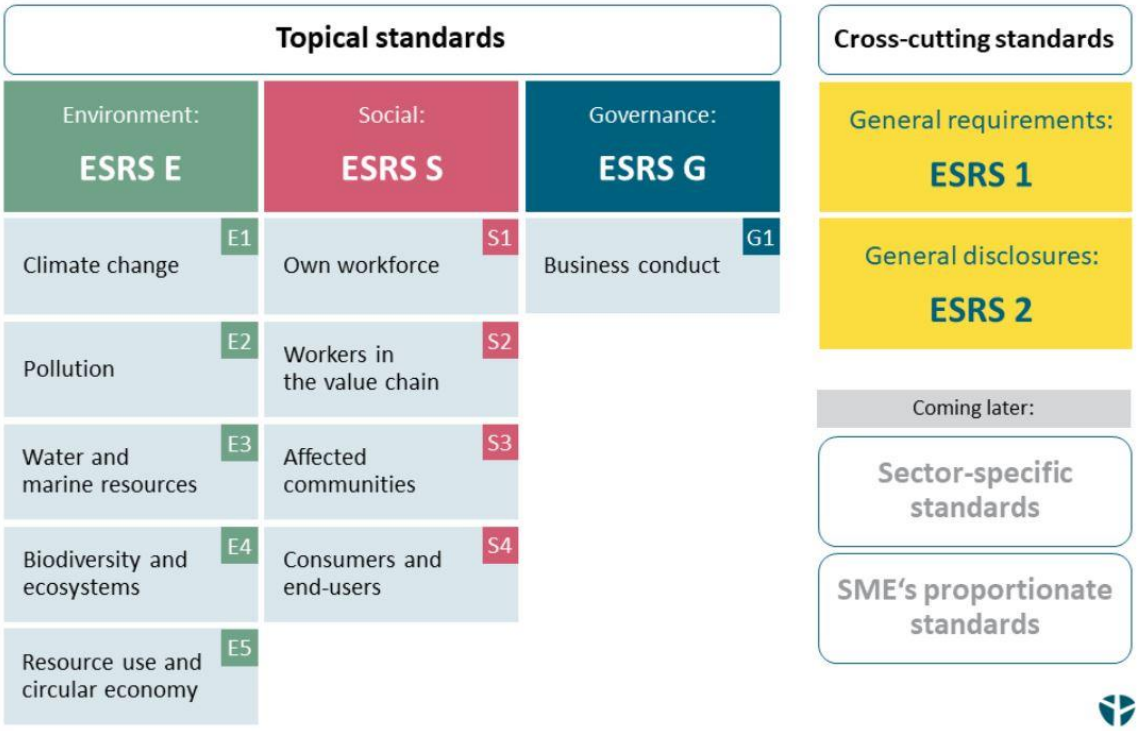

Figure 11: ESRS (Denkstatt, 2023)

The ESRS 1 (highlighted in yellow in Figure 11) is devoted to general requirements. Precisely, in alignment with the CSRD, ESRS 1 comprises compulsory standards for the preparation and disclosure of sustainability statements. Nevertheless, there must be a distinction made, since within the ESRS 1 no specific report content is mandated. Conversely, it serves as a framework the report preparation. In addition, it serves as a guide for due diligence duties, the manner of sustainability data collection and presentation, as well as value chain and time limits. Lastly, ESRS 1 mandates a materiality evaluation for each specific criterion. Nevertheless, ESRS 2 is excluded from this. In consideration of ESRS 2 (also marked in yellow in Figure 11), general characteristics and information are classified. Meant hereby are policies, measures, and objectives that must be reported on, despite the result of the materiality analysis. Furthermore, under ESRS 2, the structure and content for the topic standards are laid out. Consequently, the following four divisions are affected:

- Governance
- Strategy
- Impacts, risks, and opportunity management
- Metrics and targets (Denkstatt, 2023)

The topical standards are divided into three larger groups, namely environment, social, and governance. Among these three sections, additional specific matters are defined. The category of environmental standards contains five subjects (Climate Partner, n.d.). *Disclaimer*: Within the official drafts and documents, the term 'undertaking' is utilized to refer to companies, firms, enterprises, and organizations. Nonetheless, to allow for some alternation, various terms for depicting an undertaking are used.

6.1 Topical standard: environment

Table 1: Environment

ESRS code	Subject	Definition
E1	**Climate Change**	The primary environmental standard that most businesses will need to follow. It addresses risks and possibilities associated with climate change, energy usage within a firm, and adaptation and mitigation strategies. ESRS E1 has the most required disclosures.
E2	**Pollution**	Issues, such as microplastics and any contamination of the air, water, soil, or food supply must be reported by businesses.
E3	**Water and marine resources**	This covers a company's use, withdrawal, and consumption of water in addition to its use and extraction of other marine resources.
E4	**Biodiversity and ecosystems**	Firms must reflect on their effect on species status, ecosystem size and condition, and biodiversity loss.

E5	**Resource use and circular economy**	Firms must elaborate on their resource use (incoming and outgoing), as well as their approach to waste

In addition to the overview provided in table #1, each of the standards within the environmental division consists of sub-divisions. To provide a comprehensive summary, the sub-divisions for each of the standards are described in the following tables below.

6.1.1 ESRS E1 – Climate Change

The standard ESRS E1 comprises nine environmental disclosure criteria (E1-1to E1-9) as well as three ESRS 2 requirements (GOV-3, SBM-3, and IRO-1). To provide an overview, these are included in the table below and briefly detailed in the subsections that follow.

Table 2: ESRS E1

Disclosure criteria	Subject	Description
ESRS 2 GOV – 3	Integration of sustainable performance in incentive programs	The business must state whether the administrative, management, and supervisory body members' performance has been assessed in relation to the GHG emission reduction targets that are required to be reported under E1-4.
ESRS 2 SBM – 3	Material effects, risks, and opportunities	It must be specified whether identified climate-related risks are physical or transitional (European Financial

		Reporting Advisory Group, 2023).
ESRS 2 IRO – 1	Description of methods for the identification and assessment of material effects, risks, and opportunities (EFRAG, 2023a).	The undertaking is required to describe the processes used to evaluate and assess significant impacts, risks and opportunities related to pollution.
E1 – 1	Transition plan for climate change mitigation	Description of the firm´s protection strategy in line with limiting global warming to one point five degrees Celsius. If non-existent, the company must elaborate on whether and when it will provide one (Green Vision Solutions, n.d.).
E1 – 2	Policies concerning climate change mitigation and adaptation	Firms are obligated to report on strategies regarding any aspect of combating climate change
E1 – 3	Actions and resources devoted to climate change policies	Elaboration on measures and resources concerning climate strategies shall be disclosed. Must comply with

		requirements in ESRS 2 MDR – A
E1 – 4	Climate change adaptation and mitigation targets	Goals related to climate change mitigation must be disclosed, thereby rules from ESRS 2 MDR-T have to be used.
E1 – 5	Energy consumption and energy mix	A detailed report on a company´s energy consumption and energy mix is mandated. Information on non-renewable and renewable sources must be contained.
E1 – 6	Total GHG emissions (broken down in scopes)	Requirement for reporting on total GHG emissions. Scope 1 is devoted to
E1 – 7	GHG removals and GHG mitigation projects	Enterprises must declare the manner of how GHG are removed and stored, resulting from the firm´s actions, as well as the upstream and downstream value chain. If carbon credits have been purchased, these as well as

		their impacts must be reported on.
E1 – 8	Internal pricing of Carbon	Firms must disclose if they use internally set pricing schemes for carbon.
E1 – 9	Financial effects raised from opportunities and risks	Reporting on anticipated financial impacts from material physical and transition risks. Additionally reporting on potential opportunities related to climate

(Aschauer & Kühmayer, 2024)

6.1.2 ESRS E2 – Pollution

The ESRS E2 standard devoted to the matter of pollution, within the section of environment, encompasses six environmental disclosure requirements (from E2-1 to E2-6). In addition, the second standard entails one further ESRS 2 requirement, ESRS 2 IRO-1. These specifications are elaborated on more in detail in the table following.

Table 3: ESRS E2

Disclosure criteria	**Subject**	**Description**
ESRS 2 IRO-1	Description of processes applied for the identification and assessment of material pollution-related results, risks and opportunities	The firm is compelled to explain the processes used to evaluate and assess significant impacts, risks and

		possibilities related to pollution.
E2-1	Policies devoted to pollution	Implemented policies concerning pollution prevention and control must be published by the firm.
E2-2	Measures and resources concerning pollution	Pollution-related actions and resources devoted to the implementation should be disclosed. Additionally, the principles of ESRS 2 CCR-2 must be applied.
E2-3	Objectives regarding pollution	ESRS 2 CCR-3 displays the information needed to identify targets of a firm concerning pollution.
E2-4	Pollution of air, water, and soil	An enterprise is obliged to report on pollutants created, consumed or procured in its

		production processes.
E2-5	Substances of concern and substances of particularly high concern	Required in separate forms, a company must communicate whether it is using substances of concern and/ or substances of very high concern.
E2-6	Prospective financial impact stemming from pollution-related effects, risks and opportunities	In monetary terms, an enterprise is compelled to report on potentially positive or negative financial effects coming from pollution-related risks, possibilities, and impacts.

(Aschauer & Doppler, 2023; Winkelbauer, 2023)

6.1.3 ESRS E3 – Water and marine resources

The ESRS E3 standard for water and marine resources consists of five distinguished disclosure criteria concerning the environmental disclosure requirements. Additionally, it contains one requirement from ESRS 2, namely the ESRS 2 IRO -1 standard.

Table 4: ESRS E3

Disclosure criteria	Subject	Description
ESRS 2 IRO-1	Description of methods utilized for the identification and assessment of impacts, risks, and opportunities, concerning water and marine resources	The firm is compelled to explain the processes used to evaluate and assess significant impacts, risks, and possibilities related to pollution.
E3-1	Policies in relation to water and marine resources	Applied and integrated policies about water and marine resources prevention and control must be published by the firm.
E3-2	Measures and resources in relation to water and marine resources	Water and marine resource-related actions and resources devoted to the implementation should be disclosed. Additionally, the principles of ESRS 2 CCR-2 must be applied.
E3-3	Goals related to water and marine resources	A company is compelled to publish its objectives related to water and marine resources in accordance with ESRS 2 CCR-3. Information on (local) environmental thresholds and organisation- specific allocations

		were considered during the goal setting.
E3-4	Water consumption	In particular, an enterprise must disclose as follows: • Its total water consumption in cubic meters (m^3) • its total water consumption in cubic meters in areas with significant water stress • the total volume of reused and recycled water • the water intensity
E3-5	Potential financial consequences of water and marine-related impacts, risks, and possibilities	In monetary terms, an enterprise is compelled to report on potentially positive or negative financial effects coming from pollution-related risks, possibilities, and implications.

(Doppler & Winkelbauer, 2023)

6.1.4 ESRS E4 – Biodiversity and ecosystems

Standards regarding biodiversity and ecosystems are laid out in the fourth ESRS E standard within the environmental division. The ESRS E4 includes six environmentally concerned standards, which stretch from E4-1 to E4-6. Moreover, similar to the standards previously noted, two criteria from ESRS 2 are entailed as well (ESRS 2 SBM-3 and ESRS 2 IRO-1).

Table 5: ESRS E4

Disclosure criteria	**Subject**	**Description**
E4-1	Transition plan for biodiversity and ecosystems	The enterprise is expected to reveal its transition plan to ascertain that its business model and strategy respect the planetary boundaries. Furthermore, the integrity of the biosphere and the change of land system, as well as the work towards the objectives of the EU Biodiversity strategy to 2030 are targeted.
ESRS 2 SBM-3	Resilience of strategy and business model	The firm is to explain its resilience strategy and business model in regard to biodiversity and ecosystems. The scope and results of a resilience analysis, its time period used, and the main

		assumptions should be added. Furthermore, among others, the inclusion of different interest groups shall be addressed.
ESRS 2 IRO-1	Description of methods utilized for the identification and assessment of implications, risks, and opportunities, in relation to biodiversity and ecosystems	The enterprise is expected to explain the processes used to identify and assess significant implications, risks and possibilities related to biodiversity and ecosystems.
E4-2	Policies concerning biodiversity and ecosystems	Implemented policies for managing significant effects, risks and opportunities associated with biodiversity and ecosystems are to be reported by the firm.
E4-3	Measures and resources in reference to biodiversity and ecosystems	The company shall give a report on the measures for biodiversity and ecosystems, as well as the funds provided for implementation. More precisely, whether compensation for biodiversity is part of the company´s planned or

		applied measures should be contained.
E4-4	Targets concerning biodiversity and ecosystems	Goals, a firm set for biodiversity and ecosystems shall be explained and their progress should be documented.
E4-5	Metrics associated with effects on biodiversity and ecosystem change	A firm must disclose substantial impacts it might have on biodiversity and changes in the ecosystem. If a company is located near to a biodiversity-sensible site, the effects must be communicated.
E4-6	Prospective financial implications of biodiversity and ecosystems related risks and possibilities	An enterprise is compelled to report on potentially positive or negative financial effects coming from pollution related risks, possibilities, and implications.

(Aschauer & Doppler, 2023b)

6.1.5 ESRS E5 – Resource use and circular economy

Lastly within the environmental part of the topical standards is the ESRS E5 standard which lays out regulations for resource use and circular economy. Due to the close link to the other standards within the environmental section, slight overlaps can be identified. This particular last part entails six environmental disclosure criteria, from E5-1 to E5-6).

As seen in the other standards, the ESRS 2 requirement ESRS 2 IRO-1 is implied here too.

Table 6: ESRS E5

Disclosure criteria	**Subject**	**Description**
ESRS 2 IRO-1	Description of methods utilized for the identification and assessment of implications, risks and opportunities, in regard to resource use and circular economy	The enterprise is expected to explain the processes used to identify and assess significant implications, risks and possibilities related to biodiversity and ecosystems.
E5-1	Policies in relation to resource use and circular economy	The undertaking must communicate its policies that manage severe impacts, possibilities and risks related to resource use and circular economy.
E5-2	Actions and resources associated with resource use and circular economy	A company is compelled to disclose its supplies and measures regarding circular economy. The explanation of the measures shall follow the example of ESRS 2 CCR-2

E5-3	Goals tied to resource use and circular economy	The enterprise must describe the resource use and circular economy targets and indicate whether and how these targets relate to inflows and outflows, as well as increasing the circular design, minimising the share of non-renewable raw materials and other targets
E5-4	Inflow of resources	Material resource inflows shall be communicated. Products with its packaging should be reported. In line with the Circular Economy Action Plan of the EU, the information should also contain: • Overall weight of used products and materials needed during the period of reporting. • Absolute vale and percentage of renewable input materials,

		utilized to create the products and services. • The weight of re-used or recycled products and materials
E5-5	Outflow of resources	Similarly, to the previous point, information on the outflow of main resources including waste, must be provided. Anew, the EU Circular Economy Action Plan shall be respected.
E5-6	Possible financial impacts from resource use and circular economy associated effects, risks, and opportunities	Reporting on potential financial impacts from material physical and transition risks. Additionally reporting on potential opportunities concerning resource use and circular economy are expected.

(TPA, 2023)

6.2 Topical standard: social

The second pillar within the thematical standards is committed to the social aspects a firm is expected to report on.

Table 7: Social

ESRS code	Subject
S1	Own workforce
S2	Workers in the value chain
S3	Affected communities
S4	Consumers and end-users

6.2.1 ESRS S1 – Own workforce

The first standard within the social pillar, the ESRS S1, deals with a firm´s own workforce. More precisely, the intent behind this standard is to illustrate several aspects associated with its own workforce. A company is expected to disclose positive, negative, possible as well as actual implications in relation to its own human capital. Furthermore, it is supposed to elaborate on potential opportunities and risks. Moreover, the managerial activities to mitigate, reduce or even avoid such impacts must be published. Due to the variety of existing sectors and companies, individual characteristics and classifications are to be involved in such reports (Aschauer & Binder, 2023a) . ESRS S1, overall devoted to a firm´s own workforce contains 17 social associated disclosure criteria, S1-1 to S1-17. Furthermore, the ESRS 2 contributes the ESRS 2 SBM-2 (Strategy Business Model) and ESRS 2 SBM-3 to the extent of the standard.

Table 8: ESRS S1

Disclosure criteria	Subject	Description
ESRS 2 SBM-2	Interests and views of the stakeholders	The firm is to report on the manner of how viewpoints and interest of employees impact its strategy and business model. Special

		emphasis is given to human rights
ESRS 2 SBM-3	Significant effects, hazards, and prospects, their interaction with strategy and company model	Disclosure whether and the fashion of aforementioned aspects contribute to the business strategy
S1-1	Policies regarding a firm´s employees	An enterprise is expected to report severe influence and hazards on its own employees. Among other aspects, a particular focus is to be given to policies combating any form of discrimination. Additionally, the importance of policies on equality shall be demonstrated.
S1-2	Procedures for discussing potential effects with employees and their respective representatives	Importance and emphasis is to be granted to the exchange of the firm and its employees, as well as representatives. The manner and frequency of such discussion is to be disclosed.

S1-3	Techniques for handling detrimental effects and channels for workforce to voice concern	The options, as well as the process for raising issues for employees shall be disclosed
S1-4	Action taking on severe impacts on the employees and the effectiveness of such actions	Disclosure mandated on the way the firm handles negative and positive effects and the effectiveness of such activities.
S1-5	Objectives associated with severe negative impacts, further improving positive implications, and managing hazards and opportunities.	Time related and out-come-oriented targets, defined concerning the reduction of negative implication on the workforce, as well as promoting and improv-ing positive impacts for them and the manage-ment of severe risks and possibilities for their workforce.
S1-6	Characteristics of a firm´s employees	The firm must elaborate on the key characteris-tics of non-employees of the company.
S1-7	Characteristics of non-employee workers among its employees the firm	Non-employees within a firm can be, among others, due to a form of self-employment. The

		firm shall describe the key characteristics of non-employees of the company.
S1-8	Collective bargaining coverage and the social dialogue	As mentioned in the left column, the disclosure in regard to the collective bargaining coverage and social dialogue within a firm shall be reported.
S1-9	Metrics for diversity	Among top level management the distribution of gender, as well as the age distribution among the employees shall be disclosed.
S1-10	Appropriate renumeration	Disclosure if the workforce is paid an adequate wage, if not the country and the percentage of employees affected shall be communicated.
S1-11	Social protection	A firm must report where its employees are covered by social protection, in case of loss of income due to

		various events (sickness, retirement etc.)
S1-12	Employees with disabilities	An enterprise must pass on the percentage of employees with disabilities.
S1-13	Metrics for skills development and training	The provision of skills development and training possibilities is mandated.
S1-14	Metrics for health and safety	The extent of health and safety coverage a firm is providing for its workforce, as well as a report on incidents occurred due to work.
S1-15	Metrics for work-life balance	Disclosure required on whether and how employees are allowed to make us of family associated leave.
S1-16	Metrics devoted to the (total) remuneration and pay gaps	An enterprise is mandated to publish the pay gap between female and male employees, as well as a ratio of its highest paid employee and a median value for

		the remaining employees.
S1-17	Incidents, complaints as well as significant implications on human rights	Reports must be communicated on the number and severity of work-related incidents (discrimination etc.)

(EUR-Lex, 2023)

6.2.2 ESRS S2 – Workers in the value chain

The ESRS S2 section is committed to set out the requirements according to the workers in the value chain. In essence, a value chain is a set of stages in the production process of a product or service for a consumer. In basic terms, it is the chain from the product or service conception to the consumption. Each stage is intended to add value to the product or service (Knez, et al., 2021). This particular standard stretches from ESRS 2 SBM-2 and ESRS 2 SBM-3 to five requirements specifically from the ESRS S2, namely S2-1 to S2-5.

Table 9: ESRS S2

Disclosure criteria	**Subject**	**Description**
ESRS 2 SBM-2	Interests and views of the stakeholders	The firm is to report on the manner of how viewpoints and interest of employees impact its strategy and business model. Special emphasis is given to human rights
ESRS 2 SBM-3	Significant effects, hazards, and prospects, their interaction with strategy and company model	Disclosure whether and the fashion of

		aforementioned aspects contribute to the business strategy
S2-1	Policies in relation to the workers in the value chain	Reporting on the company´s policies for the management of impacts on value chain workers, in relation to hazards and opportunities.
S2-2	Methods for the engagement with workers in the value chain about implications	The process of engagement with value chain workers and their representatives is expected to be disclosed.
S2-3	Processes to remediate negative implications and channels for the voicing of concerns of value chain workers	A description of an enterprise´s strategies for remediating negative implications. In addition the option of raising concerns for value chain workers shall be illustrated.
S2-4	Action taking on material effects on value chain workers and strategies to mitigate severe risks. Pursuit of material opportunities in relation to value chain workers and their effectiveness	An understanding of the measures for prevention of severe negative effects associated with the labour of value chain workers and the measure

		of effectiveness shall be reported on.
S2-5	Goals devoted to the management of negative impacts, promoting positive development and the management of risks and opportunities.	In order to be informed about the level of the subject matters mentioned on the left column, a firm must report on: • The goals for reduction of negative outcomes on value chai workers • Strategies for fostering positive implications. • The management of severe risks and opportunities in accordance with value chain workers.

(Aschauer & Takacs, 2023; EFRAG, 2023)

6.2.3 ESRS S3 – Affected communities

The third part within the social pillar of topical standards, ESRS S3, deals with subjects evolving around affected communities. In accordance to this standard, firms are mandated to describe their strategies for the identification and management of material positive, as well as negative potential and actual impacts. In addition, possible and actual hazards and opportunities must be elaborated and reported on (Aschauer & Binder, 2023b). The standard specialized on affected communities contains five requirements created for the ESRS S3, such as S3-1 to S3-5, and similar to the previous standards, the ESRS 2

SBM-2 and ESRS 2 SBM-3. In order to keep a comprehensive overview, albeit repetition, these two latter standards will be included in the following table.

Table 10: ESRS S3

Disclosure criteria	**Subject**	**Description**
ESRS 2 SBM-2	Interests and views of the stakeholders	The firm is to report on the manner of how viewpoints and interest of employees impact its strategy and business model. Special emphasis is given to human rights
ESRS 2 SBM-3	Significant effects, hazards, and prospects, their interaction with strategy and company model	Disclosure whether and the fashion of aforementioned aspects contribute to the business strategy
S3-1	Policies associated with affected communities	Reporting on the company´s policies for the management of impacts on affected communities, in relation to hazards and opportunities.
S3-2	Processes for the engagement with affected communities about implications	The strategies of engagement with affected communities and their

		representatives is expected to be disclosed.
S3-3	Processes to remediate negative implications and channels for the voicing of concerns of affected communities	A description of an enterprise´s strategies for remediating negative implications. Additionally, the option of raising concerns for affected communities shall be illustrated.
S3-4	Taking action on material effects on value chain workers and strategies to mitigate severe risks. Pursuit of material opportunities in relation to affected communities and their effectiveness	An understanding of the measures for prevention of severe negative effects associated with the affected communities and the measure of effectiveness shall be reported on.
S3-5	Targets concerning the management of negative impacts, promoting positive development and the management of risks and opportunities.	A firm is mandated to disclose information on time dependent and result oriented goals for the reduction of negative implications. Furthermore, positive aspects are to be promoted.

(Aschauer & Binder, 2023b)

6.2.4 *ESRS S4 – Consumers and end-users*

The last standard within the ESRS S4 is dominated by topics evolving around consumers and end-users. By now, a visible pattern within the social pillar can be assessed. The standards, from S1 to S4, and their sub-sequent disclosure requirements deal with four different topics. Holistically evaluated, these four topics are distinguishable, however strongly connected with one another. However, when taking a closer look of each disclosure criteria, the scheme they follow is noticeable. Here again, two ESRS 2 standards are implied, exactly as in the previous mentioned social standards. Besides this, five new requirements stemming from ESRS S4 are contained as well.

Table 11: ESRS S4

Disclosure criteria	**Subject**	**Description**
ESRS 2 SBM-2	Interests and views of the stakeholders	The firm is to report on the manner of how viewpoints and interest of employees impact its strategy and business model. Special emphasis is given to human rights
ESRS 2 SBM-3	Significant effects, hazards, and prospects, their interaction with strategy and company model	Disclosure whether and the fashion of priorly stated aspects contribute to the business strategy
S4-1	Associated policies with consumers and end-users	Reporting on the company´s policies for the management of impacts on consumers and end-

		users, in relation to hazards and opportunities.
S4-2	Processes for the engagement with consumers and end-user communities about implications	The approach of engagement with end-users and consumers and their representatives is expected to be disclosed.
S4-3	Processes to rehabilitate negative implications and channels for the voicing of concerns of consumers and end-users	An explanation of an enterprise´s strategies for remediating negative implications. Additionally, the option of raising concerns for end-users and consumers communities shall be illustrated.
S4-4	Taking action on material effects on value chain workers and strategies to mitigate severe risks. Pursuit of material opportunities in relation to consumers and end-users and their effectiveness	An understanding of the measures for prevention of severe negative effects associated with the end-users and consumer and the measure of effectiveness shall be reported on.
S4-5	Targets in relation to the management of negative impacts, promoting	A firm is mandated to disclose information on time dependent and result oriented goals for

	positive development and the management of risks and opportunities.	the reduction of negative implications. Furthermore, positive aspects are to be promoted.

(Aschauer & Doppler, 2023c)

6.3 Topical standard: governance

The third and last pole within the topical standards is the governance section containing one standard. The single standard for governance, ESRS G1, is committed to topics concerning business conduct. The aims of this standard are to gain an understanding for the company´s strategy and business model. Moreover, the business conduct standard should foster the comprehension of the procedures, methods and its performance in accordance with corporate policy. This covers the corporate culture, the relationship management with suppliers, as well as the avoidance of corruption and bribery. Beyond that, it includes the enterprise´s commitment to exerting political influence, which also entails lobbying and payment practices.

Table 12: Governance

Disclosure criteria	**Subject**	**Description**
ESRS 2 GOV-1	The role of the administrative, supervisory and management bodies	The combination of the administrative managements, as well as supervisory bodies, their roles and responsibilities are to be reported. In addition, data on access on knowledge and expertise concerning

		sustainability must be published.
ESRS 2 IRO-1	Description of the process to identify and assess material impacts, risks and opportunities	Enterprises shall report on methods of recognizing and evaluation risks, effects, and opportunities
G1-1	Corporate cultures and business conduct policies	The undertaking must reveal its efforts to foster a corporate culture and its policies about business conduct
G1-2	Managing the relationships with suppliers	The firm shall give information on managing supplier relationships and their influence on the supply chain.
G1-3	Prevention and detection of corruption or bribery	A firm must disclose its system for avoiding, identifying, investigating, and responding to accusations of corruption and bribery. Additionally, the

		concerning training shall be included.
G1-4	Confirmed incidents of corruption or bribery	Information on verified cases of corruption or bribery must be provided during the reporting period.
G1-5	Political influence and lobbying activities	The undertaking is required to explain its political influence and lobbying actions, as well as their substantial repercussions.
G1-6	Payment practices	Transparency on payment processes to ascertain regular cash flows for business partners, specifically for SMEs is expected of the firms.

(EFRAG, 2022b)

6.4 ESRS 2 – General disclosures

The second part of the cross-cutting standards, which outlines requirements that must be declared regardless of the company´s industry, is the ESRS 2 for general disclosures. In addition, general disclosures also comprise the declaration of information no matter which type of sustainability issue is under consideration. It is focused on reporting vital information. Hence, ESRS 2 is compulsory for any firm reporting under the CSRD (European Commission, 2023).

1. Basis for Preparation

Table 13: ESRS 2 - Basis for preparation

Disclosure criteria	Name	Description
BP-1	General foundation for the preparation of sustainability reports	This standard mandates disclosure on the following aspects: • Preparation of statements separately or consolidated • Scope for consolidation equal to the one for financial statements • To which level do the statements on sustainability address the firm´s upstream and downstream value chain • If the company chose to withhold certain information A declaration for companies that are exempt from disclosure
BP-2	Disclosures in association to particular conditions	BP-2 is focused on the consideration of effects of special circumstances during the preparation of such sustainability statements. Therefore, within this standard, seven of such circumstances are taken into account: • Time ranges • Estimation of value chains

		• Uncertainties in results and sources of such estimates • Adaptations regarding the compilation or presentation of information • Reporting errors in earlier periods • Disclosures necessitated due to local legislation • Inclusion by reference

(OPTEL, 2024)

2. Governance

According to the governance section of the ESRS 2, the focus is on obtaining an awareness of the governance procedures, controls and processes that have been established for the oversight and management of sustainability matters (Aschauer & Binder, 2023c).

Table 14: ESRS 2 - Governance

Disclosure criteria	Name	Description
GOV-1	The role of administrative, management and supervisory organs	The constitution of the administrative managements, as well as supervisory bodies, their roles and responsibilities are to be reported. These efforts are aimed at increasing the diversity of the active bodies and gender equality. Additionally, data on access on knowledge and expertise, as well as skills

		concerning sustainability must be published.
GOV-2	Information offered to and sustainability matters dealt with be the firm´s administrative, management and supervisory organs	Firms are obligated to report on their manner of communication of sustainability issues to the management.
GOV-3	Inclusion of sustainability associated performance in incentive systems	This standard requires the integration of sustainability related performance into incentive systems.
GOV-4	Statement on sustainability due diligence	An undertaking must indicate where the sustainability review procedure information can be obtained.
GOV-5	Risk management and company-internal controls over sustainability reporting	An enterprise is obligated to report on the firm´s procedures on risk management and internal control concerning sustainability reporting practices.

(Aschauer, 2023)

3. Strategy

Table 15: ESRS 2 - Strategy

Disclosure criteria	Name	Description
SBM-1	Market position, strategy, business model, and value chains	Due to SBM-1, a firm is mandated to reveal its market position, additionally its sustainability

		specific aspects within the firm´s strategy and business models. Moreover, its essential value chains must be reported on.
SBM-2	Interests and perspectives of stakeholders	This standard aims to assess whether a company´s strategy is in alignment with the interest of stakeholders, by showing how their views are taken into account in the business model.
SBM-3	Severe impacts, risks and opportunities and their interaction with business models and strategies	SBM-3 mandates enterprises to hand out information on their significant sustainability associated impacts, risks, and possibilities. In addition, their relevance and relation to the firm´s business model, as well as strategy, must be shown.

(Aschauer, 2023)

4. Impact, risk, and opportunity management (IRO)

Within the IRO division, there are further three sub-divisions serving a clear overview.

Table 16: ESRS 2 - IRO

4.1 Disclosures on the materiality assessment process		
Code	**Name**	**Description**

IRO-1	Description of the procedures for the identification and assessment of material impacts, risks, and opportunities	Undertakings must reveal methods on the manner of recognizing and evaluation risks, effects, and opportunities
IRO-2	Disclosure mandates in ESRS health with by the firm´s sustainability statements	The disclosure criteria contained in the sustainability reports must be presented. In addition, as well as a selection of topics, which have been deemed immaterial and hence were neglected, must be included.
4.2 Reporting on opportunities		
4.3 Content of strategies and measures exposure		
Code	**Name**	**Description**
DC-P	Adopted policies for the management of significant sustainability issues	Firms are mandated to reveal the methods used to tackle substantial sustainability issues.
DC-A	Actions and resources associated with severe sustainability matters	Enterprises are to submit an explanation of the measures utilized to deal with such material sustainability issues. Therefore, the foreseen resources and the plan of action need to be communicated as well.

(Aschauer, 2023)

5. Metrics

Regardless of which metrics, from topical and sector-particular ESRS or company-specific metrics, a company uses to evaluate the impacts, risks, and opportunities, it must be communicated.

Table 17: ESRS 2 - Metrics

Disclosure criteria	Name	Description
DC-M	Metrics related to material sustainability matters	The undertaking must follow the disclosure standards outlined in this paragraph when disclosing its sustainability indicators.
DC-T	Effectiveness tracking of policies and actions by utilizing goals	An enterprise shall comply with the disclosure standards laid out within this standard when publishing information regarding its sustainability aims.

(EFRAG, 2022a)

7 Discussion

7.1 The current situation

In the beginning of this year, January 2024, the delay of the CSRD implementation for non-EU countries was made public. In a joint decision, the Council and the European Parliament concluded to grant companies in certain industries, as well as third-country enterprises, amending the CSRD, more time to prepare, adapt and apply the ESRS. Moreover, the delay also implies the specific standards for large non-EU firms. The new time horizon for the adoption of these standards is set to be June 2026 (Council of the EU, 2024). The European Parliament's Committee on Legal Affairs decided to postpone

reporting obligations for specific industries for two years, which was accepted by a majority vote. The sectors affected of the postponement are:

- Oil and gas, mining
- coal, and quarrying
- transportation by road
- automobiles
- textiles
- farming and agriculture
- food and beverage
- real estate
- energy utilities and power generation
- financial markets, insurance, and banking

In addition, the agreed plan extends the deadline for reporting to businesses with headquarters outside of the European Union. These businesses would now have until 2026 to start complying with the CSRD. The Commission stated in its draft that it intends to streamline these requirements and lessen the "extra burden" that these reporting obligations place on businesses by 25 percent (Mirza, 2024).

7.2 Findings

7.2.1 Assumptions

In accordance with the priorly considered fact that the paper´s topic is rather new, it can be stated that the availability of sources reflected this circumstance. Despite the fact that there were various publications on this paper´s subjects, nevertheless, the sources seemed similar in their content. As for now, mostly definitions and explanations, especially on the CSRD and ESRS are available. In addition, assumptions on the potential and impacts of the new reporting requirements were found. Due to this, a vast portion of this paper interpreted the obtainable assumptions.

7.2.2 Complexity

Considering the entire topic from a firm´s point of view, the amount and complexity of the subject can be overwhelming at first. While there is an obvious need for such directives and standards to be introduced and applied, the approach of the European Union offers some potential for improvement. As gathered during the conducted interviews,

more than 50 percent of the interviewees voiced their opinion about the introductory technique that was applied. In terms of the many different sub-categories within the ESRS and their punctuality, a gradual introduction process could have been aimed for. By presenting the standards one by one, the departments or firms would have time to gather the data and review the purpose of it. Furthermore, by granting the industries and companies time to profoundly deal with the requirements and to voice concerns, respectively give feedback, a structured execution could have been targeted. For the sake of simplicity and increased cooperation of the considered firms, a gradual introduction could have been a preferred solution (Anonymous, private communication, 2024).

7.2.3 Data origin

One aspect, that was not subject to the interview questions, however, raised by the interviewees was the concern of the required criteria within the ESRS. In order to know which data a firm must publish; a materiality analysis must be carried out. Nonetheless, even after such an assessment the concern for mandated information on complex subjects or aspects, that a company has not dealt with before, was stated. For instance, since one of the interview partners is an employee of a service company, the information on how much waste their services generate was not assessed before the CSRD. This information is mandated under ESRS E5 resource use and circular economy, but due to the fact that the company does not produce tangible products, instead, they develop software services, the subject of waste has not been considered up until now. Moreover, during the discussions with the interview partner, it was clearly stated that there is an underlying assumption that the CSRD and its ESRS will be reviewed after the first cycle of collected reports. This claim stems from the previously identified complexity and "one size fits all" approach. All interview partners were of the same positive opinion about the intention behind unified and consolidated reporting approaches for promoted sustainability. They agreed on the need for and importance of such directives, however, they also shared concerns and apprehensions. Two-thirds of the interviewees however saw a potential within the topic of data origin. If data has to be collected and assessed for the ESRS, they see the possibility of potential future requirements, where the same data might be needed. Regardless of whether this might be for a regulatory or company internal purpose (Anonymous, private communication, 2024)

7.2.4 Personnel

Moreover, in order to understand the requirements and to appropriately carry out a materiality analysis, skilled and trained personnel are needed. It was repeatedly voiced that such extensive handling of the matter, on a short- or long-term basis mandates personnel. However, since most firms established a sustainability department or team, the responsibility for handling such matters lies within these teams or departments. Due to the broad spectrum of data mandated within the ESRS, one interviewee emphasized that a task force in the company has been established, which consists of employees from different departments. These individuals work in the fields where data needs to be reported. This approach ensures that the knowledge stems from experts (Anonymous, private communication,2024). Besides trained employees, the option of commissioning a consulting team with the task of a materiality analysis, as well as the reporting can be carried out. However, this would pose additional costs for firms and is not the case for the interviewed parties (Anonymous, private communication, 2024).

7.2.5 Greenwashing

The intent behind international agreements, regulations and directives is exemplary. Simultaneously to the fast-paced and changing world, also the legislation must adapt. Paving the way by introducing directives aiming for more disclosure and transparency in itself is a valuable approach. However, the question if greenwashing is posing as a potential threat is existent. In particular, since the first reports are to be submitted in 2025, the question of how faulty information or withheld data can be assessed, remains (Anonymous, private communication, 2024).

7.2.6 Answer to research question 1

In light of the originally formulated first research question "**How have ICT enterprises prepared for compliance with the CSRD? What were the key challenges in aligning?**", this sub-chapter is aimed to summarize the answers.

- In consequence of the introduction of the CSRD and the ESRS, respectively the communication of the time horizons for the reports, companies have gathered their decision makers to raise awareness for the subject. Moreover, strategies and plans for the familiarization on the procedure and delegation of the tasks of the topics followed. After completion of the interviews, it can be stated that despite the focus on the ICT industry of this paper, no unified answer can be provided.

- It was found that the preparational measures for the CSRD and ESRS are mainly dependent on the company´s size and consequently the budgetary means. Furthermore, since the first reports will be due in 2025, some undertakings have not yet completed their exact approach or their processes for the data collection of the reports. Nevertheless, it was assessed that some firms approach this matter from a collaborative angle. Experts from required departments are gathered, to evaluate the requirements and to identify how the mandated information will be collected (Anonymous, private communication, 2024).
- Furthermore, since it seems like a "one size fits all" solution, it is a unified approach for sustainability reporting. Different industries face different challenges and also bear different potentials, this is not at all considered within the CSRD (Anonymous, private communication, 2024). This concern was supported by others as well, due to the fact that the approach was criticised. While all the different sectors within the European Union deal with contrasting issues and opportunities, it does not seem reflected enough in the reporting requirements. Especially in light of the service sector. The CSRD seems quite focused on to the industries producing tangible goods, while the service aspect seems neglected (Thomas Delayes, personal communication, 2024).

7.2.7 Answer to research question 2

What, if any, opportunities, or obstacles do these companies identify in adopting sustainability reporting practices? Although the interviewed parties were aware and also concerned about the intricacy of the directive and its standards, they do see opportunities for their companies and industries.

- The increasing need for more awareness and disclosure in regard to sustainability cannot be denied. Especially to hinder and halt a threatening side-effect of the directive, greenwashing, or withholding data. In regard to potential opportunities for companies, the rising awareness of sustainability as well as the potential in gathering the data was stated. Exporting data, which is mandated by the ESRS, could potentially by useful for future purposes. One interviewee emphasized that there is the aim to generate a reporting process, which offers access to this data sustainably and accurately. This benefits the data collection for the CSRD but also possibly further requirements to come (Anonymous, private communication, 2024).

- Furthermore, since ESG reporting is growing due to additional standards, frameworks, and directives, it was stated that the image around ESG reporting could use a better approach. On the example of the CSRD, one interviewee voiced that the approach of the publication of the directive could have been done differently. By simply publishing it and requiring firms to comply, it is an old and not user-friendly approach. If it would have been marketed by emphasizing why it is important, the benefits of the disclosure and what potential it holds, firms could hold more enthusiasm towards the subject (Anonymous, private communication, 2024).
- According to Thomas Delayes, there is a significant potential in within identifying primary data for the first time, not only for sustainability reporting purposes. As an independent consultant, he pointed out that firms, regardless of their performance, hold the possibilities of improving in certain areas. ”Newly extracted data is of value, as it can bear the possibility for firms to identify areas where advancement is necessary.” (Thomas Delayes, personal communication, 2024).

7.3 Limitations

In line with the previously mentioned emphasis on the novelty of the subject matter, the aim is hereby to emphasize the obstacles faced during the writing period. Due to the broad and vast scale of the research topic, as well as the underlying standards and requirements, finding accurate and up to date data posed as a challenge. Officially published institutional information, such as on official EU websites, was attainable. Nevertheless, occasionally the disclosed data was not precise. However, various scientific articles and research papers on the topics of CSRD, ESRS and Taxonomy were on accessible. Apart from the available hard facts in regard to the topic, some content seemed to be subject to interpretation, as the directives only recently came into effect. Originally, this research paper was aimed to be supported by conducted interviews within the DACH region. The availability of interview partners, moreover also the willingness for disclosure was low. Alongside the data collected due to secondary literature, the performed interviews fostered, respectively strengthened some existing assumptions. Due to the limited scope of the paper in regard to the industry it is devoted to, the findings can only be used in consideration of the respective sector. The findings cannot simply be transferred to other industries, regardless of similarities, symmetries, or other.

Following the General Data Protection Regulation (GDPR) collected data and gained insights during the interviews can only be shared in an anonymised manner. No personal information in relation to the interview partners will be published or contained in this research paper.

7.4 Recommendation for further research

In light of the novelty of these topics, an evaluation of the CSRD and the ESRS after the first cycle of submitted reports can bring further insights. Once firms had to report on the mandated data, the real implications, potentials, and obstacles can be assessed. In addition, in order to have a comparison among countries, more nations can be taken into account. For a distinguished result, different industries can be evaluated in regard of the new directives.

8 Conclusion

In conclusion, it can be stated that the primary necessity of the CSRD, respectively the ESRS is understood and agreed on by enterprises. However, since it is entering into force this year and its results and implications will be visible in 2025, mostly speculations can be stated. Nonetheless, as this paper focuses on the ICT technology in Austria, the results of the conducted interviews further underline the findings. Despite the primary collected data, the impression of the subject was similar. The demands and requirements in order to comply with the new directive are high and specific. For a firm within the ICT sector, although dependent on the size and available resources, dealing with this topic can be cost and time-sensitive. The CSRD discloses a vast amount of mandated data and while requiring compliance through a certain format, the amount of disclosure requirements is plenty. The topic of sustainability and its related issues must be of increasing priority in our society. During the conduct of the interviews, the opinion of the CSRD being a prototype and hence not matured or fully established was prominent. The approach of the enterprises mirrors this circumstance.

References

Adebayo, T. S., Agyekum, E. B., Altuntaş, M. K., Zawbaa, H. M., & Kamel, S. (2022). Does information and communication technology impede environmental degradation? fresh insights from non-parametric approaches. *Heliyon*. doi:10.1016/j.heliyon.2022.e09108

AMF. (2024). CSRD sustainability reporting: preparing for the new requirements. Retrieved from https://www.amf-france.org/en/news-publications/depth/csrd-sustainability-reporting

Andrae, A., & Edler, T. (2015). On Global Electricity Usage of Communication Technology: Trends to 2030. doi:10.3390/challe6010117

Aschauer, E. (2023). European Sustainability Reporting Standard 2: General disclosures. Retrieved from https://www.tpa-group.com/en/front-blog-en/european-sustainability-reporting-standard-2-general-disclosures/

Aschauer, E., & Binder, S. (2023). ESRS S1 – Own workforce. Retrieved from https://www.tpa-group.at/news/esrs-s1-own-workforce/?lang=en

Aschauer, E., & Binder, S. (2023). ESRS S3 - Affected communities. Retrieved from https://www.tpa-group.at/news/esrs-s3-affected-communities/?lang=en

Aschauer, E., & Binder, S. (2023). European Sustainability Reporting Standard 2: General disclosures. Retrieved from https://www.tpa-group.at/news/european-sustainability-reporting-standard-2-general-disclosures/

Aschauer, E., & Doppler, O. (2023). ESRS E2 – Umweltverschmutzung. *TPA*. Retrieved from https://www.tpa-group.at/news/european-sustainability-reporting-standard-e2/

Aschauer, E., & Doppler, O. (2023). ESRS E4 - Biodiversität und Ökosysteme. Retrieved from https://www.tpa-group.at/news/esrs-e4/

Aschauer, E., & Doppler, O. (2023). ESRS S4 – Consumers and End-users. Retrieved from https://www.tpa-group.at/news/esrs-s4-consumers-and-end-users/?lang=en

Aschauer, E., & Kühmayer, T. (2024). ESRS E1 – Climate Change. *TPA*. Retrieved from https://www.tpa-group.at/news/esrs-e1-climate-change/?lang=en

Aschauer, E., & Takacs, A. (2023). ESRS S2 – Workers in the value chain. Retrieved from https://www.tpa-group.at/news/esrs-s2-workers-in-the-value-chain/?lang=en

AWS. (2024). Understanding your customer carbon footprint tool overview. Retrieved from https://docs.aws.amazon.com/awsaccountbilling/latest/aboutv2/ccft-overview.html

Balaras, C. A., Lelekis, J., Dascalaki, E. G., & Atsidaftis, D. (2017). High Performance Data Centers and Energy Efficiency Potential in Greece☆. *Procedia Environmental Sciences*. doi:10.1016/j.proenv.2017.03.091

Batmunkh, A. (2022). Carbon Footprint of The Most Popular Social Media Platforms. doi:10.3390/su14042195

Belkhir, L., & Elmeligi, A. (2018). Assessing ICT global emissions footprint: Trends to 2040 & recommendations. doi:10.1016/j.jclepro.2017.12.239

Bernoville, T. (2024). All 2024 ESG and non-financial reporting regulations in the EU. Retrieved from https://plana.earth/academy/eu-esg-regulations

Bieser, J. C., Hintemann , R., Hilty, L. M., & Beucker, S. (2023). A review of assessments of the greenhouse gas footprint and abatement potential of information and communication technology. *Environmental Impact Assessment Review*. doi:10.1016/j.eiar.2022.107033

Bieser, J. C., Hintemann, R., Hilty, L. M., & Beucker, S. (2023). A review of assessments of the greenhouse gas footprint and abatement potential of information and

communication technology. *Environmental Impact Assessment Review*. doi:10.1016/j.eiar.2022.107033
Breidenreich, C., Magraw, D., Rowley, A., & Rubin, J. W. (2017). The Kyoto Protocol to the United Nations Framework Convention on Climate Change. Retrieved from https://www.cambridge.org/core/journals/american-journal-of-international-law/article/abs/kyoto-protocol-to-the-united-nations-framework-convention-on-climate-change/963B9A4FEEB7342563BFE2A5B17AD188
Brill, T., Munoz, L., & Miller, R. (2019). Siri, Alexa, and other digital assistants: a study of customer satisfaction with artificial intelligence applications. *Journal of Marketing Management*. doi:10.1080/0267257X.2019.1687571
Budd, J., Miller, B. S., Manning, E. M., & Lampos, V. (2020). Digital technologies in the public-health response to COVID-19. *Nat Med*. doi:10.1038/s41591-020-1011-4
Cambridge Centre for Alternative Finance. (2023). Cambridge Bitcoin Electricity Consumption Index. Retrieved from https://ccaf.io/cbnsi/cbeci/methodology
Carter, R. (2024). How Many Bitcoins Are There in 2023? *Bankless Times*. Retrieved from https://www.banklesstimes.com/how-many-bitcoins-are-there/
Chamanara, S., Ghaffarizadeh, S. A., & Madan, K. (2023). The Environmental Footprint of Bitcoin Mining Across the Globe: Call for Urgent Action. doi:10.1029/2023EF003871
Charfeddine, L., & Umlai, M. (2023). ICT sector, digitization and environmental sustainability: A systematic review of the literature from 2000 to 2022. *Renewable and Sustainable Energy Reviews*. Retrieved from https://www.sciencedirect.com/science/article/pii/S1364032123003398
Climate Partner. (n.d.). European Sustainability Reporting Standards (ESRS). Retrieved from https://www.climatepartner.com/en/knowledge/glossary/european-sustainability-reporting-standards-esrs
Council of the EU. (2024). Council and Parliament agree to delay sustainability. *Press Release*.
CSR in Deutschland. (n.d.). Corporate Sustainability Reporting Directive (CSRD). *CSR in Deutschland*. Retrieved from https://www.csr-in-deutschland.de/DE/CSR-Allgemein/CSR-Politik/CSR-in-der-EU/Corporate-Sustainability-Reporting-Directive/corporate-sustainability-reporting-directive-art.html
Cuomo, F., Gaia, S., Girardone, C., & Piserà, S. (2022). The effects of the EU non-financial reporting directive on corporate social responsibility. *The European Journal of FInance*, pp. 726-752. doi:0.1080/1351847X.2022.2113812
Dahr, P. (2020). The carbon impact of artificial intelligence. *Nat Mach Intell*. doi:10.1038/s42256-020-0219-9
De Cristofaro, T., & Gulluscio, C. (2023). In Search of Double Materiality in Non-Financial Reports: First Empirical Evidence. doi:10.3390/su15020924
Denkstatt. (2023). European Sustainability Reporting Standards (ESRS) Zusammenfassung. Retrieved from https://denkstatt.at/esrs-standards-zusammenfassung/
Digiconomist. (2023). Bitcoin Energy Consumption Index. Retrieved from https://digiconomist.net/bitcoin-energy-consumption
Directorate-General for Communication. (2022). The European Union – What it is and what it does. Retrieved from https://op.europa.eu/webpub/com/eu-what-it-is/en/
Doppler , O., & Winkelbauer, B. (2023). ESRS E3 – Wasser- und Meeresressourcen. *TPA*. Retrieved from https://www.tpa-group.at/news/esrs-e3-wasser-und-meeresressourcen/

EFRAG. (2021). *CURRENT NON-FINANCIAL REPORTING FORMATS AND PRACTICES.* EFRAG, STREAM A6 ASSESSMENT REPORT. Retrieved from https://www.efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2FSiteAssets%2FEFRAG%2520PTF-NFRS_A6_FINAL.pdf&AspxAutoDetectCookieSupport=1 p.44)

EFRAG. (2022). ESRS 2 General disclosures. Retrieved from https://www.efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2FSiteAssets%2F07.%2520Draft%2520ESRS%25202%2520General%2520disclsoures%2520November%25202022.pdf

EFRAG. (2022). ESRS G1 Business conduct. Retrieved from ESRS S4 – Consumers and End-users

EFRAG. (2023). ESRS 2 Delegated act 2023/5303 (Annex 1) . Retrieved from https://www.efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2FSiteAssets%2FESRS%25202%2520Delegated-act-2023-5303-annex-1_en.pdf

EFRAG. (2023). ESRS S2 Workers in the value chain. Retrieved from https://www.efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2FSiteAssets%2FBfC_ESRS%2520S2_workers%2520in%2520the%2520value%2520chain%2520.pdf

EUR-Lex. (2014). Directive 2014/95/EU of the European Parliament and of the Council of 22 October 2014 amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large undertakings and groups Text with EEA relevance. Retrieved from https://eur-lex.europa.eu/eli/dir/2014/95/oj

EUR-Lex. (2023). Commission Delegated Regulation (EU) 2023/2772 of 31 July 2023 supplementing Directive 2013/34/EU of the European Parliament and of the Council as regards sustainability reporting standards. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202302772

Europäische Kommission. (2014). Disclosure of non-financial information by certain large companies: European Parliament and Council reach agreement on Commission proposal to improve transparency. Retrieved from https://ec.europa.eu/commission/presscorner/detail/de/STATEMENT_14_29

European Commission. (2017). *Commission takes further steps to enhance business transparency on social and environmental matters.* European Commission. Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/IP_17_1702

European Commission. (2017). Commission takes further steps to enhance business transparency on social and environmental matters. Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/IP_17_1702

European Commission. (2022). Corporate sustainability reportingDirective (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate s. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022L2464

European Commission. (2023). Questions and Answers on the Adoption of European Sustainability Reporting Standards. Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_4043

European Commission. (n.d.). Corporate Sustainability Reporting. Retrieved from https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en

European Commission. (n.d.). EU Taxonomy Navigator. Retrieved from https://ec.europa.eu/sustainable-finance-taxonomy/
European Commission. (n.d.). Glossary: Carbon dioxide emissions. Retrieved from (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Carbon_dioxide_emissions)
European Commission. (n.d.). Sustainability-related disclosure in the financial services sector. Retrieved from https://finance.ec.europa.eu/sustainable-finance/disclosures/sustainability-related-disclosure-financial-services-sector_en
European Commission. (n.d.). The European Green Deal. Retrieved from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
European Council. (n.d.). European Green Deal. Retrieved from https://www.consilium.europa.eu/en/policies/green-deal/#:~:text=The%20European%20Green%20Deal%20is%20a%20package%20of%20policy%20initiatives,a%20modern%20and%20competitive%20economy
European Financial Reporting Advisory Group. (2023). ESRS E1 Delegated act 2023/5303 (Annex 1) . Retrieved from https://www.efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2FSiteAssets%2FESRS%2520E1%2520Delegated-act-2023-5303-annex-1_en.pdf
European Parliament. (2021). Non-financial Reporting Directiv. Retrieved from https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/654213/EPRS_BRI(2021)654213_EN.pdf
European Parliament. (2024). E-waste in the EU: facts and figures (infographic). Retrieved from https://www.europarl.europa.eu/pdfs/news/expert/2020/12/story/20201208STO93325/20201208STO93325_en.pdf
European Securities and Markets Authority. (n.d.). Electronic Reporting. Retrieved from https://www.esma.europa.eu/issuer-disclosure/electronic-reporting
European Union. (2020). European Union (2020) Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R0852&from=EN
European Union. (2020). Regulation (EU) 2020/852. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32020R0852
Eurostat. (2023). Glossary: Information and communication technology (ICT). Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Information_and_communication_technology_(ICT)
EU-Taxonomy Info. (n.d.). EU Taxonomy Overview. Retrieved from https://eu-taxonomy.info/info/eu-taxonomy-overview
Faisal, F., Azizullah, Turgut, T., & Pervaiz, R. (2020). Does ICT lessen CO2 emissions for fast-emerging economies? An application of the heterogeneous panel estimations. *Environmental Science and Pollution Research*. doi:10.1007/s11356-019-07582-w
Fasan, M. (2024). SUSTAINABILITY REPORTING FROM THE EU PERSPECTIVE:. doi:10.16930/2237-7662202434661

Freitag, C., Berners-Lee, M., Widdicks , K., Knowles, B., Blair, G. S., & Friday, A. (2021). The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations. *Patterns*. doi:10.1016/j.patter.2021.100340

Fuhrmann, K., & Kerbl, G. (2022). CSRD: What you need to know about Sustainability reporting. Retrieved from https://www.tpa-group.at/news/csrd-what-you-need-to-know-about-sustainability-reporting/?lang=en

Ghulam, S. T., & Abushammala, H. (2023). Challenges and Opportunities in the Management of Electronic. *Sustainability*. doi:10.3390/su15031837

Göçen, S. (2023). Glocal Policy and Strategies for Blockchain: Building Ecosystems and Sustainability. doi:10.4018/978-1-6684-4153-4.ch005

Green Vision Solutions. (n.d.). ESRS-E1. Retrieved from https://greenvisionsolutions.de/esrs-e1/

Harkiolakis, N. (2013). In *Carbon Footprint* (p. 313). Springer. doi:10.1007/978-3-642-28036-8_38

Higón , D. A., Gholami , R., & Shirazi, F. (2017). ICT and environmental sustainability: A global perspective. *Telematics and Informatics*. doi:10.1016/j.tele.2017.01.001

Holzheuser, S., Hairabedian, J., Valence, D., & Juliette. (2023). New developments to the CSRD: What are the implications for non-financial disclosures? Retrieved from https://eco-act.com/blog/csrd-non-financial-disclosure-in-eu/#:~:text=The%20CSRD%20came%20into%20force,applies%20to%20approximately%2012%2C000%20companies.

Hummel, K., & Jobst, D. (2024). An Overview of Corporate Sustainability Reporting Legislation in the European Union . *Accounting in Europe*, 36. doi:10.1080/17449480.2024.2312145

ICT Footprint EU. (n.d.). ICT Carbon footprint. Retrieved from https://ictfootprint.eu/en/about/ict-carbon-footprint/ict-carbon-footprint

Ilankoon, I., Ghorbani, Y., Chong, M. N., Herath, G., Moyo, T., & Petersen, J. (2018). E-waste in the international context – A review of trade flows, regulations, hazards, waste management strategies and technologies for value recovery. *Waste Management*, pp. 258-275. doi:10.1016/j.wasman.2018.10.018

International Telecommunication Union. (2014). REPORT ON THE WORK CARRIED OUT BY THE CORRESPONDENCE GROUP ON. *ITU*.

Jones, B., Goodkind, A., & Berrens, R. (2022). Economic estimation of Bitcoin mining's climate damages demonstrates closer resemblance to digital crude than digital gold. doi:10.1038/s41598-022-18686-8

Katal, A., Dahiya, S., & Choudhury, T. (2022). Energy efficiency in cloud computing data centers: a survey on software technologies. *Cluster Comput*. doi:10.1007/s10586-022-03713-0

Kayal, P., & Rohilla, P. (2021). Bitcoin in the economics and finance literature: a survey. doi:10.1007/s43546-021-00090-5

Kilgore, G. (2024). Carbon Footprint of Data Centers & Data Storage Per Country (Calculator). Retrieved from https://8billiontrees.com/carbon-offsets-credits/carbon-ecological-footprint-calculators/carbon-footprint-of-data-centers/

Knez, K., Jaklic, A., & Stare, M. (2021). An extended approach to value chain analysis. *Journal of Economic Structures*. doi:10.1186/s40008-021-00244-6

Lawrence, C. (2023). The environmental reality of audio and video streaming is high carbon emissions. Retrieved from https://tech.eu/2023/11/15/the-environmental-impact-of-audio-and-video-streaming/#:~:text=The%20internet%20is%20a%20major,0.57%20billion%20tonnes%20a%20year.

Lexikon der Nachhaltigkeit. (2015). Nachhaltigkeit. Retrieved from https://www.nachhaltigkeit.info/artikel/definitionen_1382.htm

Liu, Y., Wei, X., Xiao, J., Liu, Z., Xu, Y., & Tian, Y. (2020). Energy consumption and emission mitigation. *Global Energy Interconnection*. doi: 10.1016/j.gloei.2020.07.008

Luu, L., Chu, D.-H., Olickel, H., Saxena, P., & Hobor, A. (2016). Making Smart Contracts Smarter. doi:10.1145/2976749.2978309

Malmodin, J., & Lundén, D. (2018). The Energy and Carbon Footprint of the Global ICT and E&M Sectors 2010–2015. doi:10.3390/su10093027

Malmodin, J., Lövehagen, N., Bergmark, P., & Lunden, D. (2024). ICT sector electricity consumption and greenhouse gas emissions – 2020 outcome. *Telecommunications Policy*. doi:10.1016/j.telpol.2023.102701

Mclean, S. (2023). The Environmental Impact of ChatGPT: A Call for Sustainable Practices In AI Development. *Earth Org*. Retrieved from https://earth.org/environmental-impact-chatgpt/

Mirza, Z. (2024). EU lawmakers approve 2-year delay of CSRD reporting for non-EU companies and specific sectors. *ESG DIVE*. Retrieved from https://www.esgdive.com/news/eu-lawmakers-approve-two-year-delay-of-csrd-reporting/705625/

Morey, M., McGrath, G., & Minato, H. (2024). Tracking electricity consumption from U.S. cryptocurrency mining operations. *EIA US Energy Information Administration* . Retrieved from https://www.eia.gov/todayinenergy/detail.php?id=61364#:~:text=The%20CBECI%20estimates%20that%20global,to%20have%20been%2027%2C400%20TWh .

N'dri, L. M., Islam, M., & Kakinaka, M. (2021). ICT and environmental sustainability: Any differences in developing countries? *Journal of Cleaner Production*. doi:10.1016/j.jclepro.2021.126642

Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. Retrieved from https://bitcoin.org/bitcoin.pdf

Obringer, R., Rachunok, B., Maia-Silva, D., & Arbabzadeh, M. (2021). The overlooked environmental footprint of increasing Internet use . doi:10.1016/j.resconrec.2020.105389

OPTEL. (2024). THE EU DELAYS CSRD REPORTING STANDARDS BY TWO YEARS. Retrieved from https://www.optelgroup.com/en/blog/the-european-union-delays-csrd-reporting-standards-by-two-years/

Perkins BS, D., Brun Disse MS, M.-N., & Nxele MS, T. (2014). E-Waste: A Global Hazard. *Annals of Global Health*. doi:10.1016/j.aogh.2014.10.001

Plassmann, K., & Edwards-Jones, G. (2010). In *Environmental Assessment and Management in the Food Industry* (pp. 272-296). Woodhead Publishing. doi:10.1533/9780857090225.3.272

PwC. (2024). Worldwide impact of CSRD - are you ready? Retrieved from https://viewpoint.pwc.com/dt/us/en/pwc/in_the_loop/assets/csrditl0124.pdf

Rakic, U. (2023). The impact of the EU Non-Financial Reporting Directive. 43.

Ren, S., Li, P., Yang, J., & Islam, M. (2023). Making AI Less "Thirsty": Uncovering and Addressing the. Retrieved from https://arxiv.org/pdf/2304.03271

Richins, D., Ketankumar Doshi, D., & Blackmore, M. (2021). AI Tax: The Hidden Cost of AI Data Center Applications. *ACM Transaction on Computer Systems*. doi:10.1145/3440689

Sandri, S., Hussein, H., Alshyab, N., & Sagatowski, J. (2023). The European Green Deal: Challenges and opportunities for the Southern Mediterranean. doi:10.1080/13629395.2023.2237295

Sarker, I. H. (2022). AI-Based Modeling: Techniques, Applications and Research Issues Towards Automation, Intelligent and Smart Systems. doi:10.1007/s42979-022-01043-x

Saunavaara , J., Laine, A., & Salo, M. (2022). The Nordic societies and the development of the data centre industry: Digital transformation meets infrastructural and industrial inheritance. *Technology in Society*. doi:10.1016/j.techsoc.2022.101931

Savaresi, A. (2015). The Paris Agreeement: A New Beginning? Retrieved from https://dspace.stir.ac.uk/bitstream/1893/24099/1/ParisAgreementANewBeginning.pdf

Schiliro, F., & Choo, K.-K. R. (2017). *Mobile Security and Privacy.* doi:10.1016/B978-0-12-804629-6.00005-5

Schütze, F., & Stede, J. (2024). The EU sustainable finance taxonomy and its contribution to climate neutrality. *Journal of sustainable finance & investment*, 33. doi:0.1080/20430795.2021.2006129

Simmons, & Simmons. (2020). EU regulation on sustainability-related disclosures. Retrieved from https://www.simmons-simmons.com/en/publications/ck66jdb3x2i8y0a592qa33id6/eu-regulation-on-sustainability-related-disclosures

Soeder, U. (2023). Double Materiality. Retrieved from https://www.ecobeweb.com/doublemateriality/

Statistics, U. I. (2009). *Guide to measuring information and communication technologies (ICT) in education.* Retrieved from https://learningportal.iiep.unesco.org/en/glossary/information-and-communication-technologies-ict#:~:text=Information%20and%20communication%20technologies%20(ICT)%20is%20defined%20as%20a%20diverse,create%2C%20share%20or%20exchange%20information

Strubell, E., Ananya, G., & McCallum, A. (2019). Energy and Policy Considerations for Deep Learning in NLP. doi:10.18653/v1/P19-1355

Taddeo, M., Tsamados, A., Cowls, J., & Floridi, L. (2021). Artificial intelligence and the climate emergency: Opportunities, challenges, and recommendations. *One Earth Cell Press*. doi:10.1016/j.oneear.2021.05.018

Technology Ireland ICT Skillnet. (n.d.). Artificial Intelligence (AI) – What Is It & How Do I Learn it? Retrieved from https://ictskillnet.ie/news-and-insights/artificial-intelligence-ai-what-is-it-how-do-i-learn-it/#:~:text=AI%20is%20one%20of%20the,services%20and%20low%2Dcarbon%20economies

The Economic Times. (n.d.). What is 'Fiscal year'. *The Economic Times*. Retrieved from https://economictimes.indiatimes.com/definition/fiscal-year

TPA. (2023). ESRS E5 – Resource use and circular economy. Retrieved from https://www.tpa-group.rs/en/news-serbia/esrs-e5-resource-use-and-circular-economy/

Tredinnick, L. (2019). Cryptocurrencies and the blockchain. *Sage Journals*. doi:10.1177/0266382119836314

Ultimaco. (n.d.). What is a Peer-to-Peer Network? Retrieved from https://utimaco.com/service/knowledge-base/blockchain/what-is-a-peer-to-peer-network

UN Environment Programme. (2024). European Sustainability Reporting Standards (ESRS). Retrieved from https://www.unepfi.org/impact/interoperability/european-sustainability-reporting-standards-esrs/

UNFCCC. (n.d.). Glossary. Retrieved from https://unfccc.int/resource/cd_roms/na1/ghg_inventories/english/8_glossary/Glossary.htm

UNFCCC. (n.d.). History of the Convention. Retrieved from https://unfccc.int/process/the-convention/history-of-the-convention#Essential-background

UNFCCC. (n.d.). The Paris Agreement. Retrieved from https://unfccc.int/process-and-meetings/the-paris-agreement

United Nations Climate Change. (n.d.). What is the United Nations Framework Convention on Climate Change? Retrieved from https://unfccc.int/process-and-meetings/what-is-the-united-nations-framework-convention-on-climate-change#:~:text=The%20UNFCCC%20entered%20into%20force,called%20Parties%20to%20the%20Convention.

United Nations. (n.d.). Sustainability. *United Nations Academic Impact*. Retrieved from https://www.un.org/en/academic-impact/sustainability

Vishwakarma, S., Kumar, V., Arya, S., Tembhare, M., Rautela, R., Dutta, D., & Kumar, S. (2022). E-waste in Information and Communication Technology. *Environmental Technology & Innovation*. doi:10.1016/j.eti.2022.102797

Wang, Q., Hu, S., & Li, R. (2024). Could information and communication technology (ICT) reduce carbon emissions? The role of trade openness and financial development. *Telecommunications Policy, 48*(3). doi:10.1016/j.telpol.2023.102699

Wilhelm, A., & Müller, A. (2023). Transparency and Relevance: How to Succeed in Materiality Assessment According to the ESRS. Retrieved from https://www.roedl.com/insights/esg-news/2023-5/materiality-assessment-according-to-esrs#objective

Winkelbauer, B. (2023). European Sustainability Reporting Standard E2. Retrieved from https://www.energy-tomorrow.eu/en/energy-news/european-sustainability-reporting-standard-e2-pollution/

Zauchner, A. (n.d.). Double Materiality Assessment for CSRD Reporting. *Denkstatt*. Retrieved from https://denkstatt.at/en/double-materiality-assessment-csrd/

Zhang, X., Shinozuka, M., Tanaka, Y., Kanamori, Y., & Masui, T. (2022). How ICT can contribute to realize a sustainable society in the future: a CGE approach. doi:10.1007/s10668-021-01674-9

Zimmer, M., & Holzhausen, A. (2023). More emissions than meet the eye: Decarbonizing the ICT sector. Retrieved from https://www.allianz.com/en/economic_research/insights/publications/specials_fmo/decarbonizing-information-technologies.html

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Appendix

A.1 Personal Interview with CEO of an ICT Company

Role: Chief Executive Officer, Anonymous, (ca. 100 employees) in Vienna, Austria
Method: In person interview
Date: 23.05.2024
Key: Interviewer Barbara Karlovcec (BK)/ Respondent: Interviewee (I), within the paper referred to as anonymous or interviewee

BK: 2023 wurde ja die CSRD bzw auch die ESRS und Ihre Anforderungen veröffentlicht, wie war die erste Reaktion Ihrerseits?

I: Als Tochterunternehmen haben wir, gemeinsam mit den anderen Töchtern, die CSRD in einer Besprechung vorgestellt bekommen. Die erste Frage wurde von einem Kollegen gestellt, aber gedacht hat sich diese jeder. Die Frage war nämlich, wie es um die Haftung bzgl. der CSRD steht. Das ist auch einfach unseren Positionen geschuldet. Darüber hinaus war es dann natürlich auch erst einmal viel und auch sehr breit gefächert, was da vorgestellt wurde. Ich muss ehrlich sagen, dass zuerst niemand einen Überblick hatte und es jetzt auch noch nicht allzu einfach ist, sich einen zu verschaffen.

BK: Dass es viel und breit gefächert war, bezieht sich auf die ESRS, oder?

I: Ja, genau. Diese gehen ja von dem Umgang mit seinem Personal bis hin zu Kreislaufwirtschaft und und und. Also auf den ersten Blick schon einiges an Daten und auch aus einigen Bereichen.

BK: Verstehe. Das habe ich auch während meiner Recherche für meine Thesis tatsächlich so empfunden. Also bis ich mich da eingelesen habe und dann auch danach, habe ich das als sehr umfangreich und detailiert gesehen. Aber gut, das Thema Sustainability bzw. Nachhaltigkeitist ja nun schon viel länger existent. Gefühlt aber wächst erst seit einigen paar Jahren das Bewusstsein dafür. Siehst du das auch so?

I: Ich empfinde das schon auch so, dass das Bewusstsein wächst, aber nicht stark genug. Ich befinde mich halt auch in meiner Bubble. Beispielweise fällt mir das bei meinen Mitarbeitern auf. Wir legen hier sehr viel Wert auf Nachhaltigkeit. Unsere Mitarbeiter kommen entweder mit den Öffis, zu Fuß oder mit dem Fahrrad ins Büro. Wir fördern dies auch, indem wir einen Geldbeitrag zu Jahreskarten oder dem Klimaticket beisteueren. Und ganz stark merke ich das auch bei der jüngeren Generation, die solche Themen tatsächlich schon beim Einstellungsgespräch erwähnen und auch wissen wollen, was wir im Thema Klimaschutz, Nachhaltigkeit usw.tun. Aber wie gesagt, bewege ich mich aus meiner Bubble heraus, dann sieht das schon wieder ganz anders aus. Nicht für jeden hat Nachhaltigkeit einen wichtigen Stellenwert, das ist leider auch wahr.

BK: Deiner Meinung nach, durch Richtlinien wie CSRD und die ESRS, wird nun umso mehr verdeutlicht wie wichtig das Thema ist oder gegenteilig? Glaubst du, es wird als mühsam gesehen?
I: Ob es jemand als mühsam ansieht, glaub ich hängt davon ab, inwiefern man sich damit befasst und ob es generell ein Thema für jemanden als Person ist. Im Business Kontext kann das dann schon auch zusammenhängen, aber ich finde es mehr als wichtig, und

mühsam nur dann, wenn man sieht, dass nichts weitergeht. Die CSRD ist theoretisch eine super Idee und sicher auch notwendig. Aber, das muss ich ganz klar so sagen, gefühlt kennt sich niemand zu 100% aus. Zum Einen ist es was Neues, es ist viel und es wirkt noch nicht ausgereift.

BK:Wie meinst du das?

I: Es ist ja angekündigt worden und wird für die Berichte dann 2025 fällig. Es wirkt wie eine „one size fits all" Lösung. Ich stehe dem Ganzen natürlich offen gegenüber, aber habe schon meine Bedenken. Ich glaube auch, dass das nach der ersten Runde von eingegangenen Berichten nicht dabei bleiben wird. Da hat man nämlich auch die Learnings und kann schauen, was kann man verbessern, was muss genauer gemacht werden etc.

BK: Lt. CSRD können Falschangaben oder das Weglassen von Daten mit Geldstrafen usw belangt werden, was denkst du davon?
I: Haftung dahinter ist sinnvoll, ganz klar. Diese wirkt sehr milde. Ich habe aber schon die Bedenken, ob es von Betrieben nicht auch zu Greenwashing kommen könnte. Dadurch, dass das alles neu und so umfangreich ist, bin ich mir nicht sicher wie die Kontrolle letzendlich wirklich die Richtigkeit und Vollständigkeit bestimmen kann.

BK: In Hinblick auf die CSRD/ ESRS, mussten Vorbereitungen getroffen werden? Ich meine hier fachliche Vorkehrungen.

I: Von Vorbereitugen wüsste ich so nichts. Wir müssen uns damit befassen, ja ganz klar. Man muss sich einlesen, prüfen was trifft auf uns zu und wo sind wir in der Bringschuld.

BK: Die Anforderungen gerade die der ESRS sind schon detailreich, musste hierfür Personal eingestellt oder geschult werden?

I: Zum jetzigen Zeitpunkt haben wir kein Recruiting speziell dafür vorgesehen. Dafür fehlt auch das Budget. Bei uns haben Mitarbeiter oft mehrere Hüte auf, so auch hier.

BK:Siehst du Potentiale oder Möglichkeiten seit der Einführung dieser Richtlinien, innerhalb des Unternehmens? Also ist etwas zum Thema geworden, dass es vorher nicht gab ?

I: Möglichkeiten sehe ich darin, mehr Bewusstsein zu schaffen. Man gewinnt hoffentlich einen Einblick in Unternehmensdaten, konsolidiert. Vielleicht gibt es hier das ein odere andere Learning oder einen Aha Effekt. Den Rest wird man dann mit der Zeit sehen. Und, ich kann mir auch vorstellen, dass es für Consulting Unternehmen ein lukratives Thema ist. Kann sich eine Firma nicht ausschließlich selbst damit befassen, dann profitieren Berater davon.

BK: Kann man dann schon jetzt sagen, dass, Themen aufgekommen sind, evtl Probleme auch, die branchenspezifisch sind?

I: Ich kann jetzt nur für uns als Unternehmen sprechen, ob man da branchenweit was erkennen wird, mal sehen. Für uns zum Beispiel hat man unter dem Punkt, wo man angeben muss, wie viel Müll man produziert, uns schon überrascht. Wir stellen ja

Software bereit, haben also per se keine Produkte die wir produzieren. Dazu müssen wir nun rausfinden, ob es reicht einfach bei der MA anzufragen, wieviel Müll von unserem Gebäude monatlich abgeholt. Und das ist nur mal so ein Gedankenansatz.

BK: Wenn Sie das nennen dürfen, innerhalb der angeforderten Nachhaltigkeitsberichterstattung, gibt oder gab es in dem Unternehmen einen Punkt, der dafür am größten ausgeschlagen hat?

I: Hierzu kann ich leider noch nichts sagen, da wir momentan noch in der Datenerhebung sind und vieles noch nicht abgeschlossen ist. Ob da was aufkommt oder nicht, das wird die Zeit zeigen. Das finde ich übrigens mit der ganzen Thematik, all das braucht Zeit. Erstens um die Anforderungen umsetzen zu können und dann auch eben um zu sehen, ob das so Sinn macht weiterzuführen oder nicht.

BK: Wärst du ein Entscheidungsträger bzgl. CSRD, was hättest du anders gemacht? Sowohl inhaltlich als auch strategisch?

I: Von der EU Seite her, hätte ich eine sukzessive Einführung vorgeschlagen. Einfach auch, weil es dann vom Umfang weniger gewesen wäre und man sich das genauer ansehen kann,wie und ob die angeforderten Daten sinnvoll und machbar sind.

A.2 Personal Interview with Team Lead of Sustainability

Role: Team Lead Sustainability, Anonymous, of a Tech Company (more than 5,000 employees) in Upper Austria, Austria
Method: Personal interview over MS Teams
Date: 29.05.2024
Key: Interviewer Barbara Karlovcec (BK)/ Respondent: Interviewee (I), within the paper referred to as anonymous or interviewee

BK: Nach der Vorstellung der CSRD bzw. der ESRS? Wurden erste Maßnahmen getroffen? Wenn ja, welche?

I: Die CSRD wurde der Geschäftsleitung vorgestellt, und dann lief die Kommunikation wie bei anderen Themen auch. Also, es wurden dann den entsprechenden Managern, u.a. mir auch davon berichtet. Maßnahmen wurden insofern getroffen, dass beschlossen wurde, dass das speziell im Bereich Nachhaltigkeit aufgearbeitet wird. Und dann, wenn nötig geht man auf die entsprechenden Leute zu, die einem zum Beispiel dann notwendige Infos oder Daten liefern können.

BK: Die ESRS haben detailierte Anforderungen zu den verschiedensten Bereichen. Kommt es vor, dass manche Daten zuvor nicht erhoben wurden? Sind diese nun schwieriger zu erfassen?

I: Dass es vorkommen kann, dass manche Daten hierzu noch gar nie abgefragt wurden, das kann ich mir schon vorstellen. Gerade auch weil die CSRD so umfangreich ist und viele Bereiche miteinander kombiniert. Aber ich sehe das eher als Vorteil für die Zukunft. Nur weil gewisse Infos zuvor nicht gebraucht wurden, und wir diese nun erstmalig erheben müssten, kann es ja auch sein, dass die öfters für andere Zwecke gebraucht werden. Das heißt,wenn wir jetzt schon schauen, dass wir Daten nachhaltig abfragen und aufbearbeiten, dann profitieren wir nachher davon.

BK: Ist die Menge der Anforderungen erschlagend? Wäre eine sukzessive Einführung besser?

I: Ob es sukzessive besser wäre, kann ich nicht beurteilen. Wir im Unternehmen fokussieren uns jetzt mal auf den Stand der Dinge, auch wenn es viel und detailreich ist.

BK: Musste für die CSRD Personal eingestellt/ geschult werden?

I: Wir haben in unserem Team zwar neue Mitarbeiter, aber diese sind nicht aufgrund der CSRD eingestellt worden. Also kann ich die Frage verneinen, da auch niemand wirklich geschult wird hierfür.

BK: Ziehen Sie zur Unterstützung zu diesem Thema ein Conuslting Unternehmen zu Rat?

I: Bisher hatten wir hierfür keine Intention, dass wir das extern abwickeln. Und ich denke auch, dass das vorerst so bleiben wird. Momentan sehe ich da auch noch nicht den Nutzen bzw.den Need dahinter.

BK: Gibt es Themen in der CSRD/ ESRS, die zu wenig/ zu viel Aufmerksamkeit bekommen?

I: Das müsste ich mir nochmal genauer ansehen, bzw.all die Reqiurements nochmal genauer durchgehen. Ich könnte das jetzt so nicht beantworten, denke aber, dass das auch erst mit der Zeit wohl aufkommt.

BK: Dadurch, dass keine Kontrollinstanz existiert bzw. die Kontrolle eher schwierig ist und die Haftung anders als bei anderen Richtlinien ist – könnte das Thema dadurch eine niedrigere Priorität haben?

I: Es gibt eine Kontrollinstanz, das ist dann die Wirtschaftsprüfung. Wie gut das dort überprüft werden kann, das wird sich auch noch zeigen. Aber, ich bezweifle, dass man daher ableiten kann, dass dieses Thema eine kleinere Priorität hätte. Außerdem, drohen doch Bußgelder wenn falsche Daten angegeben werden.

BK: Ergeben sich neue Potentiale oder Möglichkeiten seit der Einführung dieser Richtlinien, innerhalb des Unternehmens? Also ist etwas zum Thema geworden, dass es vorher nicht gab ?

I: Wie ich vorher schon erwähnt hab, kann ich mir das schon vorstellen, dass wir nun Daten abfragen müssen, die wir so in der Form noch nicht gebraucht haben. Aber um das zu sehen, brauchen wir noch Zeit. Aber hinsichtlich Corporate Social Responsibility finde ich das ganz ganz wichtig, dass wir hier diese neue Richtlinie haben und uns damit jetzt auseinandersetzen müssen. Ich finde das schon super und wichtig.Es muss ja dahingehend mehr passieren. Ich sehe das ganze als Chance endlich was zu tun, Betrieben zu zeigen, was alles möglich ist in diesem Bereich und was einfach auch noch getan werden muss.

BK: Kann es Ihrer Meinung nach auch als Greenwashing gesehen werden? Dadurch, dass die Überprüfung der Daten und deren Vollständigkeit noch ausgereift werden muss?

I: Greenwashing? Nein, das finde ich nicht. Zumindest sehe ich nicht, warum das jemand machen würde in diesem Kontext. Die Definition von Greenwashing und die CSRD passen da für mich nicht zusammen.

BK: Aber ist es denn nicht generell nicht nachvollziehbar, weshalb Greenwashing betrieben wird?

I: Ja, das stimmt schon. Aber hier, ich weiß nicht, da tue ich mir schwer das so nachzuvollziehen. Daher denke ich nicht, dass da Greenwashing eine Gefahr ist.

BK: Bekommt das Thema Nachhaltigkeit nun mehr Aufmerksamkeit, oder wird es als mühsam aufgefasst?

I: Naja, nicht zuletzt durch mediale Präsenz, drohenden Klimaauswirkungen usw. finde ich schon, dass das Thema Nachhaltigkeit mehr diskutiert wird. Aber es ist trozudem noch ein weiter Weg, weil manche das gar nicht kümmert. In unserem Umfeld, Personen wie du und ich, die sich damit befassen, ist das natürlich ganz anders. Aber rein vomGefühl her, würd ich schon sagen, dass sich da was tut. Und damit es eben auch auf Unternehmensebene ankommt, muss es mehr Richtlinien geben. Leute müssen verstehen,dass Nachhaltigkeit wichtig ist und Chancen bietet.

BK: Wären Sie ein Entscheidungsträger bzgl. CSRD, was hätten Sie anders gemacht? Sowohl inhaltlich als auch strategisch?

I: Als Entscheidungsträger in der EU? Da würd ich ganz klar versuchen, dass alles ganz anders aufzuziehen. Besseres Marketing bzw.überhaupt Marketing. Den Leuten und Unternehmen zeigen, was für Potential hinter solchen Directives steckt und ihnen deutlich machen, warum wir das benötigen. Ich hätte da mehr investiert das gut zu verkaufen, nicht nur einfach zu beschließen und das wars. So bekommt man ja das Gefühl, dass es einfach nur ein weiterer Beschluss der EU ist. Macht man das aber anders, geht man das mit mehr Schwung an, kann man da schon Begeisterung schüren und die Leute mitreißen.

A.3 Personal Interview with Thomas Delayes

Role: Independent ICT Consultant
Method: In person interview
Date: 29.05.2024
Key: Interviewer Barbara Karlovcec (BK)/ Respondent: Thomas Delayes (TD)

BK: How was the initial reaction to the CSRD upon introduction for you or the companies you work for?

TD: At this time, I had an international client, which seemed big enough to be affected by it. I can only say that I have not been contacted within the first few months regarding this topic.

BK: What is your role now, for the CSRD for the company you work with?

TD: Well, I am a software engineer but for this case, the company requires me to go out of my usual line. I now have to read it into the requirements they sent me and find a way

to extract data that they want from me. I am also looking into the formatting requirements. How we could make that work for everyone, or if we gather the reports internally first. And maybe someone from us consolidates them then into the right format. But this will be a task for when we know more or already got all the data.

BK: How does this work since you are an independent consultant and not an employee?

TD: This is simply, I am contracted by this company and so I have the needed access to their data and also to colleagues which are employed there. For the CSRD, for aspects affecting us, we have a kind of task force.

BK: Can you explain this further please?

TD: The task force consists of several people from different teams and even departments. They can be from Marketing, HR etc. and we try together, to find the wanted information.

BK: Do you see the possibility or threat of it being greenwashing?

TD: I am not sure, because I think everyone wants to do it well. So, I would not say that it is greenwashing. There can be mistakes, surely. But I would not say it is greenwashing.

BK: Do you think there are topics that are not treated or not treated well enough in the ESRS?

TD: I am afraid that I am not the best person to answer this, because I am just responsible for my portion of the whole project. But honestly, maybe when we gather all the data, we could say something to this. For now, I am sorry, I cannot claim one or the other.

BK: Do you see any potentials or opportunities in this reporting directive?

TD: I mentioned this earlier that we have to figure out ways to retrieve certain data. Especially data that is now needed for the first time. But I find this great, in case there is some data that will surface, and we have not discovered it yet. This can be a good chance for a company, another benchmark or something of this kind. Newly extracted data is of value, as it can bear the possibility for firms to identify areas where advancement is necessary.