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Carbon Credits: Curse or Blessing for Companies on the Path to Net Zero?

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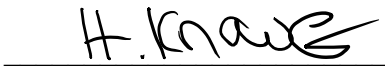
Statutory Declaration

I herewith confirm that I have independently written the chapters of the thesis for which I am named as author, that I have not used any sources or aids other than those specified, and that I have not submitted this thesis to any other examination procedure.

Ulm, May 28th 2024 Signature 

Abstract

This research addresses the question “How should companies ideally use carbon credits as part of their decarbonization activities and how are they currently used in corporate practice?”. More and more companies are aiming to achieve net-zero emissions by 2050 at the latest, as a key contribution to the Paris Agreement's goal of limiting global warming to 1.5 degrees Celsius by mid-century. Carbon credits are seen as one of the most effective tools for financing solutions to the climate crisis and offer companies the opportunity to offset their emissions. In recent years, a complex debate has developed around the use of carbon credits as a sustainable instrument for climate change mitigation. Previous studies reveal a gap in research as they have mainly examined the effectiveness of individual carbon projects and the communication of carbon credits and their impact on consumers and other stakeholders. This paper aims to contribute to closing this research gap by comparing the current use of carbon credits by companies with the recommendations of existing standards to capture the status quo. To this end a quantitative content analysis of the sustainability reports of 39 European companies was carried out. The main findings show that only about half of the project types identified meet the Science-Based Targets initiative's recommendation to protect and enhance carbon sinks. In addition, only a small percentage of companies follow the Climate Contribution Approach for the use of carbon credits in line with the Science Based Targets Initiative's Net Zero Standard. This shows that although all companies in the sample are considered leaders in climate protection, only a small proportion are using carbon credits as a tool to go beyond minimizing or offsetting their own emissions. Finally, communication of carbon credit activities in particular was found to be below current standards. This reveals a transparency problem as well as a lack of consistent and binding reporting standards. In conclusion, although voluntary carbon markets are one of the most effective tools for financing solutions to the climate crisis, there is still much room for improvement. High quality carbon credits, consistent standards and transparency are essential for voluntary carbon markets to be effective tools for climate change mitigation. However, the urgent and substantial reduction of emissions throughout the own value chain should always take precedence over the use of carbon credits.

Key words: Net Zero, Carbon Credits, Voluntary Carbon Market, Offsetting, Carbon Neutral

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List of Abbreviations

BVCM ..... Beyond Value Chain Mitigation
CCS ..... Carbon Capture and Storage
CSRD ..... Corporate Sustainability Reporting Directive
DACCS ..... Direct Air Capture and Carbon Storage
ESRS ..... European Sustainability Reporting Standards
ICVCM ..... Integrity Council for the Voluntary Carbon Market
IPCC ..... Intergovernmental Panel on Climate Change
ISEAL ..... International Social and Environmental Accreditation and Labelling Alliance
NBS ..... Nature Based Solutions
NFRD ..... Non-Financial Reporting Directive
REDD ..... Reducing Emissions from Deforestation and Forest Degradation
SBTi ..... Sience Based Target initiative
VCM ..... Voluntary Carbon Market
VCMI ..... Voluntary Market Integrity Initiative
VCS ..... Voluntary Carbon Standard
WWF ..... World Wide Fund for Nature

1 Introduction

“We urgently need every business, investor, city, state and region to walk the talk on their net zero promises. We cannot afford slow movers, fake movers or any form of greenwashing.” − António Guterres, UN Secretary General (United Nations’ High-Level Expert Group, 2022). The urgency of the UN Secretary-General's appeal reflects the growing global recognition of the need for decisive and authentic action on climate change. In addition to governments, non-state actors are increasingly being called upon to make a decisive contribution to creating a sustainable planet. As a result, companies face the challenge of achieving net zero emissions by 2050 at the latest, as this will be a crucial contribution to achieving the Paris Agreement's goal of limiting global warming to 1.5 degrees Celsius by mid-century (Calvin et al., 2023a). On the path to net zero emissions, carbon credits play an important role in many corporate strategies. They enable companies to offset their CO_2 emissions by investing in projects that reduce or remove greenhouse gases from the atmosphere (Allen et al., 2020). To fulfil legal requirements and also to benefit from a green public image, these certificates have become a central component of many companies' climate efforts in recent years. However, the reputation of carbon credits is controversial. Aside from the effectiveness of some carbon credit projects, the unregulated structures of the carbon market and the approach to offsetting in general have been heavily criticized. Concerns that carbon credits will discourage companies from implementing their own reduction strategies, which could undermine their long-term commitment to reducing their own emissions, or that carbon credits could even be used as a tool for greenwashing, are often central to the debate (Gomez and Pour, 2023). In response, a growing number of initiatives and organizations have emerged in recent years to improve the transparency, integrity and effectiveness of the carbon market. Carbon crediting programs such as the Gold Standard are working to implement rigorous monitoring and validation processes to ensure that projects issuing carbon credits deliver real, measurable and sustainable emissions reductions (Gold Standard, n.d.). Other initiatives, such as the Science Based Target Initiative, have developed standards that provide companies with clear guidance on how to integrate carbon credits into their net zero strategy as a responsible and effective tool (Watson et al., 2023). These efforts aim to unlock the full potential of carbon credits as a legitimate instrument in the fight against climate change, while minimizing the risk of abuse and greenwashing.

Carbon credits and related issues have been the subject of a number of studies. However, it is important to note that the focus to date has been on research into the effectiveness of individual carbon projects (Chausson et al., 2020; Cohen-Shacham et al., 2016; Griscom et al., 2017; Seddon, Chausson, et al., 2020; Seddon, Daniels, et al., 2020; Gifford, 2020; Greenfield, 2023; Kallio et al., 2016; Lindsay Hooper, 2021; Rifai et al., 2015; West et al., 2020; Probst et al., 2023) and the

communication of carbon credits and their impact on consumers and other stakeholders (Kreibich & Hermwille, 202; Baxter, 2021; Causone et al., 2021; Dawson et al., 2022; Hale et al., 2022; Bertini et al., 2022; Guix et al., 2022; Helmers et al., 2021; Trouwloon et al., 2023). Consequently, the review of existing studies suggests that there is a research gap in analysing the use of carbon credits by companies on the path to net zero. This paper aims to contribute to closing this research gap by comparing the current use of carbon credits by companies with the recommendations of existing standards to capture the status quo.

1.1 Objective and methodology

The aim of the paper is to understand the opportunities and challenges associated with the use of carbon credits and to identify the application strategies recommended in the literature for companies. The objective is to answer the following central research question: "How should companies ideally use carbon credits as part of their decarbonization activities and how are they currently used in corporate practice?". To answer this question, the research is divided into two parts. In the first part, the existing literature on carbon credits is analyzed and processed. In the second part, a quantitative content analysis is carried out. The sustainability reports of European companies are examined to analyze how companies apply and report on carbon credits in corporate practice. This research is to be understood as exploratory research, which aims to learn more about the underlying topic and collect data that can be used to formulate hypotheses for future, more in-depth studies. The main objective is to create a detailed and systematic picture of current practices by collecting and analyzing relevant data from company reports. The exploratory approach allows for a comprehensive understanding of current practices, allowing for an analysis of the similarities and differences between these practices and existing standards, without the need to test pre-determined assumptions. This approach keeps the research open to any observed patterns and trends that emerge from the data, providing a solid basis for future confirmatory research in this area. The following sub-questions were formulated to explore the main question in greater depth and are to be answered through the quantitative content analysis:

Q1 Which carbon credits do companies use?

Q2 How do companies utilize carbon credits?

Q3 How do companies communicate about their use of carbon credits?

1.2 Structure of the work

To answer the research question comprehensively, the thesis is divided into a theoretical and an empirical part. The first part analyses the existing literature on carbon credits and forms the basis for

the second part, in which the theoretical foundations for the ideal use of carbon credits were worked out. It describes the role of carbon credits, highlights the differences between different types of credits, and introduces and links the main players in the market. It also examines the complex debate surrounding carbon credits, discussing the arguments for and against their use in the fight against climate change. Furthermore, the development of the voluntary carbon market is divided into three distinct phases, detailing the evolution, expansion and key events within these phases. The theoretical part concludes by examining how carbon credits can serve as a credible and responsible tool for companies aiming for net zero, by explaining the net zero standard of the Science Based Target initiative. The second part is intended to complement and finalize the theoretical findings with insights from actual corporate practice. Therefore, the empirical section analyses the content of companies' sustainability reports. These findings are then summarized and discussed to determine the extent to which theory and practice converge or diverge. Finally, the central research question is answered based on the findings.

This work makes an important contribution to understanding the dynamics and application of carbon credits as a tool in the fight against climate change and provides valuable insights for policy makers, business leaders and the academic community. By identifying current practices, best practices and potential weaknesses, this research supports the goal of developing more sustainable and effective ways to reduce global carbon emissions.

2 Terminology

This chapter defines and differentiates key terms to provide a sound understanding of the thematic basis of the work and to lay the foundation for the subsequent discussion.

There are several terms related to carbon credits that are often used interchangeably, but do not have the same meaning. Carbon credits and carbon offsets (credits) are the most commonly used. The Integrity Council for Voluntary Carbon Markets defines a carbon credit as a tradable emissions unit "issued by a carbon-crediting program, representing a Greenhouse gas (GHG) emission reduction to, or removal from, the atmosphere equivalent to one metric tonne of carbon dioxide equivalent" (CO^2e) (ICVCM, 2024b, p. 68). But a carbon credit is not necessarily a carbon offset (credit). It can only be called such if it is used for carbon offsetting, which is the counterbalancing of the carbon footprint (e.g. from a company), by retiring carbon credits as a substitute for abatement of value chain emissions (ISO, 2023). The term carbon offsetting in connection with carbon offset credit is mainly found in older literature, where carbon credits were primarily seen as a cost-effective way for companies to offset emissions (Broekhof et al., 2019). However, in more recent definitions, carbon credits are no longer limited to their offsetting function, which is why this paper uses the term carbon credit rather than carbon offset credit (ICVCM, 2024a; ISO, 2023; Watson et al., 2023).

There are also different terms for the concept of climate neutrality, such as greenhouse gas neutrality, carbon neutrality and net zero emissions, which are often used interchangeably as there is still no globally accepted standard definition (Deutsche Energie-Agentur, 2022). In the absence of universally agreed definitions, a number of standards, initiatives and labels have emerged in recent years, each with its own definition. As a result, different definitions and interpretations of the terms are in circulation, which has led to inconsistencies and ambiguities (ibid.). This paper applies the Intergovernmental Panel on Climate Change's (IPCC) definitions, which are also used in the Science Based Target initiative's (SBTi) Net Zero standard. Climate neutrality is defined "as the concept of a state in which human activities result in no net effect on the climate system. Achieving such a state would require balancing of residual emissions with emission (carbon dioxide) removal as well as accounting for regional or local biogeophysical effects of human activities that, for example, affect surface albedo or local climate " (IPCC, 2022, p. 545). In addition to climate neutrality, the IPCC and SBTi also use the term net zero emissions, which describes a state that will be achieved "when anthropogenic emissions of GHGs to the atmosphere are balanced by anthropogenic removals over a specified period" (IPCC, 2022, p. 555). At the global level, both terms refer to a balance between (global) greenhouse gas emissions and removals that should be achieved by 2050 at the latest in order to limit global warming to 1.5°C (Deutsche Energie-Agentur, 2022). At the sub-global level (e.g. at the level of countries or companies), the concepts of climate neutrality and net zero emissions do not

have the same meaning. Net zero emissions can be seen as an overall target point. Climate neutrality can be achieved along the way through the use of offsetting (Deutsche Energie-Agentur, 2022). Accordingly, climate neutrality and net zero emissions at the sub-global level should be seen as complementary approaches that are not mutually exclusive (ibid.).

3 The Voluntary Carbon Market

This chapter provides a comprehensive insight of the voluntary carbon market. It begins with an overview of the market, a definition of carbon credits and a categorization of their role in the context of global climate change objectives. The regulatory and policy framework is then explained in more detail to gain a better understanding of how the market works and its particularities. It then presents a classification scheme that identifies five types of carbon credits. Among other things, it explains how key mechanisms such as Reducing Emissions from Deforestation and Forest Degradation (REDD+) and Carbon Capture and Storage (CCS) differ and what their potential is in the context of the global climate change strategy. This is followed by an explanation of the criteria that can be used to determine the quality of carbon credits and an overview of the main certification standards currently in use. The opportunities and challenges of carbon credits are then presented in order to gain a deeper understanding of the public debate surrounding the assessment of their effectiveness in the context of global emission reduction targets. The chapter concludes with a brief summary of market developments up to 2023 and an outlook for the future.

3.1 Overview and Role in Global Climate Action

The Voluntary Carbon Market (VCM) is an instrument for private financing of climate change projects, which emerged as a complement to the compliance market (Borgmann et al., 2023). The commodities traded on the VCM are carbon credits that are issued, bought and sold by private individuals and organizations outside of regulated or mandatory carbon pricing instruments (Dyck et al., 2023). Carbon credits, which have been traded on the voluntary market since the 1990s, are emissions units "issued by a carbon-crediting program, representing a GHG emission reduction to, or removal from, the atmosphere equivalent to one metric tonne of carbon dioxide equivalent" (CO^2e) (ICVCM, 2024b, p. 68). Carbon credits are generated through carbon projects, which are designed to reduce, eliminate, or remove greenhouse gas emissions from the atmosphere (Faires, 2022). Such projects can include renewable energy, reforestation or Carbon Capture and Storage (Climate Focus, 2024). Once a project is operational, its impact on emissions is measured against a baseline, which estimates emissions without the project (Faires, 2022). Then, a corresponding number of carbon credits are issued, each representing one tonne of CO_2 equivalent reduced or removed from the atmosphere. The price at which a credit is sold depends on the type of project, its environmental performance, the year in which the credit was issued (vintage) and the additional social or environmental benefits of the project (co-benefits) (Borgmann et al., 2023). In 2022, the global volume-weighted average price was $7.37 per tonne of CO_2e (Donofrio & Procton, 2023). To receive carbon credits, the owner of a carbon project must submit their project to a third party for verification. So called crediting programs or certification standards, such as Verra and Gold Standard, set out the

methodologies and verification, validation and monitoring procedures that project owners must follow in order to certify their activities as credibly sequestering or avoiding greenhouse gas emissions (Dyck et al., 2023). Since 2002, private crediting programs have added more than 1,600 million emission credits (1 tonne CO_2 equivalent each) to their registers (Borgmann et al., 2023). This is more than twice Germany's CO_2-equivalent emissions in 2022 (746 million tonnes of CO_2-equivalent) (Wilke, 2024).

Businesses are among the main purchasers of carbon credits in the VCM. They use the credits to offset their own emissions, to achieve their own climate goals such as climate neutrality, or to contribute to broader public climate change goals (Borgmann et al., 2023). The motivation is to meet the growing expectations of consumers and investors for more climate protection, to show responsibility in the fight against climate change and to strengthen the company's image as a responsible business (ibid.). In 2021, the annual volume reached $2 billion for the first time (Donofrio & Procton, 2023). The almost continuous growth of the market is partly due to the adoption of the Paris Agreement, which has led to a significant increase in climate ambition, including among non-state actors (Borgmann et al., 2023). As a result, many companies and other non-state actors have set themselves the goal of achieving net zero by 2050 and have joined initiatives such as the Race to Zero and Science Based Target initiatives (Net Zero Tracker, n.d.; SBTi, n.d.).

To increase our chances of limiting global warming to 1.5°C and mitigating the catastrophic effects of climate change, it is essential to reduce global emissions to zero, as the Intergovernmental Panel on Climate Change (IPCC) has stated (IPCC, 2022). To achieve rapid and deep cuts in greenhouse gas emissions across all sectors, and to build a net-zero global economy, an average of $3.5 trillion per year in investment will be needed between now and 2050 (Energy Transision Comission, 2023). While the importance of achieving net zero emissions by 2050 is recognized globally, it is also clear that current climate finance is not growing fast enough and measures and investments not available on the scale required to meet the Paris Agreement's climate goals (UNEP, 2023; United Nations, 2017; United Nations Environment Programme, 2023). The Voluntary Carbon Market can play a crucial role in filling this gap by providing a financing mechanism for emission reduction projects, such as renewable energy or reforestation, thus mobilizing much needed finance quickly (Dyck et al., 2023). It can therefore be seen as a key tool for global climate change mitigation, contributing to the overall goal of reducing global greenhouse gas emissions in line with international climate targets (Borgmann et al., 2023).

3.2 Political Frameworks and Regulations

To date, the Voluntary Carbon Market has largely operated outside of regulatory control, as neither individual regulations nor the United Nations Framework Convention on Climate Change (UNFCCC)

currently have a significant influence on the market (Borgmann et al., 2023). The VCM is therefore referred to as an unregulated market, which differs from regulated carbon crediting schemes such as the EU Emissions Trading System (EU ETS), and offers greater adaptability, enabling financing for climate change mitigation, biodiversity and sustainable development through important climate change mitigation activities that are not fully addressed by public policy (Dyck et al., 2023). However, governments can influence the voluntary market indirectly through policies, safeguards or regulations. For example, the EU has recently introduced new sustainability reporting requirements. The Corporate Sustainability Reporting Directive (CSRD) and the Green Claims Directive both require companies to provide more detailed information on their sustainability activities and claims, with the aim of reducing greenwashing (see section 4.3). As the disclosures also relate to the use of carbon credits, these requirements also have an impact on the VCM and could influence the demand for carbon credits.

However, the majority of VCM regulation is done through private certification standards and initiatives that aim to set more consistent and higher standards for carbon offset projects (Borgmann et al., 2023). Examples include the Integrity Council for the Voluntary Carbon Market (ICVCM), which has established quality standards for carbon credits and intends to ensure transparency and integrity on the supply side, and the Voluntary Carbon Markets Integrity Initiative (VCMI), which aims to provide clear guidelines for corporate climate change claims on the demand side (ICVCM, 2024a; VCMI, 2023). However, it is still unclear to what extent these new initiatives can contribute to improving the quality of carbon projects and the credibility and transparency of the Voluntary Carbon Market (Borgmann et al., 2023). Critics describe the current self-regulation as ineffective and point to the problems caused by a lack of political regulation. On the one hand, the lack of government oversight leads to varying requirements in certification standards and incentives for less stringent certifications, as well as deliberate misrepresentation of CO_2 savings by project organizers (Borgmann et al., 2023). It is also criticized that, due to the large number of actors involved in the VCM, only a fraction of the money reaches the projects after high brokerage commissions (Dyck et al., 2023). In addition, the lack of transparency of the financial flows makes it difficult to evaluate the climate protection projects (ibid.). The current jumble of voluntary standards and regulatory requirements creates additional uncertainty and confusion in the VCM as well as barriers to entry, especially for new market participants (Borgmann et al., 2023). Direct regulation of voluntary carbon markets, although unlikely in the near future, could set guard rails to ensure consistency within the market, which could ultimately increase confidence in the market and lead to a more effective contribution to climate change mitigation (Downey, 2023).

3.3 Types of Carbon Credits

Carbon credits can be generated by a wide variety of projects and therefore have different attributes by which they can be differentiated. Figure 1 shows a simplified classification scheme that distinguishes five types of carbon credits, depending on whether carbon is stored and the type of storage.

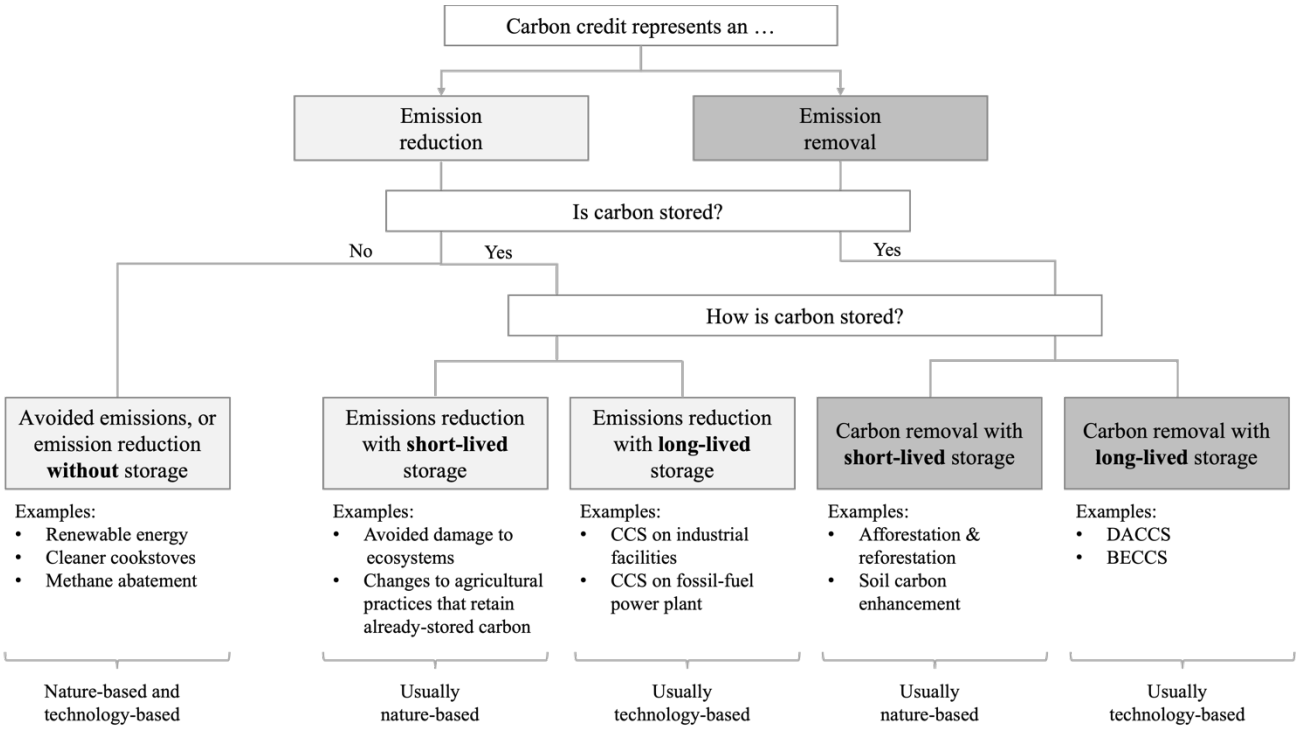

Figure 1 Taxonomy of Carbon Credits (own illustration based on Allen et al., 2020)

First, a distinction can be made as to whether the carbon credit represents an emission reduction or an emission removal. Emissions reduction (or avoided emissions) credits are generated by activities that reduce or completely avoid emissions into the atmosphere (Faires, 2022). Examples of this type of credit include renewable energy projects or the protection of tropical forests (Allen et al., 2020). In 2023, the majority of carbon credits issued on the voluntary market from projects to avoid greenhouse gases came from renewable energy projects (36%), although interest in these projects continues to decline each year since 2021 (Climate Focus, 2024). The reasons for this include concerns about the quality of the associated credits, which reduce buyer interest, low carbon prices for this project category and new restrictions imposed by leading certification standards (Climate Focus, 2024). The advantage of emission reductions is that they are readily available in high quality on voluntary markets and can play a crucial role in reducing emissions and protecting existing carbon

stocks, which is why they are expected to remain a key part of global climate change efforts for decades to come (Faires, 2022).

If carbon credits represent a emission removal, they are generated from projects that remove carbon dioxide directly from the atmosphere and store it permanently (Allen et al., 2020). Forestry and land use projects account for the majority of removal credits in 2022 (Donofrio & Procton, 2023). As different categories of carbon reduction and removal credits exist in the literature, it is difficult to find standardised numbers for the total market share of these two credit types (Allen et al., 2020; Borgmann et al., 2023; Climate Focus, 2024; Donofrio & Procton, 2023). From these different figures, however, it can be concluded that by 2023 reduction certificates had a significantly higher market share than removal credits. At the same time, however, there is an increasing demand for removal credits and a decreasing demand for reduction credits (Donofrio & Procton, 2023).

Emission reductions and emission removals are both essential elements in the fight against climate change. In the short term, high quality emission reductions provide the same benefits to the atmosphere as emission removals by preventing the production of greenhouse gases (Allen et al., 2020). The main difference between the two methods lies in their long-term effects. While emissions reductions help reduce the amount of greenhouse gases released into the atmosphere, carbon removals go further by actively filtering CO_2 out of the atmosphere. For this reason, removal technologies are not only essential to achieving net zero emissions, they also play an extremely important role in stabilising and potentially reducing carbon dioxide concentrations in the atmosphere beyond this target (Allen et al., 2020). The Sixth Assessment Report (AR6) of the IPCC, in particular the third part of the report dealing with mitigation strategies for climate change (Working Group III), emphasises that significant amounts of carbon dioxide will need to be removed from the atmosphere in order to meet the Paris Agreement goal of limiting global warming to well below 2°C, and preferably to 1.5°C, compared to pre-industrial levels (Calvin et al., 2023a). In scenarios with a high probability of limiting warming to 1.5°C, it is estimated that between 100 and 1000 billion tonnes of CO_2 need to be removed from the atmosphere by 2100. This wide range reflects uncertainties in emission pathways, the efficiency and scalability of CO_2 removal technologies, and assumed societal changes and policies. In particular, carbon capture technologies such as Direct Air Capture and Storage (DACS) are seen as crucial to offset the remaining emissions that will continue to occur even after comprehensive mitigation measures are put in place (Calvin et al., 2023a). Buyers of carbon credits should therefore invest in the development of these technologies now and only purchase carbon removal credits from 2050 at the latest, i.e. from the point at which net zero emissions are achieved, in order to ensure compatibility with the goals of the Paris Agreement (Watson et al., 2023).

Following this initial distinction between carbon reduction and carbon removal, a further distinction can be made as to whether the reduced or removed carbon is stored or not (Allen et al., 2020). Projects without subsequent carbon storage are exclusively projects in which emissions are reduced or avoided. Examples include cleaner cookstoves and renewable energy projects. Carbon removal projects always aim to store the carbon removed. In the case of credits involving carbon storage, a further distinction is made as to whether the storage is likely to be short-lived or long-lived. Short-lived carbon storage projects risk a potential reversal within a few decades due to various uncertainties (Allen et al., 2020). In the case of emission reduction credits, these include projects to prevent damage to ecosystems or to change agricultural practices. In the case of carbon sinks, examples include afforestation and reforestation projects or projects to improve soil carbon content. In theory, all these approaches have the potential to sequester CO_2 for thousands of years - provided that land use and environmental conditions remain constant (Broekhof et al., 2019). However, factors such as changing political conditions, economic pressures, forest fires, disease and the effects of climate change itself can increase the risk of the stored carbon being released back into the atmosphere in the near to medium future (Chagas et al., 2020). Storage methods meet the requirements for long-term storage if the risk of reversal over centuries to millennia is low (Allen et al., 2020). This is the case, for example, with Carbon Capture and Storage projects at industrial facilities (emission reduction credits) or Direct Air Capture and Carbon Storage (DACCS) (carbon removal credits). Careful monitoring and verification is essential to ensure the integrity of CO_2 storage in these projects and to prevent potential leaks (Budinis et al., 2018). In general, however, these storage methods are characterised by much greater stability and safety (Allen et al., 2020). Long-lived carbon storage projects in particular are becoming increasingly important, given the growing importance of removal credits. In order to meet global climate change targets and maintain a stable level of net-zero emissions, it is crucial to invest now in the expansion and improvement of technologies that enable long-lived storage (Science Based Target Initiative, 2021).

In the final classification stage for carbon credits, a distinction is made between nature-based and technology-based projects. Short-lived storage carbon credits generally result from nature-based solutions (NBS), while technology-based projects generally result in carbon credits with long-lived storage (Donofrio & Procton, 2023). Although the VCM volumes for NBS and technology-based credits are almost the same in 2021 and 2022, the prices for NBS credits are more than twice as high in these years (see Table 1) (Donofrio & Procton, 2023).

Table 1 Annual Total VCM Volume, Value, and Price, Nature-based Solutions vs. Technology-based Projects. (Own illustration according to Donofrio & Procton, 2023)

	2021			2022			2023
Type	Volume ($MtCO_2e$)	Value (USD)	Price (USD)	Volume ($MtCO_2e$)	Value (USD)	Price (USD)	Price (USD)
Nature-based	243	$1.4Bn	$5.80	117	$1.2Bn	$10.17	$10.61
Technology-based	270	$640M	$2.37	130	$617M	$4.76	$4.66

The International Union for Conservation defines NBS as “actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits” (IUCN, International Union for Conservation of Nature, 2020). In terms of climate change, Nature Based Solutions avoid, reduce or remove emissions by protecting and restoring natural ecosystems (Faires, 2022). It is estimated that NBS, such as reducing deforestation, restoring forests, wetlands and peatlands, as well as bioenergy, could make a feasible and sustainable contribution of 15 billion tonnes of carbon dioxide equivalent (GtCO2e) per year to global reductions (Griscom et al., 2017; Reise et al., 2022; Roe et al., 2019; Seymour & Langer, 2021). In this way, nature could provide about a third of the cost-effective mitigation needed to meet the 1.5°C target (ibid.). At this point, however, it must be added that NBS is not a substitute for the rapid phase-out of fossil fuels, but rather a supplement. As outlined above, NBSs play a vital role in the fight against climate change, but decarbonizing our economies must become an equal imperative (Anderson et al., 2019). The likelihood of meeting the Paris targets falls dramatically every year that emissions reductions in the energy and industrial sectors are delayed (ibid.). From a climate perspective, it is therefore crucial that emissions reductions in agriculture, forestry and land use go hand in hand with the decarbonization of fossil fuels (Watson et al., 2023).

In addition to their high potential for climate change mitigation, NBS also have other benefits. They are typically linked to environmental and social "beyond carbon" benefits, so-called co-benefits (Seymour & Langer, 2021). For example, they can support adaptation to climate change through flood protection, air and water quality regulation and urban cooling, while also helping to mitigate climate change and preserve or enhance biodiversity (Griscom et al., 2017). This means that in addition to the climate, ecosystems, biodiversity and indigenous people also benefit from NBS (Maes & Jacobs, 2017; Reise et al., 2022; Seymour & Langer, 2021). The importance and popularity of

these co-benefits has increased significantly in recent years, resulting in credits with co-benefits being sold at remarkable higher prices on the VCM (see table 1) (Donofrio & Procton, 2023).

Among the NBS options, the conservation of natural ecosystems plays a particularly important role (Seymour & Langer, 2021). In its Special Report 2019, the Intergovernmental Panel on Climate Change describes reducing deforestation and forest degradation as one of the most effective and robust options for mitigating climate change (IPCC, 2019). Also because of the significant co-benefits for improved climate adaptation, biodiversity and other sustainable development goals, protection of remaining intact ecosystems should be prioritized over other NBS (ibid.). In particular, tropical forests, peat bogs and mangroves should be conserved, as their carbon stocks are particularly high, with mangroves and peat bogs storing up to five times more carbon than terrestrial forests (Donato et al., 2011; Pan et al., 2011). The conversion of these ecosystems and the associated increase in emissions, as well as the loss of biodiversity and ecosystem services, cannot be offset by other NBS, such as planting new trees elsewhere (Seymour & Langer, 2021). In fact, tropical deforestation will contribute around 200 billion tonnes of CO2 emissions by the end of the century if no special efforts are made to prevent deforestation (Fuss et al., 2021). In order to achieve global climate goals, it is therefore essential to make the protection of carbon-rich ecosystems the top short-term priority for global climate protection in the land sector (Goldstein et al., 2020).

REDD+

Nature-based solutions that aim to protect forests are summarized under the concept of REDD+ (Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries) (Borgmann et al., 2023). Developed under the UN Framework Convention on Climate Change (UNFCCC), REDD+ is a global climate initiative that aims to halt deforestation and forest degradation in the Global South through international funding, thereby combating climate change (Greenpeace e.V., 2020). The idea is to support local and regional communities with sustainable development options that avoid deforestation and make forest conservation more financially attractive (Gifford, 2020; West, 2016). REDD+ carbon credits put a financial value on the carbon stored in forests and are mainly offered to companies to offset their own emissions (Greenpeace e.V., 2020). About half of the carbon credits from nature-based solutions come from projects that prevent deforestation, and a third from projects that prevent the conversion of ecosystems such as forests, peatlands and grasslands to cropland or pasture (Borgmann et al., 2023). However, the concept of REDD+ carbon credits has been criticized from the outset due to many scientific challenges and disagreements. There are three main challenges that the concept has to face: Carbon credits under

REDD+ are awarded on the basis of performance. This involves comparing actual forest cover with a hypothetical baseline scenario that predicts expected forest cover in the absence of REDD+ intervention (West et al., 2020). However, such scenarios are inherently hypothetical and unverifiable, and the causes of deforestation are very complex and individual from project to project, making a one-size-fits-all solution impossible (Greenpeace e.V., 2020; south pole, 2023). Project developers are motivated to create a baseline scenario that predicts the greatest possible degradation without the project, as only the difference in greenhouse gas emissions between this baseline scenario and the actual project outcome can be sold as certified carbon offsets (Greenpeace e.V., 2020; Kallio et al., 2016; Mertz et al., 2018). The more damaging the predicted development of the forest stock without the intervention, the higher the number of credits that can be traded. The design of this business model inevitably leads to baseline scenarios with excessively high deforestation rates (West et al., 2020). Numerous studies have already shown that a large number of REDD+ credits represent imaginary emission reductions due to flawed baseline scenarios, which means that the projects do not deliver the promised benefits in terms of emissions mitigation (Greenfield, 2023; Kallio et al., 2016; Mertz et al., 2018; Rifai et al., 2015; West et al., 2020). The same applies to the assessment of the risk of future carbon release from the trees protected by the project, for example from environmental factors such as fire. Again, the risk of deforestation is often underestimated, which distorts the quality of the carbon credits (Gifford, 2020). As a result, protected forests can be destroyed after just a few years, and CO_2 emissions that were supposed to be reduced/removed are released back into the atmosphere (Greenpeace e.V., 2020). There is also a risk that REDD+ projects will simply shift avoided deforestation elsewhere, rather than preventing it altogether. Critics argue that this risk is often not properly accounted for in the calculations, which means that the climate mitigation performance of the credits can again be considered uncertain (Gifford, 2020).

The uncertainties associated with some NBS result in them being categorised and used differently by private certification standards. For example, the proportion of NBS in the Gold Standard is only 2 per cent, compared to almost 50 per cent in the Verified Carbon Standard (Borgmann et al., 2023). While carbon credits from climate change projects that avoid deforestation or conversion of natural areas are generally not certified under the Gold Standard, they account for around 85 per cent of all climate change projects under the Verified Carbon Standard (Borgmann et al., 2023; Leugers, 2023). Public criticism has also had an impact on the issuance of nature-based carbon reduction credits which declined by one-third in 2023 in comparison to 2022 (Climate Focus, 2024). At the same time, there is growing interest in nature-based carbon removal credits. Issuance of these credits increased by 7 percent in 2023 compared to the previous year, and now accounts for more than 10 percent of total annual NBS emissions (ibid.). This development can be seen as a response to the Science Based

Targets initiative, which prescribes removal credits for companies to neutralize residual emissions (see section 4.2) (Watson et al., 2023).

To rebuild trust in REDD+ methodologies and realize the full potential of all NBS in the fight against climate change, developing and implementing a sound legal framework and improving measurement, reporting and verification are just some of the measures that will be needed (West et al., 2020).

Carbon Capture and Storage

Technology-based solutions are the counterpart or complement to NBS. They avoid, reduce or remove emissions through technological approaches such as solar panels or Carbon Capture and Storage (Faires, 2022). The advantage of technology-based solutions is that they enable long-term storage (Allen et al., 2020). Particularly in the context of carbon removal, these solutions offer great hope, as carbon removal plays a crucial role in stabilising atmospheric carbon dioxide concentrations, as described above. In addition capture and removal technologies have the potential to generate more measurable and verifiable carbon credits (Borgmann et al., 2023). However, most carbon removal technologies remain in nascent stages and are notably expensive and not yet scalable for widespread application (Faires, 2022). To date, investment in technological carbon removal credits has therefore been used primarily to drive innovation in early-stage technologies, increase availability and reduce costs, thereby helping to mitigate climate change in the long term (Budinis et al., 2018). One technology-based solution that has been increasingly discussed recently is Carbon Capture and Storage. The IPCC defines CCS as a "process in which a relatively pure stream of carbon dioxide from industrial and energy-related sources is separated (captured), conditioned, compressed and transported to a storage location for long-term isolation from the atmosphere" (Calvin et al., 2023, p.121). CCS technology enables thus significantly reduce emissions from the industrial and energy sectors (Paltsev et al., 2021). This is particularly important as these sectors are the largest emitters of greenhouse gases, accounting for around 56.3% of total greenhouse gas emissions in Germany in 2022, which corresponds to around 425 million tonnes of CO_2 equivalent (Umweltbundesamt, 2024). In addition, industrial emissions are considered hard-to-abate because many industrial processes have few alternatives yet for reducing emissions (Paltsev et al., 2021). It is also estimated that the total discounted abatement costs will increase by 138% if the global climate targets are to be achieved without the use of CCS (Budinis et al., 2018). CCS is therefore seen as a key technology for reducing carbon dioxide emissions from the energy and industrial sectors and meeting net-zero targets (Budinis et al., 2018; Global CCS Institute, 2022; IEA, 2020, 2022a; Martin-Roberts et al., 2021; Paltsev et al., 2021; Qiu et al., 2022). The CO_2 capture capacity of all CCS plants under development increased by more than 44% to 244 million tonnes per year in 2022, demonstrating that the potential of CCS is

increasingly recognized and exploited (Global CCS Institute, 2022). However, it is predicted that the number of large plants will need to increase a hundredfold by 2040 to capture the amount of $C0_2$ required by international climate scenarios (Martin-Roberts et al., 2021). In addition, the global development of CO_2 storage is currently lagging behind that of CO_2 capture with around 10 million tonnes of CO_2 being stored each year (IEA, 2022a). It is assumed that there are sufficient CO_2 storage resources available worldwide, such as geological, terrestrial, or oceanic reservoirs, but further site assessment is required, which has not been adequately undertaken in recent years (ibid.). At current rates, CO_2 storage is expected to be only one tenth of demand by 2050 (Martin-Roberts et al., 2021). Suitable CO_2 storage facilities are even more important in the context of technological carbon removal activities (CDR), such as DACCS. The main objective of these technologies is to remove CO_2 direct from the atmosphere and store it permanently, thereby contributing to the reduction of atmospheric CO_2 levels (Calvin et al., 2023b). According to the IPCC and the United Nations Environment Programme, these technologies are also essential for achieving net zero CO_2 emissions by mid-century (Calvin et al., 2023b; United Nations Environment Programme, 2023). In 2022, 18 direct capture plants were in operation worldwide, but they only captured 0.1 Mt CO_2/year, a fraction of the 60 Mt CO_2/year needed to achieve net-zero by 2050 (IEA, 2022b). The main challenges for CCS, DACCS and other carbon capture technologies are cost and energy, location and capacity of the storage site, and other barriers such as lack of market mechanisms, incentives or inadequate regulatory frameworks for CO_2 transport and storage (Budinis et al., 2018). One of the consequences of these challenges is that, despite the critical importance of these technologies, implementation is progressing (too) slowly and there are still significant gaps in meeting the required capture and storage capacity to fulfill global climate targets (Martin-Roberts et al., 2021).

3.4 High-Quality Carbon Credits

The Voluntary Carbon Market can unlock urgently needed finance and channel it at speed and scale to projects that will reduce and remove tonnes of carbon credits and thus play a key role in meeting global climate targets (ICVCM, n.d.-a). However, this requires that the carbon credits are of high integrity and that buyers can be confident that they are funding projects that have a real impact. While the VCM is not regulated, there is currently no legally defined "minimum quality" for carbon credits, but rather an "organic ecosystem of actors" (Donofrio & Procton, 2023, p.27). These actors, such as associations like the ICVCM and certification standards, support the market by establishing standardization and robust principles (south pole, 2023). This chapter outlines the key quality criteria for carbon credits and describes the key market actors responsible for implementing and monitoring these criteria.

3.4.1 Quality Criteria

Meta-standards such as the ICVCM play a key role in defining the quality criteria for carbon credits. The aim of these meta-standards is to strengthen confidence in the market through clear guidelines and standards, thereby contributing to a more efficient and credible reduction of greenhouse gas emissions. It serves as an overarching body to promote integrity and quality in the voluntary carbon market. Unlike specific certification standards such as the Gold Standard, which assesses and certifies individual projects for their environmental and social impacts, the ICVCM focuses on creating and monitoring frameworks and criteria that apply to the entire market. (GenZero, 2023)

In March 2023, the Integrity Council launched its "Core Carbon Principles" (CCPs). The CCPs are based on the consultation with stakeholders across the market and solid science and define 10 core carbon principles to identifying high-quality carbon credits (ICVCM, 2024a). Together with the ICVCMs Assessment Framework, the CCPs set a definitive global benchmark standard for high-integrity carbon credits (ibid.). The CCPs are divided into three categories: Emissions Impact, Governance and Sustainable Development (see table 2).

Table 2 Core Carbon Principles (own illustration according to ICVCM, 2024)

Governance	**Emissions Impact**	**Sustainable Development**
1. Effective governance	5. Additionality	9. Sustainable development benefits and safeguards
2. Tracking	6. Permanence	10. Contribution to net zero transition
3. Transparency	7. Robust quantification of emission reductions and removals	
4. Robust independent third-party validation and verification	8. No double counting	

Governance

1. The carbon crediting programme should be designed with a governance structure to ensure that the scheme operates in a transparent and accountable manner. It should focus on promoting continuous improvement and maintaining high standards for the quality of carbon credits issued.
2. The carbon crediting programme should use or integrate a registry system to uniquely identify, record and monitor mitigation efforts and the issuance of carbon credits. This will ensure that credits are securely and unambiguously recognized.

3. The carbon crediting programme should commit to providing detailed and transparent information on all its credited mitigation efforts. This information should be readily available in an electronic format and tailored to be understandable to a general audience. This approach should facilitate external verification of mitigation activities.
4. The programme should require comprehensive third-party validation and verification of all program-level mitigation activities to ensure the integrity and credibility of the carbon credits generated. (ICVCM, 2024a)

Emissions Impact

5. The reduction or removal of greenhouse gas emissions by the mitigation measure must be additional. This is the case if they would not have taken place without a market for carbon credits and thus the sale of the certificates and the resulting proceeds (Broekhof et al., 2019; ICVCM, 2024a). This is crucial for the quality of carbon credits, because if the associated greenhouse gas reductions or removals are not additional, the purchase of carbon credits would not have a (positive) impact on climate change. Carbon crediting programmes have developed two main approaches to determining the additionality of a project: "project-specific" and "standardized", neither of which is perfect, and each approach has its strengths and weaknesses. Project-specific approaches are used by most voluntary carbon offset programmes (Broekhof et al., 2019). This approach is based on an analysis of the individual characteristics and circumstances of a project to determine whether it is additional, including, for example, a demonstration that the proposed project is not legally required (ibid.) However, this approach often involves making imprecise and uncertain assumptions about the future, which is the biggest disadvantage of this procedure (ibid.). The standardized approach assesses the additionality of projects based on criteria previously defined in an analysis (ibid.). This approach significantly reduces the administrative burden but is sometimes considered too imprecise.
6. It must be ensured that the carbon credits represent carbon reductions or removals that are permanent and cannot be reversed (ICVCM, 2024a). This is particularly relevant for nature-based solutions such as forestry projects, as there is a risk that the stored carbon could be released back into the atmosphere, for example through a fire. If there is a risk of such a reversal, measures must be taken to minimize the risk (ibid.). Many carbon crediting programmes have established 'buffer reserves'. These are pools of carbon credits from individual projects that act as an insurance mechanism (Broekhof et al., 2019). With this approach, the risk of reversals, e.g. due to fire or drought, can be effectively addressed.

7. The quantification of GHG emission reductions or removals from the mitigation activity must be accurately calculated using conservative, comprehensive and scientifically valid methodologies to ensure the robustness and reliability of the data (ICVCM, 2024a). Among other things, this is intended to prevent an overestimation of baseline emissions. These are the reference for calculating greenhouse gas reductions or removals and are linked to additionality (Broekhof et al., 2019). If the amount of these emissions is overestimated, it can lead to the actual performance of the mitigation activity being lower than reported (ibid). To ensure the quality of carbon credits, it is therefore crucial to avoid overestimation by using detailed and solid quantification methods.
8. To avoid double counting, GHG emission reductions or removals attributed to a specific mitigation activity must only be counted once towards the achievement of a mitigation target (ICVCM, 2024a). This principle prevents three different types of double counting: double issuance, double use and double claiming. Double issuance happens i.e. if more than one carbon credit is issued for the same greenhouse gas reduction (Broekhof et al., 2019). Double use occurs when two different parties count the same offset credit towards their GHG reduction entitlements (ibid.). Double claiming can arise when carbon credits are awarded to a project, but another entity (e.g. a government) then counts the same greenhouse gas reductions towards its own reduction targets (ibid.). Double counting must therefore be avoided at all costs to ensure the uniqueness and integrity of each carbon credit.

Sustainable Development

9. The programme must provide comprehensive guidance, tools and compliance mechanisms to ensure that mitigation measures meet or exceed industry best social and environmental practices. This approach not only ensures compliance, but also promotes a positive impact on sustainable development. (ICVCM, 2024a)
10. The reduction measure must be compatible with the goal of achieving net zero greenhouse gas emissions by mid-century. Locking-in levels of greenhouse gas emissions, carbon-intensive technologies or processes that are incompatible with a zero-carbon/low-carbon economy should be avoided (Broekhof et al., 2019; ICVCM, 2024a).

With the launch of the Core Carbon Principles (CCPs) by the Integrity Council, a number of certification programmes have already begun to apply for assessment against the CCP criteria. Programmes that meet the requirements of the Core Carbon Principles will be awarded the CCP label. This provides allows buyers to easily identify high-integrity carbon credits and encourages investment in efficient climate protection measures. (ICVCM, n.d.-b)

3.4.2 Carbon Standards

Quality or carbon standards certify projects by ensuring that these projects meet the rules and requirements the standards set, with the aim of proving and guaranteeing the climate efficiency (Donofrio & Procton, 2023). By doing so they set out rules, requirements and procedures for all phases of project development, allocation and monitoring and define elements such as start date, crediting period, additionality, sustainability targets and permanence requirements, as well as the management of public registries of carbon credits (south pole, 2023). Certification to the standards and the fulfilment of certain criteria is intended to provide buyers with the assurance that the stated amount of greenhouse gas emissions will be avoided/reduced or removed with each carbon credit purchase (Wolters et al., 2018). As such, the standards make an important contribution to the integrity of the Voluntary Carbon Market and contribute to greater climate action and impact (Wolters et al., 2018). As already mentioned, there is no uniform standard for determining the quality of carbon credits on the voluntary market, which has led to many different standards in recent years. The Verified Carbon Standard (VCS) and Gold Standard are international standards and cover most of the market, making them the most relevant for VCM (Donofrio & Procton, 2023) (see table 3).

Table 3 Key Facts by Certification Standard (own illustration according to Climate Focus, 2024; Donofrio & Procton, 2023; Gold Standard, n.d.-b, 2023; Verra, n.d.; Wolters et al., 2018)

Standard	Foundation year	Volume 2022 ($MtCO_2e$)	Value 2022 (USD)	Carbon credits certified of total issuances 2023	Volume of greenhouse gas reduced/removed (until end of 2022)
Verified Carbon Standard (VCS)	2005	79.3	$724.5Bn	48%	1.2B+ tonnes
Gold Standard	2003	11.8	$98.4M	20%	238,3M tonnes

Verified Carbon Standard

The Verified Carbon Standard is managed by Verra, a non-profit organization founded in 2007 by the Climate Group, the International Emissions Trading Association (IETA) and the World Economic Forum (Verra, n.d.). In 2022 the VCS Program certified 72% of all carbon credits issued under the Voluntary Carbon Market, making it the most widely used greenhouse gas crediting program in the world with a market volume of 79.3 $MtCO_2e$ and a market value of $724.5Bn (Donofrio & Procton, 2023). The VCS Standard forms the basis of the VCS program. As such, it sets out the rules and requirements, such as project or validation and verification requirements, that projects must meet in order to be certified (Verra, n.d.). In addition to the VCS Standard, the VCS Program has three other important components: Independent Auditing, Accounting Methods, and the Verra Registry System

(ibid.). This four-part process is designed to ensure, in accordance with the VCS Quality Assurance Principles, that all carbon credits generated by a project registered in the VCS Program "represent GHG emission reductions or removals that are real, measurable, additional, permanent, independently verified, conservatively estimated, uniquely numbered, and transparently listed" (Verra, n.d.). At the end of 2022, a total of 3,134 projects were certified by the VCS and over 1 billion carbon credits were issued (Verra, 2023). According to Verra, more than 1.2 billion tonnes of greenhouse gases have been reduced or eliminated as a result.

However, Verra and the VCS programme have come under increasing criticism in recent years, which is closely related to the general criticism of REDD+ projects described in section 3.2. As the Gold Standard does not include projects aimed at preventing deforestation, the VCS has become the preferred standard for the vast majority of forest-based carbon credits in the Voluntary Carbon Market, including almost all projects under REDD+ (Chagas et al., 2020). As a result VCS is considered the leading standard for REDD+ project certification and Verra was thus primarily affected by the increasing criticism. In particular, an article in the Guardian, produced in collaboration with the German weekly Die Zeit and SourceMaterial, a non-profit investigative journalism organization, made serious allegations against Verra, claiming that at least 90% of its rainforest carbon credits do not represent real emissions reductions (Greenfield, 2023). The article, based on a new analysis of scientific studies, also accuses Verra of overestimating the risk of deforestation in its projects by an average of 400%, and of human rights violations allegedly linked to at least one Verra project (ibid.). It can be assumed that the ongoing criticism is also a reason for the significant decline in the transaction volume of VCS credits from 2021 to 2023 (Climate Focus, 2024; Donofrio & Procton, 2023).

Gold Standard

The Gold Standard was launched in 2003 by the World Wide Fund for Nature (WWF) and other environmental organizations and is now the second largest VCM certification standard with a market volume of 11.8 MtCO2e and a market value of $98.4 million (see table 3) (Donofrio & Procton, 2023; Gold Standard, n.d.). The Gold Standard certification process was developed in close collaboration with technical and policy experts from civil society, governments, multilateral organizations and the private sector. Today, the standard is endorsed by more than 80 international non-governmental organizations, and more than 1,400 projects in 80 countries are in the certification process. The standard certifies projects in the areas of waste management, land use and forests, energy efficiency, municipal services and renewable energies, with the last two categories accounting for the largest scope by far (Gold Standard, 2023a). In total, 238.3 million Gold Standard carbon credits have been

issued, reducing emissions by 238.3 million tonnes (Gold Standard, 2023a). In 2022, Gold Standard experienced its most significant growth to date, with a record-setting issuance of 43.7 million credits. This achievement marks an all-time high for the organization, continuing the momentum from its substantial expansion in 2021 (ibid.). Carbon credits from REDD+ projects are not issued by the Gold Standard as current REDD+ approaches face technical and political challenges that could undermine their long-term sustainability (Gold Standard, n.d.).

One of the unique features of the Gold Standard is that all certified projects make a positive contribution to at least three of the United Nations Sustainable Development Goals, including climate action. This is to ensure that projects also contribute to climate justice and support SDG goals such as poverty reduction and improved health. Further, the standard emphasizes gender-sensitive approaches, requiring projects to consider gender dynamics in society and to meet specific criteria for gender equality and women's empowerment. Finally, the Gold Standard was recognized by ISEAL (International Social and Environmental Accreditation and Labelling Alliance) as the first climate-related standard to achieve Code Compliant status. It is an example of best practice in transparency, stakeholder engagement and efficiency, and encourages collaboration for greater impact (Gold Standard, n.d.). These unique features underscore the standard's stance that all efforts to mitigate global warming and promote sustainable development must be multi-faceted, and that climate action must be linked to broader development benefits such as clean energy and health.

However, the existing structure and functionality of the various standards may undergo further decisive developments in the coming years. This is due to the fact that at the COP28 conference in Dubai on 4 December, the world's leading independent carbon standards, including Verra and the Gold Standard, announced a collaboration with the objective of increasing the impact of activities under their respective standards and strengthening their efforts to mitigate climate change. A significant objective of this collaboration is the harmonization of their standards, with the intention of enhancing the integrity and efficiency of carbon markets. Through this process, they aim not only to better understand the differences between their programmes, but also to increase the transparency of their standards and methodologies. In conclusion, the collaboration of independent crediting programmes and the alignment of their standards could play a pivotal role in promoting the integrity and reliability of global carbon markets, thereby making an effective contribution to climate protection and sustainable development. (IETA, 2023)

3.5 Perspectives of Carbon Credits

This chapter provides a comprehensive analysis of the opportunities and challenges of carbon credits in the context of global efforts to reduce greenhouse gas emissions and combat climate change. While the importance of carbon credits as a tool for promoting sustainable development and achieving

climate change goals has been repeatedly emphasized, they have also come under increasing criticism due to issues of effectiveness, transparency, and equity. By reviewing the relevant literature, this chapter aims to provide a balanced understanding of the potential and limitations of carbon credits and thus contribute to the debate on their role in future climate policy.

3.5.1 Chances

As already described, the world is facing a critical situation with regard to climate change, and rapid and effective mitigation efforts are needed to achieve the climate goals of the Paris Agreement (United Nations, 2017; United Nations Environment Programme, 2023). It is crucial to mobilize funds for climate protection quickly in order to mitigate the devastating effects of climate change (Calvin et al., 2023b). The United Nations Environment Programme's 2019 Emissions Gap Report found that even if all countries implemented their current climate action plans (Nationally Determined Contributions, or NDCs), greenhouse gas emissions in 2030 would be an impressive 32 billion tonnes ($GtCO_2e$) higher than needed to meet the Paris Agreement's 1.5°C goal (United Nations Environment Programme, 2019). It is therefore vital to actively support activities that reduce and remove carbon from the atmosphere (Ecosystem Marketplace, 2020). At this point, the Voluntary Carbon Market offers enormous potential to unlock funds for climate action quickly. The VCM creates a marketplace where emissions reductions or removals can be traded. The proceeds from the sale of these carbon credits provide immediate income to project organizers. This in turn is used directly to implement and expand climate protection projects. In this way, the voluntary market is an agile and effective resource in the global effort to tackle the climate crisis (Broekhof et al., 2019). By creating a financial incentive system for CO_2 savings and channeling private capital into sustainable projects, the VCM also provides an opportunity to promote the development and research of innovations and technologies such as Carbon Capture and Storage (CCS), which is seen as a key technology for reducing CO_2 emissions from the energy and industrial sectors and achieving net zero targets (Budinis et al., 2018; Global CCS Institute, 2022; IEA, 2020, 2022a; Martin-Roberts et al., 2021; Paltsev et al., 2021; Qiu et al., 2022). Carbon credits also make it possible to neutralize emissions that cannot be avoided in the long term due to technical restrictions and thus offer an opportunity to achieve the global net zero target (Watson et al., 2023). The positive impact of carbon credits in the global fight against climate change is also reflected in the fact that companies with carbon credits are leading the way in climate protection. According to studies, companies that use carbon credits decarbonize on average twice as fast as companies that do not (MSCI Carbon Markets, 2023). They are actively using the Voluntary Carbon Market to further intensify their efforts to reduce emissions (Ecosystem Marketplace, 2020; MSCI Carbon Markets, 2023).

Although climate commitments have steadily increased since the 2015 Paris Agreement, the proportion of Fortune Global 500 companies with significant climate commitments remained at around two-thirds last year (Climate Impact Partners, 2023). According to the UNFCCC (United Nations Framework Convention on Climate Change) Climate Action Platform, 13,478 companies worldwide that are registered on the portal had made climate commitments at the start of 2024, but only 5,134 had actually taken action (UNFCCC, n.d.-a). This shows that while a first step has been taken towards global climate action, significant efforts are still needed to realize the full potential of corporate climate action. The possibility of supporting climate protection targets through carbon markets could also encourage previously hesitant companies to commit to binding targets and take action (Streck, 2021). Especially in times of scarce public funds and often inadequate climate policy targets, voluntary carbon markets play a key role in channeling investments into mitigation measures that go beyond government action (ibid.). Further, a large proportion of carbon credits are derived from projects in developing countries (Climate Focus, 2024). Implementing projects in developing countries accelerates the implementation of mitigation actions in these countries, where funding constraints are often the biggest obstacle (United Nations' High-Level Expert Group, 2022). By providing financial support, the sale of carbon credits can fill important financing gaps and drive decarbonization in developing countries, for example through reforestation or renewable energy projects (ibid.). As a result, countries benefit from lower costs for emission reductions and significant advantages for sustainable development (Streck, 2021). Carbon credits also play an important role in promoting the Sustainable Development Goals (SDGs) (Borgmann et al., 2023). In addition to SDG 13, which calls for climate-friendly measures, many carbon projects also support other SDGs such as the promotion of renewable energies (SDG 7), the protection of ecosystems and biodiversity (SDG 15) or contribute to sustainable economic growth and job creation (SDG 8) (United Nations, 2023). In addition, many climate protection projects support sustainable agricultural practices (SDG 2), improve water management (SDG 6) and strengthen global partnerships for the implementation of climate goals (SDG 17) (ibid.). By financing projects with environmental and social benefits, carbon credits thus enable a multi-faceted approach to achieving the global sustainability agenda. Certification standards such as the Gold Standard, which defines the fulfilment of three SDGs as a project standard, further strengthen this approach. Last but not least, the financial flows directly generated by the VCM for the expansion of climate protection measures can significantly reduce climate costs in the future by mitigating both the direct and indirect effects of climate change (UNEP, 2023). Investing in carbon credits reduces greenhouse gas emissions, helping to slow global warming and its negative consequences. Less warming means fewer extreme weather events, less damage to infrastructure and less damage to agriculture, reducing the need for expensive emergency relief and reconstruction (ibid.).

3.5.2 Challenges

Despite the opportunities surrounding the Voluntary Carbon Market and carbon credits, there are still challenges and criticism from various stakeholders. Criticism of carbon credits by the press, researchers and environmentalists falls into two categories: On the one hand, there are concerns about how the carbon credits are used and on the other hand, concerns about the quality of the carbon credits.

One aspect that raises concerns about the use of carbon credits by companies is the goal of climate neutrality (or carbon neutrality). For a lot of companies using carbon credits, this is the core of their voluntary commitment. However, the concept of climate neutrality is still an unregulated and largely open concept (Borgmann et al., 2023). Due to this lack of definition, several standards have emerged in recent years, each of which has developed its own definitions with its own requirements for climate neutrality. These differ, for example, in terms of objectives, GHG accounting and the requirements for the use of carbon credits (Borgmann et al., 2023). For companies, this offers the opportunity to either follow one of the various existing standards or even use their own methodologies and definitions of carbon neutrality. An analysis of the targets communicated by companies to date shows, on the one hand, the lack of standardized definitions and, on the other hand, very different approaches with regard to underlying targets, strategies and measures (e.g. setting interim targets, covering emission sources) (Day et al., 2022; Kreibich et al., 2021). This is problematic for two reasons. Firstly, it makes it difficult to compare and verify the credibility of carbon neutrality claims, as it is not immediately clear to outsiders which definition of carbon neutrality a company is using (Deutsche Energie-Agentur, 2022). This, in turn, makes it more difficult for consumers and stakeholders to make informed choices, as the transparency and traceability of compensation is not guaranteed. Secondly, there is a risk of greenwashing, whereby companies present their environmental impact in a more favorable light than it actually is (Kreibich et al., 2021). There are also fears that carbon credits and the associated possibility of offsetting one's own emissions could lead to false incentives for companies. There is a risk that organizations will ignore the mitigation hierarchy (see section 4.2) and use offset credits instead of investing in their own emission reductions (Broekhof et al., 2019). This could lead to organizations continuing to engage in emission-intensive activities, which in turn could delay the development of important climate change policies and infrastructure (lock-in effect) (Borgmann et al., 2023). This is particularly problematic given that many of the companies that are among the world's largest purchasers of carbon credits also produce or trade in fossil fuels, or at least require them for their business model (Chen et al., 2021). However, different studies puts these fears to rest. As already described the data shows that companies that use carbon credits do so in addition

to, rather than in place of, internal emissions reductions (Ecosystem Marketplace, 2020; MSCI Carbon Markets, 2023).

Furthermore, the quality of carbon credits has been criticized for a number of reasons. A key issue is the question of additionality, i.e. whether projects actually lead to emission reductions that would not have taken place without the project (see chapter 3.3.1). REDD+ projects in particular have been criticized because, according to the latest study, only 6 per cent of the REDD+ projects examined, which were certified by the private certification standard Verified Carbon Standard, led to an additional reduction in CO_2 emissions (Greenfield, 2023). The results of other studies of REDD+ projects also confirm these findings and point to causes such as overestimation of baseline scenarios and the lack of uniform standards (see chapter 3.2) (Guizar-Coutiño et al., 2022; West et al., 2020, 2023). REDD+ projects have also been questioned over their permanence and the potential for leakage, where emissions reductions are cancelled out by deforestation (Borgmann et al., 2023). However, additionality has also been criticized in the context of renewable energy projects. In addition to REDD+ projects, the majority of carbon credits on the voluntary market come from renewable energy projects (Borgmann et al., 2023). As the cost of renewable energy has fallen sharply in recent years, it is questioned whether voluntary market financing is necessary to initiate such projects (ibid). Finally, a common point of criticism is the lack of uniform standards, which makes it difficult or impossible to assess the quality of carbon credits (Faires, 2022).

In conclusion, the voluntary carbon market has the potential to become a significant driver for climate protection and to make a notable contribution to the achievement of the goals set out in the Paris Agreement. Nevertheless, the increasing adoption of net zero targets by companies is often met with skepticism and criticism due to a lack of detailed implementation plans and consistent definitions of terms, which contributes to uncertainty in the market. The complexity of assessing the quality of carbon credits, the constantly evolving science and the lack of uniform standards further fuel this debate. It is therefore of the utmost importance that those purchasing carbon credits are fully aware of the criticisms and challenges and select high-quality carbon offset projects that address these concerns. Compliance with recognized standards and transparency are crucial for the credibility and effectiveness of carbon credits and the integrity of the whole market.

3.6 Market Development and Future Vision

The Voluntary Carbon Market and the role of carbon credits in companies' climate strategies have developed continuously in recent decades. Figure 2 shows the total annual volume of carbon credits issued through private certification standards from pre 2005 to 2022.

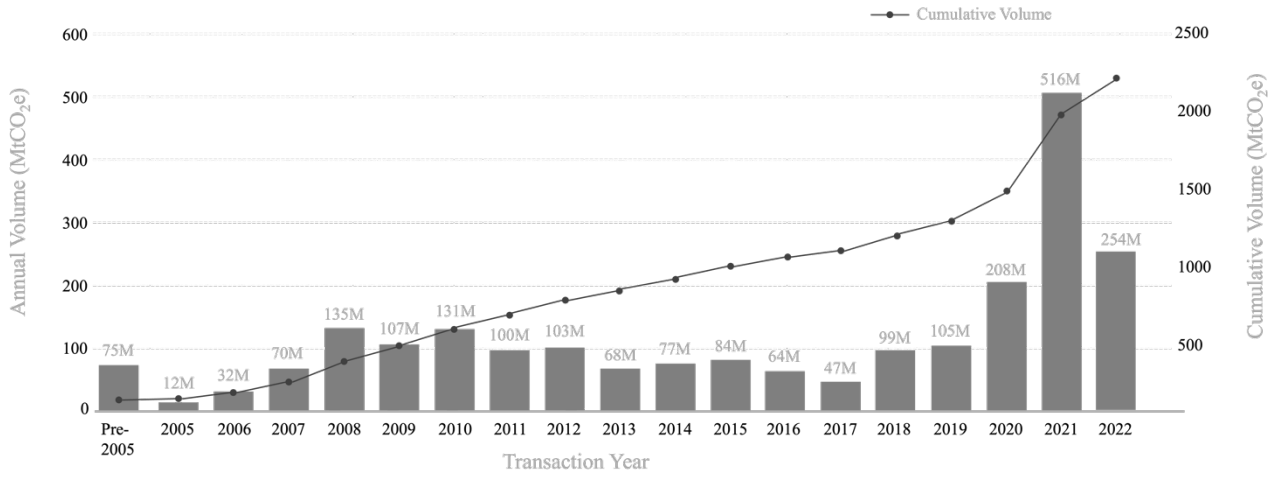

Figure 2 Voluntary Carbon Market Size by Volume of Traded Carbon Credits, pre-2005 to 2022 (own illustration, according to Donofrio & Procton, 2023)

The evolution of the VCM over time can be divided into three phases, illustrated in figure 3:

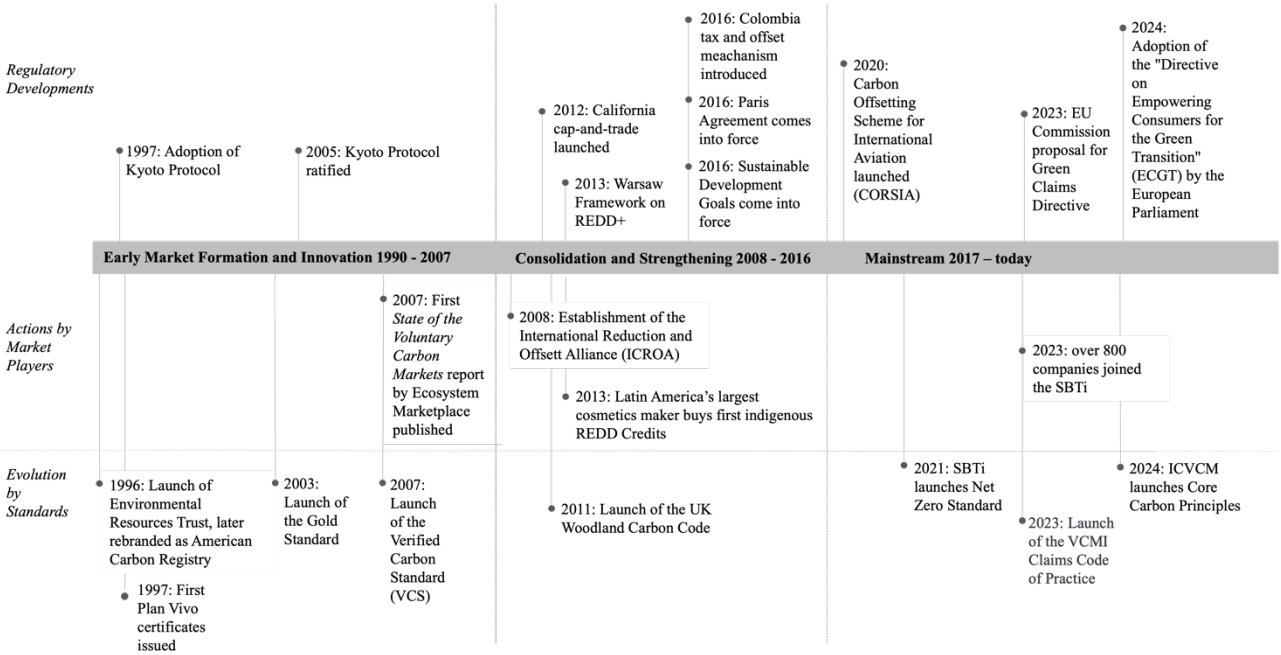

Figure 3 The Evolution of the VCM and Key Milestones (own illustration based on voluntarycarbonmarket.org, n.d.)

The first phase, *Early Market Formation and Innovation*, runs from 1990 to 2007 and is marked by innovative new approaches to combating climate change. Private certification standards such as Plan Vivo, Gold Standards and the Verified Carbon Standard emerged during this period, laying an important foundation for the trading of carbon credits at the Voluntary Carbon Market. This phase also saw the adoption of the Kyoto Protocol, which entered into force in 2005. It was an important first step in international climate policy, setting binding emission reduction targets for the first time for 37 industrialized and developing countries and the European Union (UNFCCC, n.d.-d). The

growing interest in climate change has also had an impact on the Voluntary Carbon Market. 2006 was a year of growth, with many new players entering the market and 23.7 million tonnes of carbon dioxide equivalent (MtCO2e) traded for the first time (Hamilton et al., 2007).

The next phase, *Consolidation and Strengthening*, from 2008 to 2016, is characterized by the continued development of the market infrastructure (voluntarycarbonmarket.org, n.d.). Among other things, the International Carbon Reduction and Offset Alliance (ICROA), a leading industry accreditation program designed to improve the integrity of the voluntary sector (ICROA, n.d.), was launched in 2008. Based on the ICROA Code of Best Practice, the program provides quality assurance and guidance on emissions reductions and the use of high-quality carbon credits (ibid.). Another key milestone was the surge in demand for REDD+ credits. This is particularly evident in an event in 2013 when the Brazilian cosmetics company Natura Cosméticos purchased 120,000 tonnes of carbon offsets from the Paiter-Suruí, an indigenous people of the Amazon (Ecosystem Marketplace, 2013). The transaction was the first of its kind and served as a model for indigenous peoples throughout the Amazon (ibid.). In addition to REDD+ projects, renewable energy and clean cookstoves projects in Africa and Latin America have been particularly popular in these years (Peters-Stanley & Yin, 2013). Key regulatory milestones were the entry into force of the Paris Agreement and the Sustainable Development Goals in 2016, which marked a decisive turning point in the global perception and approach to climate change (UNFCCC, n.d.-c). However, this period is also characterised by a market slump after 2008, which is mainly due to two factors. Firstly, the global financial crisis caused many companies to rethink and reprioritise their spending, leading to a reduction in carbon credits purchases in particular (Donofrio & Procton, 2023). Second, the political uncertainty surrounding climate change policy in the US contributed to a loss of confidence and interest in VCMs. Initially, there were hopes for a comprehensive climate policy under the Obama administration, including the possibility of a federal cap-and-trade system (ibid.). However, as it became clear that climate policy was not high on the agenda and there was no significant legislative action on climate change, interest in the carbon market waned (ibid.). However, the market was able to recover in the following years.

The third and most recent phase of the VCM, *Mainstream*, from 2017 to date is characterized by the largest growth of the voluntary carbon market to date. From 2017 to 22021, the volume of carbon credits issued in the market rose from 47 million tonnes of CO_2 equivalent (MtCO2e) up to 526 MtCO2e. The goal of limiting global warming to well below 2°C has made climate change a key concern for governments, businesses and civil society, and has led many companies to set ambitious climate targets of their own and to use carbon credits to help meet these targets (Borgmann et al., 2023). 2021 was then a record-breaking year for the VCM, as the value reached the $2 billion mark

for the first time, a fourfold increase on the 2020 market value (Ecosystem Marketplace, 2022b). This strong increase in value is due to a significant rise in demand for carbon projects that not only reduce or avoid greenhouse gas emissions but also offer co-benefits, as well as for nature-based solutions, as these carbon credits have a significantly higher price (Ecosystem Marketplace, 2022a). From 2021 to 2022, the transaction volume shrank by 51 per cent (Figure 2), but the value of the VCM kept pace with the 2021 value at just under 1.9 billion, due to an 82 per cent increase in the price of credits (Donofrio & Procton, 2023). The average price per tonne of carbon credits in 2022 was $7.37, the highest since 2008 (ibid.). Full figures for 2023 were not available at the time of this research, but preliminary analysis suggests that the transaction volume in 2023 will be even lower than in 2022 (ibid.). According to Ecosystem Marketplace, the 38.5% decrease in emissions compared to 2022 is one of the main reasons for this (ibid.).

However, during this period, carbon credits also came under scrutiny, particularly with regard to their effectiveness and integrity. Issues of additionality, sustainability and the actual environmental contribution of offset projects came to the fore (see section 3.5.2). In response, stricter standards and certification systems have been developed to ensure the quality and credibility of carbon credits. First, the Science Based Target initiative published its Net Zero Standard for 2021, popularizing a new approach to using carbon credits for a broader commitment to climate action beyond an organization's direct emissions, in addition to achieving its own net zero emissions (see section 4.2) (Watson et al., 2023). At this time, a paradigm shift is taking place in the way companies approach climate protection measures and the acquisition of carbon credits, which is increasingly moving away from the previous offsetting approach (Borgmann et al., 2023). Principles for ensuring supply-side integrity have also been published, such as the Core Carbon Principles of the Integrity Council for the Voluntary Carbon Market. New EU rules on corporate climate claims and the VCMI´s Claims Code of Practice have strengthened the regulatory framework for VCM in this phase.

Despite the slowdown in growth at the beginning of 2022, which can be attributed to a number of factors, including temporary market saturation after the very active previous year, a loss of confidence in carbon credits or a shift towards internal reduction efforts, many market participants are optimistic that the VCM will recover fast and that strong growth can be expected again in the future (Donofrio & Procton, 2023). On the one hand, experts repeatedly emphasize that REDD+ carbon markets and technological carbon removals, among others, are necessary to achieve the goals set out in the Paris Agreement (United Nations Environment Programme, 2023). On the other hand, the buyers currently in the market are more committed than ever, which is reflected in the fact that they are signaling a higher willingness to pay for high-quality carbon credits (Donofrio & Procton, 2023). Furthermore, compliance carbon markets, especially in the context of CORSIA and Article 6 of the Paris

Agreement, could create new opportunities for carbon trading and thus have a positive impact on it (ibid.). CORSIA stands for the Carbon Offsetting and Reduction Scheme for International Aviation, an international mechanism for offsetting CO_2 emissions from aviation (ICAO Environment, n.d.). The VCM can benefit from the growing demand for credits that meet the requirements of CORSIA, as airlines required to offset their carbon footprint under CORSIA may increasingly turn to the VCM to purchase credits. In addition, the number of independent initiatives increases standardization, quality assurance on the supply side and ultimately buyer confidence in the integrity of the credits.

In conclusion, the voluntary carbon market (VCM) is in a state of constant evolution, characterized by a dynamic regulatory environment, technological advances and the evolving needs of stakeholders. Given this ongoing transformation, it remains an open question as to what developments can be expected in the future and how these will continue to shape the market and its participants. Forecasts continue to predict strong growth in the VCM of up to USD 40 billion in 2030 (Donofrio & Procton, 2023; Mistry et al., 2023). Whether this prediction comes true will depend, among other things, on the implementation of Article 6.4 of the Paris Agreement. Article 6 of the Paris Agreement sets out strategies that allow countries to create voluntary carbon credits, provided they meet certain transparency standards and are consistent with the Nationally Determined Contributions (NDCs) (UNFCCC, n.d.-b). The article is therefore a key aspect in the development of a regulatory framework for global trade in greenhouse gas emissions reductions. Article 6.4 stipulates that countries should create these credits with the involvement of public and private actors, on the basis of a detailed plan, including rigorous verification procedures (Burtons et al., 2023). Although these mechanisms are primarily aimed at the compliance market, they could also influence the VCM in various ways. In particular, a bridge could be constructed between the regulated and voluntary carbon markets by potentially trading credits generated under Article 6.4 on the voluntary market (Crook, 2023). So far, no agreement has been made on the detailed rules for Article 6.4 at previous UN climate conferences (Marcos, 2023). It will therefore be some time before the paragraph is implemented, and it's not clear to what extent the new rules will then influence the VCM. In addition, the future role of carbon credits that remove CO_2 from the atmosphere will be crucial. These processes, which could play an important role in mitigating climate change, have the potential to become more cost-effective and marketable through the voluntary market (ibid.). The development of alternative corporate carbon strategies, such as the Climate Contribution Approach (see section 4.2), also plays a role, as it is still uncertain what impact this will have on the voluntary market. Finally, media coverage also has an important influence on the development of the VCM, as media reports on unethical and/or ineffective carbon projects and standards, regardless of their fairness, can have a deterrent effect on the market (Donofrio & Procton, 2023).

4 Carbon Credits in the Corporate World

The previous chapter explained the voluntary carbon market in detail by describing its structure and development, discussing the definition and function of carbon credits, and contrasting their importance in the context of global climate change and the opportunities and barriers associated with them. The following chapter links the concept of carbon credits to the corporate world. This chapter aims to provide a comprehensive overview of the strategic use of carbon credits in the corporate world, highlighting their impact on climate change strategies and evaluating communication in the context of corporate environmental engagement. It begins with an examination of the existing scientific discourse and then explores the integration of carbon credits into corporate climate strategies, focusing on the Net-Zero Standard of the Science Based Targets initiative. Finally, it outlines how companies can communicate credibly with their stakeholders about their climate neutrality and the use of carbon credits and describes the requirements and current developments in reporting and claiming.

4.1 State of Research

The following chapter provides an overview of the current state of research in relation to the guiding question of this paper. However, due to the constantly evolving landscape of empirical studies on carbon credits and related topics, this research review does not claim to be exhaustive.

The literature on carbon credits and carbon project reveals that opinions are divided, reflecting the complexity of the issue. The diversity of perspectives in the field of research is particularly highlighted in relation to Nature-based Solutions. While some authors emphasize the positive value of NBS for climate change in their studies (Chausson et al., 2020; Cohen-Shacham et al., 2016; Griscom et al., 2017; Seddon, Chausson, et al., 2020; Seddon, Daniels, et al., 2020) others argue that many REDD+ programmes in particular have not delivered the promised environmental benefits and lack especially in transparency and accountability (Gifford, 2020; Greenfield, 2023; Kallio et al., 2016; Lindsay Hooper, 2021; Rifai et al., 2015; West et al., 2020). Other projects as well have also been criticised for their actual emission reductions, such as in a study by Anadon et al. that summarized existing rigorous empirical studies evaluating more than 2,000 offset projects from all major offset sectors (Probst et al., 2023). Furthermore, current studies show a growing interest in Carbon Capture and Storage which is characterized by an increase in research activities in this area. A number of studies have explored its potential and role in achieving global climate goals, highlighting the economic and environmental benefits of transitioning to a net-zero economy (Bahman et al., 2023; Budinis et al., 2018; Bui et al., 2018; Küng et al., 2023; Martin-Roberts et al., 2021; Paltsev et al., 2021; Shu et al., 2023; Zhang et al., 2023).

A lot of research has already been done on carbon credits in connection with corporate climate claims. Kreibich and Hermwille found that the majority of companies want to use carbon credits to offset their own emissions. Thus, 45% of the companies they analyzed had an explicit intention to use carbon offsets and only 7% had an explicit intention not to use carbon credits to offset emissions (Kreibich & Hermwille, 2021). They also found that almost half of the companies analyzed (48%) were not clear about their use of carbon credits, reflecting the lack of transparency in corporate climate claims (ibid.). In this context the wording of climate claims was also analyzed in more detail. It has been shown that, unlike net zero claims, carbon neutrality claims are often not directly linked to global climate targets or comprehensive corporate strategies, but vary in terms of supply chain emissions reductions (Baxter, 2021; Causone et al., 2021; Helmers et al., 2021). A study by Dawson, Dargusch and Hill of the insurance company Allianz provides a good illustration of how companies often distinguish and apply net zero and carbon neutrality. They were able to show that the company described itself as carbon neutral, even though it had only achieved this status through carbon offsetting (Dawson et al., 2022). At the same time, it has set itself a net zero target for 2050, in which, in addition to offsetting, it intends to pursue a decarbonization path consistent with the 1.5°C target (ibid.). However, Hale et al. also noted that the terminology around net zero and climate neutrality is not yet sufficient, both in the literature and in company claims, and terms are often used interchangeably although they imply different climate outcomes (Hale et al., 2022). An analysis of the robustness of net zero claims also found that only 3% of companies with a net zero target meet all the robustness criteria, including timing, status, coverage, use of offsets and governance (Hale et al., 2022). The same study concludes that while the concept of net zero is now widespread, implementation is still far from ideal (ibid.).

Some research has also examined the risk of "greenwashing" in connection with misleading climate claims. Firstly, it has been found that claims of climate neutrality are particularly misleading because of a lack of consumer understanding of offsetting (MacCutcheon et al., 2020; SINUS Markt- und Sozialforschung GmbH, 2022). Several studies have pointed out the dangers arising from this misinterpretation of offsetting. Among other things, it can lead to "rebounding", in which consumers classify their consumption as "green" based on company claims and subsequently intensify their environmentally harmful consumer behavior (Bertini et al., 2022; Guix et al., 2022; Helmers et al., 2021). A misclassification of climate-damaging behavior based on misleading climate claims can therefore make it considerably more difficult to achieve global climate targets (ibid.). Further research has shown that climate-related claims involving carbon offsetting are often vaguely worded, further increasing the risk of greenwashing (Guix et al., 2022; Hale et al., 2022). Guix, Ollé and Font's research also indicates that companies' claims often contain a mixture of misleading and credible communications, which complicates the categorization of such claims but also highlights their

importance (Guix et al., 2022). In their study, Trouwloon et al. provide a first attempt to categorize climate claims in order to facilitate a better understanding of the claims. In their analysis of the existing literature, they identify the following three key dimensions of corporate climate claims: “1) the intended use of carbon credits: offsetting versus non-offsetting claims; 2) the framing and meaning of headline terms: net-zero versus carbon neutral claims; and 3) the status of the claim: future aspirational commitments versus stated achievements” (Trouwloon et al., 2023, p. 1).

Existing studies indicate that there is a research gap in examining the use of carbon credits by companies on the way to net zero. This paper aims to contribute to closing this research gap by comparing the current use of carbon credits by companies with the recommendations of existing standards to capture the status quo.

4.2 Role of Carbon Credits in the Corporate World

The evolution of carbon credits in the corporate world reflects a significant shift from a reactive to a proactive role within corporate social responsibility (CSR) strategies and climate change mitigation plans. While for a long time they were primarily used as an image-building tool to demonstrate environmental awareness and responsibility by offsetting their own emissions, the role of credits has changed with growing awareness of climate change and criticism of the existing approach (Kreibich et al., 2023). In recent years, an alternative concept has developed that is less about offsetting the companies own emissions and more about supporting ambitious global climate targets. The so-called climate contribution approach is currently the alternative to the previous offset approach (Kreibich et al., 2023). A key difference is that the companies involved cannot offset the emission reductions against their own carbon footprint with the aim of climate neutrality, but declare them as a contribution to climate financing (Kreibich et al., 2023). In other words, as a complement to (and not as an alternative to) direct reduction, companies voluntarily support projects outside their own value chain ("beyond value chain mitigation") to contribute to the global goal of greenhouse gas neutrality and take responsibility for their own GHG emissions (Borgmann et al., 2023). This development away from carbon offsetting reflects the growing recognition of the urgency of climate change and the willingness of companies to make a significant contribution to global climate protection (WWF International & Boston Consulting Group, 2020).

Standards such as the Science Based Target initiative's Net Zero Standard have been instrumental in driving this change, as they provide a clear and science-based framework for companies to use carbon credits. The Science Based Targets Initiative (SBTi) is a non-profit organization that promotes climate action by businesses and financial institutions worldwide to tackle the climate crisis. It develops standards, tools and guidelines that enable companies to reduce their greenhouse gas

emissions below critical levels in line with global requirements to limit global warming and achieve net zero emissions by 2050 at the latest (Watson et al., 2023). Partners include CDP, the United Nations Global Compact, the We Mean Business Coalition, the World Resources Institute (WRI) and the WWF (ibid.). In 2021, the initiative published the first global, science-based standard for companies to set net-zero targets in line with climate science. The standard includes guidelines, criteria and recommendations that provide a consistent and robust approach to corporate climate action (ibid). By the end of 2022, a total of 2,079 companies had had their science-based targets officially validated by the Science Based Targets Initiative since its inception (Science Based Target Initiative, 2023). A further 2,151 companies had committed to setting such targets in the future (ibid.).

The SBTi Net-Zero Standard defines corporate net-zero as: "Reducing scope 1, 2, and 3 emissions to zero or a residual level consistent with reaching net-zero emissions at the global or sector level in eligible 1.5°C-aligned pathways; and permanently neutralizing any residual emissions at the net-zero target year and any GHG emissions released into the atmosphere thereafter" (Watson et al., 2023, p. 12). The principle underlying the Net-Zero Standard is the mitigation hierarchy. It is used to prioritize certain climate measures over others and provides a structured approach to how companies can systematically reduce their greenhouse gas (GHG) emissions to achieve net zero emissions (Watson et al., 2023). This approach ensures that measures to directly reduce own emissions take precedence over other measures. It also clearly defines where and to what extent carbon credits are to be used.

The Net Zero Standards set out the following key elements for companies to achieve corporate net zero, illustrated in figure 4 (Watson et al., 2023):

1. Setting near-term science-based target
2. Setting long-term science-based target
3. Beyond value chain mitigation (BVCM)
4. Neutralization of any residual emissions

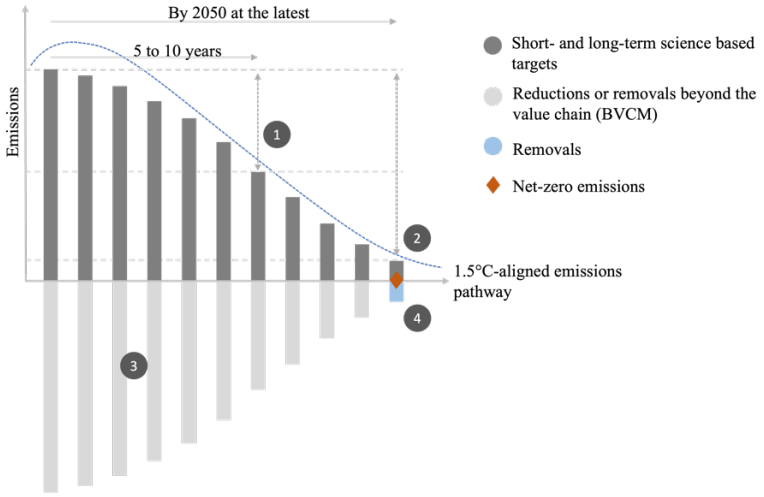

Figure 4 1.5°C-aligned emissions pathway Net-Zero Standard (own illustration according to Watson et al., 2023)

The Science Based Targets initiative has recently updated and expanded certain sections of the Net-Zero Standard. This study aligns with the contents of version 1.1 of the Corporate Net-Zero Standard.

Steps one and two relate to the decarbonization of the company's operations. As a first step, short-term, science-based 5–10-year greenhouse gas emission reduction targets should be set and regularly updated, which is essential to reduce emissions immediately and to meet the global emissions budget. This will be followed by long-term targets, which will serve as the basis for companies to reduce their value chain emissions to zero by 2050 or earlier. (Watson et al., 2023)

Step three refers to "mitigation action or investments that fall outside of a company's value chain" (Watson et al., 2023, p. 14). The SBTi refers to this approach as Beyond Value Chain Mitigation (BVCM). According to the recommendations of the Net Zero Standard, companies should go beyond the short and long-term scientific targets to further mitigate climate change and help society achieve net zero global emissions by 2050. Carbon credits that avoid or reduce emissions as well as credits that remove and store emissions can be used for that. The SBTi recommends supporting projects to secure and enhance carbon sinks (terrestrial, coastal, marine, etc.) to avoid emissions resulting from their degradation. In addition, investment should be made in emerging GHG removal technologies (e.g. Direct Air Capture (DAC) and storage), as the technology is required for key element 4. However, care should be taken to ensure that all carbon credits provide co-benefits for people and nature. It is important to note that the use of carbon credits at this stage is not a substitute for emission reductions within the value chain and therefore should not be counted as emission reductions towards progressing companies' short or long-term science-based targets. In contrast to the conventional offset approach, BVCM does not seek to offset a company's residual emissions. Instead, it is designed to facilitate the overall reduction of greenhouse gases, thereby contributing to the achievement of global climate targets. Consequently, BVCM activities encompass a more extensive range of measures that are not directly related to the company's core business activities. Furthermore, they may seek to encourage emissions reductions in sectors or regions that have traditionally proven more challenging to decarbonize. The SBTi clearly emphasizes the importance of companies going beyond value chain reduction, as companies that have set science-based targets represent a growing proportion of the economy, but the vast majority still do not have emissions reduction targets. SBTi companies are therefore called upon to increase the likelihood of achieving the global 1.5-degree climate target by mobilizing additional mitigation actions beyond the value chain. Contrary to points 1, 2 and 4, BVCM and annual reporting on the nature and extent of their BVCM activities and investments is recommended but not required. (Watson et al., 2023)

The final step relates to the measures companies must take to neutralize any remaining emissions after achieving their long-term net zero target. Any unavoidable residual emissions within the

company's value chain must be neutralized by an equivalent amount of carbon removal credits, in the target year and all subsequent years. For most companies, unavoidable residual emissions will account for around 5 to 10% of total emissions, as around 90 to 95% of emissions can be reduced through prior decarbonization measures. The neutralization of residual emissions is crucial to achieving a net-zero state with no impact on the climate. Only when a company has achieved the long-term, science-based target for all scopes and neutralized any remaining emissions can it claim to have reached net zero. (Watson et al., 2023)

In summary, carbon credits play a role in achieving net zero in two areas: First, in the transition to net zero, to finance additional mitigation beyond their science-based emission reduction targets to help society fight climate change. And secondly, at net zero, to neutralize any residual emissions through carbon removal credits. Overall, only high-quality carbon credits should be used, and priority should always be given to achieving the near-term science-based targets and thereby decarbonizing emissions from one's own value chain.

Following the description of the Net Zero Standard, it is important to note recent developments that highlight the challenges and complexities faced by companies in realizing this ambitious climate strategy. The Science-Based Targets Initiative has withdrawn net zero commitments from over 200 companies, including major sustainability players, because they missed the deadline to set full net zero targets or chose not to follow the SBTi standard (Robinson-Tillett, 2024). Many of these companies were part of the “Business Ambition for 1.5°C” campaign to mobilize the private sector as part of the UN's Race to Zero initiative (ibid.). However, only a small proportion of companies have actually set, or are in the process of setting, full net zero targets. The majority of companies cited reducing emissions in the value chain (especially Scope 3 emissions) as the main reason for the difficulty in setting and meeting these targets (Robinson-Tillett, 2024). Relatively few companies are prepared to set far-reaching decarbonization targets for their value chain, partly due to too many unknowns about future technological developments (ibid.). In response to these findings, and under increasing pressure from carbon market players and corporate interests, the SBTi has now announced new plans to allow companies to recognize carbon credits to offset scope 3 emissions (SBTi, 2024b). The announcement was met with considerable criticism, including from the company's own employees. The new rules proposed by the SBTi increase the risk that companies will improve their carbon footprint on paper, yet in reality result in an increase in greenhouse gases being emitted into the atmosphere (Dufrasne, 2024; Greenfield & Harvey, 2024). According to Carbon Market Watch Executive Director Sabine Frank the decision will "strip the SBTi of its ‘science-based’ nature and (will) mark a setback for voluntary climate initiatives globally” (Dufrasne, 2024). Civil society organizations, partners and other stakeholders are now calling on the initiative to reverse this decision

and not to implement the new rules as planned. Nevertheless, the criticism of the SBTi's approach is also qualified by those who view the SBTi's decision as an effective incentive for companies to assume responsibility for their Scope 3 emissions (Greenfield & Harvey, 2024). As the debate continues, it remains to be seen whether the revised standards will actually come into force in July and, if so, whether they can drive forward meaningful measures for global decarbonization or simply offer superficial compliance that undermines the stringent goals of the Paris Agreement.

4.3 Communication

As companies deal with the complexities of carbon credit utilization, their communication strategies, particularly reporting mechanisms and the justification of climate claims, become critical. This section examines how companies communicate their carbon credit utilization strategies and sets out the reporting requirements for companies to ensure they meet the growing demand for transparency and accountability on the road to sustainability.

4.3.1 Reporting

The Corporate Net-Zero Standard emphasizes the importance of transparent reporting on BVCM activities and their results, and therefore recommends that companies report annually on the nature and extent of BVCM (SBTi, 2024). The report should be published in line with the company's GHG inventory reporting period and provide transparent information on the financial resources used for BVCM and the reduction results and co-benefits achieved (ibid.). If companies use a carbon price to determine the level of their BVCM commitment, they should disclose the chosen carbon price, explain the methodology or source that underpins it, and provide a rationale for the chosen price. Companies are advised to disclose their BVCM activities and investments through established reporting frameworks such as the CDP's annual climate change questionnaire, and to integrate this information into their annual financial and sustainability reports, as well as on their websites for transparency (ibid.). The SBTi recommends, alongside the CDP framework, other resources such as the use of Carbon Market Watch's checklist and the VCMI Monitoring Reporting and Assurance Framework for comprehensive reporting on their BVCM actions (ibid.).

At the EU level, corporate sustainability reporting has recently been strengthened by the new Corporate Sustainability Reporting Directive (CSRD). The directive, which came into force at the beginning of 2024, is intended to complement the Non-Financial Reporting Directive (NFRD) and fill existing gaps in reporting requirements (Bundesministerium für Arbeit und Soziales, n.d.). The aim is to increase the accountability of European companies on sustainability issues and introduce binding reporting standards at EU level for the first time (ibid.). A key element of the CSRD is a single set of European reporting standards that companies must apply when preparing their reports.

The European Sustainability Reporting Standards (ESRS) are designed to ensure that companies report more comprehensively and according to more uniform standards (Umweltbundesamt, 2021). They also aim to improve the measurability and comparability of information through greater quantification of report content using key figures (Bundesministerium für Arbeit und Soziales, n.d.). The Standard ESRS E1 contains reporting requirements on climate protection, climate adaptation and energy and also includes specific requirements regarding carbon credits (EFRAG, 2022). Among other things, it requires companies to disclose the following subtopics: "(a) GHG removals and storage in metric tonnes of CO_2eq resulting from projects it may have developed in its own operations, or contributed to in its upstream and downstream value chain" and "(b) the amount of GHG emission reductions or removals from climate change mitigation projects outside its value chain it has financed or intends to finance through any purchase of carbon credits" (EFRAG, 2022, p. 13). For example, in the case of carbon credits outside the company's own value chain, companies are required to disclose (a) the proportion (percentage on volume) of reduction and removal projects; (b) for carbon credits from removal projects, an explanation of whether they are from biogenic or technological sinks; (c) the proportion (percentage on volume) for each recognized quality standard; and (d) the proportion (percentage by volume) from projects in the EU (ibid.). For companies that claim to be carbon neutral or have set a net zero target, further disclosure is required, particularly on the integrity of the carbon credits used. The EU Sustainability Reporting Directive thus marks a significant shift in ESG reporting by increasing the scope and quality of disclosures and ensuring greater transparency and accountability in the use of carbon credits by companies.

4.3.2 Claims

Climate claims are part of companies' climate change commitments and their carbon credit strategy. By communicating about the purchase and use of carbon credits, companies are responding to the growing public expectation to present their strategies for reducing their environmental footprint and their commitment to climate protection (Watson et al., 2023). Further climate claims allow them to demonstrate responsibility by communicating concrete steps towards more sustainable management, differentiating themselves in the eyes of consumers and other stakeholders (SBTi, 2024a). The International Social and Environmental Accreditation and Labelling (ISEAL) Alliance defines a claim as a "message used to set apart or promote a product, process, business, or service with reference to one or more of the three pillars of sustainability" (social, economic, environmental) (ISEAL, 2015). Claims can be made directly to consumers or to a wider audience and communicated through sustainability reports, press releases, product labelling, promotional materials or various marketing materials (SBTi, 2024a). The Science Based Target Initiative names climate claims that concern the beyond value chain mitigation of companies, BVCM claims (ibid.). The different

approaches to mitigation beyond a company's value chain (offsetting vs. climate contribution, see section 4.2) lead to a diversity of BVCM claims.

In particular, compensation or offsetting claims that suggest to the public that the avoidance, reduction or elimination of greenhouse gas emissions outside a company's value chain through carbon credits offsets the emissions within the company or the value chain have been increasingly criticized in the past (SBTi, 2024a). Specifically, carbon neutrality claims have been repeatedly found to be non-transparent, lacking in integrity and deceptive (Day et al., 2023; Guix et al., 2022). Doubts about the actual impact of the use of offset credits and the lack of standardized definitions of climate neutrality and similar terms, as well as criticism that the term may obscure the residual climate impact of companies that have not yet fully decarbonized, make the issue of communicating carbon neutrality controversial and contentious (Day et al., 2023). However, in the transition to net-zero, many companies still use the term "carbon neutral" as a central marketing statement (Science Based Target Initiative, 2021). However, in the face of continued criticism, it is questionable whether this is the most effective way for leading companies to differentiate their climate actions from those that are not decarbonizing based on science. The Science Based Targets Initiative (SBTi) has not yet taken a position on whether companies should claim 'carbon neutrality' in the first version of its guidelines, but plans to reflect further on this issue in order to incentivize mitigation actions outside the value chain (Science Based Target Initiative, 2021).

Contribution claims represent an alternative approach to offsetting claims aligning with the climate contribution approach. These convey to audiences that the company has supported mitigation actions beyond the company's value chain, with the climate benefit not offsetting the remaining emissions, but contributing to global climate goals (SBTi, 2024a). Companies taking this approach to BVCM often use participation in initiatives such as SBTi or the VCMI in their communications to further enhance the integrity and credibility of their BVCM claims. In 2023 the VCMI has launched its Claims Code of Practice, which is a framework to guide companies on how to credibly use carbon credits and make appropriate claims (VCMI, 2023). By providing concrete criteria and guidance, the Code of Practice aims to increase the integrity of the demand side of VCM by helping the companies to make credible climate claims and providing validation in the form of VCMI claims (ibid.). According to the principles defined by the VCMI claims should be clear to target audience(s), transparent, traceable, true and verifiable, accurate, conservative, relevant and not misleading, informative and set the right incentives for the target audience (ibid.). In addition to the VCMI Claims Code of Practice, other resources that companies can use to make transparent and accurate BVCM claims include ISEAL's Making Credible Jurisdictional Claims Good Practice Guide (ISAEL, 2022) and Gold Standard's Guidance on Fairly Contributing to Global Net-Zero (Gold Standard, 2023b).

However, the legal framework for regulating corporate climate claims is also slowly taking shape, as is guidance from consumer, competition, and financial authorities. One of the most important examples is the EU's Green Claims Directive, which will set out the EU's first detailed rules on the marketing of environmental impact and performance. The aim of the Directive is to create clear and transparent standards for the use of environmental claims for companies' products and services (Bundesverband Nachhaltige Wirtschaft, 2023). The Directive will require all sustainability claims to be scientifically substantiated and certified. Advertising that "claims based on emissions offsetting schemes that a product has neutral, reduced or positive impact on the environment" is so to be banned (European Parliament, 2023, p. 1). The Directive applies to all companies operating in the EU and provides for significant penalties for non-compliance in order to increase the credibility and transparency of environmental information (IHK, n.d.). It can be seen as an important first step in the fight against greenwashing, closing the loopholes that some companies use to advertise with vague, unsubstantiated or false climate claims, and giving companies the confidence to make ambitious, high integrity claims about their corporate actions (Downey, 2023). Other policies that aim to prevent greenwashing by establishing rules for claiming carbon neutrality and requirements for annual disclosure of the use of carbon credits include California's bill AB-1305 and France's Decree No. 2022-539 (California Legislative Information, 2023; Legifrance, 2022).

The challenge for companies is to strike a balance between communicating their efforts and avoiding greenwashing - misleadingly claiming to be more environmentally responsible than they are. Clear and honest communication and transparent disclosure about the use of carbon credits is essential to build trust with stakeholders and ultimately enhance the company's environmental credibility. However, the evolving regulatory landscape for environmental claims, coupled with increasing criticism of misleading climate claims, has led to a range of responses from companies. Some companies, such as EasyJet, have already announced that they will no longer use carbon credits to offset their emissions (Nguyen, 2023). Others, such as the German drugstore chain Rossmann, have stated that they will no longer use the term 'climate neutral' in relation to their products (Rossmann, n.d.). In addition, companies are increasingly engaging in so-called Green Hushing. Green Hushing refers to the phenomenon of companies deliberately not communicating their climate change actions and achievements in order to avoid being accused of greenwashing (Reketat, 2023). It is reported that 25% of companies surveyed worldwide practice green hushing, partly for fear of reputational and legal problems (south pole, 2022).

5 Methodology

This chapter describes the methodological approach of the empirical study. It begins by explaining the subject of the study and outlining the objectives and research questions. This is followed by a justification of the choice of method and a more detailed explanation of the codebook.

The aim of this master's thesis is to understand the opportunities and challenges associated with the use of carbon credits and to identify the application strategies recommended in the literature for companies. These findings will be compared with practical insights from corporate practice to determine how literature and practice relate to each other. The objective is to answer the following central research question: *How should companies ideally use carbon credits as part of their decarbonization activities and how are they currently used in corporate practice?* To answer this question, the research was divided into two parts. In the first part, the existing literature on carbon credits was analyzed and processed. This made it possible to outline the role of carbon credits, to highlight their differences and to introduce and relate key market players. In addition, the complex discourse surrounding carbon credits was analyzed and the arguments for and against their use to combat climate change were discussed. Furthermore, the development of the voluntary carbon market over the years was divided into three phases, and the development, growth and key events within these phases were presented. The content analysis concluded with an analysis of the role that carbon credits can play as a credible and responsible tool for companies to reach net zero. The literature review thus formed the basis for the second part, in which the theoretical foundations for the ideal use of carbon credits were worked out.

The second part is intended to complement and finalize the theoretical findings with insights from actual corporate practice. A sample of 39 companies was formed as part of this study. The object of analysis includes sustainability reports, annual reports and other documents relating to sustainability, as they are permanently available and contain the data required for analysis. The companies analyzed are European companies that are listed on the CDP's A-List. The CDP A-List is an award from the non-profit organization CDP (formerly the Carbon Disclosure Project) and is considered a benchmark for corporate responsibility and sustainability. (CDP, n.d.-a). The CDP ranks organizations based on data and information about their environmental practices, particularly in the area of CO_2 emissions, but also their use of water and forest resources (ibid.). CDP A-list companies are leading the way in terms of high-quality sustainability reports that provide detailed and comprehensive information on their environmental performance and climate change activities (ibid.). Their reports are particularly reliable and credible due to their transparency and frequent verification by independent third parties (CDP, n.d.-b). They therefore form a suitable database for a content analysis to gain a deeper insight into the use of carbon credits by leading companies. At the time of sample selection (20 April 2024),

CDP listed 184 European companies on its 2023 Climate Change A-List (CDP, n.d.-b). A random sample of 39 European companies was drawn from this list.

Quantitative content analysis was chosen as the research method. As the aim of this study is to analyze how companies use and report on carbon credits in corporate practice, quantitative content analysis is the appropriate research method. It allows to reduce the complexity of the text volume and to reveal the patterns and trends relevant to the research question (Früh, 2017). Central working tool of the content analysis is a codebook in which all significant variables for which the text is to be analyzed were determined according to a systematic procedure. Since the aim of this study is to compare existing theory with practical application, most of the variables were formed by a deductive approach and only supplemented by individual empirically derived categories. The variables have been divided into four sections. Section A contains variables on the attributes of the company, section B contains variables on the characteristics of the emission credits, section C contains variables on the purpose of applying for emission credits and section C contains variables on communication in connection with the emission credits. Table 4 gives an overview of the categories of the sections. All content was coded according to these categories. Excel was used for data processing. It was used for data entry, calculation of descriptive statistics, frequency analysis and data visualization. The codebook with coding instructions can be found in the appendix of this paper.

Table 4 Overview of the variables in the codebook (own illustration)

Section A	**Section B**	**Section C**	**Section D**
A1 Country	**B1** Types of carbon credits	**C1** Near-term mitigation target	**D1** Reporting BVCM
A2 Sector	**B2** Co-benefits	**C2** Long-term mitigation target	**D2** Climate neutral claims
A3 Company size	**B3** Volume → **Excluded from analysis**	**C3** Approach	
A4 Application of carbon credits	**B4** Certification	**C4** Offsetting	
	B5 Types of carbon credits for neutralization	**C5** Percentage of offsetting → **Excluded from analysis**	
		C6 BVCM scale → **Excluded from analysis**	
		C7 Neutralization	
		C8 Percentage of neutralization	

Section A

To gain a deeper understanding of the sample, section A contains various variables on the attributes of the companies such as country of origin, sector, company size and the application of carbon credits.

Section B

In section B, all variables relating to the characteristics of the carbon credits are coded. Firstly, it is coded whether the company uses carbon credits in its climate strategy or plan to use carbon credits. This is followed by coding the types of credits used. The characteristics of this variable were formed inductively in order to respond more flexibly to the material analyzed. In addition, this section defines which co-benefits are associated with the carbon credits used. The categories for this variable correspond to the Sustainable Development Goals (SDGs), as the co-benefits of carbon credits are generally based on these goals (Donofrio & Procton, 2023). The volume of credits purchased per year is also determined to obtain an overall view of the credits used per company. The carbon standard according to which the credits are certified is also determined. This is important because the standards contribute significantly to the quality of the credits, as the certification ensures that the carbon projects meet certain rules and requirements with the aim of proving and guaranteeing climate efficiency (Donofrio & Procton, 2023). The categories of this variable were formed through a mixed deductive approach, in accordance with Borgmann et al. (2023), and additionally through an inductive process. The types of credits to be used for neutralization are also analyzed and coded with inductively formed categories.

Section C

The variables in this section were primarily derived from the net zero standard of the Science-Based Targets Initiative (SBTi), as this standard is the most well-known framework which provides a clear and science-based framework for companies to utilize carbon credits within their net-zero strategies. In line with the standard, the first step is to assess whether companies have science-based short and long-term GHG emissions mitigation targets. A science-based target is defined as one that has been approved by the SBTi. Section C also determines which approach the companies follow (BVCM or offsetting) and which type of emissions they offset. Finally, it is analyzed whether the companies plan to neutralize their residual emissions through emission credits.

Section D

Section D analyses the material on communication related to carbon credits. On the one hand, it identifies the extent to which companies report on their carbon credit activities. The categories for this have been derived from the reporting requirements of the SBTi.In light of the ongoing debate about climate claims, particularly the increasing criticism of climate neutral claims, it is important to

examine whether the companies in question are using climate neutral claims. This analysis thus forms also part of section D.

Upon conducting the quantitative content analysis, it became evident that the requisite data could not be gathered for variables B3 (volume), C5 (percentage of compensation) and C6 (BVCM scale) to conduct a valid and reliable analysis. This assessment was based on several critical considerations regarding the scientific integrity and methodological rigor of this study. Despite extensive data collection efforts through various designated sources, the data available for variables C5 and C6 were incomplete and patchy. The substantial data gaps affected more than 50% of the expected data sets, rendering statistically significant analyses and valid conclusions impossible. The quality and completeness of the data are critical to the reliability of any quantitative analysis. The presence of large data gaps in variablesB3, C5 and C6 could have led to significant bias in the results, which would have undermined the credibility of the entire study. In light of these considerations, the decision was taken to exclude the variables affected by the data gaps from the analysis. This was done to ensure the integrity of the research, given the potential impact of the gaps on the overall results of the study. This decision and its rationale were recorded in the study documentation in order to ensure the traceability and verifiability of the research processes and results.

This research is to be understood as exploratory research, which aims to learn more about the underlying topic and collect data that can be used to formulate hypotheses for future, more in-depth studies. The main objective is to create a detailed and systematic picture of current practices by collecting and analyzing relevant data from company reports. Given the nature of the study described, no hypotheses were formulated. Instead, the research questions were further deepened and narrowed down with associated sub-questions to analyze the various aspects of the use of carbon credits in detail. This approach makes it possible to gain a comprehensive understanding of current practices, whereupon the similarities and differences between these practices and existing standards can be analyzed without the need to test predetermined assumptions. It thus allows the research to remain open to any observed patterns and trends that emerge from the data, providing a solid basis for future confirmatory research in this area. The following sub-questions were formulated:

Q1 Which carbon credits do companies use?

Q2 How do companies utilize carbon credits?

Q3 How do companies communicate about their use of carbon credits?

6 Results

In the following chapter the results of the content analysis are presented and graphically illustrated. In terms of content, the order of the results is based on the sub-questions after a description of the sample.

The sample comprises 39 companies from Europe. An overview of the countries from which the companies originate is shown in Table 5. The most strongly represented countries are Germany, France and the United Kingdom.

Table 5 Countries of origin of the companies (Source: own illustration)

Country	Number of Companies
France	6
Germany	7
Switzerland	5
Sweden	2
Austria	1
Ireland	1
Portugal	1
United Kingdom of Great Britain and Northern Ireland	6
Spain	4
Belgium	1
Denmark	2
Finland	2
Netherlands	1

The following overview shows the sectors from which the companies originate. The most frequently represented sectors are "Electrical Equipment and Machinery" (5), "Electric Utilities and Independent Power Producers and Energy Traders" (4), "Banks" (4), "Construction and Engineering" (4) and "Consumer Durables, Household and Personal Products" (4).

Table 6 Company sectors (Source: own illustration)

Sector	Number of Companies
Food and Beverage Processing	4
Textiles, Apparel, Footwear and Luxury Goods	2
Telecommunication Services	2
Real Estate	2
Electric Utilities and Independent Power Producers and Energy Traders (including fossil, alternative and nuclear energy)	4
Banks, Diverse Financials, Insurance	4
Electrical Equipment and Machinery	5
Pharmaceuticals, Biotechnology and Life Sciences	1
Software and Services	1
Construction and Engineering	4
Water Transportation	1
Consumer Durables, Household and Personal Products	4
Containers and Packaging	1
Aerospace and Defense	1
Automobiles and Components	2
Professional Services	1

The company size was determined by the number of employees. The following categories were defined: Small enterprises (1-49 employees), medium enterprises (50-249 employees) and large enterprises (250 employees or more). The analysis of the sample showed that 100% of the enterprises had 250 or more employees and therefore all of them could be classified as large businesses.

Furthermore, it was analyzed whether the companies are currently using carbon credits or not. Figure 5 shows the percentage distribution of the different application statuses of carbon credits. 59% of the 39 companies analyzed use carbon credits in their climate strategy. 5% of the companies plan to use carbon credits in the future and 14% do not use carbon credits and do not plan to do so.

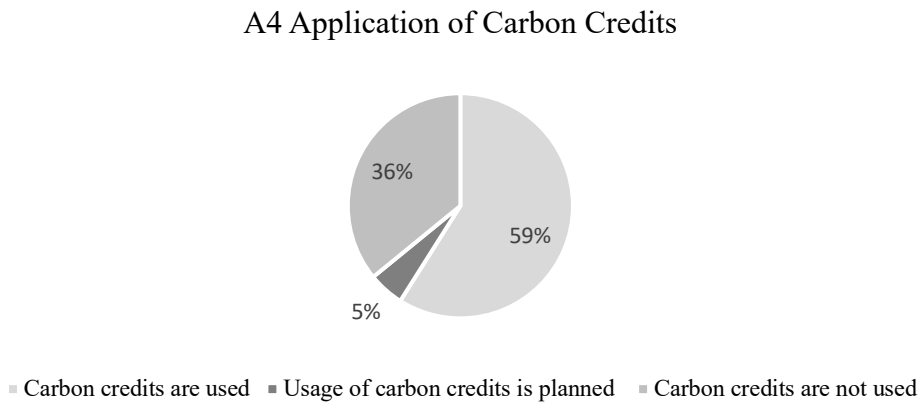

Figure 5 Application of Carbon Credits in per cent (own illustration)

59% of the companies (23 companies) were therefore relevant for further data analysis, as these companies currently use carbon credits.

Q1 Which carbon credits do the companies use?

The variable *B1 Types of carbon credits* analyzed which type of carbon credits the companies prefer. The analysis showed that 18 companies use avoidance/reduction credits, 14 companies use disposal credits, and two companies did not provide any information on the type of carbon credits they use (figure 6).

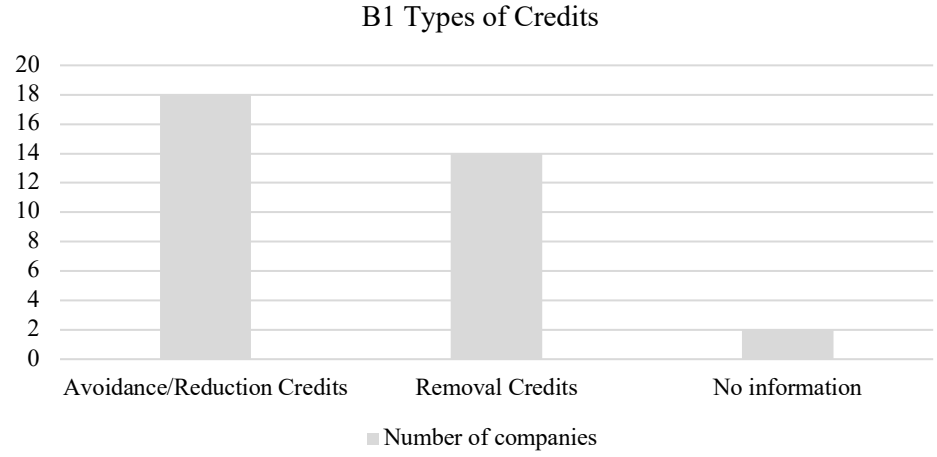

Figure 6 Number of companies using avoidance/reduction and removal carbon credits (own illustration)

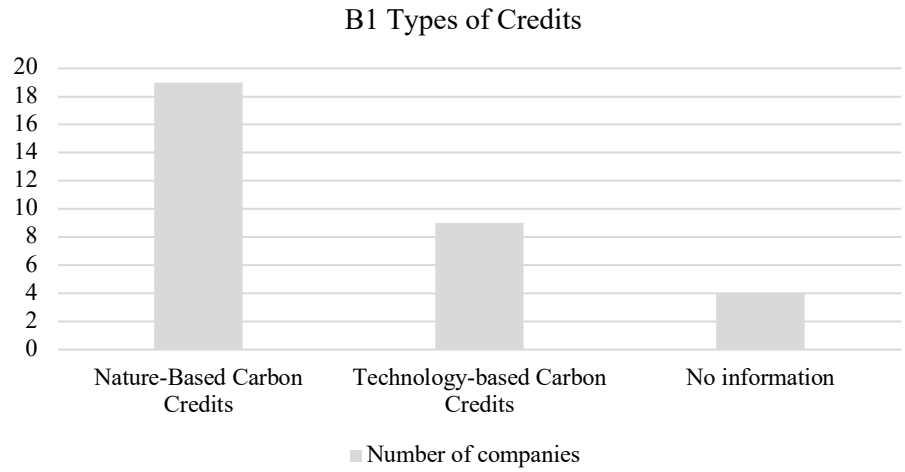

Figure 7 Number of companies using nature-based and technology-based carbon credits (own illustration)

Subsequently, it was analyzed whether companies tended to use nature-based or technology-based carbon credits. Figure 7 shows the results of this analysis. 19 companies use nature-based credits, and 9 companies use technology-based credits. 4 companies did not indicate whether the credits used were nature-based or technology-based. The frequencies of the specific project types were also determined and are shown in table 7.

Table 7 Types of carbon projects used by companies (Source: own illustration)

Project type	Number of companies
Mangrove Restoration	2
Rural Energy Access	3
Agroforestry	1
Sustainable Supply Chain	1
REDD+	11
Regenerative Agriculture	2
Renewable Energy	4
Energy Efficiency	1
Landfill Gas Recovery	1
Reforestation	5
No information	9

The frequencies of the specific project types were also determined and are shown in table 7. The table shows that 11 companies use carbon credits from REDD+ projects, making this type of carbon credit the most frequently used. Carbon credits from reforestation projects are used second most frequently (by 5 companies) and credits from renewable energy projects third most frequently (by 4 companies). In addition, 9 companies did not provide any information on the projects from which their carbon credits originate.

Regarding the quality of the carbon credits the pertinent variables are *B3 Co-Benefits* and *B5 Certification.* Of the total of 23 companies that use carbon credits, 20 companies use credits that are certified by carbon standards, while three companies use credits that are not certified. The frequencies of the standards are shown in Figure 8.

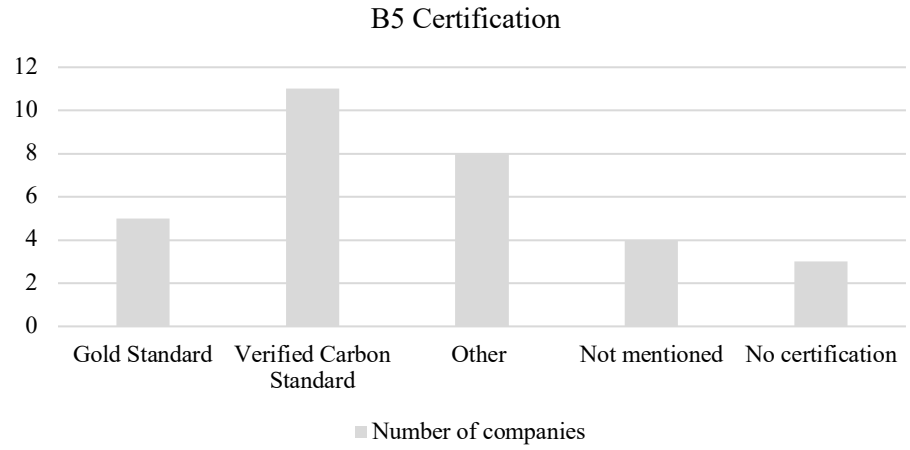

Figure 8 Certification of the Carbon Credits (own illustration)

The carbon credits were most frequently certified with the verified carbon standard and were therefore used by 11 companies. Other standards were used second most frequently, by 8 companies. 5 companies used carbon credits certified by the Gold Standard and 4 companies stated that their credits were certified but did not mention the carbon standard. 3 companies used carbon credits without certification.

Figure 9 illustrates the distribution of companies that utilize carbon credits with co-benefits. The data reveals that 78% of companies employ carbon credits with co-benefits, while 22% utilize carbon credits without co-benefits. Table 8 shows the frequency of the co-benefits mentioned.

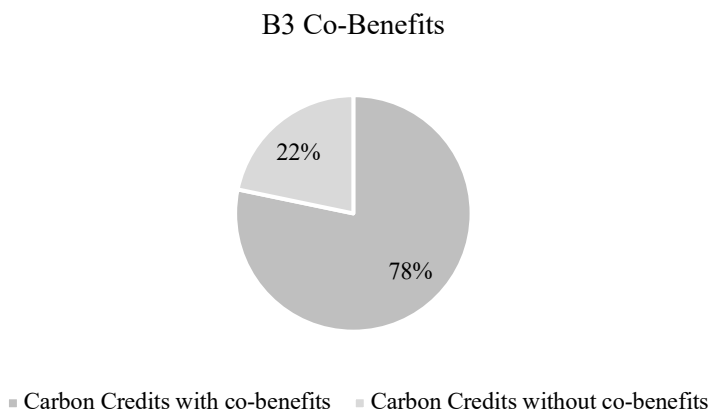

Figure 9 Proportion of companies utilizing carbon credits with and without co-benefits. (own illustration)

Table 8 Frequency of mentioned Co-Benefits (Source: own illustration)

Sustainable Development Goal	Frequency
SDG 1 No poverty	3
SDG 2 Zero Hunger	2
SDG 3 Good Health and Well-Being	3
SDG 4 Quality Education	2
SDG 5 Gender Equality	2
SDG 6 Clean Water and Sanitation	2
SDG 7 Affordable and Clean Energy	3
SDG 8 Decent Work and Economic Growth	4
SDG 9 Industry, Innovation and Infrastructure	2
SDG 10 Reduced Inequalities	2
SDG 11 Sustainable Cities and Communities	7
SDG 12 Responsible Consumption and Production	4
SDG 14 Life Below Water	2
SDG 15 Life on Land	13
SDG 16 Peace, Justice and Institutions	2
SDG 17 Partnerships for the Goals	2

The table indicates that SDG 15 Life on Land was the most frequently cited co-benefit. Consequently, a significant proportion of the carbon credits provide benefits for terrestrial ecosystems in addition to their benefits for the climate. The elevated figure for SDG 15 can be attributed to the prevalence of nature-based carbon credits among the majority of companies. The second most frequently mentioned Sustainable Development Goal (SDG) was SDG 11, which aims to make cities and human settlements inclusive, safe, resilient, and sustainable.

Furthermore, the preferred types of emission credits for the neutralization of residual emissions from the net zero target year were identified. The corresponding variable is *B6 Types of Credits for Neutralization*. Figure 10 shows the results of this analysis.

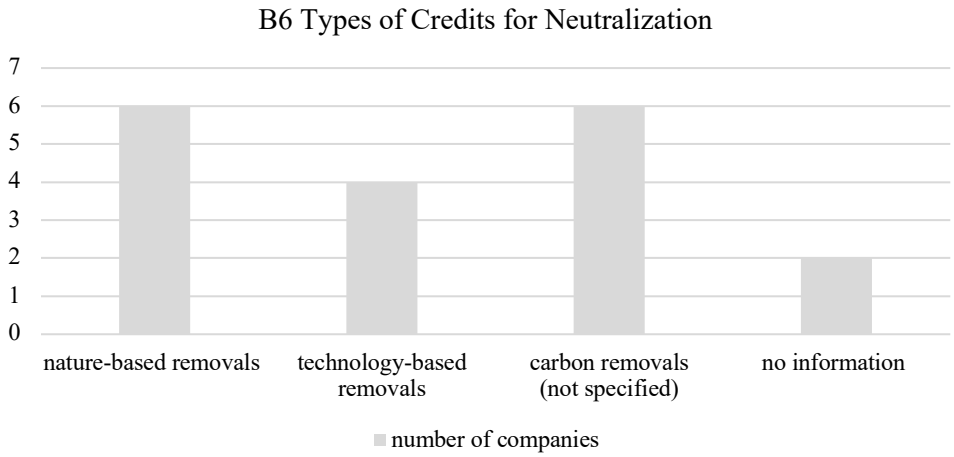

Figure 10 Distribution of carbon credit types for the neutralization of residual emissions in companies. (own illustration)

The analysis revealed that six companies intend to utilize nature-based removal techniques, such as reforestation and wetland restoration, to neutralize their residual emissions. Four companies plan to employ technology-based removal methods such as Direct Air Capture (DAC). Six companies have indicated that they will utilize carbon removals for neutralization purposes, although they have not specified whether nature-based or technology-based carbon removals are intended. Two companies have not provided any information regarding the type of credits they intend to utilize. The analysis also revealed that four of the 14 companies intend to utilize both nature-based and technology-based carbon removal credits. This implies that these companies use several different types of carbon credits to neutralize their residual emissions.

Q2 How do companies utilize carbon credits?

To answer this question, it is necessary to ascertain the point at which the companies utilise carbon credits. This is because the mitigation hierarchy clearly prioritizes the reduction of own emissions

over the application of carbon credits, both as Beyond Value Chain mitigation and as offsetting. Companies should first set short and long-term targets for reducing greenhouse gas emissions before resorting to the use of carbon credits. Thus, the three variables *A1 Application of* Credits, *B1 Near-term mitigation target* and *B2 Long-term mitigation target* were combined. Figure 11 shows the results of the analysis.

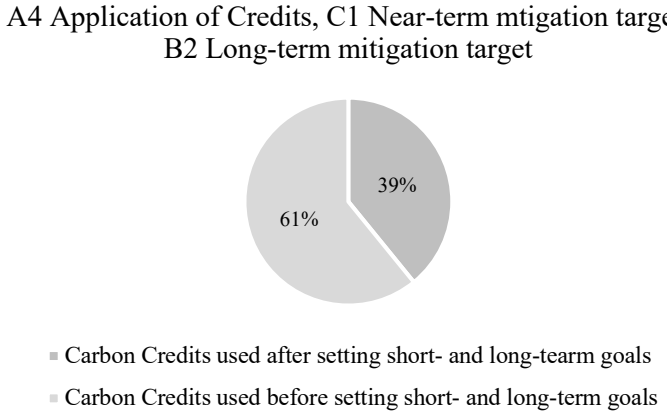

Figure 11 Share of companies with short- and long-term climate targets before the use of carbon credits. (own illustration)

The data shows that 39% of companies only integrate carbon credits into their own climate strategy after they have set short-term and long-term GHG reduction targets in line with current scientific recommendations. 61% of companies already apply carbon credits even though they lack either short-term or long-term targets. 86% of the 61% have short-term mitigation targets but lack long-term targets.14% of companies have neither short-term nor long-term targets when using carbon credits.

Variable *C3 Approach* provides information on the approach taken by companies when using carbon credits. The following four approaches were differentiated in the analysis:

1. Approach in which companies use carbon credits to contribute to global climate efforts. The Beyond Value Chain Mitigation (BVCM) outcomes does not offset or counterbalance any remaining value chain emissions.
2. The organization has delivered BVCM proportional to a stated percentage of unabated value chain emissions and stated that the BVCM outcomes counterbalance or “net out” that stated percentage of unabated value chain emissions. This offsetting was not preceded by comprehensive decarbonization measures.
3. The organization has delivered BVCM proportional to a stated percentage of unabated value chain emissions and stated that the BVCM outcomes counterbalance or “net out” that stated percentage of unabated value chain emissions. This offsetting is in addition to scientifically coordinated decarbonization measures, so that only the remaining emissions are offset in the

transition to net zero. The offsets are not included when assessing the company´s progress towards meeting its goals to reduce GHG emissions.

4. The company only plans to use carbon credits to neutralize residual emissions from the net-zero target year onwards.

An illustration of all approaches can be found in appendix 2. Figure 12 reveals the results of the analysis.

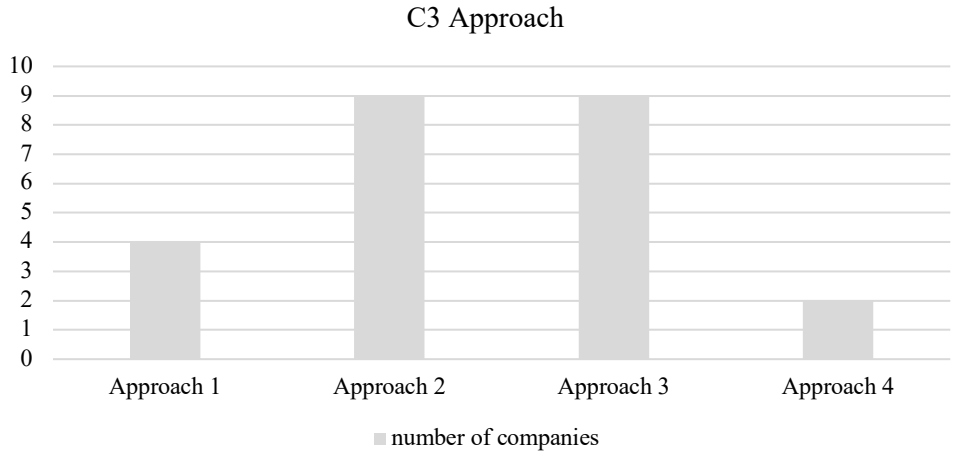

Figure 12 Number of companies in relation to the various carbon credit approaches (own illustration)

The figure illustrates that four companies (16%) employ approach 1, nine companies (36%) adopt approach 2, nine companies (36%) apply approach 3, and two companies (8%) utilize approach 4.

The variable *B4 Offsetting* was used to analyze the emission offsets carried out by companies that pursue an offsetting approach (approaches 2 and 3). The results of this analysis are presented in figure 13.

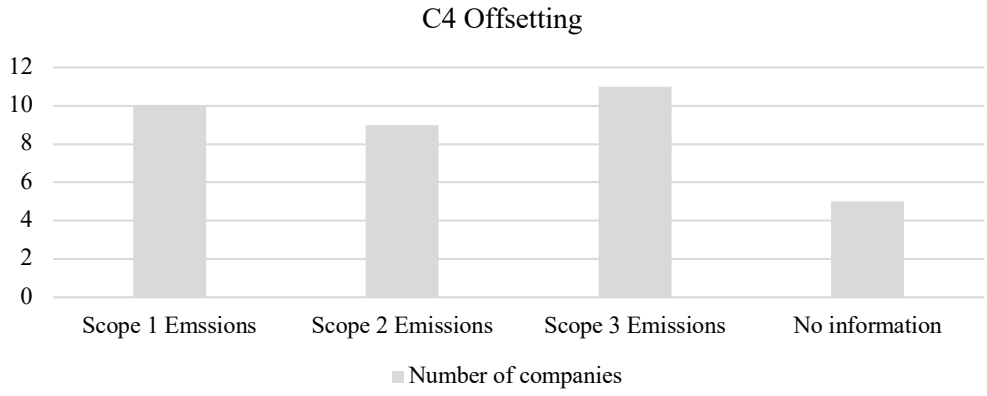

Figure 13 Proportion of companies that offset Scope 1, 2 and 3 emissions (own illustration)

The analysis carried out showed that ten companies offset Scope 1 emissions (direct emissions from sources owned or controlled by the company), nine companies offset Scope 2 emissions (indirect

emissions from the generation of the purchased energy) and eleven companies offset Scope 3 emissions (indirect emissions that do not originate from energy generation, but from the company's entire value chain). Five companies did not specify which emissions they were offsetting.

Variable *B7 Neutralization* examined if the companies plan to take responsibility for their residual emissions after achieving their net-zero target. The variable was only coded for companies that pursue long-term reduction targets, as only these companies strive for the net zero target and the neutralization of residual emissions is relevant. This applied to 14 companies in the sample.

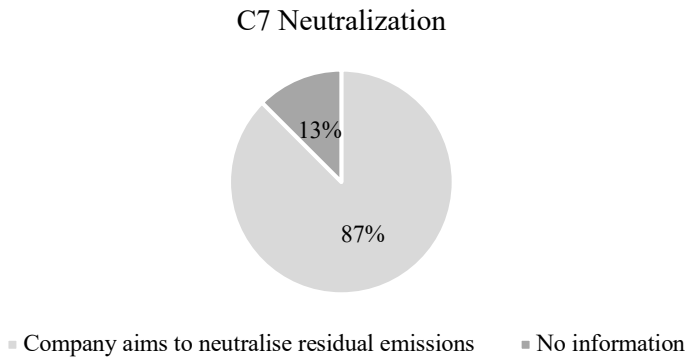

Figure 14 Proportion of companies with and without plans to neutralize their residual emissions (own illustration)

Figure 14 illustrates that 87% of companies aiming for a net zero target plan to neutralize their remaining emissions from this year onwards. 13% of companies have not provided information on whether they plan to neutralize. Furthermore, the variable *B8 Percentage of Neutralization* was employed to assess the extent to which the companies intend to neutralize their baseline emissions. The distribution of the various values is illustrated in figure 15.

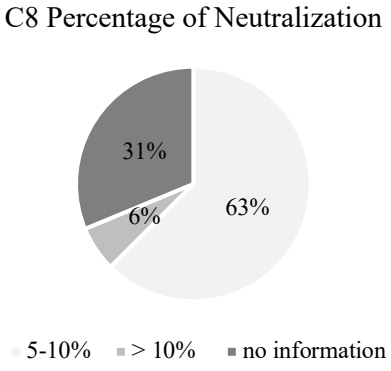

Figure 15 Corporate strategies for neutralizing residual emissions: 5-10%, more than 10% and no information. (own illustration)

The data indicates that 63% of companies intend to neutralize 5-10% of their original baseline emissions from their net zero target year. Of these companies, 70% have an SBTi-recognized net zero

target, while 30% do not. A significant proportion of companies (31%) do not provide any information on the residual emissions that they intend to neutralize from their net zero target. Furthermore, 6% of companies plan to neutralize more than 10% of their baseline emissions from the net zero target year onwards.

Q3 How do companies communicate about their use of carbon credits?

The way companies report on their utilization of carbon credits has a significant impact on the transparency of their climate protection measures. Transparent reporting enables stakeholders and customers to evaluate the authenticity and seriousness of a company's climate protection efforts. This study therefore analyzed the extent to which companies provide transparent information about the use of carbon credits in their sustainability reporting. The corresponding variable is *C1 Reporting*. Transparent reporting was assumed if the companies reported on the nature and scope of their carbon credits in accordance with SBTi. This included information on the financial resources used for the CO2 certificates, the reduction results and the co-benefits achieved. If any of this information was missing, the reporting was assessed as incomplete. Figure 16 presents the findings of the analysis.

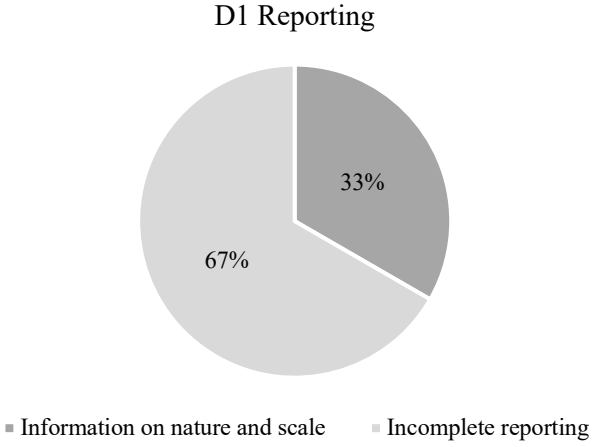

Figure 16 Comparison of companies according to the extent of reporting on the use of carbon credits (own illustration)

The graphic indicates that 33% of companies provide comprehensive information on the nature and scale of their carbon credits. Conversely, 67% of companies provide only partial information, which is why their reporting was rated as incomplete.

The analysis also examined whether the companies make statements about their climate neutrality. Three categories were defined for this purpose:

1. The company describes itself as climate neutral.

2. The company is aiming for climate neutrality in the future.

3. The company does not use either of the two claims on climate neutrality.

The results of the analysis are shown in figure 17.

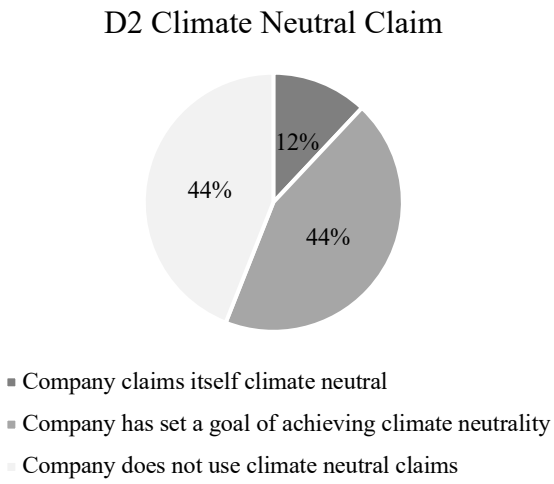

Figure 17 Proportion of companies that use a climate neutral claim (own illustration)

It can be seen that 12% of the companies describe themselves as climate neutral. 44% percent of the companies have set themselves the goal of achieving climate neutrality, while 44% percent do not use any climate neutral claims. Further, it was determined that 57,1 % of the companies making a climate neutral claim, have a scientifically recognized long-term reduction target.

7 Discussion

The findings of the analysis provide valuable insights into the strategies employed by companies in relation to their climate change policies, with a particular focus on the utilization of carbon credits. The following chapter will interpret the empirical results, contextualize them with the findings from the theoretical part and critically discuss them.

7.1 Types of Carbon Credits in Corporate Practice

Q1 Which carbon credits do companies use?

The distinction between emission reduction and emission removal is a critical factor in the categorization of the different types of carbon credits. Emissions reduction (or avoided emissions) credits are generated by activities that reduce or completely avoid emissions into the atmosphere (Faires, 2022). If carbon credits represent a emission removal, they are generated from projects that remove carbon dioxide directly from the atmosphere and store it permanently (Allen et al., 2020). The results of the study showed that the majority of companies (18) use avoidance/reduction credits, while 14 companies use removal credits. The difference between the two categories is therefore relatively minor. The popularity of avoidance/reduction carbon credits among the companies analysed suggests that companies have recognised the benefits of this type of carbon credit. On the one hand, they are already available in high quality on voluntary markets and, on the other hand, they are seen as an important part of global climate protection efforts, as they can play a decisive role in preserving existing carbon stocks (Faires, 2022). The results are also consistent with other studies that have found that while the share of reduction credits has increased in recent years, the demand for distance credits continues to rise. The relatively small difference in the use of reduction and removal credits in this study suggests that companies are increasingly recognising the importance of removal credits, particularly with regard to the stabilisation and potential reduction of carbon dioxide concentrations in the atmosphere.

Furthermore, the research revealed a significant difference in the use of nature-based and technology-based carbon credits. In fact, more than twice as many companies were found to be using nature-based credits. This result contrasts with previous studies, in which an almost equal market share of nature-based and technology-based credits was found. In addition to the high potential of nature-based carbon credits to mitigate climate change, the interest in this type of credits can also be attributed to their co-benefits. Typically, nature-based solutions bring other benefits to people and nature in addition to their climate benefits, such as supporting local communities, creating jobs, maintaining water quality and protecting natural habitats. The importance and popularity of these co-benefits has increased significantly in recent years (Donofrio & Procton, 2023). This increased

demand may also explain why significantly more nature-based than technology-based carbon credits are used in this study. In addition, nature-based solutions tend to be longer established and more widely available than many technological alternatives, which may still be in the development or pilot phase (see section 3.2). This could lead to greater market acceptance and familiarity among companies and be another reason for favouring nature-based credits. However, NBS are also characterised by significantly higher prices compared to other credits, mainly due to the co-benefits mentioned above (Donofrio & Procton, 2023). The fact that the companies in the study opted for nature-based credits despite the high price could be attributed to the fact that, as companies on the CDP A list, they place a stronger focus on maintaining and expanding their sustainability reputation. Nature-based projects often have a high public profile and can strengthen a company's image as environmentally conscious and socially responsible, which can also improve relationships with stakeholders and increase customer trust. Furthermore, all of the companies in the sample are large businesses, which suggests that they have greater financial resources available for achieving sustainability goals.

When analysing the source of carbon credits, it is noteworthy that the majority of carbon credits in the study come from REDD+ projects. The use of REDD+ credits is still a controversial issue, mainly due to ongoing criticism of both the effectiveness and the social and environmental impacts of these projects (see section 3.2). Whether REDD+ credits make an adequate contribution to climate change mitigation will therefore depend primarily on the extent to which the criticisms are addressed in the respective projects. Further analysis at this point could therefore examine the extent to which companies select projects that have a demonstrable positive social and environmental impact, adhere to strict standards and are regularly independently audited. The results of this research could help inform the debate around REDD+ certificates and the measures companies are taking to ensure that their investments in REDD+ certificates are ethical and effective, and provide important new insights. A comprehensive analysis of company-specific motivations and circumstances could also lead to new conclusions why the majority of companies have chosen to utilise REDD+ certificates (despite criticism).

The SBTi recommends supporting projects that secure and enhance carbon sinks (terrestrial, coastal, marine, etc.) to avoid emissions from their degradation (Watson et al., 2023). REDD+ forest conservation projects fall into this category, which could be a reason for companies to choose this type of credit. In addition to REDD+ projects, the analysis also identified mangrove restoration, agroforestry, regenerative agriculture, and reforestation projects. These projects account for more than 50% of all project types identified. In summary, more than half of the identified project types meet the SBTi recommendation to secure and enhance carbon sinks. Furthermore, the Science Based

Target initiative recommends investments in emerging greenhouse gas removal technologies (e.g. Direct Air Capture (DAC) and storage), as this technology is necessary to neutralize residual emissions. In this study, no such project was identified. This leads to the conclusion that the companies in this sample only partially follow the recommendations of the SBTi. However, it should be noted that nine companies did not provide information on the types of carbon projects they support. It is therefore possible that the projects in question could not be identified.

Regarding the quality of carbon credits, the original SBTi documents used for this analysis only require the purchase of high-quality carbon credits. However, it did not specify what standards would be used to define the quality. The study found that 18 companies use certified credits. Only seven companies do not state that the credits they use are certified. This suggests that the majority of companies are committed to purchasing high quality carbon credits that meet the SBTi specifications. However, the analysis shows that a further detailed examination of the carbon crediting standards used by companies is needed. As eight of the standards mentioned could not be assigned to the two most widely recognized and important standards - the Verified Carbon Standard and the Gold Standard - it is important to examine these alternative standards in more detail. It is necessary to determine what specific criteria and verification processes these standards include and to what extent they meet the stringent requirements of transparency, additionality, permanence, and independence necessary to ensure the environmental integrity of carbon credits. These findings will be critical in assessing whether these lesser-known standards are of similar or sufficient quality and reliability to established standards and can therefore enhance stakeholder confidence in carbon credit markets. In updated documents, the SBTi recommends that companies set their own minimum quality standards and guardrails for carbon credits to ensure that they are additional, permanent and free from double counting or leakage (SBTi, 2024a). Further research is therefore required to review the scope, implementation and effectiveness of these company set quality standards.

The Science Based Targets Initiative specifies as an additional requirement criterion for carbon credits that they should offer additional benefits for people and nature (co-benefits). The analysis of the sample showed that 78% of companies use carbon credits with co-benefits. This indicates that there is a strong preference for projects that go beyond the mere reduction of CO_2 emissions. It can therefore be derived that the current practices of the companies regarding co-benefits of carbon credits are largely in line with the recommendations from the literature. Further, the preference of companies for projects with additional environmental or social benefits indicates that these companies are taking a more comprehensive approach to achieving their sustainability goals than those using carbon credits without additional benefits. Further, the analysis has revealed that SDG 15, "Life on Land," is the most frequently cited co-benefit. This is largely due to the high volume of nature-based carbon credits

utilized, as these often directly contribute to the enhancement and protection of terrestrial ecosystems. Measures such as reforestation, forest protection or sustainable management practices therefore contribute to achieving the "Life on Land" goal (SDG 15). This explains the dominance of these co-benefit in the carbon credits used by the companies. Following the analysis, it would be beneficial to conduct a comparative analysis to gain insight into the ways in which different sectors or regions leverage co-benefits. This would provide insight into which sectors are particularly active in this area and why certain regions may invest more or less in co-benefits.

The final aspect of this question was to investigate which carbon credits the companies plan to use to neutralize their residual emissions from their net zero target year onwards. The analysis revealed that all but two companies intend to utilize removal credits for the neutralization. This indicates that the companies are aware of the distinction between carbon reduction and carbon removal credits. Only carbon removal credits are able to remove CO_2 from the atmosphere, which is why only these are suitable for neutralizing emissions. The SBTi states in its Net-Zero Standard: "Companies shall remove carbon from the atmosphere and permanently store it to counterbalance the impact of any unabated emissions that remain once companies have achieved their long-term science-based target, and for subsequent years thereafter" (Watson et al., 2023, p. 41). It is important to note that there is a distinction to be made between nature-based and technology-based carbon credits. The literature generally categorizes the storage of CO_2 through nature-based solutions as short-lived. Short-lived carbon storage strategies risk a potential reversal within a few decades due to various uncertainties (Allen et al., 2020). In the case of nature-based credits, forest fires, diseases and the effects of climate change itself threaten carbon storage and increase the risk that the stored carbon will be released back into the atmosphere in the short to medium term. Only technology-based carbon credits such as Carbon Capture and Storage projects fulfil the requirements for long-lived storage, as the risk of reversal over centuries to millennia is low (Allen et al., 2020). It is therefore recommended that technology-based removal credits be used to remove CO_2 from the atmosphere and store it reliably and permanently. However, the analysis has shown that only four companies intend to rely exclusively on these types of credits. Ten companies plan to neutralise all or part of their residual emissions with nature-based credits. At this point, it can tehrefore derived, that the company practices do not fully align with the findings and recommendations from the theory. It would be of scientific interest to investigate the reasons that lead companies to favor nature-based solutions. To this end, qualitative research methods such as interviews or surveys could be used to gain deeper insights into companies' decision-making processes. With this study, the perceived benefits, risks and challenges of both approaches - nature-based and technology-based solutions - could be systematically researched and analyzed.

7.2 Strategies for the Use of Carbon Credits

Q2 How do companies utilize carbon credits?

To ascertain whether the companies in question adhere to the mitigation hierarchy, the point at which they utilize carbon credits was analyzed. The mitigation hierarchy represents the fundamental principle underlying the SBTi´s Net Zero Standard and prioritizes the reduction of companies' own emissions over the utilization of carbon credits (Watson et al., 2023). Consequently, companies should establish both science-approved short-term and long-term GHG reduction targets prior to using carbon credits to implement emissions reductions strategies outside their value chain. The findings of the analysis thus provide valuable insights into how the companies integrate carbon credits into their overall climate strategy. The analysis reveals that the vast majority of companies using carbon credits have defined short-term reduction targets, but no long-term targets. This suggests that many companies are focusing on immediate or short-term actions without developing a clear strategy or vision for long-term sustainability and climate impact. This raises questions about the sustainability and strategic direction of their climate action. Merely 39% of companies integrate carbon credits into their climate strategy only after they have set both short- and long-term greenhouse gas reduction targets. This aligns with the mitigation hierarchy recommended by science. As a result, these companies adopt an ideal approach that prioritizes direct emission reduction over the application of beyond value chain mitigation. The prevalence of companies utilizing carbon credits without the establishment of both short-term and long-term targets raises concerns regarding the potential for greenwashing. These companies may be employing carbon credits as a superficial solution to enhance their public image, without a genuine commitment or strategy to reducing their own emissions. The results presented provide a basis for further research into the reasons why companies tend to neglect long-term goals, what obstacles they recognize and what support they need to develop comprehensive and long-term climate protection strategies.

Furthermore, the approach taken by the companies when utilizing carbon credits was analyzed. The analysis demonstrated that 8% of the companies employ approach 4, which entails the utilization of carbon credits solely to neutralize residual emissions from the net zero target year onwards, with the assistance of corresponding carbon removal credits. Consequently, these companies employ an approach that is in accordance with the SBTi standard, as they have established scientifically validated targets for both short-term and long-term emission reductions and have devised a plan to neutralize residual emissions. Nevertheless, it is evident that companies are not contributing to the achievement of global climate targets by pursuing BVCM in the transition to net zero and reducing emissions outside their value chain. However, as BVCM has so far been a voluntary measure that complements internal reduction measures, this approach cannot be regarded as negative. An approach

that focuses strongly on internal measures and neglects external emission reductions is nevertheless in line with the basic principles of SBTi, provided that the measures implemented actually lead to significant internal emission reductions. Companies that pursue SBTi-certified targets but do not engage in BVCM demonstrate that they take climate change seriously but focus their emission reduction strategies on areas that they can directly control. However, it can be argued that augmenting the climate strategy of these companies with BVCM would be desirable in any case, as this can be a valuable addition to achieve a broader impact on climate change. Based on this finding, further research could investigate in more detail the reasons why companies decide not to use BVCM and thus reveal barriers.

A 36% of the analyzed companies employ an approach wherein the BVCM is delivered in proportion to a stated percentage of the value chain's unabated emissions. These companies also state that the BVCM results offset this stated percentage of the value chain's unabated emissions. This approach is primarily characterized by the fact that offsetting was not preceded by comprehensive decarbonization measures. Consequently, the companies do not have scientifically recognized short- and/or long-term reduction targets. The absence of comprehensive decarbonization measures suggests that these companies may favor expedient solutions or are unable to implement immediate reductions in their own emissions. This can be attributed to a number of factors, including financial constraints, technological limitations or a desire to fulfil short-term regulatory or market requirements. It can also be inferred that the strategies employed to reduce emissions are less rigorous and less ambitious. This indicates that they are less focused on sustainability and climate change strategies, which would require stricter criteria or long-term commitments. The utilization of carbon credits for offsetting without prior significant reduction efforts may affect the credibility of the company's climate neutrality claims with stakeholders and customers. There is a risk that such practices may be perceived as "greenwashing", particularly if the public or investors apply more rigorous standards to the actual climate impact. As previously stated, one potential rationale for adopting this strategy could be a response to prevailing market and regulatory pressures. It is possible that companies have adopted this approach in response to market pressures or regulatory requirements that demand prompt responses. In industries with high emissions and fewer direct opportunities for reduction, this could be a viable short-term strategy while long-term solutions are developed. Further research could investigate the relationship between high-emitting industries and their preferred mitigation strategies, with a particular focus on the use of Beyond Value Chain Mitigation (BVCM) in the absence of prior comprehensive decarbonization. This could provide new insights into the reasons why certain high-emitting industries select specific climate protection strategies and the factors that influence these decisions. In conclusion, it can be stated that this approach is the least consistent with the approach specified by SBTi. This is due to the fact that the climate strategy applied

is not compatible with compliance with the global 1.5-degree target, as it lacks internal reduction measures.

Similarly, 36% of the companies employ an approach whereby they deliver BVCM in proportion to a stated percentage of unabated value chain emissions. They further state that the BVCM outcomes counterbalance or "net out" that stated percentage of unabated value chain emissions. This offsetting is in addition to scientifically coordinated decarbonization measures, so that only the remaining emissions are offset in the transition to net zero. Companies that adopt this approach do not utilize BVCM to support global climate protection efforts, but rather to offset their own remaining emissions as part of a strategy to achieve net zero emissions. By offsetting all remaining emissions, companies can actively position themselves as "climate neutral", even if they continue to cause emissions that they cannot (yet) eliminate internally. Nevertheless, the approach demonstrates that the companies have comprehensive targets and strategies for reducing their emissions that are in line with scientific standards. In addition to this, the BVCM enables these companies to take responsibility for their unavoidable emissions on the way to net zero. Nevertheless, the utilization of BVCM outcomes to offset emissions and achieve climate neutrality is open to criticism. Despite the implementation of extensive decarbonization measures, there is a risk of greenwashing, whereby the term "climate neutrality" is employed as a marketing tool without the provision of transparent and comprehensible information regarding the actual climate impact. Furthermore, stakeholders may perceive this behavior as an attempt to enhance the company's image without any tangible reduction in emissions.

A mere 16% of companies apply an approach that is fully aligned with the SBTi's prescribed approach. These companies therefore have approved short- and long-term emission reduction targets and use carbon credits to participate in global climate protection efforts by reducing emissions outside their value chain (BVCM). The results of the BVCM are not intended to offset or compensate for any remaining emissions within the value chain; rather, they represent a contribution to the global reduction of greenhouse gases. These companies demonstrate a profound commitment to climate protection that extends beyond the minimization of their own emissions. Furthermore, the credibility and transparency of the companies is enhanced by the fact that they communicate that their BVCM activities do not serve to offset their own emissions, but rather support global emission reductions independently of this. This could potentially lead to an increase in trust among stakeholders, investors and consumers. The relatively low number of companies pursuing this approach may indicate structural and strategic barriers, such as financial constraints, a lack of understanding of the benefits of such an approach, or insufficient support from governments and industry standards. The observation that only a minority of companies are adopting a fully aligned approach with the SBTi highlights the necessity for intensified efforts to promote and support such climate change strategies.

The approach chosen by these companies can serve as an example of best practice and inspire other companies to pursue similar strategies.

In summarizing the findings regarding the approach, it can be observed that although all companies in the sample are considered pioneers in the field of climate protection, there are significant differences in their approach to integrating carbon credits into their own climate strategy. A considerable proportion of the companies continue to utilize carbon credits to offset their own emissions, thereby contradicting the recommendations of the SBTi Net Zero Standard. Nevertheless, a substantial proportion of these companies have ambitious climate targets aligned with scientific standards, in addition to offsetting. The contribution approach, in which BVCM serves to contribute to global climate targets in line with the net zero standard, is not yet widespread.

Furthermore, the types of emissions that were offset by the companies through the issuance of carbon credits were examined. The results of the analysis indicate that ten companies offset their Scope 1 emissions, which originate from sources that they own or control. This suggests that a significant proportion of companies are taking direct action to mitigate the impact of their most direct sources of emissions. Nine companies are implementing offsetting measures for Scope 2 emissions resulting from the energy they purchase. The results indicate that eleven companies offset Scope 3 emissions, which result from the entire value chain and typically pose the greatest challenge as they include indirect emissions that go beyond the company's direct business activities. Five companies did not specify which specific emissions they offset. This could indicate a general offsetting strategy that does not differentiate which emissions are offset, or it could be a lack of transparency or detailed reporting. The disclosure of which categories of emissions are offset by a company demonstrates a higher level of transparency and a specific commitment to reducing the company's climate impact. Failure to fulfil this obligation could result in criticism from stakeholders, who demand more detailed accountability.

The analysis also examined whether the companies plan to assume responsibility for their remaining emissions after reaching their net zero target. This is the final key element of the net zero standard. The SBTi requires companies to reduce their own emissions by approximately 90-95% by the net zero target year, before neutralizing the remaining 5-10% through an equivalent of carbon removal credits in the target year and all subsequent years. The findings indicate that the majority of companies with net zero targets are developing a responsible strategy to neutralize their remaining emissions. The fact that 87% of companies pursuing a net zero target plan to neutralize their remaining emissions from the target year onwards demonstrates a strong commitment to comprehensive climate responsibility. These companies recognize the need to continue to take responsibility for their environmental impact even after substantial emission reductions have been achieved. The fact that

63% of companies intend to neutralize between 5% and 10% of their original emissions indicates that the majority of companies possess neutralization plans in accordance with the net zero standard. The analysis has also revealed that 70% of companies intending to neutralize 5-10% of their emissions have a net zero target recognized by the SBTi. This evidence demonstrates the significance of validation by renowned climate protection initiatives. The relatively high proportion of companies (31%) that do not provide information on how much of their emissions they intend to neutralize raises questions about the transparency and specificity of their climate action plans. The lack of information regarding the intended neutralization of emissions can impede the ability of stakeholders to assess the actual commitment and progress of these companies towards their climate targets. It has been observed that 6% of companies plan to neutralize more than 10% of their baseline emissions. This approach, therefore, is not in line with the requirements of the Net Zero Standard. One potential reason for this discrepancy is that it may affect companies in "hard to abate" sectors, i.e. industries in which reducing greenhouse gas emissions is particularly challenging and costly, such as the cement industry. To gain more detailed insights into sector-specific neutralization strategies, further analysis could examine the differences in neutralization approaches between different sectors. This could shed light on how industries with different emission profiles and reduction potentials adapt their neutralization strategies.

7.3 Transparency and Reporting on Carbon Credits in Corporate Communications

Q3 How do companies communicate about their use of carbon credits?

To answer this question, it was first analyzed to which extent the companies report on their carbon credit activities. In accordance with the SBTi guidelines, companies are required to provide comprehensive information about the nature and scope of their activities. This includes details of the financial resources used to purchase carbon credits, the reductions achieved and the resulting co-benefits. The investigation revealed that only 33% of companies provide all the necessary information to enable transparent reporting. The majority of companies only communicate individual pieces of information about their activities in the area of carbon credits. Incomplete reporting makes it difficult to evaluate the effectiveness of these credits in terms of emission reductions and the achievement of sustainability goals. This undermines the ability of external stakeholders to assess the real environmental benefits of these measures and makes it difficult to compare companies and set benchmarks. Furthermore, the low rate of full reporting indicates a transparency problem. Transparency is a crucial factor in establishing trust among stakeholders, including investors, customers, and regulators. Companies that fail to publish comprehensive reports may inadvertently erode the trust of these key groups. Further research could examine the obstacles preventing

companies from disclosing all relevant information and identify strategies for overcoming them. Additionally, the influence of industry norms and practices on the quality of reporting could be a valuable area for investigation. A comprehensive examination of these factors could also facilitate the formulation of tangible recommendations for enhancing transparency and credibility in the utilization of carbon credits.

Another variable that was analyzed regarding the guiding question was whether companies make use of carbon neutral claims. Carbon neutrality claims are considered as compensation claims and are used by companies to indicate that they have purchased carbon credits equivalent to their volume of unabated emissions and that they have offset these emissions (SBTi, 2024a). In their research, Trouwloon et al. (2023) have established the first key criteria for the evaluation of climate claims. According to this categorization, the 12% of carbon-neutral claims from the analysis can be assigned to the "stated achievement" category. This category therefore applies to all companies that describe themselves as carbon-neutral in their claims. 44% of the analyzed companies have set themselves the goal of achieving climate neutrality. These claims can be categorized as "aspirational commitments“. As outlined in section 4.3.2 the Science Based Targets Initiative has not yet taken a position on whether companies should claim 'carbon neutrality'. However, considering the ongoing criticism, it is questionable whether this is the most effective way for leading companies to differentiate their climate actions from those that are not decarbonizing based on science (see section 4.3.2). The results of the analysis are noteworthy, with 52% of the companies in the sample utilizing carbon neutral claims. This result emphasizes the prevailing uncertainty and differing views on the extent to which carbon neutral claims should be used. Moreover, it was determined that 57,1 % of the companies making a climate neutral claim, have a scientifically recognized long-term reduction target. This outcome aligns with previous findings indicating that carbon neutrality claims are often not directly linked to global climate targets or comprehensive corporate strategies, but vary in terms of supply chain emissions reductions (Helmers et al., 2021; Dawson et al., 2022). To gain further insights into this debate, it is important to conduct further research in this area. Firstly, a study could investigate more deeply how companies achieve their carbon neutral claims. This could include analyzing the carbon credits used, the methods used to calculate emissions and the transparency of communication. The aim would be to assess the authenticity and scientific basis of these claims. Further research could be conducted to gain insight into consumer response to carbon neutral claims and the extent to which these claims influence purchasing behavior. In particular, it would be beneficial to investigate whether consumers differentiate between different types of statements (e.g. "stated achievement" vs. "aspirational commitments"). Furthermore, a comprehensive examination of the current transparency standards and guidelines for carbon neutral claims could identify areas for improvement. This could involve an analysis of the specific information that companies should disclose to substantiate and

clarify their claims. These research approaches can help to develop a deeper understanding of the dynamics and effectiveness of carbon neutral claims, which could ultimately lead to companies and regulators making more informed decisions in the context of climate protection.

8 Conclusion

This study examined the question "How should companies ideally use carbon credits as part of their decarbonisation activities and how are they currently used in corporate practice?". In order to achieve this objective, a quantitative content analysis was conducted on the carbon credit activities of European companies. The results of this study were then compared with the recommendations of current standards and scientific findings.

The results of the study showed that twice as many companies opted for nature-based credits, a departure from previous studies where the distribution was more balanced. This trend towards nature-based credits reflects companies' awareness of the multiple benefits of nature-based solutions, despite their higher costs. However, the predominance of REDD+ credits within the nature-based category underlines the complex dynamics in this context. Although the effectiveness and socio-environmental impacts of REDD+ projects remain controversial, their popularity continues unabated. Overall, only about half of the project types identified meet the Science-Based Targets initiative's recommendation to safeguard and enhance carbon sinks. However, the study also found that none of the companies are using carbon credits to invest in the development of new GHG removal technologies such as Direct Air Capture (DAC), which is in clear contradiction to the SBTi recommendations and may be due to the current high costs and technical uncertainties of these projects. The study also found that the majority of companies are committed to purchasing high quality carbon credits, with only seven companies in the study using non-certified carbon credits. However, it was also examined that the majority of standards mentioned could not be assigned to the two most widely recognised and important standards - the Verified Carbon Standard and the Gold Standard. On the one hand, this shows the lack of uniform standards and reveals the unregulated structure of the VCM. On the other hand it also highlights the need for further research to assess whether these lesser-known standards are of similar or sufficient quality and reliability to the established standards, and can therefore increase stakeholder confidence in carbon markets. This further investigation is needed to determine what specific criteria and verification processes these standards include and to what extent they meet the stringent requirements of transparency, additionality, permanence and independence necessary to ensure the environmental integrity of carbon credits.

In terms of how companies are using carbon credits, the study found that the majority of companies are focusing on immediate or short-term actions, using carbon credits without a clear strategy or vision for long-term sustainability and climate impact. This raises serious questions about the sustainability and strategic direction of these companies' climate actions. Only 39% of companies integrate carbon credits into their climate strategy only after setting both short and long-term GHG reduction targets. In doing so, these companies are aligning themselves with the core principle of the

SBTi's Net Zero Standard, prioritizing internal reductions over the use of carbon credits. The study also revealed that most companies are using carbon credits primarily to offset their own emissions and achieve carbon neutrality. This approach is not in line with the SBTi recommendations, which encourage the use of carbon credits as a voluntary contribution to global climate goals. Most companies therefore deviate from the standard's recommendations. It was also found that 36% of these companies do not have scientifically recognized short and/or long-term reduction targets, i.e. they are not implementing comprehensive decarbonization measures in addition to carbon credits. This approach is in stark contrast to the recommendations of the SBTi and illustrates the lack of ambition of these climate strategies, which also greatly increases the risk of being perceived as greenwashing. Only a small percentage of companies (16%) follow an approach that is fully in line with the SBTi's recommendations: using carbon credits to participate in global climate protection efforts by reducing emissions outside their value chain. These companies show a strong commitment to climate protection that goes beyond minimizing their own emissions. The findings further indicate that the majority of companies with net zero targets are developing a responsible strategy to neutralize their remaining emissions. The majority of companies pursuing a net zero target plan to neutralize their remaining 5-10% of emissions from the target year onwards through carbon removals. This demonstrates a strong commitment to comprehensive climate responsibility for most companies and a consistency with the current recommendations of the SBTi.

Finally, the communication of carbon credit activities in particular was found to fall short of current standards. Only 33% of companies provided all the information required for transparent reporting. The majority of companies provided only fragmented information. The low rate of adequate reporting indicates a transparency problem that can have a massive impact on the confidence of key stakeholders and the commodity market. It also highlights the lack of consistent and binding reporting standards. More than half of the companies also use climate neutrality claims. This again highlights the need for greater transparency and adherence to rigorous, science-based methodologies, especially when companies make climate neutrality claims.

After conducting the study, the research question can therefore be answered as follows: according to the existing literature and the prevailing standards, carbon credits should be regarded as a supplementary measure to comprehensive internal decarbonization strategies that are aligned with scientific evidence. In addition to using carbon credits to neutralize residual emissions from the net-zero date, companies should also invest in projects in the transition to net-zero that go beyond the immediate requirements to reduce emissions outside their own value chains to support the global climate change agenda. In order to ensure the credibility of their carbon credit purchases, companies should ensure that the credits they purchase meet the highest standards, such as Vera (VCS), Gold

Standard or similar verified schemes. These standards guarantee that the projects in question will deliver additional, permanent and verifiable emission reductions. Furthermore, transparency is of paramount importance. It is recommended that companies report clearly and openly on the number of carbon credits purchased, the projects supported, the standards applied, and the co-benefits generated. This increases stakeholder confidence and demonstrates the company's commitment to real climate protection measures. The analysis of the current use of carbon credits shows that the implementation of the companies only partially corresponds to the recommendations from the theory. Many companies use carbon credits to quickly offset their emissions instead of implementing long-term measures to reduce emissions. This can often be perceived as greenwashing. The contribution approach, as recommended by the SBTi, has so far only been used to a limited extent in practice. However, it is clear that in many cases companies are keen to buy high-quality credits that are both certified and bring co-benefits. On the negative side, however, the majority of companies do not offer sufficient transparency about their use of carbon credits. Furthermore, a considerable number of companies utilize carbon neutral claims, which, in conjunction with a lack of transparency, can give rise to a lack of trust among stakeholders.

The limitations of the study are mainly due to the small sample size, which means that the significance of the results is lower than if more data had been analyzed. In the content analysis, it was particularly difficult to assign an approach to the use of carbon credits to the companies. This is mainly due to the terminological vagueness in carbon neutrality and net zero, which has already been mentioned several times, and the resulting different use of the terms by the companies. A more precise definition of the individual categories would be useful here. However, as the content analysis was carried out by only one person, it can be assumed that the results were coded consistently. However, the imprecise definition of some categories may affect the reliability of the analysis. As this is an exploratory study with a small sample size, the representativeness of the sample cannot be guaranteed. Rather than generalizing the results, the aim of the study is to deepen understanding of the topic, open up new areas of research and create a basis for the development of new hypotheses.

This paper contributes to a deeper understanding of the use of carbon credits by companies and provides a nuanced perspective on the interplay between corporate action and current standards to achieve global climate goals. Looking to the future, it emphasizes the need for continuous review and adaptive corporate strategies that align more closely with the evolving science of climate change and the global urgency of the climate crisis. A review of the literature and of current practice has shown that while there is still room for improvement, voluntary carbon markets are one of the most effective tools for financing solutions to address the climate crisis. High-integrity markets for voluntary carbon credits can mobilize private finance and channel funds to where they are most needed and thus close

the significant gap in climate finance. This leads not only to a reduction in greenhouse gas emissions, but also to other benefits such as job creation and support for biodiversity. Nevertheless, it is important to note that carbon credits are not a panacea and should be employed as part of a broader strategy to address climate change. Non-state actors must give priority to the urgent and substantial reduction of emissions across their entire value chain. High-integrity carbon credits in voluntary markets should be employed for beyond-value-chain mitigation, but they should not be counted toward a non-state actor’s interim emissions reductions required by its net zero pathway or claimed to offset emissions. Moreover, any credit transactions must be transparently reported, and the associated claims must be easily understandable, consistent and verified. Concurrently with the aforementioned endeavors, it is of the utmost importance to enhance the ambition of climate action across the globe's private sector. To date, only a small proportion of the world's largest companies have adopted climate action plans, and only a small fraction of small and medium-sized enterprises has done so. Therefore, it is important to provide incentives, recognition and rewards to those companies that demonstrate high levels of integrity in their purchase and retirement of carbon credits. This will facilitate the acceleration of climate action by such companies. To ensure that credits are only used once a non-state actor’s own mitigation efforts are in line with science, it is essential to establish a transparent and high-integrity framework. It remains to be seen how politics, science and businesses will respond to these challenges. This investigation is intended to serve as a foundational reference, facilitating the continued exploration and refinement of corporate strategies with the objective of fostering genuine sustainability and climate responsibility.

Bibliography

Allen, M., Axelsson, K., Caldecott, B., Hale, T., Hepburn, C., Mitchell-Larson, E., Malhi, Y., Otto, F., & Seddon, N. (2020). *The Oxford Principles for Net Zero Aligned Carbon Offsetting 2020*.

Anderson, C. M., DeFries, R. S., Litterman, R., Matson, P. A., Nepstad, D. C., Pacala, S., Schlesinger, W. H., Shaw, M. R., Smith, P., Weber, C., & Field, C. B. (2019). Natural climate solutions are not enough. *Science*, *363*(6430), 933–934. https://doi.org/10.1126/science.aaw2741

Bahman, N., Al-Khalifa, M., Al Baharna, S., Abdulmohsen, Z., & Khan, E. (2023). Review of carbon capture and storage technologies in selected industries: Potentials and challenges. *Reviews in Environmental Science and Bio/Technology*, *22*(2), 451–470. https://doi.org/10.1007/s11157-023-09649-0

Baxter, G. (2021). Achieving Carbon Neutral Airport Operations By 2025: The Case of Sydney Airport, Australia. *Transport and Telecommunication Journal*, *22*(1), 1–14. https://doi.org/10.2478/ttj-2021-0001

Bertini, M., Buehler, S., Halbheer, D., & Lehmann, D. R. (2022). Carbon Footprinting and Pricing Under Climate Concerns. *Journal of Marketing*, *86*(2), 186–201. https://doi.org/10.1177/0022242920932930

Borgmann, M., Gierds, J., Fischedick, M., Henning, H.-M., Matthies, E., Pittel, K., Renn, J., Sauer, D. U., & Spiecker genannt Döhmann, I. (2023). *Was ist der freiwillige Kohlenstoffmarkt – und welchen Beitrag leistet er für den Klimaschutz?* [Application/pdf]. acatech - Deutsche Akademie der Technikwissenschaften. https://doi.org/10.48669/ESYS_2023-7

Broekhof, D., Gillenwater, M., Colbert-Sangree, T., & Cage, P. (2019). *Securing Climate Benefit: A Guide to Using Carbon Offsets*. https://www.offsetguide.org/wp-content/uploads/2020/03/Carbon-Offset-Guide_3122020.pdf

Budinis, S., Krevor, S., Dowell, N. M., Brandon, N., & Hawkes, A. (2018). An assessment of CCS costs, barriers and potential. *Energy Strategy Reviews*, *22*, 61–81. https://doi.org/10.1016/j.esr.2018.08.003

Bui, M., Adjiman, C. S., Bardow, A., Anthony, E. J., Boston, A., Brown, S., Fennell, P. S., Fuss, S., Galindo, A., Hackett, L. A., Hallett, J. P., Herzog, H. J., Jackson, G., Kemper, J., Krevor, S., Maitland, G. C., Matuszewski, M., Metcalfe, I. S., Petit, C., … Mac Dowell, N. (2018). Carbon capture and storage (CCS): The way forward. *Energy & Environmental Science*, *11*(5), 1062–1176. https://doi.org/10.1039/C7EE02342A

Bundesministerium für Arbeit und Soziales. (n.d.). *Corporate Sustainability Reporting Directive (CSRD)*. www.bmas.de. Retrieved April 1, 2024, 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

Bundesverband Nachhaltige Wirtschaft. (2023, November 14). *FAQ Green Claims Directive | BNW*. https://www.bnw-bundesverband.de/faq-green-claims-directive

Burtons, B., Hyland, S., & Knoll, T. (2023, December 5). Analysis: Article 6.4 Talks Have Stalled in Dubai. Here's What's At Stake. *Ecosystem Marketplace*. https://www.ecosystemmarketplace.com/articles/analysis-article-6-4-talks-six-talks-have-stalled-in-dubai-heres-whats-at-stake/

California Legislative Information. (2023). *Assembly Bill No. 1305 – Voluntary carbon market disclosures*. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202320240AB1305

Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P. W., Trisos, C., Romero, J., Aldunce, P., Barrett, K., Blanco, G., Cheung, W. W. L., Connors, S., Denton, F., Diongue-Niang, A., Dodman, D., Garschagen, M., Geden, O., Hayward, B., Jones, C., … Péan, C. (2023a). *IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland.* (First). Intergovernmental Panel on Climate Change (IPCC). https://doi.org/10.59327/IPCC/AR6-9789291691647

Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P. W., Trisos, C., Romero, J., Aldunce, P., Barrett, K., Blanco, G., Cheung, W. W. L., Connors, S., Denton, F., Diongue-Niang, A., Dodman, D., Garschagen, M., Geden, O., Hayward, B., Jones, C., … Péan, C. (2023b). *IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland.* (First). Intergovernmental Panel on Climate Change (IPCC). https://doi.org/10.59327/IPCC/AR6-9789291691647

Causone, F., Tatti, A., & Alongi, A. (2021). From Nearly Zero Energy to Carbon-Neutral: Case Study of a Hospitality Building. *Applied Sciences*, *11*(21), 10148. https://doi.org/10.3390/app112110148

CDP. (n.d.-a). *About CDP*. Retrieved April 20, 2024, from https://www.cdp.net/en/info/about-us

CDP. (n.d.-b). *CDP A List companies 2023*. Retrieved April 20, 2024, from https://www.cdp.net/en/companies/companies-scores

Chagas, T., Galt, H., Lee, D., Neeff, T., & Streck, C. (2020). *A close look at the quality of REDD+ carbon credits*. https://climatefocus.com/wp-content/uploads/2022/06/A-close-look-at-the-quality-of-REDD-carbon-credits-2020-V2.0.pdf

Chausson, A., Turner, B., Seddon, D., Chabaneix, N., Girardin, C. A. J., Kapos, V., Key, I., Roe, D., Smith, A., Woroniecki, S., & Seddon, N. (2020). Mapping the effectiveness of nature-based solutions for climate change adaptation. *Global Change Biology*, *26*(11), 6134–6155. https://doi.org/10.1111/gcb.15310

Chen, S., Marbouh, D., Moore, S., & Stern, K. (2021). Voluntary Carbon Offsets: An Empirical Market Study. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3981914

Climate Focus (Ed.). (2024). *VOLUNTARY CARBON MARKET- 2023 REVIEW*. https://climatefocus.com/wp-content/uploads/2024/01/VCM-2023-Review-Report.pdf

Climate Impact Partners. (2023). *Fortune Global 500 Climate Commitments*. https://www.climateimpact.com/news-insights/fortune-global-500-climate-commitments/

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (Eds.). (2016). *Nature-based solutions to address global societal challenges*. IUCN International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2016.13.en

Crook, J. (2023, November 24). *FAQ: Everything you need to know about Article 6 at COP28*. Carbon Market Watch. https://carbonmarketwatch.org/2023/11/24/faq-everything-you-need-to-know-about-article-6-at-cop28/

Dawson, C., Dargusch, P., & Hill, G. (2022). Assessing How Big Insurance Firms Report and Manage Carbon Emissions: A Case Study of Allianz. *Sustainability*, *14*(4), 2476. https://doi.org/10.3390/su14042476

Day, T., Mooldijk, S., Hans, F., Smit, S., Posada, E., skrippe, R., Woollands, S., Fearnehough, H., Kuramochi, T., Warnecke, C., Kachi, A., & Höhne, N. (2023). *Corporate Climate Responsibility Monitor 2023* (New Climate Institute & Carbon Market Watch, Eds.). https://newclimate.org/sites/default/files/2023-04/NewClimate_CorporateClimateResponsibilityMonitor2023_Feb23.pdf

Day, T., Mooldijk, S., Smit, S., Posada, E., Hans, F., Fearnehough, H., Kachi, A., Warnecke, C., Kuramochi, T., & Höhne, N. (2022). *Corporate Climate Responsibility Monitor 2022—ASSESSING THE TRANSPARENCY AND INTEGRITY OF COMPANIES' EMISSION REDUCTION AND NET-ZERO TARGETS* (Carbon Market Watch & New Climate Institute, Eds.).https://newclimate.org/sites/default/files/2022/02/CorporateClimateResponsibilityMonitor2022.pdf

Deutsche Energie-Agentur (Ed.). (2022). *Klimaneutralität von Unternehmen – Bestehende Standards, Initiativen und Label sowie Einordnung der Rolle von Treibhausgas-*

Kompensation.https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2022/ANALYSE_Klimaneutralitaet_von_Unternehmen.pdf

Donato, D. C., Kauffman, J. B., Murdiyarso, D., Kurnianto, S., Stidham, M., & Kanninen, M. (2011). Mangroves among the most carbon-rich forests in the tropics. *Nature Geoscience*, *4*(5), 293–297. https://doi.org/10.1038/ngeo1123

Donofrio, S., & Procton, A. (2023). *Paying for Quality: State of the Voluntary Carbon Markets 2023* (Ecosystem Marketplace, Ed.).

Downey, A. (2023). *The Climate Regulatory Landscape- How to prepare for impending global climate regulations* (Sylvera, Ed.). https://7608351.fs1.hubspotusercontent-na1.net/hubfs/7608351/How%20to%20prepare%20for%20upcoming%20climate%20regulation.pdf

Dufrasne, G. (2024, April 10). *Science Based Targets initiative (SBTi) Board of Trustees' decision on offsetting undermines science and endangers the climate*. Carbon Market Watch. https://carbonmarketwatch.org/2024/04/10/science-based-targets-initiative-sbti-board-of-trustees-decision-on-offsetting-undermines-science-and-endangers-the-climate/

Dyck, M., Streck, C., & Trouwloon, D. (2023). *The Voluntary Carbon Market Explained*. https://vcmprimer.files.wordpress.com/2023/12/vcm-explained-full-reportlr.pdf

Ecosystem Marketplace. (2013, September 10). Brazilian Cosmetics Giant Buys First Indigenous REDD Credits. *Ecosystem Marketplace*. https://www.ecosystemmarketplace.com/articles/brazilian-cosmetics-giant-buys-br-first-indigenous-redd-credits/

Ecosystem Marketplace (Ed.). (2020). *Voluntary Carbon and the Post-Pandemic Recovery. State of Voluntary Carbon Markets Report, Special Climate Week NYC 2020 Installment*. https://waconservationaction.org/wp-content/uploads/2020/11/EM-Voluntary-Carbon-and-Post-Pandemic-Recovery-2020.pdf

Ecosystem Marketplace. (2022a). *The Art of Integrity: State of the Voluntary Carbon Markets 2022 Q3*. https://app.hubspot.com/documents/3298623/view/433338095?accessId=3abc8b

Ecosystem Marketplace. (2022b, August 3). VCM Reaches Towards $2 Billion in 2021: New Market Analysis Published from Ecosystem Marketplace. *Ecosystem Marketplace*. https://www.ecosystemmarketplace.com/articles/the-art-of-integrity-state-of-the-voluntary-carbon-markets-q3-2022/

EFRAG (Ed.). (2022). *ESRS E1 Climate change*. https://www.efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2FSiteAssets%2F08%2520Draft%2520ESRS%2520E1%2520Climate%2520Change%2520November%25202022.pdf

Energy Transision Comission (Ed.). (2023). *Financing the Transition: How to Make the Money Flow for a Net-Zero Economy*. https://www.energy-transitions.org/wp-content/uploads/2023/08/ETC-Financing-the-Transition-MainReport_update.pdf

European Parliament. (2023, September 19). *EU to ban greenwashing and improve consumer information on product durability | News | European Parliament*. https://www.europarl.europa.eu/news/en/press-room/20230918IPR05412/eu-to-ban-greenwashing-and-improve-consumer-information-on-product-durability

Faires, J. (2022). *Carbon Credit Basics for Business*. https://business.edf.org/wp-content/blogs.dir/90/files/Carbon-Credit-Basics-for-Business-10-02-22.pdf

Fuss, S., Golub, A., & Lubowski, R. (2021). The economic value of tropical forests in meeting global climate stabilization goals. *Global Sustainability*, *4*, e1. https://doi.org/10.1017/sus.2020.34

GenZero (Ed.). (2023). *Carbon Markets 2.0 Addressing Pain Points, Unlocking Impact*. https://genzero.co/wp-content/uploads/2023/12/Carbon-Markets-2.0-Addressing-Pain-Points-Unlocking-Impact.pdf

Gifford, L. (2020). "You can't value what you can't measure": A critical look at forest carbon accounting. *Climatic Change*, *161*(2), 291–306. https://doi.org/10.1007/s10584-020-02653-1

Global CCS Institute. (2022). *GLOBAL STATUS OF CCS 2022*. https://status22.globalccsinstitute.com/wp-content/uploads/2023/03/GCCSI_Global-Report-2022_PDF_FINAL-01-03-23.pdf

Gold Standard. (n.d.). *Gold Standard*. Gold Standard. Retrieved March 7, 2024, from https://www.goldstandard.org/gold-standard-for-the-global-goals/our-standard

Gold Standard (Ed.). (2023a). *Annual Report 2022*. https://goldstandard.cdn.prismic.io/goldstandard/65b391ae615e73009ec3f4c9_GoldStandardAnnualReport2022.pdf

Gold Standard (Ed.). (2023b). *FAIRLY CONTRIBUTING TO GLOBAL NET ZERO - Considerations for credible claims*. https://goldstandard.cdn.prismic.io/goldstandard/6a4f8e5b-873c-44cb-9fdc-3b85814e86a9_fairly_contributing_to_global_net_zero_-_considerations_for_credible_claims.pdf

Goldstein, A., Turner, W. R., Spawn, S. A., Anderson-Teixeira, K. J., Cook-Patton, S., Fargione, J., Gibbs, H. K., Griscom, B., Hewson, J. H., Howard, J. F., Ledezma, J. C., Page, S., Koh, L. P., Rockström, J., Sanderman, J., & Hole, D. G. (2020). Protecting irrecoverable carbon in

Earth's ecosystems. *Nature Climate Change*, *10*(4), 287–295. https://doi.org/10.1038/s41558-020-0738-8

Greenfield, P. (2023, January 18). Revealed: More than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis shows. *The Guardian*. https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe

Greenfield, P., & Harvey, F. (2024, April 11). Climate target organisation faces staff revolt over carbon-offsetting plan. *The Guardian*. https://www.theguardian.com/environment/2024/apr/11/climate-target-organisation-faces-staff-revolt-over-carbon-offsetting-plan-sbti

Greenpeace e.V. (Ed.). (2020). *VW's Carbon Footprint Sham How Volkswagen is using an ineffective compensation project to shirk potential CO2 savings*. https://www.greenpeace.de/sites/default/files/publications/vw-engl.pdf

Griscom, B. W., Adams, J., Ellis, P. W., Houghton, R. A., Lomax, G., Miteva, D. A., Schlesinger, W. H., Shoch, D., Siikamäki, J. V., Smith, P., Woodbury, P., Zganjar, C., Blackman, A., Campari, J., Conant, R. T., Delgado, C., Elias, P., Gopalakrishna, T., Hamsik, M. R., … Fargione, J. (2017). Natural climate solutions. *Proceedings of the National Academy of Sciences*, *114*(44), 11645–11650. https://doi.org/10.1073/pnas.1710465114

Guix, M., Ollé, C., & Font, X. (2022). Trustworthy or misleading communication of voluntary carbon offsets in the aviation industry. *Tourism Management*, *88*, 104430. https://doi.org/10.1016/j.tourman.2021.104430

Guizar-Coutiño, A., Jones, J. P. G., Balmford, A., Carmenta, R., & Coomes, D. A. (2022). A global evaluation of the effectiveness of voluntary REDD+ projects at reducing deforestation and degradation in the moist tropics. *Conservation Biology*, *36*(6), e13970. https://doi.org/10.1111/cobi.13970

Hale, T., Smith, S. M., Black, R., Cullen, K., Fay, B., Lang, J., & Mahmood, S. (2022). Assessing the rapidly-emerging landscape of net zero targets. *Climate Policy*, *22*(1), 18–29. https://doi.org/10.1080/14693062.2021.2013155

Hamilton, K., Bayon, R., Turner, G., & Higgins, D. (2007). *State of the Voluntary Carbon Markets 2007: Picking Up Steam* (Ecosystem Marketplace, Ed.). https://www.forest-trends.org/wp-content/uploads/2018/09/State-of-the-Voluntary-Carbon-Market-2007.pdf

Helmers, E., Chang, C. C., & Dauwels, J. (2021). Carbon footprinting of universities worldwide: Part I—objective comparison by standardized metrics. *Environmental Sciences Europe*, *33*(1), 30. https://doi.org/10.1186/s12302-021-00454-6

ICAO Environment. (n.d.). *Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*. Retrieved April 14, 2024, from https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx

ICVCM. (n.d.-a). Core Carbon Principles. *ICVCM*. Retrieved March 14, 2024, from https://icvcm.org/the-core-carbon-principles/

ICVCM. (n.d.-b). Core Carbon Principles assessments and Working Groups now underway. *ICVCM*. Retrieved March 14, 2024, from https://icvcm.org/core-carbon-principles-assessments-and-working-groups-now-underway/

ICVCM. (2024a). *Core Carbon Principles*. https://icvcm.org/wp-content/uploads/2024/02/CCP-Section-2-V2-FINAL-6Feb24.pdf

ICVCM (Ed.). (2024b). *Section 5: Definitions—Core Carbon Principles*. https://icvcm.org/wp-content/uploads/2024/02/CCP-Section-5-V2-FINAL-6Feb24.pdf

IEA. (2020). *Energy Technology Perspectives 2020: Special Report on Carbon Capture, Utilisation and Storage*. https://iea.blob.core.windows.net/assets/181b48b4-323f-454d-96fb-0bb1889d96a9/CCUS_in_clean_energy_transitions.pdf

IEA. (2022a). *CO2 storage resources and their development: An IEA CCUS Handbook*. https://www.iea.org/reports/co2-storage-resources-and-their-development

IEA. (2022b). *Direct Air Capture 2022*. https://www.iea.org/reports/direct-air-capture-2022

IHK. (n.d.). *Empowering Consumers und Green Claims: Was gilt künftig bei Werbeaussagen zur Umweltfreundlichkeit?* Retrieved March 18, 2024, from https://www.ihk-muenchen.de/de/Service/Recht-und-Steuern/Werbung-Fairer-Wettbewerb/green-claims-werbung-mit-umweltfreundlichkeit/

IPCC. (2019). *Climate Change and Land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*. https://www.ipcc.ch/site/assets/uploads/2019/11/SRCCL-Full-Report-Compiled-191128.pdf

IPCC. (2022). *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781009157940

ISAEL (Ed.). (2022). *Making Credible Jurisdictional Claims ISEAL Good Practice Guide*. https://www.isealalliance.org/get-involved/resources/making-credible-jurisdictional-claims-good-practice-guide-v11-2022#:~:text=1%20(2022),-Home&text=ISEAL%20has%20developed%20a%20good,or%20support%20them%2C%20are%20credible.

ISEAL (Ed.). (2015). *ISEAL Sustainability Claims Good Practice Guide*. https://www.isealalliance.org/sites/default/files/resource/2017-11/ISEAL_Claims_Good_Practice_Guide.pdf

ISO (Ed.). (2023). *ISO 14068-1:2023 Climate change management Transition to net zero Part 1: Carbon neutrality*. https://www.iso.org/obp/ui/en/#iso:std:iso:14068:-1:ed-1:v1:en

IUCN, International Union for Conservation of Nature. (2020). *IUCN Global Standard for Nature-based Solutions: A user-friendly framework for the verification, design and scaling up of NbS: first edition* (1st ed.). IUCN, International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2020.08.en

Kallio, M. H., Moeliono, M., Maharani, C., Brockhaus, M., Hogarth, N. J., Daeli, W., Tauhid, W., & Wong, G. (2016). The "Virtual Economy" of REDD+ Projects: Does Private Certification of REDD+ Projects Ensure Their Environmental Integrity? *International Forestry Review*, *18*(2), 203–217. https://doi.org/10.1505/146554816818966336

Kreibich, N., & Hermwille, L. (2021). Caught in between: Credibility and feasibility of the voluntary carbon market post-2020. *Climate Policy*, *21*(7), 939–957. https://doi.org/10.1080/14693062.2021.1948384

Kreibich, N., Kühlert, M., Schulze-Steinen, M., Brandt, J., Präger, A., Schöneberg, G., & Karatassios, D. (2023). *Grundprinzipien eines Contribution Claim-Ansatzes: Konzeptpapier des transformativen Forschungsprojekts „Contribution Claim als alternativer Ansatz zur CO2-Kompensation"* (Wuppertal Institut & Stiftung Allianz für Entwicklung und Klima, Eds.). https://allianz-entwicklung-klima.de/wp-content/uploads/2023/05/2305_Konzeptpapier_CC-1.pdf

Kreibich, N., Teubler, J., Kühlert, M., Braun, N., & Brandemann, V. (2021). *Klimaneutralität in Unternehmen – 10 Empfehlungen für die Umsetzung (Zukunftsimpuls Nr. 20)* (Wuppertal Institut für Klima, Umwelt, Energie gGmbH, Ed.). https://epub.wupperinst.org/frontdoor/deliver/index/docId/7858/file/ZI20_Klimaneutralitaet.pdf

Küng, L., Aeschlimann, S., Charalambous, C., McIlwaine, F., Young, J., Shannon, N., Strassel, K., Maesano, C. N., Kahsar, R., Pike, D., van der Spek, M., & Garcia, S. (2023). A roadmap for achieving scalable, safe, and low-cost direct air carbon capture and storage. *Energy & Environmental Science*, *16*(10), 4280–4304. https://doi.org/10.1039/D3EE01008B

Legifrance. (2022, avril). *Décret n° 2022-539 du 13 avril 2022 relatif à la compensation carbone et aux allégations de neutralité carbone dans la publicité*. https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000045570611

Leugers, S. (2023, July). *The importance of trust in the carbon market*. https://www.goldstandard.org/news/the-importance-of-trust-in-the-carbon-market

Lindsay Hooper. (2021, July 5). *Targeting Net Zero: A strategic framework for business action*. Https://Www.Cisl.Cam.Ac.Uk/. https://www.cisl.cam.ac.uk/resources/low-carbon-transformation-publications/targeting-net-zero

MacCutcheon, D., Holmgren, M., & Haga, A. (2020). Assuming the Best: Individual Differences in Compensatory "Green" Beliefs Predict Susceptibility to the Negative Footprint Illusion. *Sustainability*, *12*(8), 3414. https://doi.org/10.3390/su12083414

Maes, J., & Jacobs, S. (2017). Nature-Based Solutions for Europe's Sustainable Development. *Conservation Letters*, *10*(1), 121–124. https://doi.org/10.1111/conl.12216

Marcos, M. V. (2023, December 13). *COP28: Article 6 failure avoids a worse outcome*. Carbon Market Watch. https://carbonmarketwatch.org/2023/12/13/cop28-article-6-failure-avoids-a-worse-outcome/

Martin-Roberts, E., Scott, V., Flude, S., Johnson, G., Haszeldine, R. S., & Gilfillan, S. (2021). Carbon capture and storage at the end of a lost decade. *One Earth*, *4*(11), 1569–1584. https://doi.org/10.1016/j.oneear.2021.10.002

Mertz, O., Grogan, K., Pflugmacher, D., Lestrelin, G., Castella, J.-C., Vongvisouk, T., Hett, C., Fensholt, R., Sun, Z., Berry, N., & Müller, D. (2018). Uncertainty in establishing forest reference levels and predicting future forest-based carbon stocks for REDD+. *Journal of Land Use Science*, *13*(1–2), 1–15. https://doi.org/10.1080/1747423X.2017.1410242

Mistry, K., Carroll, B., Baker, T., Ponce de Leon, P., Dewar, A., & Sims, A. (2023). *The Time for Carbon Removal Has Come*. https://web-assets.bcg.com/67/f7/0f41cd074a66b49cdb8baf5e59c0/bcg-the-time-for-carbon-removal-has-come-sep-2023-r.pdf

MSCI Carbon Markets (Ed.). (2023). *Using carbon credits to meet corporate climate targets*. https://www.msci.com/documents/1296102/42267055/Using+Carbon+Credits+to+Meet+Corp+Climate+Targets_Nov+2023.pdf

Net Zero Tracker. (n.d.). *Net Zero Tracker | Welcome*. Retrieved April 3, 2024, from https://zerotracker.net/

Nguyen, A. (2023, June 16). *Carbon Neutral Claims Under Investigation In Greenwashing Probe*. Forbes. https://www.forbes.com/sites/amynguyen/2023/06/16/carbon-neutral-claims-under-investigation-in-greenwashing-probe/

Paltsev, S., Morris, J., Kheshgi, H., & Herzog, H. (2021). Hard-to-Abate Sectors: The role of industrial carbon capture and storage (CCS) in emission mitigation. *Applied Energy*, *300*, 117322. https://doi.org/10.1016/j.apenergy.2021.117322

Pan, Y., Birdsey, R. A., Fang, J., Houghton, R., Kauppi, P. E., Kurz, W. A., Phillips, O. L., Shvidenko, A., Lewis, S. L., Canadell, J. G., Ciais, P., Jackson, R. B., Pacala, S. W., McGuire, A. D., Piao, S., Rautiainen, A., Sitch, S., & Hayes, D. (2011). A Large and Persistent Carbon Sink in the World's Forests. *Science*, *333*(6045), 988–993. https://doi.org/10.1126/science.1201609

Peters-Stanley, M., & Yin, D. (2013). *Maneuvering the Mosaic State of the Voluntary Carbon Markets 2013* (Ecosystem Marketplace, Ed.). https://www.forest-trends.org/wp-content/uploads/imported/sovcm-full-report-aug-13-version-pdf.pdf

Probst, B., Toetzke, M., Anadon, L. D., Kontoleon, A., & Hoffmann, V. (2023). *Systematic review of the actual emissions reductions of carbon offset projects across all major sectors*. https://doi.org/10.21203/rs.3.rs-3149652/v1

Qiu, Y., Lamers, P., Daioglou, V., McQueen, N., de Boer, H.-S., Harmsen, M., Wilcox, J., Bardow, A., & Suh, S. (2022). Environmental trade-offs of direct air capture technologies in climate change mitigation toward 2100. *Nature Communications*, *13*(1), 3635. https://doi.org/10.1038/s41467-022-31146-1

Reise, J., Siemons, A., Böttcher, H., Herold, A., Urruitia, C., & Lambert, S. (2022). *Nature-based solutions and global climate protection* (Umweltbundesamt, Ed.). https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2022-01-03_climate-change_01-2022_potential_nbs_policy_paper_final.pdf

Reketat, A. (2023, April 14). *Green Hushing: Das neue Greenwashing?* Utopia.de. https://utopia.de/ratgeber/green-hushing-das-neue-greenwashing_499264/

Rifai, S. W., West, T. A. P., & Putz, F. E. (2015). "Carbon Cowboys" could inflate REDD+ payments through positive measurement bias. *Carbon Management*, *6*(3–4), 151–158. https://doi.org/10.1080/17583004.2015.1097008

Robinson-Tillett, S. (2024, March 11). *SBTi axes net zero commitments of 200+ companies*. Real Economy Progress. https://real-economy-progress.com/climate/sbti-axes-net-zero-commitments-of-200-companies/

Roe, S., Streck, C., Obersteiner, M., Frank, S., Griscom, B., Drouet, L., Fricko, O., Gusti, M., Harris, N., Hasegawa, T., Hausfather, Z., Havlík, P., House, J., Nabuurs, G.-J., Popp, A., Sánchez, M. J. S., Sanderman, J., Smith, P., Stehfest, E., & Lawrence, D. (2019). Contribution of the land sector to a 1.5 °C world. *Nature Climate Change*, *9*(11), 817–828. https://doi.org/10.1038/s41558-019-0591-9

Rossmann. (n.d.). *Klimaneutrale Produkte bei Rossmann*. Retrieved March 18, 2024, from https://www.rossmann.de/de/neu/nachhaltigkeit/klimaneutral

SBTi. (n.d.). *Target dashboard*. Science Based Targets. Retrieved April 3, 2024, from https://sciencebasedtargets.org/target-dashboard

SBTi (Ed.). (2024a). *ABOVE AND BEYOND: AN SBTI REPORT ON THE DESIGN AND IMPLEMENTATION OF BEYOND VALUE CHAIN MITIGATION (BVCM)*. https://sciencebasedtargets.org/resources/files/Above-and-Beyond-Report-on-BVCM.pdf

SBTi. (2024b, April 9). *Statement from the SBTi Board of Trustees on use of environmental attribute certificates, including but not limited to voluntary carbon markets, for abatement purposes limited to scope 3*. Science Based Targets Initiative. https://sciencebasedtargets.org/news/statement-from-the-sbti-board-of-trustees-on-use-of-environmental-attribute-certificates-including-but-not-limited-to-voluntary-carbon-markets-for-abatement-purposes-limited-to-scope-3

Science Based Target Initiative (Ed.). (2021). *BEYOND VALUE CHAIN MITIGATION FAQ*. https://sciencebasedtargets.org/resources/files/Beyond-Value-Chain-Mitigation-FAQ.pdf

Science Based Target Initiative (Ed.). (2023). *SBTi MONITORING REPORT 2022 Looking back at 2022 and moving forward to 2023 and beyond*. https://sciencebasedtargets.org/resources/files/SBTiMonitoringReport2022.pdf

Seddon, N., Chausson, A., Berry, P., Girardin, C. A. J., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1794), 20190120. https://doi.org/10.1098/rstb.2019.0120

Seddon, N., Daniels, E., Davis, R., Chausson, A., Harris, R., Hou-Jones, X., Huq, S., Kapos, V., Mace, G. M., Rizvi, A. R., Reid, H., Roe, D., Turner, B., & Wicander, S. (2020). Global recognition of the importance of nature-based solutions to the impacts of climate change. *Global Sustainability*, *3*, e15. https://doi.org/10.1017/sus.2020.8

Seymour, F., & Langer, P. (2021). Consideration of Nature-Based Solutions as Offsets in Corporate Climate Change Mitigation Strategies. *World Resources Institute*. https://doi.org/10.46830/wriwp.20.00043

Shu, D., Deutz, S., Winter, B. A., Baumgärtner, N., Leenders, L., & Bardow, A. (2023). *The role of carbon capture and storage to achieve net-zero energy systems: Trade-offs between economics and the environment* [Application/pdf]. 10 p. https://doi.org/10.3929/ETHZ-B-000604625

SINUS Markt- und Sozialforschung GmbH (Ed.). (2022). *Wahrnehmung von klimaneutralen Produkten – Repräsentative Online-Befragung für die Verbraucherzentrale NRW*. https://www.mehrwert.nrw/sites/default/files/2022-09/sinus_vznrw_wahrnehmung_klimaneutrale_produkte_report.pdf

south pole. (2022). *Net Zero and Beyond: A Deep-dive on Climate Leaders and What's Driving Them*. https://www.southpole.com/publications/net-zero-and-beyond

south pole (Ed.). (2023). *The Voluntary Carbon Market | 2022–2023*. https://go.southpole.com/vcm-report-2023

Streck, C. (2021). How voluntary carbon markets can drive climate ambition. *Journal of Energy & Natural Resources Law*, *39*(3), 367–374. https://doi.org/10.1080/02646811.2021.1881275

Trouwloon, D., Streck, C., Chagas, T., & Martinus, G. (2023). Understanding the Use of Carbon Credits by Companies: A Review of the Defining Elements of Corporate Climate Claims. *Global Challenges*, *7*(4), 2200158. https://doi.org/10.1002/gch2.202200158

Umweltbundesamt. (2021, April 30). *Umweltberichterstattung—Berichtsstandards* [Text]. Umweltbundesamt; Umweltbundesamt. https://www.umweltbundesamt.de/umweltberichterstattung-berichtsstandards

Umweltbundesamt. (2024, January 15). *Detaillierte Treibhausgas-Emissionsbilanz 2022: Emissionen sanken um 40 Prozent gegenüber 1990 – EU-Klimaschutzvorgaben werden eingehalten*. https://www.umweltbundesamt.de/presse/pressemitteilungen/detaillierte-treibhausgas-emissionsbilanz-2022

UNEP (Ed.). (2023). *Adaptation Gap Report 2023*. https://www.unep.org/resources/adaptation-gap-report-2023

UNFCCC. (n.d.-a). *GCAP UNFCCC - Index*. Retrieved March 19, 2024, from https://climateaction.unfccc.int/Actors

UNFCCC. (n.d.-b). *Paris Agreement Crediting Mechanism | UNFCCC*. Retrieved May 22, 2024, from https://unfccc.int/process-and-meetings/the-paris-agreement/article-64-mechanism

UNFCCC. (n.d.-c). *The Paris Agreement | UNFCCC*. Retrieved April 9, 2024, from https://unfccc.int/process-and-meetings/the-paris-agreement

UNFCCC. (n.d.-d). *What is the Kyoto Protocol? | UNFCCC*. Retrieved April 9, 2024, from https://unfccc.int/kyoto_protocol

United Nations. (2017, November 13). *Bridging Climate Ambition and Finance Gaps*. https://unfccc.int/news/bridging-climate-ambition-and-finance-gaps

United Nations. (2023). *The Sustainable Development Goals Report 2023: Special Edition*. United Nations. https://doi.org/10.18356/9789210024914

United Nations Environment Programme (Ed.). (2019). *Emissions Gap Report 2019*. https://wedocs.unep.org/bitstream/handle/20.500.11822/30797/EGR2019.pdf?sequence=1&isAllowed=y

United Nations Environment Programme. (2023). *Emissions Gap Report 2023: Broken Record – Temperatures hit new highs, yet world fails to cut emissions (again)*. United Nations Environment Programme. https://doi.org/10.59117/20.500.11822/43922

United Nations' High-Level Expert Group. (2022). *Integrity Matters: Net Zero Commitments by Businesses, Financial Institutions, Cities and Regions United Nations'*. https://www.un.org/sites/un2.un.org/files/high-level_expert_group_n7b.pdf

VCMI (Ed.). (2023). *Claims Code of Practice—Building integrity in voluntary carbon markets*. https://vcmintegrity.org/wp-content/uploads/2023/11/VCMI-Claims-Code-of-Practice-November-2023.pdf

Verra. (n.d.). Verified Carbon Standard. *Verra*. Retrieved November 9, 2023, from https://verra.org/programs/verified-carbon-standard/

Verra (Ed.). (2023). *Annual Report 2022*. https://verra.org/wp-content/uploads/2023/11/2022-Verra-Annual-Report.pdf

voluntarycarbonmarket.org. (n.d.). *Evolution Voluntary Carbon Market*. Retrieved April 8, 2024, from https://voluntarycarbonmarket.org/docs/VCM-Interactive-PDF-Version-1-With-Introduction.pdf

Watson, E., Chang, A., Pineda, A. C., Anderson, C., Cummis, C., & Stevenson, M. (2023). *SBTi CORPORATE NET-ZERO STANDARD* (Science Based Target Initiative, Ed.). https://sciencebasedtargets.org/resources/files/Net-Zero-Standard.pdf

West, T. A. P. (2016). Indigenous community benefits from a de-centralized approach to REDD+ in Brazil. *Climate Policy*, *16*(7), 924–939. https://doi.org/10.1080/14693062.2015.1058238

West, T. A. P., Börner, J., Sills, E. O., & Kontoleon, A. (2020). Overstated carbon emission reductions from voluntary REDD+ projects in the Brazilian Amazon. *Proceedings of the National Academy of Sciences*, *117*(39), 24188–24194. https://doi.org/10.1073/pnas.2004334117

West, T. A. P., Wunder, S., Sills, E. O., Börner, J., Rifai, S. W., Neidermeier, A. N., & Kontoleon, A. (2023). *Action needed to make carbon offsets from tropical forest conservation work for climate change mitigation*. https://doi.org/10.48550/ARXIV.2301.03354

Wilke, S. (2024, January 23). *Treibhausgas-Emissionen in Deutschland* [Text]. Umweltbundesamt; Umweltbundesamt. https://www.umweltbundesamt.de/daten/klima/treibhausgas-emissionen-in-deutschland

Wolters, S., Schaller, S., & Götz, M. (2018). *Voluntary CO2 offsetting through climate protection projects* (Umweltbundesamt, Ed.). https://www.umweltbundesamt.de/sites/default/files/medien/376/publikationen/guide_voluntary_co2_offsetting_through_climate_protection_projects_bf_2020_09_14.pdf

WWF International, & Boston Consulting Group (Eds.). (2020). *Beyond Science-Based Targets: A BLUEPRINT FOR CORPORATE ACTION ON CLIMATE AND NATURE*. https://wwfint.awsassets.panda.org/downloads/beyond_science_based_targets___a_blueprint_for_corporate_action_on_climate_and_nature.pdf

Zhang, Y., Yu, L., Cui, K., Wang, H., & Fu, T. (2023). Carbon capture and storage technology by steel-making slags: Recent progress and future challenges. *Chemical Engineering Journal*, *455*, 140552. https://doi.org/10.1016/j.cej.2022.140552

Bibliography Analysis

Atlantica Sustainable Infrastructure PLC (Ed.). (2023). *Integrated Annual Report 2023*. https://www.atlantica.com/wp-content/uploads/documents/2023-Integrated-Annual-Report-Web.pdf

Capgemini (Ed.). (n.d.-a). *Capgemini Environmental Sustainability: Performance Report 2019/20*. Retrieved April 2, 2024, from https://www.capgemini.com/wp-content/uploads/2021/09/Capgemini-Environment-Report-19-20.pdf

Capgemini (Ed.). (n.d.-b). *CAPGEMINI ENVIRONMENTAL SUSTAINABILITY PERFORMANCE REPORT 2022/23*. Retrieved April 2, 2024, from https://www.capgemini.com/wp-content/uploads/2023/07/ES-Report-25th-July-i-2023.pdf

Carmila SA (Ed.). (2022). *Universal Registration Document: Including the Annual Financial Report and the Integrated Report*. https://www.carmila.com/wp-content/uploads/2023/04/OPT_MEL_CARMILA_DEU_2022_UK_-1.pdf

Coca-Cola Europacific Partners (Ed.). (n.d.). *Coca-Cola Europacific Partners—Climate Change 2023*. Retrieved April 1, 2024, from https://www.cocacolaep.com/assets/Sustainability/Documents/2023/CDP-Climate-change-repsonse-2023.pdf

Coca-Cola Europacific Partners (Ed.). (2023). *Growing faster together: Integrated Report*. https://www.cocacolaep.com/assets/Sustainability/Documents/2023/2023-CCEP-Integrated-Report.pdf

Danone (Ed.). (2022). *EXHAUSTIVE 2022 EXTRA-FINANCIAL DATA*. https://www.danone.com/content/dam/corp/global/danonecom/investors/en-sustainability/reports-and-data/cross-topic/2023/danoneenvironmental2022extrafinancialdata.pdf

Danone (Ed.). (2023a). *Integrated Annual Report 2022*. https://www.danone.de/content/dam/corp/global/danonecom/rai/2022/danone-integrated-annual-report-2022.pdf

Danone (Ed.). (2023b). *Climate Transition Plan*. https://www.danone.com/content/dam/corp/global/danonecom/about-us-impact/policies-and-commitments/en/danone-climate-transition-plan-2023.pdf

Deutsche Telekom AG. (n.d.-a). *CO2e emissions | 2023 Corporate Responsibility Report—Deutsche Telekom*. Retrieved May 24, 2024, from https://www.cr-report.telekom.com/2023/management-facts/environment/co2e-emissions#atn-19711-19719

Deutsche Telekom AG. (2023). *Corporate Responsibility Bericht 2022*. https://www.cr-bericht.telekom.com/2022/sites/default/files/pdf/cr_de_2022_dt_final.pdf

Deutsche Telekom AG, D. T. (n.d.-b). *Climate protection & risks | 2023 Corporate Responsibility Report—Deutsche Telekom*. Deutsche Telekom Corporate Responsibility Bericht 2023. Retrieved May 24, 2024, from http://www.cr-report.telekom.com/2023/management-facts/environment/climate-targets-risks

Diageo Plc (Ed.). (n.d.). *ACCELERATING TO A LOW CARBON WORLD: Our Net-Zero Carbon Strategy*. Retrieved April 2, 2024, from https://media.diageo.com/diageo-corporate-media/media/eb2cxzsp/accelerate-to-a-low-carbon-world-our-net-zero-carbon-strategy-october-2022-pdf-290mb.pdf

ENAGAS (Ed.). (2023). *Annual Report: Reliable energy for a decarbonized future*. https://www.enagas.es/content/dam/enagas/en/files/enagas-communication-room/publications/informe-anual/Annual-Report-2023.pdf

E.ON (Ed.). (2023). *Integrierter Geschäftsbericht 2023*. https://www.eon.com/content/dam/eon/eon-com/eon-com-assets/documents/investor-relations/de/geschaeftsbericht/EON_GB2023_gesamt_dt_final.pdf

E.ON (Ed.). (2024). *On course for net zero: Supporting paper for E.ON's decarbonization strategy and climate-related disclosures*. https://www.eon.com/content/dam/eon/eon-com/eon-com-assets/documents/sustainability/en/climate-related-disclosures/EON_2024_On_course_for_net_zero.pdf

Ferrovial (Ed.). (n.d.-a). *Sustainability Strategy 2023*. Retrieved April 2, 2024, from https://static.ferrovial.com/wp-content/uploads/2024/03/22141437/climate-strategy-2023-ferrovial.pdf

Ferrovial (Ed.). (n.d.-b). *Sustainability Strategy 2030*. Retrieved April 2, 2024, from https://static.ferrovial.com/wp-content/uploads/2023/06/19175457/sustainability-strategy-2030-ferrovial-2023.pdf

Ferrovial. (2022). *Climate Strategy Ferrovial 2022*. https://static.ferrovial.com/wp-content/uploads/2023/04/20160802/climate-strategy-ferrovial-2022-ferrovial.pdf

Grupo Cooperativo Cajamar (Ed.). (n.d.). *Sustainability Report 2023*. Retrieved April 1, 2024, from https://www.bcc.es/storage/documents/informe-integrado-0315f.pdf

ICADE (Ed.). (n.d.). *Corporate social responsibility*. Retrieved April 1, 2024, from https://www.icade.fr/en/content/download/5745/file/csr-chapter-extract-2023-universal-registration-document.pdf

ICADE (Ed.). (2022). *Climate Report 2022*. https://www.icade.fr/en/content/download/4539/file/climate-report-march-2022.pdf

KBC Group (Ed.). (n.d.). *Sustainability Report 2023*. Retrieved April 1, 2024, from https://www.kbc.com/en/redirects/duurzaamheidsverslag.html?zone=

KBC Group (Ed.). (2022). *Climate Report: Determining our 2021 baseline and target setting for 2030 and 2050*. https://multimediafiles.kbcgroup.eu/ng/published/kbccom/pdf/kbccom_landing_links/20220930-climate-report.pdf?zone=

Kering. (n.d.). *Restore & regenerate: Limit environmental footprint*. Retrieved May 24, 2024, from https://www.kering.com/en/sustainability/mitigating-climate-change/restore-and-regenerate/

Kering (Ed.). (2019). *KERING COMMITS TO FULL CARBON NEUTRALITY ACROSS THE GROUP*. https://www.kering.com/api/download-file/?path=Press_release_Kering_commits_to_full_carbon_neutrality_across_the_Group_c40750b222.pdf

Kering (Ed.). (2023). *Climate Strategy*. https://www.kering.cn/api/download-file/?path=KERING_Climate_Strategy_2023_b3f18dc6b4.pdf

Kone Oyj (Ed.). (n.d.). *Sustainability Report 2023*. Retrieved April 1, 2024, from https://mb.cision.com/Public/18879/3937138/8587b048711c8a4a.pdf

Koninklijke Philips NV (Ed.). (n.d.-a). *Annual Rport 2023: Creating value with sustainable impact*. Retrieved April 2, 2024, from https://www.results.philips.com/publications/ar23/downloads/files/en/PhilipsFullAnnualReport2023-English.pdf?v=20240422133943

Koninklijke Philips NV. (n.d.-b). *Climate action*. Philips. Retrieved May 24, 2024, from https://www.philips.com/a-w/about/environmental-social-governance/environmental/climate-action.html

Lenzing (Ed.). (n.d.). *Climate Action Plan: Lenzing's transition to a net-zero world by 2050*. Retrieved April 1, 2024, from

https://www.lenzing.com/de/?type=88245&tx_filedownloads_file%5bfileName%5d=fileadmin/content/PDF/04_Nachhaltigkeit/Praesentationen/lenzing-climate-action-plan.pdf

Lenzing (Ed.). (2022). *Advancing Circularity and the people making it happen: Nachhaltigkeitsbericht 2022*. https://reports.lenzing.com/nachhaltigkeitsbericht/2022/_assets/downloads/entire-lenzing-nhb22.pdf

Maersk (Ed.). (n.d.). *2023 Sustainability Report*. Retrieved April 3, 2024, from https://www.maersk.com/~/media_sc9/maersk/corporate/sustainability/files/resources/2024/2023-maersk-sustainability-report.pdf

NatWest Group plc (Ed.). (n.d.). *2023 Climate-related Disclosures Report*. Retrieved April 3, 2024, from https://investors.natwestgroup.com/~/media/Files/R/RBS-IR-V2/results-center/16022024/nwg-2023-climate-related-disclosure-report.pdf

Ørsted (Ed.). (n.d.). *Ørsted—CDP Climate Change 2023*. Retrieved April 3, 2024, from https://orstedcdn.azureedge.net/-/media/www/docs/corp/com/sustainability/rsted-2023-cdp-climate-change.pdf?rev=31f0a35ff38d4852bd2dbf8a57d576fd&hash=9785E6DA4EBFA875B32F4171B3456A20

Ørsted (Ed.). (2023). *Green bond impact report 2023*. https://orstedcdn.azureedge.net/-/media/annual-report-2023/green-bond-impact-report-2023.pdf?rev=2e63e32b6f3f47508857a7253d5c0617&hash=0E371B46EA35D3999E745056D503D1EF

PUIG (Ed.). (n.d.). *Report 2022*. Retrieved April 3, 2024, from https://astwebprd01puigcom.blob.core.windows.net/puigcomprod/uploads/Puig_2022_annual_report_ENG_b4ce20aa0e.pdf

Schroders (Ed.). (n.d.). *Funding the future: Investing in climate action*. Retrieved April 2, 2024, from https://mybrand.schroders.com/m/8645ae373488e2e/original/Schroders_TCFD_2022.pdf

Siemens AG (Ed.). (2023). *Sustainability report 2023*. https://assets.new.siemens.com/siemens/assets/api/uuid:00095b96-4712-4cd1-b045-19d5df704358/sustainability-report-fy2023.pdf

Swisscom (Ed.). (2023). *Sustainability Impact Report 2023*. https://reports.swisscom.ch/download/2023/de/swisscom_sustainability_impact_report_2023_de.pdf

Appendix

Appendix 1: Codebook

Objective:

The purpose of this codebook is to examine the use of carbon credits by companies on their way to net zero in order to compare these findings with the recommendations of existing standards.

Media analysed (sample size):

The study analyses 39 European companies listed by the CDP as leaders in environmental transparency and climate protection performance (n=39). The companies listed by CDP are suitable for the sample as they have detailed reporting on their sustainability activities, which means that there is a particularly high probability of obtaining the relevant information for the study. The sample is selected at random.

Media relevant for coding are:

- Sustainability reports
- Other sustainability-related documents of the company such as Climate Transition Plans or similar documents
- Annual reports

Time period:

All documents published by the end of March 2024 and corresponding to the relevant media will be analyzed.

Analysis level:

All variables are coded at sentence level.

The variables have been divided into four sections. Section A contains variables on the attributes of the company, section B contains variables on the characteristics of the emission credits, section C contains variables on the purpose of applying for emission credits and section D contains variables on communication in connection with the emission credits.

Variables:

Variable	Categories
A1 Country	This variable determines which country in Europe the company comes from. **01 France** **02 Germany**

	03 Switzerland **04 Sweden** **05 Austria** **06 Ireland** **07 Portugal** **08 United Kingdom of Great Britain and Northern Ireland** **09 Spain** **10 Belgium** **11 Denmark** **12 Finland** **13 Netherlands**
A2 Sector	This variable determines the sector to which the enterprise belongs. **01 Food and Beverage Processing** **02 Textiles, Apparel, Footwear and Luxury Goods** **03 Telecommunication Services** **04 Real Estate** **05 Electric Utilities and Independent Power Producers and Energy Traders (including fossil, alternative and nuclear energy)** **06 Banks, Diverse Financials, Insurance** **07 Electrical Equipment and Machinery** **08 Pharmaceuticals, Biotechnology and Life Sciences** **09 Software and Services** **10 Construction and Engineering** **11 Water Transportation** **12 Consumer Durables, Household and Personal Products** **13 Containers and Packaging** **14 Aerospace and Defense**

	15 Automobiles and Components **16 Professional Services**
A3 Company size	**01 Small business: Less than 50 employees** **02 Medium-Sized Business: 50 to 249 employees** **03 Large business: 250 or more employees**
A4 Application of carbon credits	This variable indicates whether the company is already using or plans to use carbon credits. **01 Company is already using carbon credits** **02 Company plans to use carbon credits in the future** **03 Company does not use carbon credits and does not plan to do so** **Example 01** "These emissions "removals" will be either purchased via credits or developed directly through our own projects."
B1 Types of carbon credits	These variable answers the question of what types of credits the company uses. **01 Avoidance/reduction credits** **02 Removal credits** **03 Nature-based credits** **04 Technology-based credits** **05 No information**
B2 Types of carbon projects	This variable answers the question of which projects the carbon credits used by the company originate from. **01 Mangrove restoration**

	02 Rural energy access **03 Agroforestry** **04 Sustainable supply chain** **05 REDD+** **06 Regenerative Agriculture** **07 Renewable energy** **08 Energy efficiency** **09 Landfill gas recovery** **10 Reforestation** **11 no information**
B2 Co-benefits	This variable answers the question of what co-benefits the credits used by the company generate. Multi-freight coding is possible. **01 SDG No Poverty** **02 SDG Zero Hunger** **03 SDG Good Health and Well-Being** **04 SDG Quality Education** **05 SDG Gender Equality** **06 SDG Clean Water and Sanitation** **07 SDG Affordable and Clean Energy** **08 SDG Decent Work and Economic Growth** **09 SDG Industry, Innovation and Infrastructure** **10 SDG Reduced Inequalities** **11 SDG Sustainable Cities and Communities** **12 SDG Responsible Consumption and Production**

	13 SDG Life Below Water **14 SDG Life on Land** **15 SDG Peace, Justice and Institutions** **16 SDG Partnerships for the Goals** **17 Not specified Co-Benefits** **18 No information on Co-Benefits** **Example category 07:** „In the small Indian village of Surel in the Gujarat region a photovoltaic plant was built as part of this project. With a capacity of 25 megawatts, it feeds clean, sustainable energy into the Indian power grid. The project also contributes to sustainable development in the region by strengthening the energy supply and thus supporting the local economy.“ **Example category 14:** "In addition to their direct contribution to climate protection, the carbon credits we use contribute to SDG 15, supporting the restoration and sustainable use of ecosystems and promoting biodiversity by planting native trees." **Example category 17:** „In addition to our action within our value chain, Danone is also contributing to projects allying decarbonization with other social and environmental benefits. “
B3 Volume ***Excluded from analysis***	These variable answers the question of how high the annual volume of carbon credits retired is.

	01 ***individual answer*** **02 No information** **03 Company has not yet retired any credits as the use is only planned for the future** The data from the most recently published year is relevant here, but not earlier than 2021.
B4 Certification	These variable answers the question of which certification the carbon credits have. **01 Gold Standard** **02 Verified Carbon Standard** **03 Other** **04 Certification type not mentioned** **05 No certification** **06 Company has not yet retired any credits as the use is only planned for the future** 05 This category is also coded, when the company developed own quality criteria
B5 Types of carbon credits for neutralization	These variable answers the question of which type of emission credits the company intends to use for neutralization. **01 nature-based carbon removals** **02 technology-based carbon removals** **03 carbon removals (not specified)** **04 no information**

	This variable is only coded for those companies for which variable B7 was coded as 01.
C1 Near-term mitigation targets	These variable answers the question of whether the company has near-term science approved targets for reducing greenhouse gas emissions in line with the 1.5°C pathway over the next 5 to 10 years. **01 Committed but no targets yet** The company has committed to set near-term GHG mitigation targets but did not publish them yet. **02 Targets already approved** The targets are already approved by the SBTi or are currently in approval. **03 Targets but not approved by the SBTi** The company has near-term GHG mitigation targets, but they are not approved or in approval by the SBTi. **04 No targets** The company does not have near-term GHG mitigation targets. **Example 01** "In 2021, we committed to setting short-term targets for reducing emissions as part of our climate protection plan." **Example 02** "We are proud to be one of the first FMCG to have full scope 1.5°C science-based targets, including FLAG target, approved by SBTi".

C2 Long-term mitigation targets	These variable answers the question of whether the company has science approved long-term targets to reduce emissions to a residual level in line with 1.5°C scenarios by no later than 2050. **01 Long term targets with overarching net-zero target before 2050 approved by the SBTi** The company has SBTi approved (or in approval) long-term targets with an net-zero target before 2050. **02 Long-term targets with overarching net-zero target by 2050 approved by the SBTi** The company has a SBTi approved (or in approval) long-term targets with a net-zero target by 2050. **03 Committed to net-zero** The company committed to set net-zero targets but does not have targets yet or no approved tragets. **04 No SBTi approved long-term targets** The company has not committed to reach net-zero and/or the company has no long-term net-zero targets approved by the SBTi. **05 Net-zero commitment removed** **Example 02** “In 2023, we submitted our commitment to achieve net zero by 2050 to the Science-Based Targets initiative for approval.”

C3 Approach	This variable answers the question of the company's motivation for using carbon credits. **01 Contribution to global climate efforts** **02 Offsetting of emissions** **03 Offsetting of residual emissions in the transition to net-zero** **04 No identifiable reason** **05 Neutralization at net-zero target year** **Category 01** The organization has provided support or finance to actions beyond the company's value chain with an expected climate mitigation outcome. The contribution does not imply that the BVCM outcomes are netting out or counterbalancing the claimants' remaining value chain emissions, but instead are communicated as a contribution to global climate mitigation efforts or even the efforts of a country. **Example 01** "We will follow SBTi guidelines regarding: Mitigation beyond our value chain to contribute to global decarbonization during the transition period." **Category 02** The organization has delivered BVCM proportional to a stated percentage of unabated value chain emissions and stated that the BVCM outcomes counterbalance or "net out" that stated percentage of unabated value chain emissions. This offsetting was not preceded by comprehensive decarbonization measures.

	Category 03 The organization has delivered BVCM proportional to a stated percentage of unabated value chain emissions and stated that the BVCM outcomes counterbalance or "net out" that stated percentage of unabated value chain emissions. This offsetting is in addition to scientifically coordinated decarbonization measures, so that only the remaining emissions are offset in the transition to net zero. The emissions are not included when assessing the company´s progress towards meeting its goals to reduce GHG emissions. **Example 03**: "All our remaining Scope 1&2 emissions will be offset after they could not be further reduced due to technological limitations in order to achieve climate neutrality in relation to our direct emissions." **Category 04** This category is coded if the company does not provide any information on why it uses emission credits and does not offset them against total emissions
C4 Offsetting	These variable answers the question of what type of emissions the company offsets. **01 Scope 1 Emissions** **02 Scope 2 Emissions** **03 Scope 3 Emissions** **04 No information** **05 Company does not apply offsetting**
C5 Percentage of offsetting	These variable answers the question of what percentage of the company's annual emissions (baseline year) are offset by carbon credits.

Excluded from analysis	**01 *individual answer*** **02 No information** **03 Company does not apply offsetting**
C6 BVCM scale ***Excluded from analysis***	These variable answers the question what percentage of the company's unabated Scope 1, 2 and 3 emissions correspond to the BVCM results (measured in tCO2e). **01 *individual answer*** **02 No information** **03 BVCM-scale has not yet been determined** **04 Company does not apply BVCM**
C7 Neutralization	These variable answers the question of whether the company plans to neutralize any remaining emissions at their net-zero target year. **01 Yes** **02 No information** **Example 01** "We will follow SBTi guidelines regarding: Neutralization of all residual emissions from 2050 onwards."
C8 Percentage of neutralization	These variable answers the question of what percentage of total emissions the company plans to neutralize. **01 5-10 %**

	02 More than 10% **03 No information** This variable is only coded for those companies for which variable B7 was coded as 01. **Example 01** "We will adapt to the SBTi standard and reduce our direct and indirect emissions by 90% before neutralizing the remaining emissions."
D1 Reporting	These variable answers the question of the extent to which the company provides information on the use of carbon credits. **01 Information on nature and scale** **02 Incomplete reporting** **03 Credits not yet in use** 01: all the following information must be available: Information on nature and scale: the financial resources used for carbon credits, the reduction results and co-benefits achieved 02 is to be coded if parts of the information from 01 are available but incomplete.
D2 Climate neutral claim	These variable answers the question whether the company uses climate neutrality claims. **01 Company claims itself climate neutral**

	02 Company has set a goal of achieving climate neutrality **03 company does not use climate neutral claims** **Example 01** "Our business has been operating on a climate-neutral basis since 2019." **Example 02** "In 2015, as one of the first global companies to do so, we committed to becoming climate neutral by 2030."

Appendix 2: Illustration of approach 1-4

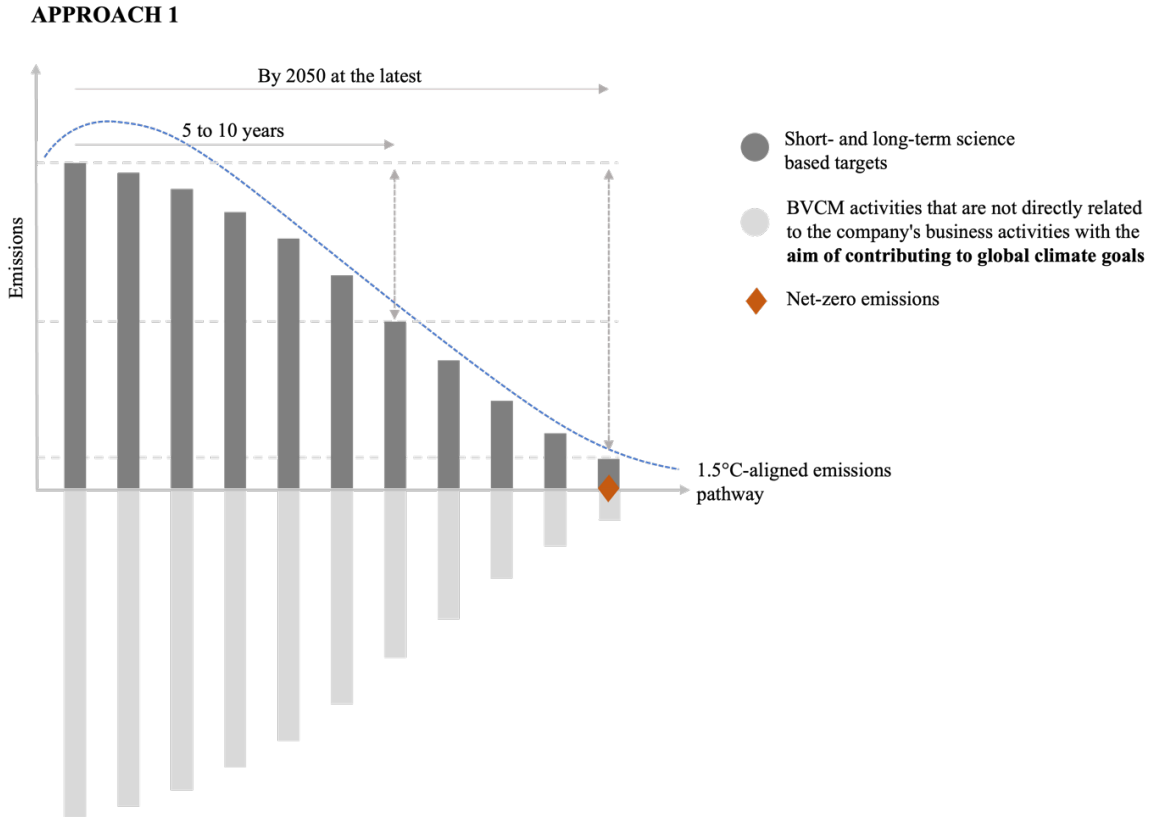

Figure 18 Approach 1 (own illustration)

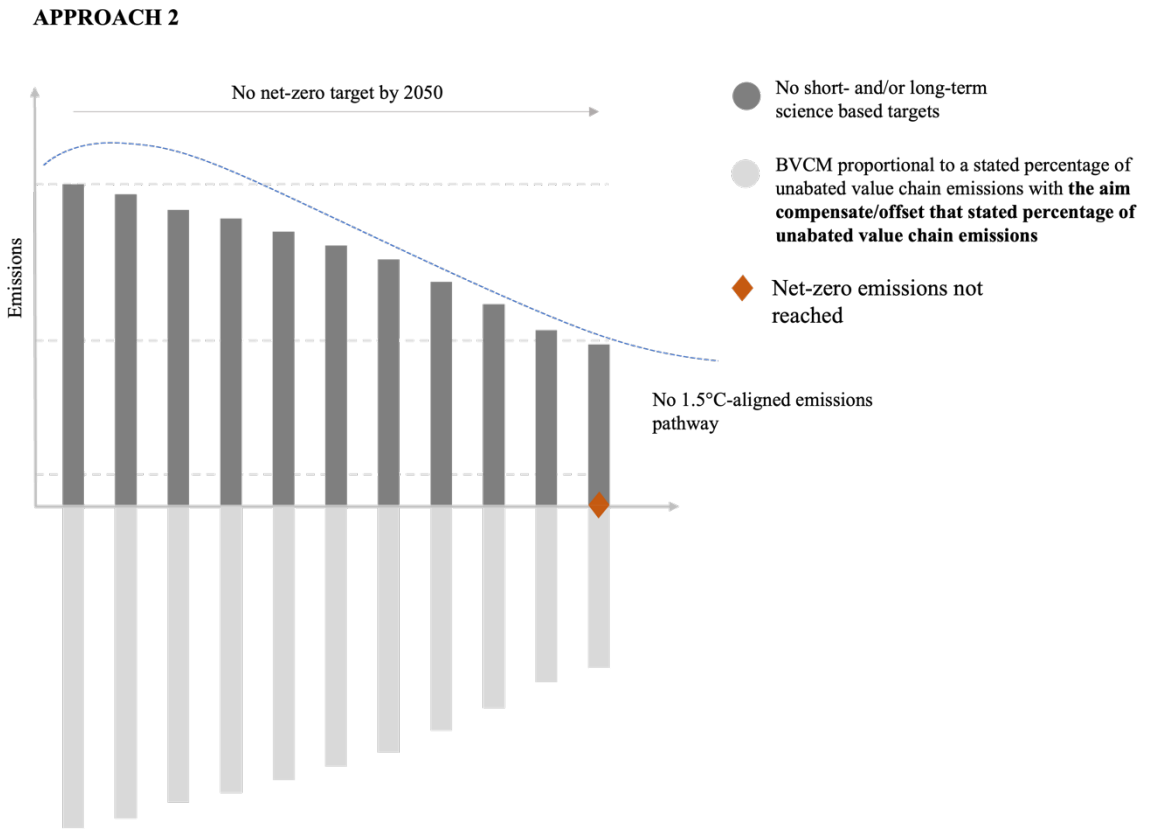

Figure 19 Approach 2 (own illustration)

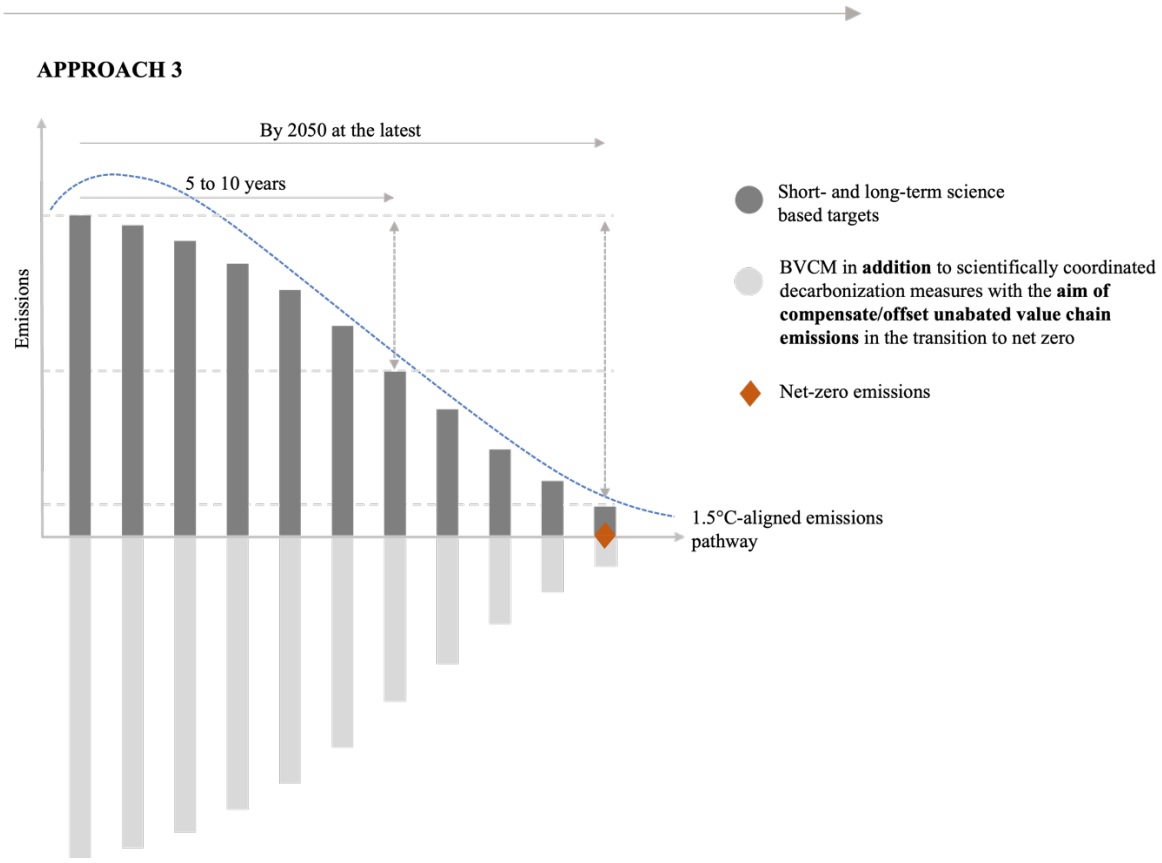

Figure 20 Approach 3 (own illustration)

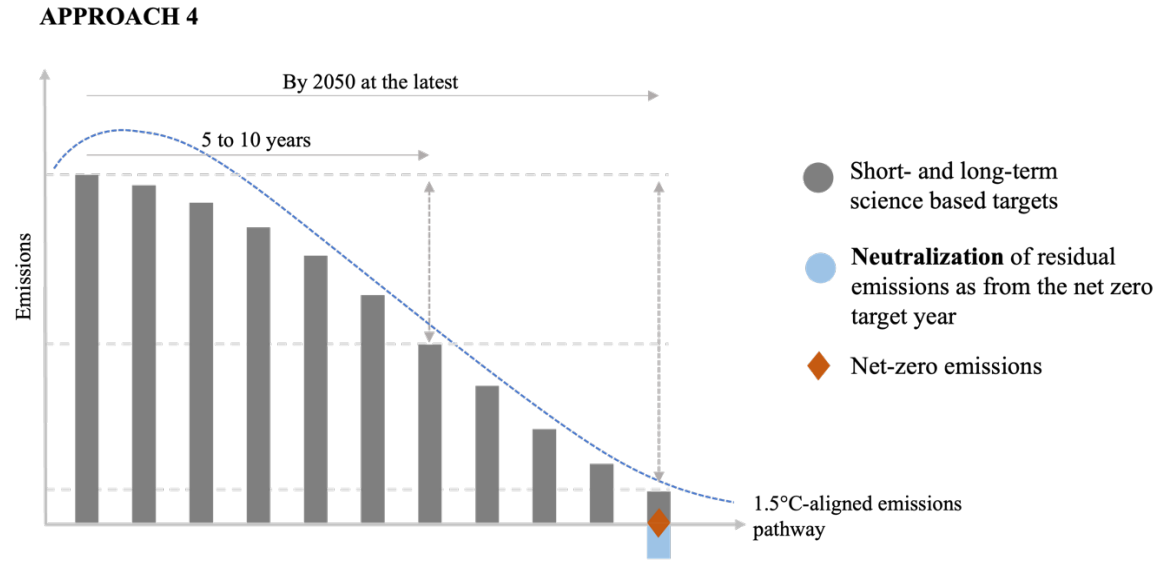

Figure 21 Approach 4 (own illustration)