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Project Report

Carbon Footprint Measurement: Reasons, Rules and Practices

The Situation of SMEs in the Black Forest

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List of Abbreviations

CCF	Company Carbon Footprint
CO ₂	Carbon Dioxide
CO _{2e}	Carbon Dioxide equivalent
CSR	Corporate Social Responsibility
CSRD	Corporate Sustainability Reporting Directive
EU	European Union
EGD	European Green Deal
GHG	Greenhouse Gas
HFU	Hochschule Furtwangen University
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
PCF	Product Carbon Footprint
SME	Small and medium-sized enterprise
WRI	World Resources Institute

1. Introduction

The urgency to address climate change has led to significant changes in the way businesses operate, particularly with regard to the management and reduction of greenhouse gas (GHG) emissions. As global warming increasingly threatens environmental stability and human health, the responsibility of business in mitigating climate change is becoming increasingly important. This report addresses the key concepts, theoretical foundations and practical applications of carbon footprint measurement and carbon accounting, with a focus on small and medium-sized enterprises (SMEs) in the Black Forest region.

The main objective of this report is to provide a detailed understanding of the principles and practices associated with carbon footprint measurement and carbon accounting. The report is structured to provide a clear and comprehensive examination of the subject. It begins by introducing the basic concepts of carbon footprint and carbon accounting. Following this, it explores the motivations behind carbon accounting and outlines the established guidelines and standards for its implementation. The report then presents findings from a study conducted among SMEs in the Black Forest, including an in-depth analysis of survey and interview data. This section reveals the current state of carbon footprint measurement, motivations for adopting carbon accounting, the challenges encountered, and the future plans of these companies.

By focusing on SMEs in the Black Forest region, the report underscores the unique challenges and opportunities that smaller companies face on their path to sustainability. SMEs are pivotal to the regional economy, and their active participation in carbon accounting and emission reduction strategies can significantly impact both local and global environmental outcomes. As global efforts to combat climate change intensify, understanding and managing carbon footprints are essential aspects of responsible business practices. This report not only examines the theoretical and practical dimensions of carbon accounting, but also presents a realistic picture of the current situation and future aspirations of SMEs in the Black Forest.

2. Key Concepts and Theoretical Foundation

2.1. Carbon Footprint

The concept of a carbon footprint originally emerged as a subset of the "ecological footprint", a term introduced by Wackernagel and Rees in 1996, which measures the biologically productive land and ocean area needed to support the consumption and waste production of a given human population, expressed in global hectares (Wackernagel & Rees, 1996, p. 9 ff.). The term "carbon footprint" originally referred to the amount of land required to sequester the carbon dioxide (CO₂) emissions produced by humanity. Over time, as global warming gained prominence on the environmental agenda, the use of the term "carbon footprint" evolved to stand alone, focusing primarily on the impact of human activities on global warming (Pandey et al., 2011, p. 137). Despite its popularity as an indicator of an entity's contribution to global warming, there is a lack of consistency in the definition of "carbon footprint" in the scientific literature. The term has been used interchangeably with other terms such as "embodied carbon", "carbon content", and "greenhouse gas footprint", among others. However, based on their comprehensive survey, Wiedmann and Minx defined the term carbon footprint as follows: "The carbon footprint is a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product" (Wiedmann & Minx, 2007, p. 4). It is expressed in CO₂ equivalent (CO₂e) and includes the emissions of various GHGs such as methane (CH₄), nitrous oxide (N₂O), and fluorinated gases. Despite varying definitions and calculation methods, the carbon footprint concept is widely used as an indicator of environmental impact, particularly in the context of climate change. Its purpose is to quantify the GHGs emitted by individuals, organizations, processes, products, or events within defined boundaries in order to assess and compare their contributions to global warming (Pandey et al., 2011, p. 137).

2.2. Carbon Accounting

Carbon accounting or greenhouse gas accounting is an increasingly important process in today's global efforts to mitigate climate change as it allows organizations to quantify their GHG emissions. Nevertheless, the term "carbon accounting" has not been widely defined yet. According to Stechemesser & Guenther, there is no comprehensive definition of the term (Stechemesser & Guenther, 2012, p. 18). However, through their semantic analysis, Stechemesser & Guenther arrived at the following definition of carbon

accounting: “Carbon accounting comprises the recognition, the non-monetary and monetary evaluation and the monitoring of greenhouse gas emissions on all levels of the value chain and the recognition, evaluation and monitoring of the effects of these emissions on the carbon cycle of ecosystems” (Stechemesser & Guenther, 2012, p. 18). In other words, carbon accounting involves the inventory of GHGs and the monitoring and decision-making related to mitigation and compensation of emissions. This can also include monitoring climate impacts and corresponding adaptation measures (Marlowe & Clarke, 2022, p. 72).

In the field of carbon accounting, the distinction between the carbon footprint of a company and the carbon footprint of a product is crucial for effective environmental management and reporting, but also for GHG reduction strategies:

Company carbon footprint (CCF): A company's carbon footprint refers to the total amount of CO₂ and other GHG emissions directly and indirectly associated with a company's operations over a given period of time, usually one year. This measurement includes all sources of GHG emissions from the company's operations, from electricity consumption in offices to fuel consumption of company vehicles. According to the standard set by the World Resources Institute (WRI) for the accounting of GHG emissions, emissions are categorized into three different scopes (Onat et al., 2014, p. 55):

- *Scope 1* emissions include direct emissions from sources owned or controlled by the organization, such as emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.
- *Scope 2* emissions are indirect and arise from the generation of purchased electricity, steam, heating and cooling consumed by the organization.
- *Scope 3* emissions include all other indirect emissions generated in a company's value chain, including upstream and downstream activities. This can range from the extraction and production of purchased materials and fuels, to the transportation of purchased goods, to the use of the company's own resources (Onat et al., 2014, p. 55).

Product carbon footprint (PCF): A product carbon footprint measures the total amount of CO₂ and other GHG emissions directly and indirectly associated with the life cycle of a particular product or service. This approach enables a detailed assessment of the environmental impact of individual products or services. To understand and manage the environmental footprint of products, the distinction between the "cradle-to-grave" and "cradle-to-gate" frameworks is essential (Schmidt et al., 2018, p. 195): While the cradle-

to-grave framework covers the entire lifecycle of a product, from raw material extraction to disposal, the cradle-to-gate framework focuses on the product lifecycle from raw material extraction to the point at which it leaves the manufacturing facility, excluding the use and disposal phases (Schmidt et al., 2018, p. 195). Both frameworks are critical for making informed decisions to reduce GHG emissions and improve sustainability (Schmidt et al., 2018, p. 195).

Figure 1 delineates the cradle-to-grave and cradle-to-gate life cycle of product emissions, dividing it into Scope 1, Scope 2, and Scope 3 activities within carbon accounting.

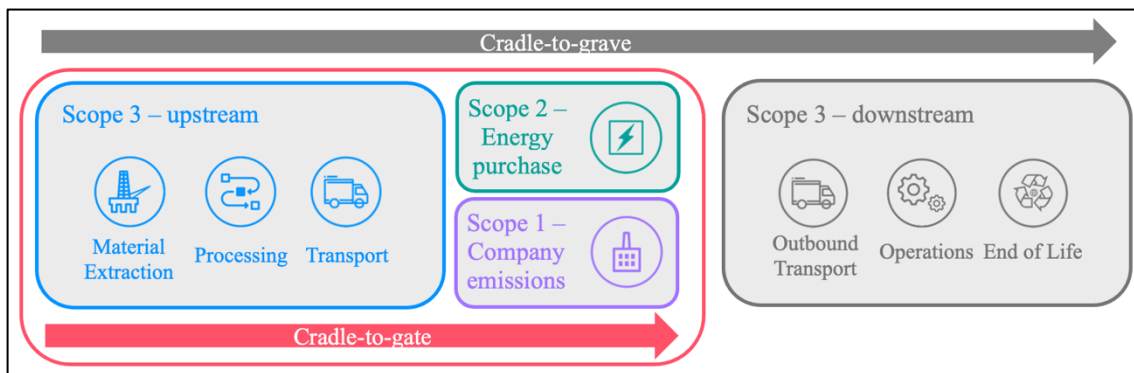


Figure 1: Life cycle of product emissions
 Source: Own illustration (2024), based on Atos SE, 2024, p. 1

3. Theoretical Part: Reasons and Rules for Carbon

Accounting

This section will examine the rationale and legal framework for carbon accounting and the reason why companies are increasingly engaging in the recording and management of their GHG emissions. It will explore both the motivations for companies to adopt carbon accounting and the formal standards that ensure the consistency and reliability of this practice. The aim is to provide a comprehensive understanding of the factors that influence carbon accounting and the established guidelines that govern its implementation.

3.1. Reasons for Carbon Accounting

3.1.1. Environmental Impact

Increased carbon emissions lead to climate change, which poses a significant threat to the environment and sustainability. The continuing rise in global average temperature – global warming – has significant impacts on human health, food production, the economy and the environment (Green et al., 2017, p. 1). Given these consequences, it is not surprising that climate change is one of the most pressing issues of the time.

The main causes of climate change are GHGs such as carbon dioxide, methane, nitrogen oxides and fluorinated gases. These accumulate in the atmosphere and wrap around the earth like a blanket to trap heat (Trencher et al., 2023, p. 2). By absorbing solar energy and emitting infrared radiation (IR), GHGs regulate the climate and warm the planet. While most GHGs occur naturally in the Earth's atmosphere but are released to a greater extent by human activities (e.g. CO₂), others, such as synthetic halocarbons, are caused solely by human activities. However, if the amount of heat that contributes to the formation of these gases increases, the average temperature on Earth also rises. This phenomenon, known as the greenhouse effect, is the main cause of climate change and global warming (Ranveer et al., 2015).

Since the 1700s and early 1800s (industrial revolution), a much higher concentration of GHGs has been released into the Earth's atmosphere (Naiyer & Abbas, 2022, p. 86). Furthermore, between 1970 and 2004, an increase in energy-related GHG emissions (such as combustion of fossil fuels, deforestation, waste management, land-use-change. etc.) of around 70% was observed. CO₂ emissions rose by around 80% at that time (Naiyer & Abbas, 2022, p. 86). Furthermore, according to the 2018 IPCC report, human activities

have caused about 1.0°C of global warming compared to pre-industrial levels. It is predicted that global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate (IPCC, 2018, p. 8).

The effects of global warming and climate change on the environment are already profound and widespread, affecting ecosystems, biodiversity, and the natural resources on which human society depends. Rising global temperatures are leading to more frequent and severe weather events such as hurricanes, floods and droughts, which not only damage habitats but also disrupt food chains and water cycles (European Commission, 2023a, p. 1). Rising sea levels, a result of the melting of the polar ice caps and glaciers, are threatening coastal and island communities and leading to the loss of valuable land and biodiversity. In addition, changing weather patterns are affecting the distribution and health of plant and animal species, leading to shifts in ecosystems and sometimes even the extinction of those that cannot adapt. The ocean acidification caused by increased CO₂ uptake is further jeopardizing marine life and disrupting coral reef ecosystems and the rich biodiversity they harbor (European Commission, 2023a, p. 1). These environmental changes challenge the resilience of natural and human systems and underscore the urgent need for concerted global and local action to mitigate the effects of climate change.

3.1.2. Regulatory Compliance

One of the primary drivers for companies, especially SMEs, to engage in carbon accounting is the need to comply with legal and regulatory requirements. Governments worldwide, including Germany, are intensifying efforts to combat climate change through legislation that mandates emission reporting and reduction for businesses. EU directives and national laws, such as the German Federal Climate Protection Act (Bundes-Klimaschutzgesetz), set ambitious targets for reducing GHG emissions across all sectors of the economy. These regulations often require companies to measure, report, and sometimes reduce their carbon emissions. However, while previous legislation such as the Non-Financial Reporting Directive (NFRD) often focused only on large companies as the main emitters of GHG emissions, the EU has removed this restriction by introducing the Corporate Sustainability Reporting Directive (CSRD) (OECD, 2021, p. 28-33; EU, 2023b, p. 1 ff.). The CSRD, which came into force at EU level on January 5, 2023, requires listed companies with more than 500 employees to disclose non-financial information in a non-financial report and extends the scope to all listed companies on an EU-regulated market (with the exception of micro-enterprises). In addition, all non-

capital market-oriented companies are covered by the CSRD if they meet two of the following three criteria (Baumüller & Grbenic, 2021, p. 373):

- (1) Balance sheet total > 25 million euros,
- (2) Net turnover > 50 million euros,
- (3) Number of employees > 250.

The CSRD is gradually obliging more and more companies to measure and disclose their CO₂ emissions based on the European Sustainability Reporting Standards (ESRS). It first obliges large capital market-oriented companies with more than 500 employees to report from 2025. The remaining large companies must report in 2026 (on the 2025 financial year). Capital market-oriented SMEs (excluding micro-enterprises) are obliged to report from 2027 (covering the 2026 financial year). In addition, SMEs have the option of opting out for two years, meaning they must report by 2029 at the latest (for the 2028 financial year) (KPMG, 2023, p. 1-2). It is estimated that the CSRD would affect around 50,000 companies in the EU, including 15,000 in Germany alone (KPMG, 2023, p. 1).

3.1.3. Corporate Social Responsibility

Beyond regulatory compliance, there's a growing recognition of the ethical imperative for businesses to operate sustainably and minimize their environmental impact. This recognition is part of a broader Corporate Social Responsibility (CSR) framework, which is defined as “corporate activities and policies that assess, manage, and govern a firm’s responsibilities for and its impacts on society and the environment” (Christensen et al., 2021, p. 1181). In the context of CSR, carbon accounting practices can be used by organizations to improve their reputation and brand image. In this way, companies can build their brand image as an ethical company with a sense of social and environmental responsibility (Magfiroh et al., 2023, p. 257-258). A recent study found that CSR can reduce companies' carbon emissions and help them achieve the Sustainable Development Goals (SDGs) (Chen P., 2023, p. 6). It also assesses what strategies need to be taken to achieve the company's goals in relation to the objectives of the European Green Deal (EGD), a movement launched by the EU to combat rising GHG emissions. The EGD aims to develop a green and clean economy with net-zero GHG emissions by 2050 and a reduction in net emissions of at least 55% by 2030 (Domorenok, E., & Graziano, P., 2023, p. 9-11).

3.1.4. Economic Benefits

Concerning economic benefits, businesses can identify areas where energy and resource use can be optimized by systematically tracking and analyzing carbon emissions, leading to cost savings. According to a 2014 study of S&P 500 companies conducted by KPMG, companies typically lose about \$212,000 for every additional thousand tons of carbon emissions. In addition, sustainability leaders that are committed to reducing their carbon footprint tend to achieve higher overall returns than companies that do not reduce their carbon footprint (Matsumura et al., 2013, p. 2). Reducing energy consumption not only cuts down on emissions but also decreases utility bills (Lohmann, 2009, p. 504 ff.). Furthermore, carbon accounting can uncover opportunities for adopting more sustainable practices, such as waste reduction, recycling, and the use of renewable energy sources, which can be financially beneficial in the long term. Additionally, companies that proactively manage their carbon footprint may gain a competitive edge by qualifying for green certifications and accessing new markets focused on sustainability (Lohmann, 2009, p. 504 ff.).

3.1.5. Stakeholder Pressure

Apart from that, climate change has long been a concern for several international government bodies and stakeholders (such as customers, investors, suppliers and the community) who have called for transparency and action on environmental sustainability. These concerns have contributed to pressure on companies to disclose their sustainability reporting. Although this may be a major burden for companies, especially SMEs, it is critical to their economic value and reputation with stakeholders. According to stakeholder theory, if a company assumes that stakeholders consider environmental issues to be relevant, it will align its performance and expectations accordingly (Adomako et al., 2021, p. 3-4). Investors are also beginning to consider environmental, social and governance (ESG) criteria in their investment decisions, recognizing that sustainable companies are likely to be more resilient and profitable in the long term. By evaluating a company's sustainability report, they can assess the company's sustainability and decide whether to invest capital or effort in the company (Kasperzak et al., 2023, p. 2-5). Consequently, responding to these pressures by adopting carbon accounting practices is not only a matter of ethical responsibility but also a strategic move to align with stakeholder expectations. In this way, companies can not only participate in international climate protection goals, but also adhere to the same principles that create trust, loyalty and a strong bond between stakeholders and the company.

3.2. Rules for Carbon Accounting

3.2.1. Greenhouse Gas Protocol

The Greenhouse Gas Protocol (GHG Protocol), developed by the WRI and the World Business Council for Sustainable Development (WBCSD) in 1998, is the most widely used accounting standard, providing a comprehensive, globally standardized framework for measuring and managing GHG emissions (WRI and WBCSD, 2011, p. 4).

The primary objective of the GHG protocol is to establish “generally accepted GHG accounting principles (...) intended to underpin and guide GHG accounting and reporting to ensure that the reported information represents a faithful, true, and fair account of a company’s GHG emissions” (WBCSD and WRI, 2004, p. 6). The principles of the GHG Protocol, which are based on financial accounting standards, ensure that GHG inventories are relevant and comprehensive and include all major sources of emissions. They prescribe the use of consistent methodologies for reliable comparisons over time, advocate transparency through clear documentation and emphasize accuracy and the minimization of uncertainties in the data provided (WBCSD and WRI, 2004, p. 7-9).

When it comes to conducting a company’s carbon footprint, the process involves the comprehensive assessment of all GHG emissions associated with the company's activities according to the Scope 1, 2 and 3 emissions. The process begins by setting organizational and operational boundaries to define what is to be covered (WRI and WBCSD, 2011, p. 17 ff.). Next, the company identifies all relevant sources of GHG emissions within these boundaries and categorizes them into direct (Scope 1), indirect from purchased energy (Scope 2) and other indirect (Scope 3) emissions. This is followed by the crucial step of data collection, where information must be gathered on the activities that lead to GHG emissions (WRI and WBCSD, 2011, p. 26 ff.). The data is then used together with selected emission factors to calculate the emissions from each source, expressed in metric tons of CO₂ equivalent (WBCSD and WRI, 2004, p. 45). For companies with multiple operations, these emissions are aggregated to create a company-level emissions profile. With a clear understanding of their GHG emissions, companies can set reduction targets and identify opportunities to reduce emissions through efficiency improvements, renewable energy and other strategies. Reporting the results in a GHG inventory report, which may be externally verified for credibility, is the final step (WBCSD and WRI, 2004, p. 62 ff.). This process is not a one-time event but requires continuous monitoring and updating to accurately reflect the company's emissions and efforts to reduce them

over time. Figure 2 describes the carbon accounting process of a company according to the GHG Protocol.

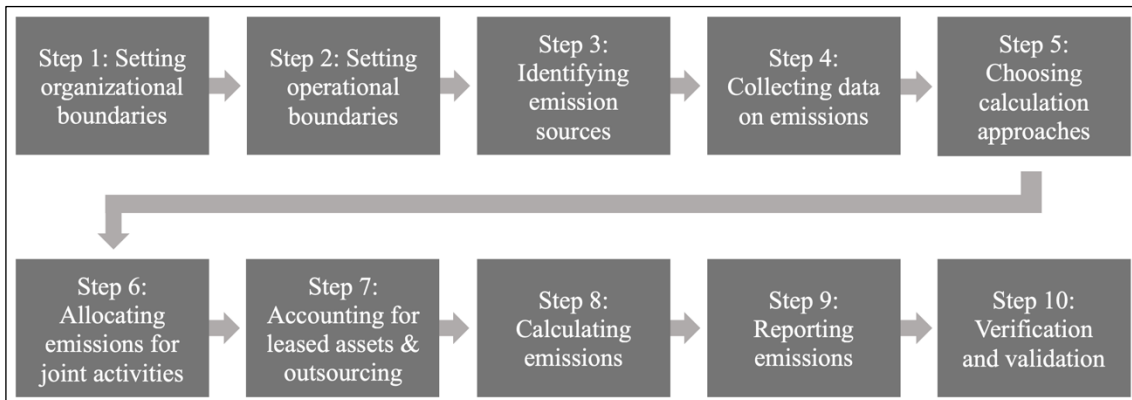


Figure 2: Company carbon accounting according to the Greenhouse Gas Protocol

Source: Own illustration (2024), based on WBCSD and WRI, 2004, p. 24 ff.

With the "Greenhouse Gas Protocol: Product Life Cycle Accounting and Reporting Standard" published in 2011, the GHG Protocol also provides requirements and guidance for organizations to quantify and report the GHG emissions associated with individual products over their entire life cycle. Creating a carbon footprint for a product involves the detailed method of life cycle assessment (LCA), which evaluates the environmental impact of all phases of a product's life. The process begins with defining the objective and scope of the product assessment, including determining the life cycle stages of the product to be analyzed and the boundaries of the analysis (WRI and WBCSD, 2011, p. 27). This is followed by an inventory analysis, which collects data on energy consumption, material use and emissions for each phase of the product life cycle (WRI and WBCSD, 2011, p. 47). The next step is the impact assessment, in which the potential environmental impact of the product emissions is evaluated. This involves applying global warming potential (GWP) factors to different greenhouse gases to express their impact in terms of carbon dioxide equivalents (CO₂e), allowing for a standardized comparison of emissions. In the last step, assurance over the GHG inventory is obtained by a first or third party, inventory results are reported, and reduction targets set (WRI and WBCSD, 2011, p. 78 ff.).

3.2.2. DIN ISO 14064

ISO 14064, published in 2006 by the International Organization of Standardization (ISO), is part of the ISO 14000 series of international standards for environmental management. It provides governments, companies, regions, and other organizations with a set of tools to help them quantify, monitor, report and verify GHG emissions.

ISO 14064 is divided into three parts, each focusing on different aspects of GHG management and carbon accounting (Kaur et al., 2022, p. 871): ISO 14064-1 focuses on the organizational level, similar to the GHG Protocol Corporate Standard, providing a framework for consistent and transparent quantification and reporting of emissions and removals. ISO 14064-2 provides guidance on project-level GHG emission reduction or enhancement, including baseline establishment and benefit quantification, and ISO 14064-3 addresses the validation and verification of GHG claims, ensuring their integrity and credibility through third-party evaluation.

ISO 14064 is often used by organizations seeking formal certification or verification of their GHG inventories or projects. It meets international expectations for quality and credibility and is therefore suitable for organizations that want to validate and verify their GHG disclosures. There is a German version of the standard called DIN EN ISO 14064-1, which is tailored to the specific requirements and regulations in Germany. It offers German companies a structured approach to quantifying and reporting their GHG emissions at an organizational level.

3.2.3. Additional Rules and Standards

In addition to the frameworks of the Greenhouse Gas Protocol and ISO 14064, there are a number of other standards that are internationally recognized and applicable in Germany. These standards complement the existing frameworks by providing specific approaches to both company carbon accounting and product accounting.

- *DIN ISO 14040/44*: This standard provides a framework for LCA that covers the principles and guidelines for conducting a comprehensive assessment of the environmental aspects and potential impacts of a product from raw material extraction through production and use to disposal (“from cradle to grave”). It comprises the systematic collection, measurement and analysis of data on carbon emissions over the entire life cycle of a product or process (Schmidt et al., 2018, p. 194).
- *PAS 2050*: The Publicly Available Specifications (PAS) 2050, developed by the British Standards Institution (BSI), builds on the existing ISO 14040 and 14044

standards for LCA. It is used by companies worldwide, including in Germany, to measure, manage and reduce the carbon footprint of their products (Garcia & Freire, 2014, p. 4).

4. Empirical Part: The Situation of SMEs in the Black Forest

In the context of environmental sustainability, small and medium-sized enterprises (SMEs) within the Black Forest occupy a crucial position in the economy and have significant potential to effect change. This chapter analyses the reasons, challenges, and practices of SMEs in the Black Forest area.

4.1. Study Design

The research methodology employed in this study was designed to gather insights into the motivations and challenges associated with measuring the carbon footprint of companies in the Black Forest region. To achieve this, a mixed-methods approach was utilized, comprising both quantitative and qualitative data collection techniques.

Firstly, a short questionnaire was administered during two sustainability events hosted by the Industrie- und Handelskammer (IHK). These events were part of the "Green Innovation Sustainability in the Company" event series and provided a platform to engage with companies actively involved or interested in sustainability practices. The questionnaire contained three key questions (appendix A):

1. Whether companies are currently measuring their carbon footprint.
2. The main reasons for measuring or not measuring their carbon footprint.
3. The challenges they encounter in measuring and managing their carbon footprint.

The answers were collected anonymously. However, the questionnaire contained an optional section in which respondents could provide their contact details if they were willing to take part in in-depth interviews on this topic. The survey was also promoted by the IHK via their newsletter and LinkedIn channel, resulting in a total of ten responses. Of these ten responses, two companies left their contact details and in-depth interviews were conducted with them.

To complement the quantitative survey data, a qualitative phase was conducted involving in-depth interviews with representatives from six SMEs in the Black Forest area. These interviews were designed to delve deeper into the motivations, challenges, standards, and practices related to carbon footprint measurement.

The interview questions were structured to allow participants to elaborate on their experiences and perspectives. Key areas explored during the interviews included (appendix B):

- The general attitude and current state of their carbon measurement.
- The motivations behind measuring their carbon footprint.
- The challenges they face in the measurement process.
- The standards and methodologies they use.
- Their collaboration with other organizations and external support received.
- Future perspectives and additional comments on their sustainability efforts.

The interviews were conducted online via MS Teams between May 13 and June 7.

The data collected from the surveys and interviews were analyzed to identify common themes, patterns, and insights. The quantitative data from the surveys were summarized using descriptive statistics, highlighting the prevalence of various motivations, challenges, and practices among the respondents. The qualitative data from the interviews were analyzed using thematic analysis, allowing for the identification of key themes and deeper insights into the experiences of the SMEs.

4.2. Status Quo

The current status of carbon footprint measurement among SMEs in the Black Forest area reveals a varied landscape of engagement and capabilities. This section delves into the survey and interview results concerning the familiarity with the concept of carbon footprint measurement, the importance of CO₂ reduction, and the extent to which companies are measuring their carbon footprints and the scope of emissions they account for.

4.2.1. Familiarity with the Concept of Carbon Footprint Measurement

The interviews revealed a range of familiarity with the concept of carbon footprint measurement among the SMEs, as illustrated in figure 3. Four out of six companies interviewed described themselves as "very familiar" with the concept, indicating a strong understanding and integration of carbon accounting principles into their business practices. These companies already have established processes and systems in place to measure their carbon emissions and are actively working to reduce their footprint.

One company rated familiarity with the concept of carbon footprint measurement as somewhere between very familiar and somewhat familiar, while another company rated it as somewhat familiar. Both companies tend to be aware of the concept and its importance but are in various stages of developing their measurement capabilities and are seeking to enhance their understanding and practices.

Figure 3 summarizes the results of the interviews regarding the familiarity with the concept of carbon footprint and carbon accounting.

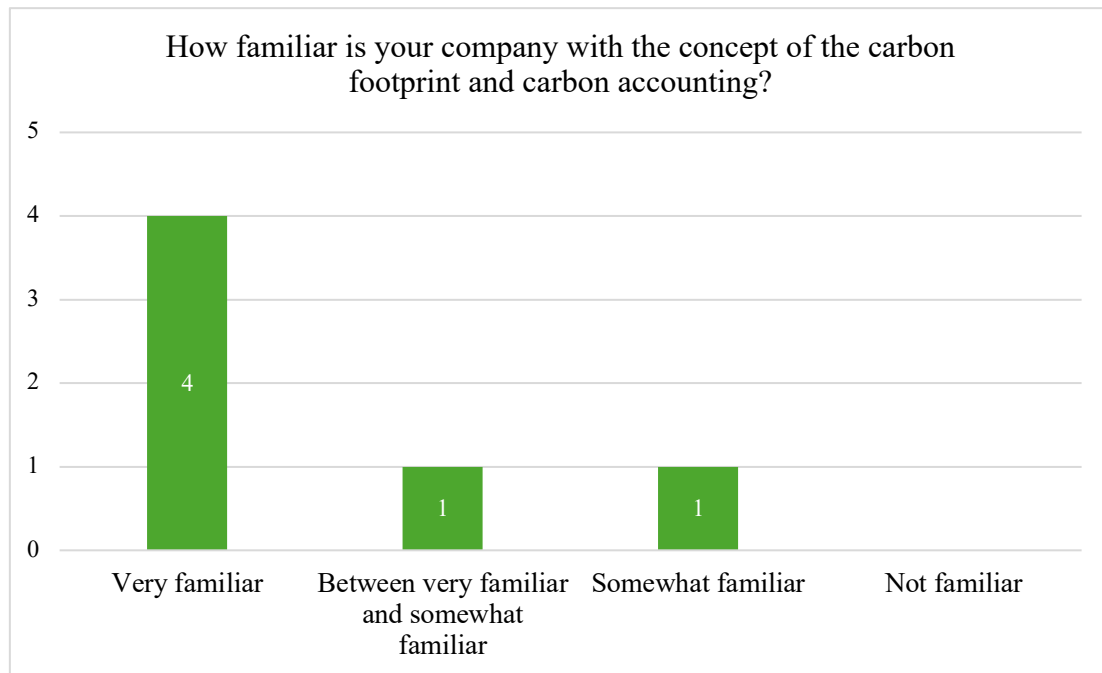


Figure 3: Results of question 1 of the interviews concerning familiarity with the concept of carbon footprint and carbon accounting

4.2.2. Importance of CO₂ Reduction

When asked about the importance of reducing their carbon footprint, five out of six companies rated it as "very important", as illustrated in figure 4. This means that almost all interviewed companies recognize the strategic significance of sustainability for their business, not only for regulatory compliance but also for maintaining competitiveness and meeting customer expectations. They tend to view reducing their carbon footprint as a critical element of their long-term strategy and corporate responsibility. Nevertheless, one company rated importance of CO₂ reduction as "somewhat important", indicating that while they acknowledge the value of reducing emissions, they may be facing other immediate business priorities or challenges that limit their current focus on this area. However, even among this company, there is an expressed intent to increase their efforts in the future. Figure 4 summarizes the results of the interviews on the assessment of the importance of CO₂ reduction.

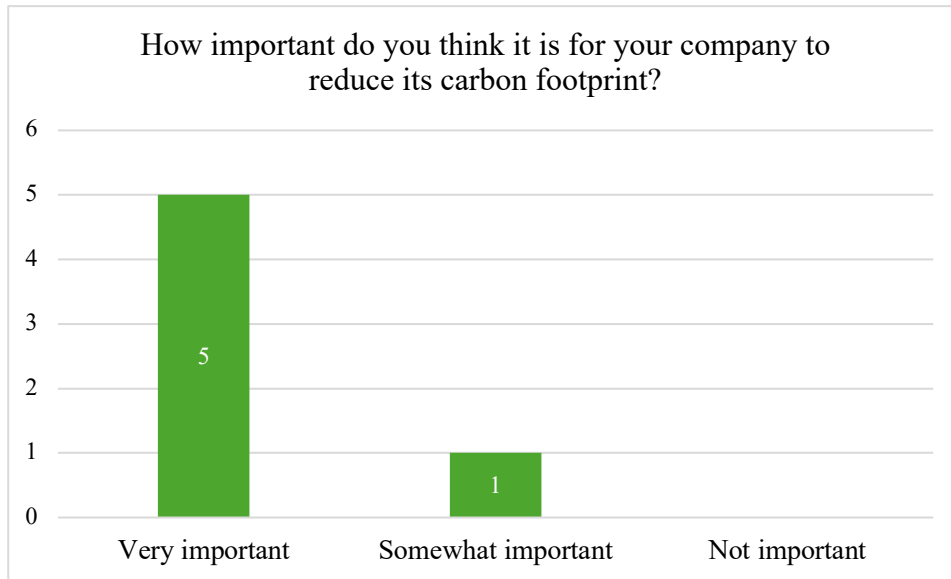


Figure 4: Results of question 2 of the interviews on the importance of CO₂ reduction

4.2.3. Carbon Footprint Measurement and Scope of Emissions

In response to the question of whether companies are already measuring their carbon footprint, the IHK survey received the following answers: Out of the ten responses collected, six companies (60%) reported that they are currently measuring their carbon footprint, while four companies (40%) indicated that they are not yet measuring their carbon footprint. These responses highlight a significant awareness and proactive attitude towards carbon footprint measurement among SMEs in the region. Figure 5 illustrates the answers from the IHK survey to the question of whether companies are already measuring their carbon footprint.

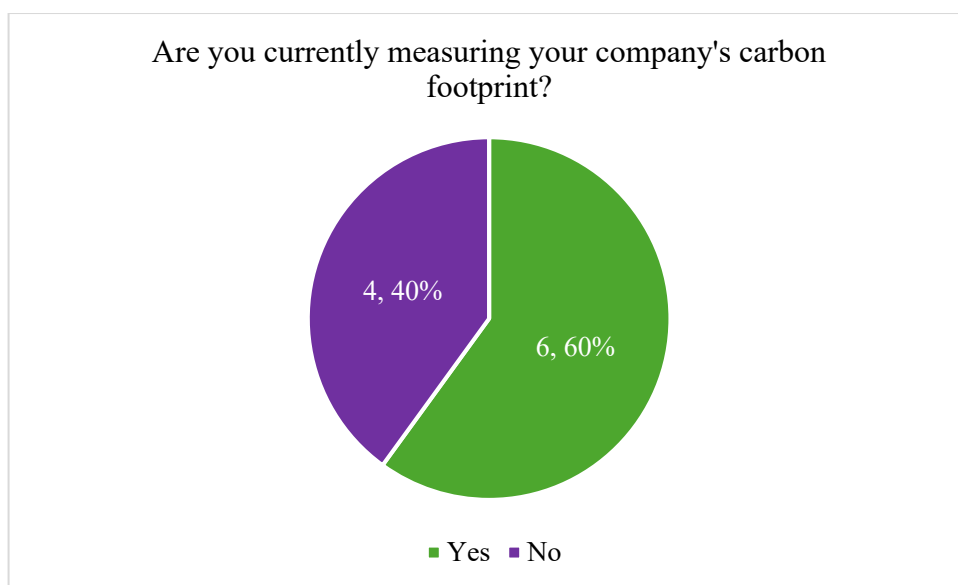


Figure 5: Results for question 1 of the survey concerning the status of CO₂ measurement

Insights from the interviews provided a more detailed understanding concerning the measurement of their carbon footprint and the scope of emissions. Of the six companies interviewed, five confirmed that they are already actively measuring their carbon footprint. In line with the survey results, this clearly indicates that a large proportion of respondents have already taken initiatives to measure their carbon footprint and reduce their company's carbon emissions. Only one company indicated that is not yet measuring their carbon footprint but expressed a strong intention to begin measuring their CO₂ footprint in the near future, recognizing the growing importance of sustainability in their industry. Figure 6 shows the results of the interviews on whether companies already measure their carbon footprint.

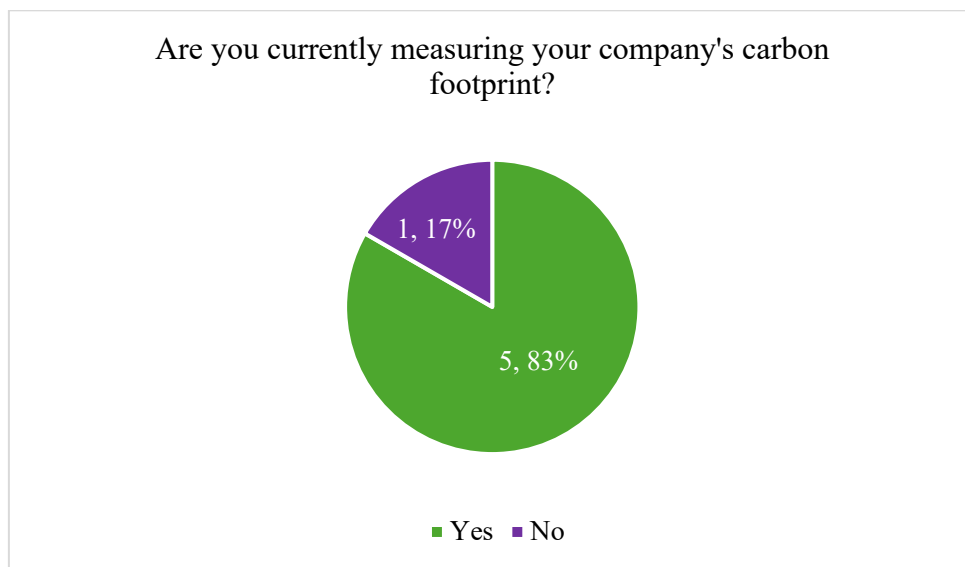


Figure 6: Results of question 4 of the interviews on whether companies already measure their carbon footprint

The interviews showed that all companies that already measure their carbon footprint also fully record Scope 1 and Scope 2 emissions and publish them in their sustainability reports. However, the measurement of Scope 3 emissions is still in progress at all of the companies interviewed. The challenges that companies face in this regard are explained in more detail in section 4.4.

4.3. Reasons for Carbon Accounting

Understanding the motivations behind why companies in the Black Forest area choose to measure their carbon footprint provides valuable insight into the driving forces behind their sustainability efforts. This section summarizes the reasons for carbon accounting that emerged from the survey and interviews.

4.3.1. Survey and Interview Findings

(A) Survey Findings

The IHK survey results concerning the reasons for carbon accounting are illustrated in figure 7 and described below.

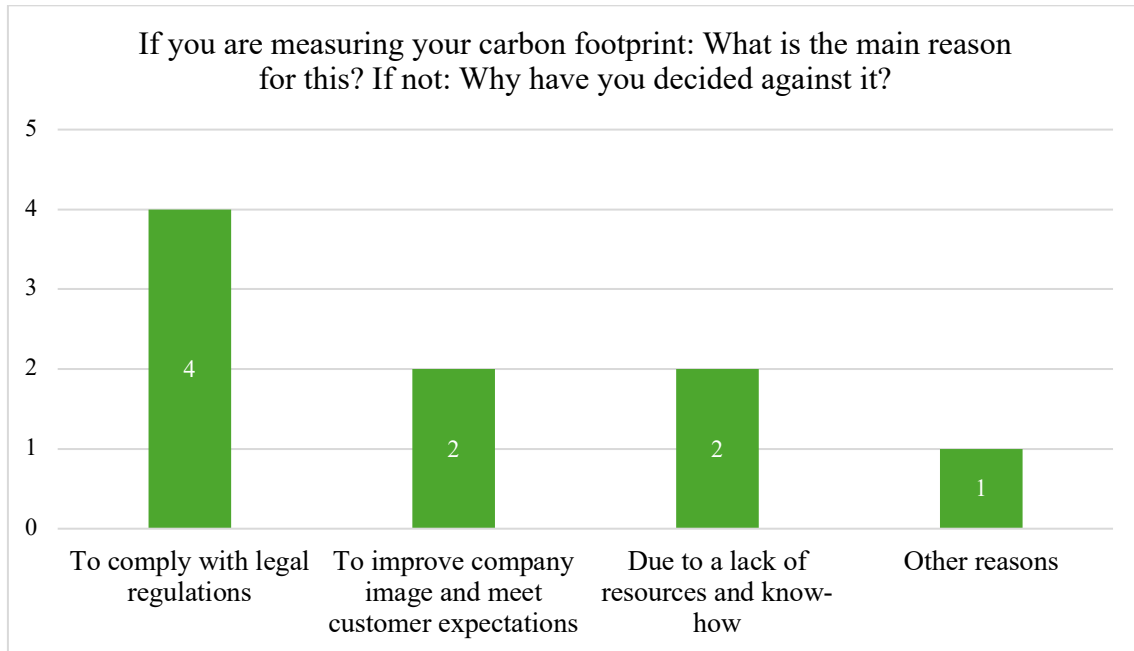


Figure 7: Results for question 2 of the survey regarding the motivation for CO₂ measurement

The survey results indicate that the primary motivations for measuring carbon footprints among SMEs are varied:

- *Compliance with legal regulations:* Four out of ten respondents indicated that their main reason for measuring their carbon footprint is to comply with legal regulations. This reflects the increasing regulatory pressure on companies to monitor and report their GHG emissions, aligning with national and international sustainability standards and directives.
- *Improving company image and meeting customer expectations:* Two respondents highlighted that measuring their carbon footprint helps improve their company image and meet customer expectations. In an era where customers and clients are

increasingly prioritizing sustainability, companies therefore find it beneficial to demonstrate their commitment to environmental responsibility.

- *Lack of resources and know-how*: For those not measuring their carbon footprint, two respondents mentioned a lack of resources and know-how as the main barriers. This highlights the need for technical support and capacity building within SMEs to facilitate effective carbon accounting.
- *Other reasons*: One respondent indicated other reasons, which were not specified, suggesting that there may be additional, less common motivations or considerations influencing their decision to measure carbon footprints.

(B) Interview Findings

The in-depth interviews provided further insights into the motivations behind carbon footprint measurement and are summarized in figure 8.

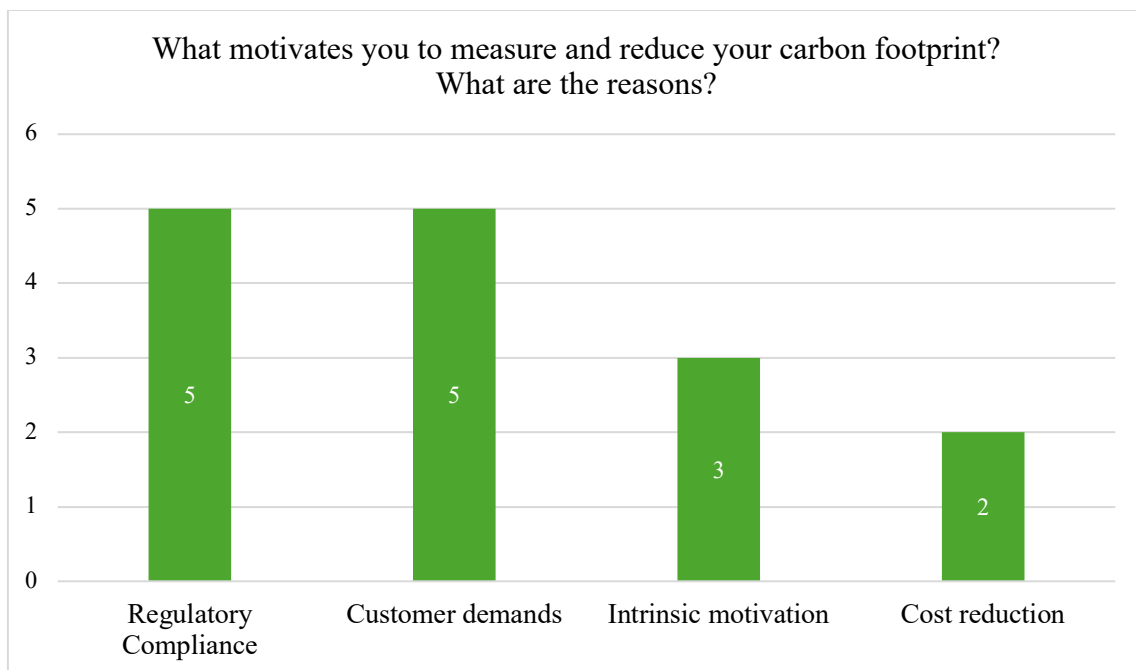


Figure 8: Results of question 5 of the interviews on the motivation of CO₂ measurement

In the following sections, the reasons for carbon accounting are discussed in more detail.

4.3.2. Regulatory Compliance

From all companies interviewed, three companies emphasized the importance of complying with legal requirements, particularly the EU's CSRD. As they fall within the scope of the CSRD, they must comply with the strict reporting and measurement standards and are therefore subject to direct regulatory pressure. However, other companies are also affected, albeit indirectly rather than directly. This indirect pressure

comes from larger customers who must comply with the CSRD and require smaller companies that are not directly subject to the CSRD to adopt similar sustainability practices in order to maintain their business relationships. One company in particular mentioned this indirect pressure and pointed out that it is not an issue for them to wait until someone comes along and forces them, but that they want to deal with the topic intensively now. Consequently, this double pressure, both direct and indirect, underlines the significant role that compliance plays in motivating companies to measure their carbon footprint.

4.3.3. Customer Demands and Future Competitiveness

All companies pointed out that customer expectations are one of the most important motivators. One company explained that their Tier-1 suppliers and end manufacturers in the automotive industry already have a very clear idea of when they want to be CO₂-neutral in their supply chain. They therefore mentioned that this is a very clear customer requirement that needs to be met if the company wants to stay in business in the future.

Another company also made it clear that sustainability is an important issue for customers and could also become an important purchasing criterion in any industry in the future. According to the company, those who demonstrate sustainability or launch a sustainable product on the market are given preference when selecting orders or contracts.

One company explained that they receive a large number of inquiries from customers asking about the CCF and the PCF, or asking whether they have any reduction measures in place. Another company also stated that their customers demand information about their sustainability practices, suggesting that carbon accounting transparency is becoming an important part of customer relationships. This expectation forces them to rigorously measure and manage their emissions in order to retain and attract key customers.

Consequently, as customers become increasingly aware of sustainability issues and factor them into their purchasing decisions, many companies have realized that maintaining a competitive advantage in the marketplace increasingly depends on their ability to demonstrate environmental responsibility and sustainability practices. Companies are therefore emphasizing that they can differentiate themselves from their competitors if they are seen as leaders in sustainability. This strategic importance to competitiveness is also driving companies to continuously improve their carbon accounting practices.

4.3.4. Intrinsic Motivation

Most interviewed companies are also intrinsically motivated by the desire to contribute positively to environmental sustainability. While one company emphasized self-interest and the realization that one has to change something if he or she wants to continue living on this planet, ethical considerations also play an important role in measuring the CO₂ footprint at another company.

For one company, suitability for grandchildren plays a particularly important role. The CEO made it clear that he and his brother, who also works in the company, have children. It is therefore important to them to make the future possible for future generations. He also believes that it is important for companies to be aware of this, as they have a great deal to influence this through purchasing. This intrinsic motivation underlines a deep commitment to reducing their environmental footprint beyond the immediate business benefits.

4.3.5. Economic Benefits and Cost Reduction

Long-term cost savings through improved energy efficiency and resource management are also key motivators. For example, one company explained that the company started measuring its carbon footprint before it became a trend in the industry to implement energy efficiency and reduction measures. This has led to significant financial savings, making sustainability efforts economically beneficial. Another company has also benefited from the application of sustainable practices and cost reductions through appropriate energy efficiency measures.

4.4. Challenges of Carbon Accounting

Measuring and managing carbon footprints pose several challenges for the surveyed and interviewed companies in the Black Forest area. These challenges are critical to understand as they highlight the barriers companies face in their sustainability efforts. This section delves into the survey and interview findings concerning the challenges of carbon accounting.

4.4.1. Survey and Interview Findings

(A) Survey Findings

Figure 9 illustrates the results of the survey on the challenges of measuring and managing the carbon footprint. In the survey, participants could choose several answers.

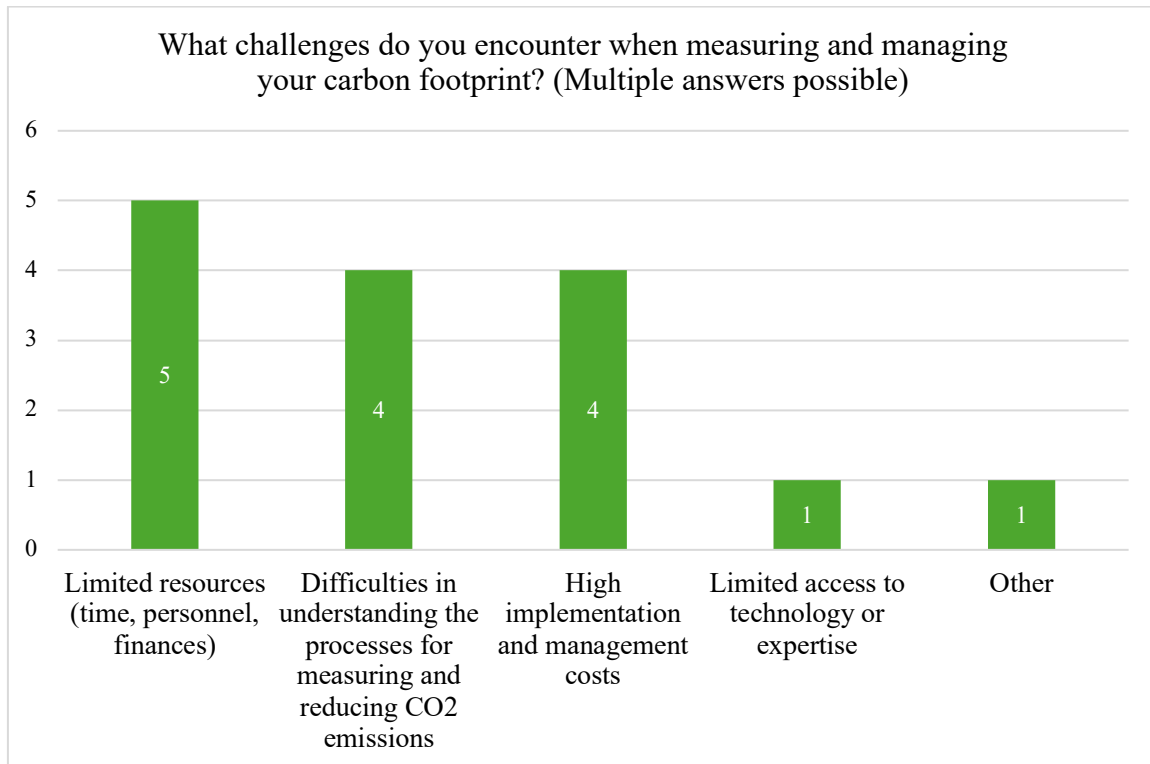


Figure 9: Results for question 3 of the survey concerning the challenges of CO₂ measurement

Consequently, according to the survey, the main challenges encountered by SMEs in the Black Forest area when measuring and managing their carbon footprints are:

- *Limited resources*: Most respondents (five respondents) indicated that limited resources, including time, personnel, and finances, are a major barrier. Therefore, many companies struggle with dedicating sufficient resources to sustainability initiatives while managing their core business operations.

- *Difficulties in understanding the processes*: Four respondents reported difficulties in understanding the processes involved in measuring and reducing CO₂ emissions.
- *High implementation and management costs*: Another four respondents cited high costs as a significant challenge. Therefore, implementing comprehensive carbon measurement systems and maintaining them can be a financial burden, especially for smaller companies with limited budgets.
- *Limited access to technology or expertise*: One respondent mentioned limited access to the necessary technology or expertise as a challenge. This underscores the need for advanced tools and specialized knowledge to effectively measure and manage carbon emissions.
- *Other challenges*: One respondent noted other unspecified challenges, indicating that there may be additional, unique obstacles faced by individual companies.

(B) Interview Findings

The in-depth interviews provided deeper insights into these challenges, reinforcing the survey findings and revealing additional context. Figure 10 provides an overview of the challenges faced by the companies interviewed.

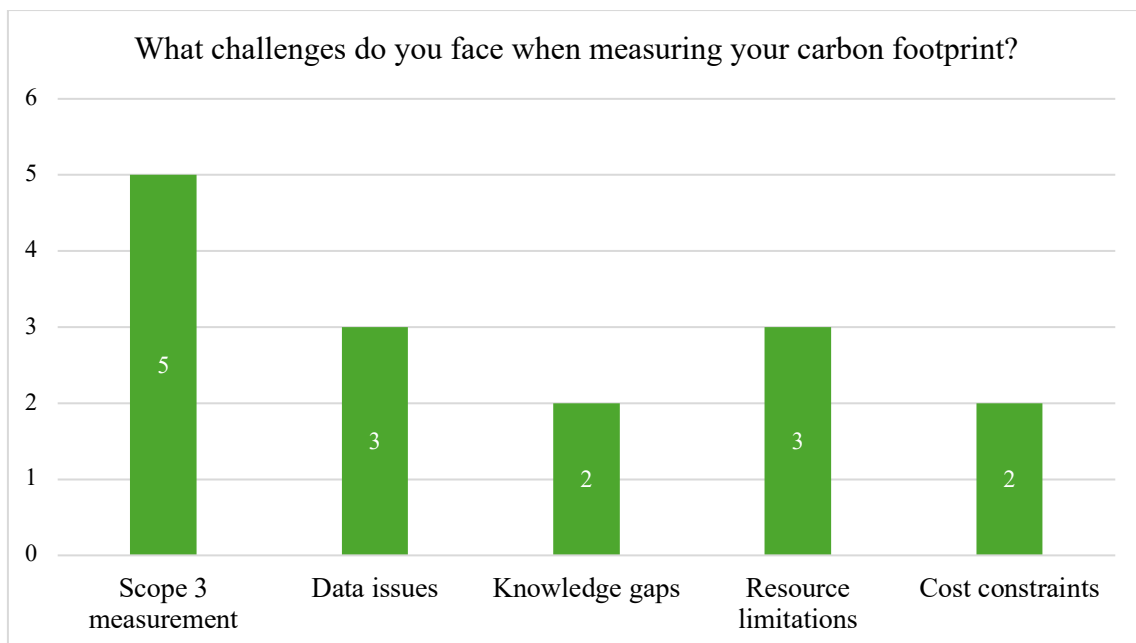


Figure 10: Results for question 11 of the interviews concerning the challenges of CO₂ measurement

The following sections discusses in more detail the challenges of carbon accounting that were mentioned during the interviews.

4.4.2. Understanding and Measuring Scope 3 Emissions

Understanding and accurately measuring Scope 3 emissions is a major challenge for all companies interviewed, primarily due to the extensive data collection required. Companies need to collect data from a variety of sources, including suppliers, transportation companies and end users.

According to two companies, obtaining comprehensive data on Scope 3 emissions requires considerable effort and resources and is a rather complex process. One company noted that they are not able to collect Scope 3 emissions data themselves but have to work with expensive service providers. Another company also mentioned that they have been working with a service provider, but the process has become too complex to manage for the provider. The company is able to calculate Scope 3 emissions from travel, employee housing, workplaces, transportation and waste, but currently has problems calculating material purchasing. In another interview, it was also explained that the company has started to include Scope 3 emissions, but that it is still a challenge to capture accurate values.

One company faces additional challenges. The company needs to familiarize its suppliers with the requirements for measuring Scope 3 emissions. This involves not only communicating the requirements, but also helping suppliers to set up their own systems to meet these requirements. This process is inherently difficult as suppliers must first understand the requirements and then set up appropriate systems, further complicating the measurement of Scope 3 emissions.

Consequently, understanding and accurately measuring Scope 3 emissions is a major challenge due to the extensive and complex data collection required from various sources. Companies tend to face significant difficulties, including the need for expensive service providers and the challenge of getting suppliers to establish systems for accurate data collection.

4.4.3. Data Reliability Issues

Accurate measurement of emissions is further complicated by various data issues, particularly regarding the comparability of standards and the reliability and validity of data.

One major challenge highlighted by companies is the comparability of standards used. According to them, when different firms calculate the PCF for the same product, the results can vary significantly. This discrepancy arises not from errors but from the use of different standards and methodologies. Such variability undermines the comparability of

data, making it difficult for companies to benchmark their performance against industry standards or competitors.

Moreover, two companies have emphasized the challenges associated with the reliability and validity of data. Often, the databases used for collecting emissions data are unstructured, user-unfriendly, and lack clarity, which complicates the data collection process. Finding specific and reliable databases is challenging due to their disorganization, lack of transparency, and issues with trustworthiness. The unstructured nature of data sources makes it difficult to obtain accurate and consistent data, further complicating the measurement of Scope 3 emissions.

Consequently, these data issues significantly impact the ability of companies to measure and report their Scope 3 emissions accurately, highlighting the need for standardized methodologies and more reliable data sources.

4.4.4. Knowledge Gaps

Another critical challenge carbon footprint measurement is the presence of knowledge gaps within companies, particularly regarding the necessary know-how to effectively measure and manage these emissions. One company has specifically highlighted the need to build internal know-how related to calculating the PCF. Developing this expertise involves not only understanding the technical aspects of emissions measurement but also staying updated with evolving standards and methodologies. Building such know-how is crucial for companies to independently and accurately assess their emissions without over-relying on external service providers.

4.4.5. Resource Limitations

Resource limitations are a significant challenge for many companies in managing their carbon footprint measurement activities. The lack of dedicated staff and the substantial time required for these tasks were frequently cited issues. Several companies described how their lean staffing models make it difficult to allocate personnel solely to sustainability tasks.

One company highlighted this problem, stating that they often struggle to dedicate sufficient resources to sustainability efforts. They noted that in many medium-sized companies, sustainability issues tend to drift towards Quality Management (QM) or Environmental Management (UM) departments. Typically, these responsibilities fall on an Environmental Management Officer or a similar role. Consequently, the tasks related to sustainability are often added to the day-to-day responsibilities of existing staff, who

are already managing compliance issues. The company observed that SMEs are frequently overwhelmed with customer inquiries on various platforms and questionnaires, leading to sustainability being handled by QM or UM officers by default.

In addition, one company, which has not yet started measuring its carbon footprint, is also affected by a shortage of qualified professionals. This shortage tends to be particularly acute in the field of engineering, which is crucial for tackling sustainability challenges. The company mentioned that many companies are currently actively looking for engineers to manage sustainability initiatives. However, such positions have been open for a long time, highlighting the lack of qualified personnel available to tackle these critical issues.

Moreover, as another company emphasized, employees need to be knowledgeable about sustainability practices, engage in extensive data collection, and perform the necessary tasks. However, their industry is characterized by significant wage costs and wage pressure, which further complicates the allocation of a considerable number of personnel resources to sustainability efforts. This challenge underscores the need for specialized roles to handle the growing demands of sustainability management.

4.4.6. Cost constraints

High costs associated with carbon footprint measurement systems were a recurring theme in the interviews. Several companies noted that the financial investment required for comprehensive tools, software and consulting services can be prohibitive. To give an example, one company explained that while they understand the importance of accurate carbon accounting, the cost of purchasing sophisticated measurement tools and hiring external consultants is a significant financial burden.

Another company echoed this concern, highlighting that although there are many software providers offering technical solutions, the cost of licenses is substantial. They also pointed out the financial strain of investing in technical solutions without receiving higher returns for their products. This creates a conflict of interest and financial challenge that needs to be resolved.

4.5. Types of Support and Resources needed

To address these challenges, the companies interviewed identified several types of support and resources that would be helpful.

4.5.1. Technical and Informational Support

Effective carbon footprint measurement requires robust technical and informational support. This includes advanced software, accurate data collection tools, and reliable information sources that enable companies to measure and analyze their emissions comprehensively. Developing industry-wide standards and centralized repositories of reliable data could significantly enhance companies' abilities to manage their carbon footprints.

One company raised the need for substantial technical support to implement and manage solutions for carbon footprint measurement. This includes assistance with sophisticated software and tools necessary for accurate data collection and analysis. In addition, another company requires reliable measurement technologies and dependable data sources to ensure the precision of their carbon accounting efforts. It also seeks transparent and unified information sources that would simplify data retrieval and potentially automate parts of the process, making it easier to handle vast amounts of data efficiently. Similarly, other companies require access to comprehensive and reliable information to facilitate their carbon footprint measurement and management.

One company primarily requires technical support in the form of digitization. This also includes attaching meters to the individual machines and networking them with each other. According to the company, the more the machines are interconnected, the less personnel are needed to monitor energy consumption.

4.5.2. Personnel Resources

Skilled personnel are crucial for the accurate and efficient measurement of carbon footprints. Companies need knowledgeable staff who are dedicated to sustainability tasks and trained in the latest measurement methodologies.

One company emphasizes the need for knowledgeable staff dedicated to sustainability tasks. This involves not only recruiting personnel with the necessary expertise but also providing ongoing training to ensure they stay updated with the latest developments in carbon footprint measurement. Another company argued that a separate department for

this area could provide efficient support. In this way, the problem can be tackled at a more serious level and with a higher priority.

One company also identified the need for additional manpower to manage and execute these measurement activities effectively. The importance of having dedicated personnel who are well-versed in sustainability practices is critical for accurate and efficient carbon accounting.

4.5.3. Financial Support

Financial resources are essential to cover the costs associated with carbon footprint measurement tools, software, and consulting services. Financial support would be of great help for many companies. Especially one company mentioned that it would be beneficial to cover the substantial costs associated with licenses for technical solutions and the additional personnel required for sustainability tasks. Another company also needs financial backing to invest in the necessary tools and resources for carbon footprint measurement. The high costs of purchasing sophisticated measurement tools and hiring external consultants highlight the need for significant financial investment to support comprehensive carbon accounting efforts.

4.5.4. Collaboration and Academic Support

Collaboration with academic institutions such as Hochschule Furtwangen University (HFU) is vital for companies seeking to enhance their carbon footprint measurement capabilities. Academic institutions can offer technical assistance, conduct targeted research, and provide access to the latest methodologies and tools for carbon accounting. Such partnerships can significantly boost a company's ability to manage and reduce its carbon emissions effectively.

Companies could benefit from collaboration with HFU by receiving specific assistance in mapping and understanding Scope 3 emissions. This partnership could help them develop more accurate measurement techniques and better integrate sustainability into their operations. Other companies also recognized the value of academic collaboration, where HFU could support by researching and identifying reliable databases, conducting substance flow analyses, and analyzing the components within purchased elements, such as backpacks. This would provide companies with detailed insights into their carbon footprint and help streamline their data collection processes.

Another company mentioned that HFU could help by developing standardized methodologies for Scope 3 emissions measurement and ensuring these standards are

implemented effectively. This support would enhance companies' ability to accurately measure and report their carbon emissions. Furthermore, academic collaboration could involve joint thesis projects that focus on carbon footprint measurement. This not only aids in practical research but also helps train future professionals in the field of sustainability.

4.6. Standards and Practices used

The standards and practices employed by the interviewed companies for measuring their carbon footprints reflect their commitment to rigorous and systematic environmental management. This section outlines the standards used, the frequency of measurements, and the extent of collaboration with other organizations.

4.6.1. Standards used

The companies interviewed utilize a variety of standards and methodologies to measure their carbon footprints, ensuring accuracy and consistency in their data. The most commonly referenced standards include:

- *GHG Protocol*: Four companies interviewed adhere to the GHG Protocol, which provides a comprehensive framework for measuring and managing GHG emissions.
- *Other standards and tools*: One company uses the Eco-Cockpit tool from the IHK and the THG-Bilanz Excel table from the Baden-Württemberg Environmental Agency.

4.6.2. Frequency of Measurement

All companies interviewed measure their carbon footprint on an annual basis, aligning this activity with their annual reporting cycles and sustainability assessments. However, most companies collect their data quarterly or monthly, allowing for timely interventions to address any emerging issues. For specific projects or at the request of clients, some companies conduct ad hoc measurements. This is particularly relevant for product-level assessments or when responding to specific customer requirements for carbon footprint data.

4.6.3. Collaboration with other Organizations

Companies in the Black Forest area often engage in various forms of cooperation for their carbon footprint measurement:

- *Consultancy services*: Many companies work with specialized consultancy firms. These firms provide expertise and tools that help companies navigate the complexities of carbon accounting.
- *Industry associations*: Companies participate in networks and initiatives facilitated by industry associations like the IHK and the Wirtschaftsverband Industrieller Unternehmen Baden e. V. (wvib). These associations offer platforms for knowledge exchange, training, and support in sustainability practices.
- *Academic collaboration*: Some companies participate in working groups, such as the Campus Schwarzwald, in which local companies have joined forces to support each other in measuring their CO₂ footprint.
- *Software and database providers*: To enhance the accuracy of their measurements, companies collaborate with providers of specialized software and databases. For instance, companies use the iPoint software and the Ecoinvent database, as these support carbon footprint calculations and ensure the use of reliable emission factors.

4.7. Future Perspectives and Additional Comments

The future perspectives of SMEs in the Black Forest area regarding carbon footprint measurement and management indicate a strong commitment to advancing their sustainability efforts. Companies are planning various initiatives to enhance their environmental performance, reflecting a forward-thinking approach to addressing climate change and regulatory demands.

4.7.1. Future Perspectives

Many companies are setting ambitious goals for the future to improve their carbon footprint management and sustainability practices. Key areas of focus include:

- *Achieving CO₂ neutrality*: Several companies have set clear targets to achieve CO₂ neutrality within specific timeframes. Some companies aim to become CO₂ neutral by 2025, primarily through the adoption of green energy sources and implementing robust reduction strategies. Other companies have set longer-term goals, such as achieving CO₂ neutrality by 2035, with an initial focus on Scope 1 and Scope 2 emissions.
- *Engaging in carbon offset programs*: While some companies are focusing on reducing emissions, other companies are also exploring carbon offset programs to compensate for any unavoidable emissions. These included, for example, forestation projects in Africa, hydropower projects in India and a sewage treatment plant project in Bulgaria.

4.7.2. Additional Comments

The commitment of SMEs to improving their carbon footprint management extends beyond immediate business benefits to broader environmental and social impacts. Several additional comments from the interviews highlight this dedication:

- *Balanced Sustainability*: One company emphasized the importance of striking a balance between economic, environmental and social factors in sustainability efforts. They emphasized that a good balance between these three factors is crucial. According to the company, neglecting the economy and focusing only on environmental and social aspects would ultimately lead to the failure of the company. In their opinion, society must also maintain this balance in order to function effectively.
- *Long-term Vision*: The interviews revealed a long-term vision for sustainability that goes beyond regulatory compliance. Companies are motivated by a sense of

responsibility towards future generations and a desire to make a positive contribution to global environmental goals. This intrinsic motivation is a driving force behind their ongoing efforts to reduce their carbon footprint.

- *Challenges and Conflicts:* There are significant conflicts of interest. Companies such emphasized that they require significant human resources and financial investment in technical solutions that do not necessarily translate into higher revenues for their products. This disparity benefits larger companies that have the resources to invest in sustainability, while smaller companies struggle to keep up. The high regulatory burden and bureaucratic procedures pose a risk of insolvency for smaller companies that cannot afford to comply. In addition, the global competitive situation is worrying, particularly the fact that large economies such as China and the US are not making comparable efforts in the area of sustainability. This disparity creates an uneven playing field and raises questions about the effectiveness of current approaches. One company suggested that alternative strategies, such as a greater focus on recycling and circular economy principles, could be more viable and effective.

In summary, while SMEs are committed to sustainability, they face significant challenges that require coordinated support and innovative approaches to ensure that these efforts are feasible and effective in the long term.

5. Discussion

The report of carbon footprint measurement and carbon accounting practices among SMEs in the Black Forest region has provided significant insights into their motivations, challenges and future aspirations. The results align with existing research but also reveal regional characteristics and the specific needs of these companies.

Concerning motivations for carbon accounting, the main expectation was that regulatory compliance, customer demand and intrinsic motivation would be an important driver for SMEs to measure their carbon footprint. The results of the survey and interviews confirm this expectation, with legal requirements such as the CSRD and customer pressure being important motivators. Intrinsic motivation to make a positive contribution to environmental sustainability was also an important driver for companies to adopt sustainability practices.

The main challenges of SMEs in the Black Forest are the complexity of measuring Scope 3 emissions, data reliability, resource constraints and high costs. These barriers are particularly pronounced for smaller companies that do not have the extensive resources of larger companies. The findings highlight the need for comprehensive support systems to help SMEs overcome these challenges.

The results of this study are consistent with existing research on measuring and accounting for the carbon footprint of SMEs. Studies have shown that legal pressure and customer expectations have a strong influence on environmental practices in companies (Christensen et al., 2021, p. 1181 ff.; KPMG, 2023, p. 1). The intrinsic motivation for sustainability is also well documented and reflects a growing ethical consideration of companies (Chen P., 2023, p. 6 ff.). However, this study also highlights the specific regional challenges faced by SMEs in the Black Forest region.

One of the main limitations of this report is the difficulty in obtaining interviews with a wider range of companies. Although many SMEs in the Black Forest region have been contacted, only a small number agreed to participate in the interviews. This limitation suggests a possible bias, as the companies that were willing to participate may have already made progress in measuring their carbon footprint and have the expertise and resources to discuss their efforts. As a result, the results may not fully reflect the experiences of SMEs that are not as advanced in their sustainability practices or do not have the resources to measure their carbon footprint. This could lead to findings from companies that have not yet started measuring their carbon footprint or are unaware of the importance of such practices being overlooked. In addition, the sample size of the

survey and interviews is relatively small, which may limit the generalizability of the results. The participating companies may not fully reflect the diversity of challenges and motivations across the region.

Another limitation is the potential bias from self-reporting in the surveys and interviews. It is possible that companies may overstate their progress or understate their challenges due to social desirability or concerns about how they are perceived by outsiders. These biases may affect the accuracy of the results and should be taken into account when interpreting the results.

Future research should focus on expanding the sample size and including a greater diversity of SMEs to gain a more comprehensive understanding of carbon accounting practices in the region. Investigating the specific needs and challenges of companies that are not currently engaged in carbon footprint measurement could provide valuable insights into how to better support these companies.

6. Conclusion

The importance of climate change and the need to reduce GHG emissions have highlighted the critical role of SMEs in achieving sustainability goals. This report has examined the principles, practices and challenges of carbon footprint measurement among SMEs in the Black Forest region. The findings show that there is significant commitment to carbon accounting, driven primarily by regulatory compliance, customer requirements, intrinsic motivations and economic benefits.

The research shows that while many SMEs in the region are proactively measuring their carbon footprint, there are significant challenges that hinder the effectiveness and efficiency of these efforts. Key challenges include the complexity of measuring Scope 3 emissions, issues with data reliability, knowledge gaps, limited resources and high costs associated with carbon accounting systems. These barriers are particularly pronounced for smaller companies that do not have the extensive resources of larger corporations.

Despite these challenges, the commitment of SMEs to sustainability is evident. Many companies have set ambitious goals to achieve carbon neutrality and are actively exploring carbon offset programs and other strategies to reduce their environmental impact. The proactive attitude of these companies underlines the strategic importance of sustainability in maintaining competitiveness and meeting stakeholder expectations.

To help SMEs address the challenges identified, the report emphasizes the need for robust technical, informational and financial support. Collaboration with academic institutions and industry associations can provide valuable resources and expertise that enable SMEs to improve their carbon accounting practices. In addition, the development of standardized methodologies and reliable data sources tailored to the needs of SMEs is critical to improving the accuracy and consistency of carbon footprint measurements.

In summary, SMEs in the Black Forest region play a crucial role in global efforts to combat climate change. By rising to the challenges and utilizing the support available, these companies can make an important contribution to environmental sustainability and set an example for other regions.

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Appendix

A. Short IHK survey

Umfrage zur Messung des CO₂-Fußabdrucks

Willkommen zur Umfrage über die CO₂-Bilanzierungspraktiken von Unternehmen im Schwarzwald. Diese Studie von Studenten der Hochschule Furtwangen möchte die gegenwärtigen Herausforderungen und Maßnahmen im Bereich der CO₂-Bilanzierung erfassen. Ihre Teilnahme ermöglicht es uns, ein detailliertes Bild des aktuellen Stands zu erhalten. Bitte beantworten Sie kurz unsere Fragen – Ihre Einsichten sind entscheidend für den Erfolg unseres Projekts.

1. Messen Sie derzeit den CO₂-Fußabdruck Ihres Unternehmens?

- A) Ja
- B) Nein
- C) Wir planen, dies in naher Zukunft zu beginnen

2. Falls Sie Ihren CO₂-Fußabdruck messen: Was ist der Hauptgrund dafür? Falls nicht: Warum haben Sie sich dagegen entschieden?

- A) Um gesetzliche Vorschriften zu erfüllen
- B) Um das Unternehmensimage zu verbessern und Kundenerwartungen zu entsprechen
- C) Um langfristige Kosteneinsparungen zu erzielen
- D) Aufgrund fehlender Ressourcen und Know-how
- E) Wir sehen keine Notwendigkeit für unser Geschäft
- F) Sonstiges

3. Welche Herausforderungen begegnen Ihnen bei der Messung und Verwaltung Ihres CO₂-Fußabdrucks? (Mehrfachnennungen möglich)

- A) Hohe Implementierungs- und Verwaltungskosten
- B) Schwierigkeiten beim Verständnis der Mess- und Reduktionsprozesse für CO₂-Emissionen
- C) Eingeschränkter Zugang zu Technologie oder Expertise
- D) Begrenzte Ressourcen (Zeit, Mitarbeiter, Finanzen)
- E) Betriebliche Störungen während der Umsetzung

F) Keine wesentlichen Herausforderungen

G) Sonstiges

4. Wären Sie bereit, ein ausführliches Interview mit Studenten der Hochschule Furtwangen über Ihre Praktiken und Herausforderungen bei der CO₂-Fußabdruckmessung zu führen? Wenn ja, hinterlassen Sie bitte Ihre Kontaktdaten – vielen Dank!

[Antwort eingeben]

B. In-depth interview questionnaire

Teil A: Allgemeiner Teil

A.1 Bewusstsein und Einstellung

1. Wie vertraut ist Ihr Unternehmen mit dem Konzept des CO₂-Fußabdrucks und der CO₂-Bilanzierung?
 - a. Sehr vertraut
 - b. Einigermaßen vertraut
 - c. Nicht vertraut
2. Für wie wichtig halten Sie es, dass Ihr Unternehmen seinen CO₂-Fußabdruck reduziert?
 - a. Sehr wichtig
 - b. Einigermaßen wichtig
 - c. Unwichtig
3. Sind Sie über lokale, nationale oder internationale Vorschriften bezüglich CO₂-Emissionen informiert?
 - a. Ja. Wenn ja, welche?
 - b. Nein
4. Misst Ihr Unternehmen derzeit seinen CO₂-Fußabdruck?
 - a. Ja → Weiter mit Teil B
 - b. Nein → Weiter mit Teil C

Teil B: Unternehmen, die ihren CO₂-Fußabdruck bereits messen

B.1 Praktiken zur Messung des CO₂-Fußabdrucks

5. Was motiviert Ihr Unternehmen dazu, seinen CO₂-Fußabdruck zu messen und zu verringern? (z. B. Einhaltung von Vorschriften, Kosteneinsparungen, Kundennachfrage, ethische Überlegungen)
6. Welche Methoden/Werkzeuge/Standards (intern und extern) verwenden Sie zur Messung des CO₂-Fußabdrucks?
7. Arbeiten Sie bei der CO₂-Bilanzierung mit anderen Organisationen zusammen?
 - a. Ja
 - b. Nein
8. Welche Scopes (Scope 1, 2 oder 3) sind in Ihrem CO₂-Fußabdruck enthalten?

9. Haben Sie von Anreizen für die Reduzierung des CO₂-Fußabdrucks oder die Einführung nachhaltiger Praktiken profitiert?
 - a. Ja → Welche Anreize und Auswirkungen?
 - b. Nein
10. Wie häufig misst Ihr Unternehmen seinen CO₂-Fußabdruck?

B.2 Hemmnisse und Herausforderungen

11. Vor welchen Herausforderungen steht Ihr Unternehmen bei der Messung seines CO₂-Fußabdrucks?

B.3 Unterstützung und Ressourcen

12. Welche Art von Unterstützung oder Ressourcen wären für Ihr Unternehmen am hilfreichsten, um die Messung seines CO₂-Fußabdrucks zu verbessern? (z. B. finanzielle Anreize, technische Unterstützung, Informationsquellen)
13. Gibt es bestimmte Bereiche, in denen Ihr Unternehmen Beratung oder Unterstützung in Bezug auf die Messung und Reduzierung des CO₂-Fußabdrucks benötigt? Wie könnte die HFU Ihnen helfen?

B.4 Zukunftsperspektiven

14. Hat Ihr Unternehmen Pläne oder Ziele in Bezug auf Nachhaltigkeit und die Reduzierung des CO₂-Fußabdrucks für die Zukunft?
15. Nehmen Sie an Programmen oder Initiativen zur Kompensation von Treibhausgasemissionen in der Region Schwarzwald teil (oder planen Sie dies)?

B.5 Zusätzliche Kommentare

16. Gibt es noch etwas, das Sie uns über den Ansatz Ihres Unternehmens in Bezug auf Nachhaltigkeit und Messung des CO₂-Fußabdrucks mitteilen möchten?

Teil C: Unternehmen, die ihren CO₂-Fußabdruck (noch) nicht messen

C.1 Hemmnisse und Herausforderungen

5. Welches sind die Haupthindernisse bei der Messung und Reduktion des CO₂-Fußabdrucks? Was hält Ihr Unternehmen davon ab, sich mit der Messung des CO₂-Fußabdrucks zu befassen?
6. Wie bewerten Sie die Kosten im Vergleich zu den Vorteilen der CO₂-Bilanzierung und -reduzierung?

7. Wären Sie bereit, die Initiative zu ergreifen, um Ihren CO₂-Fußabdruck zu verringern?
 - a. Ja
 - b. Nein

C.2 Unterstützung und Ressourcen

8. Welche Art von Unterstützung oder Ressourcen wäre für Ihr Unternehmen am hilfreichsten, um mit der Messung seines CO₂-Fußabdrucks zu beginnen? (z. B. finanzielle Anreize, technische Unterstützung, Informationsquellen)
9. Gibt es bestimmte Bereiche, in denen Ihr Unternehmen Beratung oder Unterstützung in Bezug auf die Messung und Reduzierung des CO₂-Fußabdrucks benötigt?
10. Wie könnten lokale Behörden, Industrieverbände oder Bildungseinrichtungen wie die HFU Ihnen helfen, Ihren CO₂-Fußabdruck besser zu verwalten?

C.3 Zukunftsperspektiven

11. Hat Ihr Unternehmen Pläne oder Ziele in Bezug auf Nachhaltigkeit und die Reduzierung des CO₂-Fußabdrucks für die Zukunft?

C.4 Zusätzliche Kommentare

12. Gibt es noch etwas, das Sie uns über den Ansatz Ihres Unternehmens in Bezug auf Nachhaltigkeit und Messung des CO₂-Fußabdrucks mitteilen möchten?