Norwegian School of Economics
Bergen, Fall 2023

# Accounting for diverse greenhouse gases in the environmental balance sheet

*How to account for $CO_2$ and $CH_4$ using different emission metrics*

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Master thesis, Economics and Business Administration

Major: Financial Economics,

Energy, Natural Resources and the Environment

NORWEGIAN SCHOOL OF ECONOMICS

## Acknowledgements

This master’s thesis marks the end of our MSc in Economics and Business Administration, with major in Financial Economics and Energy, Natural Resources, and the Environment. The topic of sustainability reporting and how to account for diverse greenhouse gases is highly relevant and is something we find both interesting and engaging.

Despite challenges along the way, composing this thesis has been rewarding, providing us with significant insight into sustainability reporting. We find this particularly valuable, especially as we both commence our careers in audit. The subject is both new, interesting, and dynamic, making it an exciting area to explore.

We would like to express our sincere gratitude to our supervisor, Assistant Professor Giacomo Benini, for introducing us to this specific field. Your constructive feedback has challenged our academic thinking, and has along with your dedicated guidance contributed to the successful completion of this master's thesis.

Finally, we would like to extend our gratitude to our fellow students and lecturers for making the time in Bergen and NHH memorable.

Norwegian School of Economics

Bergen, December 2023

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# Abstract

The ongoing challenges of global warming and climate change emphasize the importance of reliable and concrete sustainability reporting. Continuous rise in greenhouse gas emissions should hold a significant place in such reporting. It is essential to quantify, measure, and compare these emissions, as each greenhouse gas affects the climate differently. Our thesis investigates how to account for diverse greenhouse gases in the environmental balance sheet, with particular focus on $CO_2$ and $CH_4$ emissions.

Initially, the thesis delves into financial accounting to demonstrate how it forms the basis for climate accounting. We present the financial transactions of a steel mill, which are linked to the generation of its emissions. These emissions will be illustrated in our presentation of climate accounting, particularly in the environmental balance sheet and the income statement. Furthermore, we present the mechanics of carbon footprints, explaining the transfer of emissions from one company to another.

To convert diverse greenhouse gases to $CO_2$ equivalents, we introduce various emission metrics. The metrics we have chosen to utilize are the Global Warming Potential and the Global Temperature Change Potential. We provide critical assessments of these metrics and facilitate a comparative analysis. The thesis emphasizes the importance of time horizons and the persistence of emissions. We note that selecting varying time horizons when utilizing emission metrics changes the presentation of the quantity of $CO_2$ equivalents. This primarily arises from their differing approaches in accounting for the shorter lifespan of $CH_4$. We also recognize that distinct metrics serve specific purposes, and the choice of metric depends on the intended measurement. This includes measurements such as radiative forcing and temperature changes.

Regarding emissions reduction, we present some of the key measures within climate policy. Implementing effective measures is pivotal for transitioning towards a low-carbon economy. Finally, we calculate the decay of $CO_2$ equivalents to demonstrate how emissions diminish in the atmosphere over time.

***Keywords**: Sustainability reporting, Environmental Balance, Emission Metrics, GWP, GTP*

## Table of content

**List of figures:**

**List of tables:**

## *List of abbreviations*

| Abbreviation | Explanation |
|---|---|
| BB | Beginning balance |
| CCS | Carbon Capturing and Storage |
| CE | Carbon emissions |
| $CO_2$ | Carbon dioxide |
| $CO_2e$ | Carbon dioxide equivalents |
| $CH_4$ | Methane |
| CSRD | Corporate Sustainability Reporting Directive |
| DE | Direct emissions |
| ESG | Environmental, Social and Governance |
| ESRS | Sustainability Reporting Standards |
| ETI | Emissions transferred in |
| ETO | Emissions transferred out |
| EU | European Union |
| EU ETS | European Emission Trading System |
| EB | Ending balance |
| FG | Finished goods |
| GHG | Greenhouse gases |
| GWP | Global warming potential |
| GTP | Global temperature change potential |
| IPCC | Intergovernmental Panel on Climate Change |
| MAT | Materials |
| MAGICC | Model for the Assessment of Greenhouse Gas Induced Climate Change |
| PPE | Plant, property, and equipment |
| PPM | Part per million |
| WIP | Work in process |
| WMO | World Meteorological Organization |

# 1. Introduction

## *1.1 Global Warming*

In recent decades, the effects of *global warming* have become more significant, emphasizing the pressing need for action to address its widespread impact. Human activities are the primary contributors to climate change, and the production of coal, oil, and gas releases billions of tons of greenhouse gas emissions into the atmosphere annually. These emissions function as a blanket wrapped around the earth, trapping the sun's heat, and raising temperatures. In addition to increased temperatures, climate change leads to severe fires, flooding, intense droughts, melting polar ice, and rising sea levels (UNFCCC, 2023). No continent is left untouched, and 90 percent of disasters are now classified as weather- and climate-related (UN, 2020).

Over the past four years, we have experienced the highest recorded temperatures so far. Without a reduction in global greenhouse gas emissions, this trend will persist, leading to further temperature increase. Projections indicate that global average temperatures could rise by three degrees Celsius within 2100 (United Nations, 2020). Every additional increase of a degree bears significant weight and will have severe consequences for both life and public health (World Health Organization, 2021). To address these concerns and protect our planet, it is therefore critical to take immediate and decisive action to reduce greenhouse gas emissions.

### *1.1.1 Planetary boundaries*

Among the escalating concerns surrounding global warming, understanding the balance of the Earth's ecological systems becomes increasingly pivotal. The *planetary boundaries framework* was established by Steffen et al. in 2015, delineating a secure operational zone for humanity by identifying nine crucial ecological capacities of the Earth. This framework relies on the inherent biophysical processes governing the stability of the Earth's system at a global scale. The secure operational space is represented by the medium dark zone, while the light zone signifies uncertainty. The dark zone highlights an area of heightened risk (Schoenmaker & Schramade, p. 8-9, 2019).

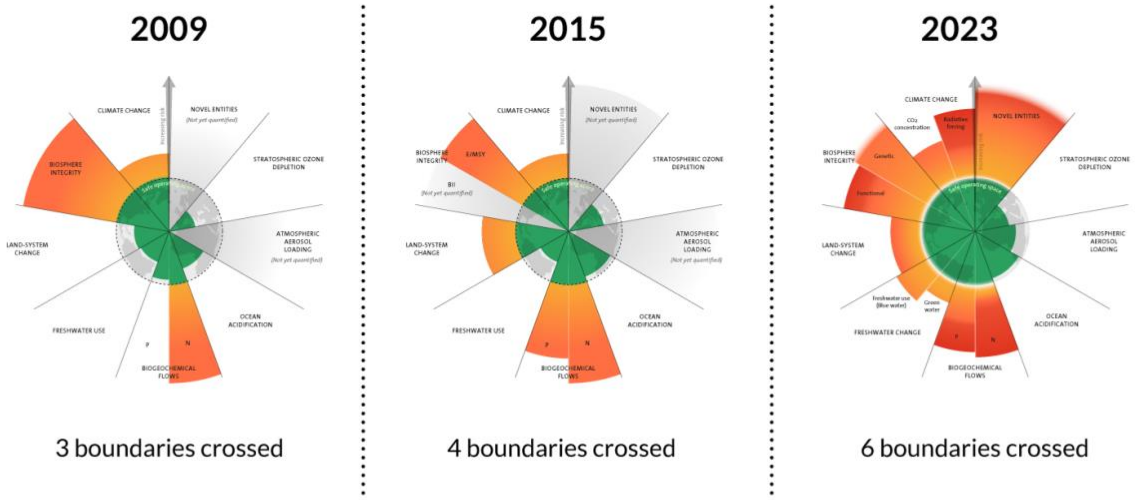


*Figure 1 - Planetary boundaries (Stockholm Resilience Centre, 2023)*

As we can see in the figure above, the orange-colored zones indicate risks that persistently expand over time. The figure displays the breaches of boundaries occurring frequently since 2009, where the planetary boundary lies at the intersection of the medium dark and light zones. We can look at the atmospheric concentration of greenhouse gases (GHG) to illustrate how the framework functions. The range of 350 to 450 parts per million (ppm) of carbon dioxide represents the zone of uncertainty. Already in 1995, the planetary boundary was crossed by 350 ppm. In 2015 the level was 399 ppm, which means a rate of about 3 ppm has been added every year. The upper limit of 450 ppm lies at the intersection of the light and dark zones (Schoenmaker & Schramade, p. 8-9, 2019). Human-induced GHGs directly challenge these planetary limits.

## *1.2 Greenhouse gases*

The atmosphere's ability to retain heat radiation from the Earth's surface is called the *greenhouse effect*. This effect works by various greenhouse gases absorbing infrared radiation from the Earth in the atmosphere, and redirecting it back towards the Earth. The difference between the amount of solar radiation reaching the Earth, and the amount of thermal radiation the Earth's surface sends back to the atmosphere, is known as *radiative forcing*. When the Earth emits as much radiation as it receives from the sun, there is equilibrium, meaning the radiative forcing is zero. Radiative forcing increases as the concentration of GHGs in the atmosphere rises. An increase in GHGs in the atmosphere results in less radiation escaping, causing the Earth to heat up. The greenhouse effect is crucial for all life, and without greenhouse gases, the average temperature on Earth would have been -18 degrees Celsius (Miljøstatus, 2023). However, the concentration of GHGs in the atmosphere is heavily influenced by human activity, reaching a level that results in adverse changes on climate.

### *1.2.1 Carbon dioxide & Methane*

*Carbon dioxide* ($CO_2$) is the most common greenhouse gas emitted by human activities. This greenhouse gas enters the atmosphere due to activities such as burning fossil fuels and certain chemical reactions. As $CO_2$ is the most significant contributor to greenhouse gas emissions, regulations have primarily been about cutting emissions of this gas. The second most important greenhouse gas emitted by humans is *methane* ($CH_4$). Emissions of $CH_4$ are mainly emitted during the production and transport of coal, natural gas, and oil (United States Environmental Protection Agency, 2023). Despite being the second largest contributor to human-induced GHGs, there has been insufficient focus on $CH_4$'s influence on climate change within sustainability reporting.

Greenhouse gases have vastly different warming effects, and their lifespans in the atmosphere range from a few years to tens of thousands of years. $CH_4$ is a potent greenhouse gas and can retain 84 times as much heat as $CO_2$. However, the gas is a so-called short-lived GHG, with an average lifetime in the atmosphere of approximately 12 years. Due to the rapid degradation time, constant emissions of $CH_4$ will over time lead to a stable concentration in the atmosphere (Jensen, 2023). In comparison, $CO_2$ has stayed in the atmosphere for hundreds of years, meaning significant amounts of $CO_2$ emissions all the way back to the industrial revolution, are partly still in the atmosphere contributing to global warming. $CO_2$ from industry reached a new historical record level in 2022, with an increase of 17 percent since 1990 (Energi & Klima, 2022).

## *1.3 Research question*

Despite the increasing focus on sustainability reporting, a challenge we face lies in the lack of clear methodologies when accounting for diverse greenhouse gases. Therefore, our thesis aims to contribute to the existing knowledge on environmental reporting, by investigating how different greenhouse gases can be accounted for in the environmental balance sheet. Specifically, we seek to identify the methodologies used today, and their impact on the overall environmental balance sheet and income statement. Thus, the thesis aims to answer the following research question:

*"How to account for diverse greenhouse gases in the environmental balance sheet?"*

## *1.4 The structure of the thesis*

This thesis is structured into primarily 8 different chapters. In the first chapter of the thesis, we have presented the background for this master's study and the associated research question we aim to address. Furthermore, chapter 2 covers relevant theory that will be emphasized in the analysis section later in the thesis. Chapter 3 is the methodology section, and in chapter 4, we delve deeper into financial accounting to demonstrate how this forms the basis for climate accounting. Chapter 5 examines current climate accounting practices, outlining the standards and regulations in use. In chapter 6 we address the thesis' problem statement, introducing various metrics that can be used to respond to the addressed issue. Chapter 7 is the thesis' analysis with corresponding results.

Finally, in chapter 8, we will present a conclusion and further recommendations. Part 9 and 10 consist of the thesis' bibliography and attachments, respectively.

# 2. Theoretical background

## *2.1 Paris agreement*

Emissions from human activities have led to an increase in the global average temperature by 1.1 degrees Celsius, a factor that correlates with ongoing rising sea levels (IPCC, 2023). To help limit climate change, world leaders at the UN Climate Change Conference in Paris agreed on the historic *Paris Agreement* in 2015. This is a legally binding international treaty, which through long-term goals guides all nations (United Nations, 2016). The purpose of the agreement is to curtail worldwide GHGs, ensuring that the increase in the global average temperature remains below 2-degrees Celsius, until the end of this century (United Nations Climate Change, 2023). As an additional goal, the countries must strive to prevent the temperature from rising by more than 1.5 degrees Celsius. However, it is important to note that even a 1.5 degrees Celsius increase in global temperatures is not considered a safe threshold (WHO, 2021).

To accomplish this, scientists recommend that nations should achieve *net zero* emissions by 2050. Net zero entails minimizing the emissions as much as possible, while simultaneously offsetting any residual emissions present in the atmosphere (BBC, 2021). In alignment with the European Green Deal and the European climate law, member states of the EU are obligated to reduce greenhouse gas emissions by a minimum of 55 percent by 2030. This new legislation is referred to as *fit for 55* (Regjeringen, 2021).

A recent report from the World Meteorological Organization (WMO) indicates that despite warnings over decades, we are still heading in the wrong direction. In 2022, $CO_2$ levels in the atmosphere hit a troubling milestone, surpassing pre-industrial levels by 50 percent for the first time. Temperatures are rising as well, and the global average temperature reached 17.18 degrees Celsius in July 2023, surpassing the previous record (Elster, 2023). Additionally, CH4 levels also kept rising throughout last year, with the increase from 2021 to 2022 being the largest ever recorded (NRK, 2023). In December 2021, as a component of the fit for 55, the Commission introduced a proposal for a new EU regulation focusing on diminishing $CH_4$ emissions within the energy sector, called the *Global Methane Pledge*. More than 100 countries pledged to decrease their $CH_4$ emissions by 30 percent by 2030, in comparison to the levels recorded in 2020 (European Council, 2022).

According to scientists from Cicero, the 1.5 degrees threshold is projected to be exceeded soon, initially on an intermittent basis, and eventually becoming a sustained trend in global warming. Previously, scientists cautioned that surpassing 1.5 degrees would occur sometime in the 2030s. Yet, an increasing number of experts suggest it could happen even sooner. Nevertheless, it is essential to understand that surpassing 1.5 degrees in a single year does not signify a failure in meeting the goal. The critical factor lies in maintaining an average below 1.5 degrees over a decade. However, researchers at Cicero argue that recent warm years indicate an accelerating approach toward this temperature threshold. A recent analysis conducted by the UN Environment Program (UNEP) examining countries' emissions reduction targets indicates a disconcerting trend. Should all nations adhere solely to their specified emissions reduction objectives, without further adjustments, the world is projected to experience a significant 2.9 degrees rise in temperature. This level of warming is categorized as catastrophic (Aasen, 2023).

## *2.2 Environmental, Social and Governance issues*

Building upon the principles established in the Paris Agreement, companies around the world are increasingly recognizing the need to integrate *Environmental* (E), *Social* (S), and *Governance* (G) principles into their operations. An ESG report, also known as a Sustainability report, is a document detailing ESG impacts. Fundamentally, ESG involves companies formulating strategic plans, identifying, and mitigating significant risks, while also recognizing emerging growth opportunities. This encompasses both their businesses and their boards' comprehensive oversight of these aspects (PwC, n.d.-e).

The ESG criteria is a three-part focus on non-financial considerations, which investors use to assess and rate companies (PwC, n.d.-d). Environmental concerns include issues such as climate risks, carbon emissions, energy efficiency, and the use of natural resources. The Social dimension delves into matters related to human capital, adherence to labor regulations, ensuring workplace safety, and human rights. On the Governance front, attention is directed towards aspects such as diversity, preventing corruption and bribery, and maintaining high business ethics standards (EY, n.d.). We have chosen to focus on the Environmental (E) part of ESG in our thesis, with particular focus on GHG emissions.

ESG functions as a comprehensive framework extending beyond regulatory compliance, fostering an integrative approach to sustainable business practices, which allows companies to openly discuss the risks and opportunities they encounter. ESG plays a vital role as a communication tool, essential for convincing stakeholders about the authenticity of the company's actions. The integration of ESG does not only align with global environmental goals, but also strengthens overall resilience, transparency, and positive societal influence. The increasing significance of sustainability reports is underscored by investors and other stakeholders, urging companies to provide more comprehensive disclosures regarding their ESG strategies (PwC, 2022).

According to PWC's Asset and wealth management survey 2022, 90 percent of investors hold the belief that integrating ESG factors into their investments will improve their returns (PwC, n.d.-e). However, ESG rating operates on the principle of *"single materiality,"* assessing the influence of global changes on a company's financial outcomes rather than vice versa. Bloomberg stated that ESG ratings do not assess the impact a company has on the Earth and the society, but rather assess how the world may impact the company and its shareholders (Pucker & King 2022).

The new EU Sustainability Directive, along with its associated standards, requires companies to conduct a *double materiality* analysis, forming the basis for both strategy and reporting. Double materiality involves evaluating the company through two perspectives: (1) its impact on external conditions and (2) the influence of external conditions on the company (Deloitte, n.d.). This concept ensures balanced reporting, as exemplified by the prevailing scenario under the Materiality principle of the Non-Financial Reporting Directive (NFRD) (Monciardini & Mähönen, 2021).

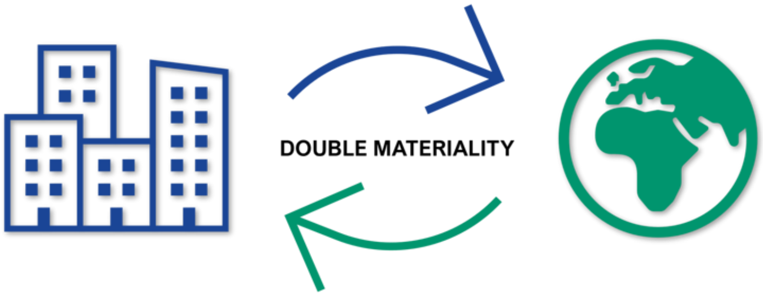


*Figure 2 - Double Materiality (Ricardo, 2023)*

### *2.2.1 The credibility of ESG*

As green markets expand, a challenge of trust has surfaced. Customers encounter difficulties in distinguishing genuine green claims (Netto et al., 2020). This refers to the fact that an organization presents inaccurate, unverified, or deceptive information regarding the eco-friendliness of a product, service, or overall business practices. This concept is known as *greenwashing* and undermines credible efforts to cut emissions and tackle the climate crisis. Such practices weaken the trust, drive, and measures essential for achieving a sustainable future (UN, 2023).

PwC’s Global Investor Survey 2023 states that 94 percent of investors believe that sustainability claims in ESG reporting lack proper support (Segal, 2023). While some greenwashing may be unintentional, due to lack of knowledge and awareness, there are also deliberate instances where companies intentionally mislead consumers through their marketing strategies (Peterdy, 2022). Companies engaging in greenwashing often vocalize their commitment to sustainability but fail to make any real contributions. In contrast, conscientious companies dedicate significant effort to establish mutual values that benefit both themselves and society. The primary advice of the guide against greenwashing emphasizes the importance of honesty and accountability. This entails providing thorough explanations and documented evidence to substantiate claims regarding sustainability (Grønnvaskingsplakaten, n.d.).

*Figure 3 - WWF Guide to Greenwashing (WWF, n.d.)*

The figure above from the Worldwide Fund for Nature, sums up how greenwashing can be revealed. Quantification of emissions can minimize the risk of greenwashing. Nevertheless, this requires the company to report on emissions from both the upstream and downstream cycle, to avoid a presentation of partial truths (Peterdy, 2022). If a company only reports on their direct emissions, this does not necessarily show the entire cycle. Indirect emissions are typically the largest emissions, and vital to report on to get an accurate understanding of the company's total emissions.

Despite various ongoing initiatives to standardize ESG reporting, investors will lack access to comparable and accurate measures in the future. This challenge makes it exceedingly difficult to attribute results or make credible impact claims (Pucker & King, 2022). To establish trust, companies must gather, analyze, and disclose robust, verifiable ESG data. Although companies may not silence all critics, taking a proactive approach to ESG reporting can set them apart from their peers and attract investments from those with a focus on ESG considerations (PwC, n.d.-e).

ESG ratings rely on relative rankings among industry peers, rather than adhering to universal standards. For instance, fossil fuel companies may receive higher ESG ratings than electric vehicle manufacturers. The data supporting ESG ratings are often incomplete, unaudited, and frequently outdated. Consequently, even those accountable for this data lack confidence in its accuracy. According to a recent study, over 70 percent of surveyed executives across various industries and regions reported a lack of confidence in their own non-financial reporting (Pucker & King, 2022).

### *2.2.2 The EU's response to criticism of ESG*

Confronting the challenges posed by the rising prevalence of greenwashing, the EU recently announced that the Parliament and Council have tentatively agreed on regulations. These regulations aim to prohibit deceptive advertisements and improve the quality of product information available to consumers. The prohibition will cover products intentionally designed to limit product durability. Only sustainability labels meeting approved certification schemes or authorized by public authorities will be permitted. Furthermore, guarantee details will be more visible, and a new label will be introduced for extended guarantees (European Parliament, 2023).

While tackling ESG issues, *the EU Action Plan* was established to boost sustainable economic growth. This measure includes ten key actions, which can be divided into three core objectives; (1) Reorient capital flows towards a more sustainable economy, (2) mainstream sustainability into risk management, and (3) fostering transparency and long-termism (European Commission, n.d.). The EU Action Plan is a pivotal step towards achieving the sustainability goals.

### *2.2.3 EU Taxonomy*

To meet the EU's 2030 climate goals, it is crucial to invest in sustainable projects. For this purpose, establishing a shared understanding and precise definition of sustainability is essential. The primary initiative in the EU Commission's action plan for financing sustainable growth involves the creation of a clear and comprehensive EU Taxonomy. This entails a classification system for sustainable activities, where the taxonomy is a pivotal element within the EU's sustainable finance framework. The EU taxonomy establishes criteria for economic activities that align with a trajectory targeting net-zero emissions by 2050. This agreement encourages more sustainable investments in the EU, by building trust among investors, preventing misleading environmental claims, and encouraging companies to adopt more eco-friendly practices. The legislation will provide investors and other stakeholders with a universal set of metrics within sustainability (European Commission, 2023-a).

In January 2022, the Taxonomy Regulation came into effect, serving as the legislation that governs the use and implementation of the EU Taxonomy (PwC, n.d.-c). The taxonomy provides a framework to evaluate how much an economic activity supports any of the EU's six environmental goals. These goals include: (1) climate change mitigation, (2) climate change adaptation, (3) responsible management of water and marine resources, (4) transition towards a circular economy, (5) prevention of pollution, (6) safeguarding biodiversity and ecosystems through protection and restoration efforts. To meet the criteria as environmentally sustainable within the taxonomy, businesses need to actively support one or more of the six established environmental goals. Simultaneously, causing substantial harm to any of the other remaining objectives must be avoided, and in addition, comply with minimum safeguards (EU Science Hub, n.d.). As companies adapt to changing standards, the integration of crucial data and metrics from the taxonomy into sustainability reporting becomes increasingly significant.

## *2.3 Sustainability reporting*

According to the IFAC-AICPA & CIMA study (2023), approximately 95 percent of large companies report on ESG issues. Most large companies will be required to report on the environmental sustainability of their economic activities, through the EU Taxonomy Regulation. These companies must adhere to the *Corporate Sustainability Reporting Directive* (CSRD), and are obligated to disclose their information in accordance with the taxonomy. Thus, essential data and relevant metrics from the EU Taxonomy will be incorporated into the CSRD report (Envoria, n.d.).

PwC's ESG investor survey states that eight out of ten global investors believe an assessment of ESG risk is critical when making good investment decisions (PricewaterhouseCoopers, n.d.-a). While companies are disclosing their ESG practices, the gap between reporting and actual environmental improvements requires closer examination. Despite increased reporting and growing interest in sustainable investing, carbon emissions have persistently increased, and environmental damage has escalated (Pucker, 2021). We must therefore delve deeper to assess the effectiveness of existing sustainability reporting initiatives.

### *2.3.1 Shortcomings in sustainability reporting*

Sustainability reporting today is characterized by being inconsistent, with both qualitative and quantitative deficiencies. This is partly due to a wide selection of voluntary sustainability standards, coupled with a limited number of concrete legal requirements. This makes it difficult for stakeholders to retrieve reliable information which is both relevant and comparable. According to Pucker (2021), corporate sustainability efforts have exhibited limited influence on either society or the planet. Moreover, the reporting itself is plagued by significant issues. Another challenge is the fact that consumers often lack an intuitive reference point to comprehend various measures of environmental impact, in contrast to easily understandable metrics like temperature (Pucker, 2021).

The Global Sustainable Investment Alliance reports that almost two-thirds of funds designated as socially responsible investments fall under the category of "negative screen" funds. While this approach may be attractive to individual investors, there is shortcomings in effectively monitoring, promoting, or rewarding ESG impact. Furthermore, there is a growing concern about the credibility of funds explicitly marketed as sustainable. A 2020 study by Barclays, analyzing two decades of ESG investing, found no discernible difference between the holdings of sustainable and traditional funds. Additionally, an investigation by the Wall Street Journal revealed that eight out of the ten largest ESG funds in 2019, were invested in oil and gas companies, raising questions about the alignment of such funds with their sustainable objectives (Pucker, 2021).

Comparing companies based on ESG performance is a challenging task due to significant discrepancies in reporting practices. Within various industries, individual firms present sustainability information in diverse formats. The challenge extends to evaluating the performance of a single company over time. Changes in methodology or the adoption of different metrics and standards to measure identical aspects can hinder meaningful year-to-year comparisons. This lack of uniformity in reporting methods poses a substantial barrier to the comprehensive assessment of ESG performance across companies and industries (Pucker, 2021).

Achieving real progress necessitates not only improved measurement and reporting practices, but also changes in regulations, investment incentives, and mindsets. While a considerable number of major companies report on their ESG issues, only a minority are validated by third parties. The real risk occurs when companies give the appearance of taking significant action, but minimal effort is being made. Consequently, much of the input data is misleading and incomplete. In contrast, financial reporting adheres to established standards, with compliance monitored by an auditor (Pucker, 2021).

### *2.3.2 Corporate Sustainability Reporting Directive (CSRD)*

The EU aims to ensure that sustainability information attains the same level of quality as financial reporting. Therefore, the EU has adopted the CSRD, alongside the European Sustainability Reporting Standards (ESRS). CSRD is a European sustainability directive, which enhances and supplements existing regulations on non-financial information, by instituting specific and compulsory reporting criteria along with attestation standards. The primary aim is to ensure the provision of both qualitative and quantitative information of high standard (PwC, n.d.-b). In accordance with the CSRD, sustainability reports must entail information about the enterprise’s own operations and the value chain, both upstream and downstream. This includes the company's products and services, business relationships and supply chain. Enhanced requirements for sustainability reporting content will offer greater detail, ensuring the provision of relevant, comparable, precise, and reliable information (PwC, n.d.-c).

When companies are assigned obligations for sustainability reporting, they are given a transition period of three fiscal years, to provide full details about the value chain (Revisorforeningen, 2023). CSRD will be implemented incrementally from 2024 in relation to the size of the company. Therefore, the rules will first apply for large enterprises which are businesses of general interest, with a minimum of 500 full-time employees throughout the fiscal year. Companies of general interest include listed companies, banks, credit companies and insurance companies (Finanstilsynet, 2022).

As of 2025, the remaining large enterprises that failed to meet these requirements, are also obligated to comply with the CSRD. Large enterprises are companies which exceed the limits for two of the following three conditions: balance sheet of NOK 160M, sales revenue of NOK 320M, and 250 full-time employees. Small and medium-sized enterprises with securities listed on a regulated market in the EEA, as well as large enterprises functioning as smaller and less complex financial entities, are required to initiate reporting starting in 2026. Small enterprises are defined as companies that do not surpass two out of three of the following criteria: balance sheet of NOK 35M, sales revenue of NOK 70M, and 50 full-time employees. As of now, the new regulations do not encompass small and medium-sized unlisted companies (Revisorforeningen, 2023).

*The Securities Act Committee* suggests that annual reports should include details about the company's sustainability impact and the influence of various sustainability factors on the company's growth, position, and financial outcomes. This involves assessing how well the company's business model and strategic initiatives are in line with the transition to a sustainable economy. Furthermore, it includes the goal of limiting global warming to 1.5 degrees Celsius and reaching net-zero emissions by 2050 (Revisorforeningen, 2023). Therefore, accounting for greenhouse gases has become a key component in efforts to reduce and manage climate change. The ability to monitor, analyze, and subsequently decrease emissions is an essential aspect of these efforts. This requires precise quantification and documentation of emissions from various sources, such as industry, transport, and energy production.

# 3. Methodology

## *3.1 Non-data driven thesis*

This master's thesis is *non-data driven*, where the quantitative values employed are hypothetical. Opting for a fictional company was deliberate, as actual data is not requisite for addressing the research question. The primary objective is to illustrate the process of creating an environmental balance sheet, intentionally maintaining simplicity in this example. Subsequently, the thesis will delve into the accounting methods for different greenhouse gases within this balance sheet. The emission metrics applied to converting GHGs into the same quantity are $GWP_{100}$, $GWP_{20}$, $GTP_{100}$ and $GTP_{20}$.

## *3.2 Steel Production*

The steel industry is known for high emissions of greenhouse gases, and the industry alone accounts for almost 8 percent of the world's total $CO_2$ emissions. Operating as one of the most polluting industries globally, steel production faces a significant challenge in minimizing emissions due to its energy-intensive nature (Lei et al., 2023). Today, two primary methods are used to produce steel: either through blast furnaces or electric arc furnaces. The essential difference between these methods is that the blast furnace uses iron ore and coal, while the electric arc furnace is based on scrap and electricity. The ore-based and most polluting method accounts for approximately 70 percent of the world's production, while the remaining 30 percent comes from scrape-based production (Norsk Stål, n.d.).

In traditional steel production, approximately two tons of $CO_2$ are emitted for every ton of steel produced (Nordic Steel, n.d.). In blast furnace production, iron ore is melted in the reduction process, where crude iron is produced. Coking coal is used as fuel, which causes the iron ore to release oxygen (oxides) at an extremely elevated temperature. The oxides bind to the carbon during the melting process, producing substantial amounts of $CO_2$. However, the $CO_2$ contribution from steel production does not only come from the blast furnaces and their use of coal coke. In addition, significant contributions come from the mine itself and from the transportation of iron ore from the mine (ArcelorMittal, n.d.).

### *3.2.1 Fictitious steel company "Stockholm Steel"*

Given the substantial emissions attributed to the steel industry, we have opted to utilize emission data from a hypothetical steel company "*Stockholm Steel*," to generate climate accounts in subsequent sections of this thesis. An additional factor influencing our decision, is that steel production causes both $CO_2$ and $CH_4$ emissions, which shows the conversion problem we will address later in the thesis. Since production of steel from blast furnaces is the most used method today and results in the highest emissions of greenhouse gases, we have chosen to base our thesis on this method. This method is rarely used in Norway today, which is why we have based our study on a fictitious Swedish company. Due to the high emissions from steel production, the company will not be able to reduce their overall emissions. Therefore, we will also introduce various measures for carbon offsetting.

# 4. Financial Accounting

## *4.1 Accounting*

Accounting provides an insight into a company's financial status and progressions. It involves documenting and monitoring the inflow and outflow of resources within the company. This practice is crucial for understanding the company's financial situation and to be able to make necessary adjustments, such as cost reduction or increasing the workforce. Moreover, accounting contributes to transparency in the business world (Iwuozor, 2023).

Listed companies within the EU are mandated to disclose their financial statements following a unified set of global standards, known as *International Financial Reporting Standards* (IFRS). Compliance with IFRS requires that the accounts are prepared based on four principles: *clarity*, *relevance*, *reliability*, and *comparability* (Morley, 2016). This not only facilitates understanding and assessment within corporations, but also enhances trust and reliability for stakeholders operating in a globalized economy.

## *4.2 Balance Sheet and Income Statement*

In financial accounting, the *income statement* provides insight into how profitable or unprofitable a business has been in the given period, and consists of income and expenses. The difference between these that constitutes the result, and the income statement thus states whether the company has made a profit or a loss (Schmidt, 2023). Profits contribute positively to the company's equity, while a loss has the opposite effect, weakening the equity.

The income statement shows only the company's financial performance for a specific period, and it is therefore important to consider other financial reports, such as the *balance sheet*. This gives a comprehensive understanding of the company's financial situation. A balance sheet provides information on how values and funds are distributed in the company, and consists of the firm's *assets*, *liabilities*, and *equity* (Stobierski, 2020). This shows what the company owns, and what proportion of these assets is financed with own funds, and what proportion is funded with debt (Systima, 2021).

## 4.3 Bookkeeping

The practice of monitoring a business's financial transactions is referred to as *bookkeeping*. This involves documenting the inflow and outflow of money within the business. To ensure accurate tracking, all transactions within the company must be registered in the ledger. *Double entry bookkeeping* stands a fundamental principle in accounting practices. This method entails recording each transaction twice, once as debit and once as credit, where the sum of debits must align with the total of credits. This approach is based on the basic principle in the balance sheets, ensuring that assets equal liabilities and equity.

## 4.4 Accounting for Stockholm Steel

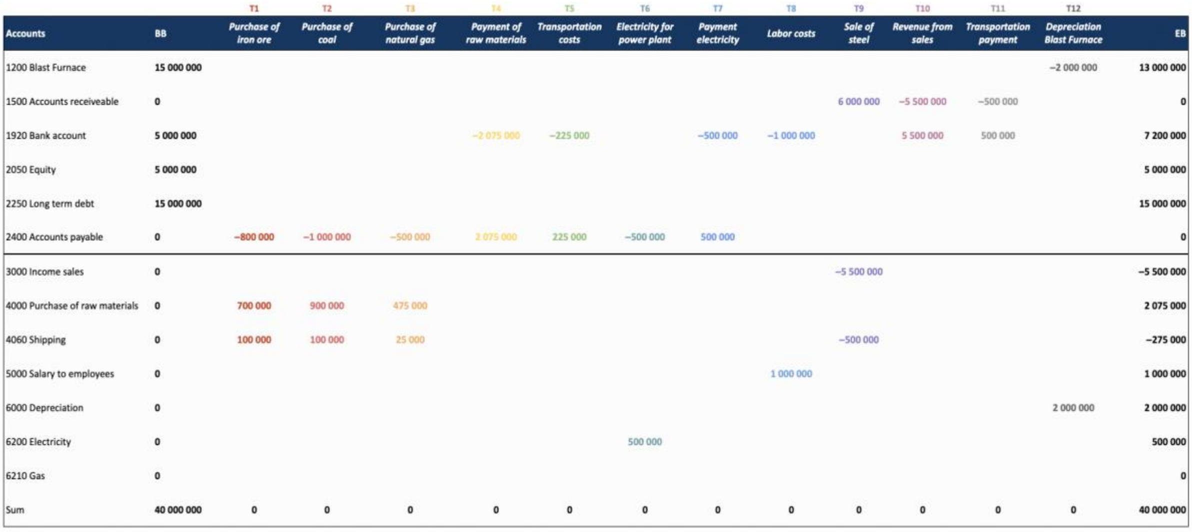
In this section of the thesis, we will construct a balance sheet and income statement for Stockholm Steel, based on financial transactions we believe are significant for the company as a steel producer. The transactions are recorded in accordance with the principle of double-entry bookkeeping. As mentioned initially, our thesis revolves around a fictitious steel mill, implying that the transactions and their corresponding values are entirely fictitious. Nonetheless, we have familiarized ourselves with contemporary steel production, and the transactions in table 1 are grounded in this comprehension. To simplify matters, the entries do not consider taxes and VAT.

**Financial transactions**

1. *Purchase of iron ore*
2. *Purchase of coal*
3. *Purchase of natural gas*
4. *Payment of raw materials*
5. *Transportation costs*
6. *Electricity for power plant*
7. *Payment electricity*
8. *Salary costs*
9. *Sale of steel*
10. *Payment sale*
11. *Transportation payment*
12. *Depreciation blast furnace*

*Table 1 – Financial transactions for Stockholm Steel*

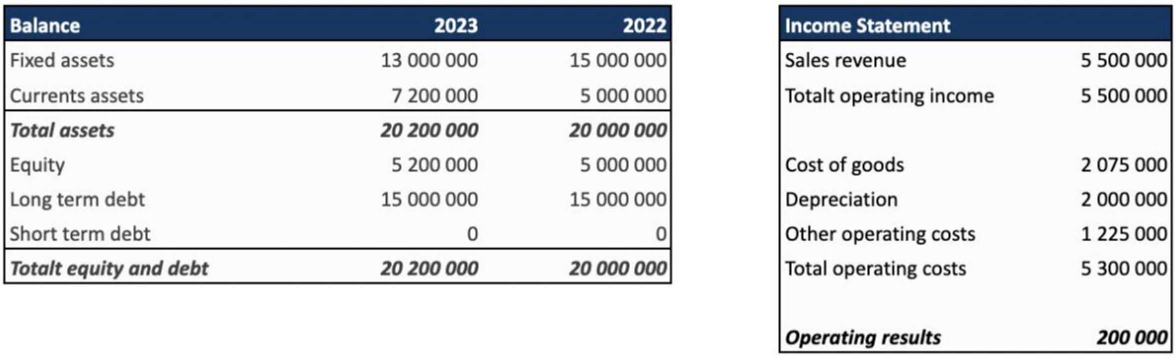
In the table below we have recorded the financial transactions related to the corresponding cost account (Review appendix 1 for bookkeeping using T – accounts). The cost accounts in the 1000 series are assets, while the 2000 series accounts for equity and liabilities. These accounts collectively constitute the company's balance sheet. Account 3000 represents revenues, while the remaining accounts represent expenses. Together, these accounts comprise the company's income statement.



| | | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accounts** | **BB** | ***Purchase of iron ore*** | ***Purchase of coal*** | ***Purchase of natural gas*** | ***Payment of raw materials*** | ***Transportation costs*** | ***Electricity for power plant*** | ***Payment electricity*** | ***Labor costs*** | ***Sale of steel*** | ***Revenue from sales*** | ***Transportation payment*** | ***Depreciation Blast Furnace*** | **EB** |
| 1200 Blast Furnace | **15 000 000** | | | | | | | | | | | | −2 000 000 | **13 000 000** |
| 1500 Accounts receiveable | **0** | | | | | | | | | 6 000 000 | −5 500 000 | −500 000 | | **0** |
| 1920 Bank account | **5 000 000** | | | | −2 075 000 | −225 000 | | −500 000 | −1 000 000 | | 5 500 000 | 500 000 | | **7 200 000** |
| 2050 Equity | **5 000 000** | | | | | | | | | | | | | **5 000 000** |
| 2250 Long term debt | **15 000 000** | | | | | | | | | | | | | **15 000 000** |
| 2400 Accounts payable | **0** | −800 000 | −1 000 000 | −500 000 | 2 075 000 | 225 000 | −500 000 | 500 000 | | | | | | **0** |
| 3000 Income sales | **0** | | | | | | | | | −5 500 000 | | | | **−5 500 000** |
| 4000 Purchase of raw materials | **0** | 700 000 | 900 000 | 475 000 | | | | | | | | | | **2 075 000** |
| 4060 Shipping | **0** | 100 000 | 100 000 | 25 000 | | | | | | −500 000 | | | | **−275 000** |
| 5000 Salary to employees | **0** | | | | | | | | 1 000 000 | | | | | **1 000 000** |
| 6000 Depreciation | **0** | | | | | | | | | | | | 2 000 000 | **2 000 000** |
| 6200 Electricity | **0** | | | | | | 500 000 | | | | | | | **500 000** |
| 6210 Gas | **0** | | | | | | | | | | | | | **0** |
| Sum | **40 000 000** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **40 000 000** |

*Table 2 - Bookkeeping of financial transactions*

The *beginning balance* (BB) derives from the prior period, while we obtain the *ending balance* (EB) by adding the BB to the transactions occurring in the current period. We use values from both the beginning balance and ending balance to generate the company's balance sheet, whereas the income statement solely consists of values from the ending balance. We incorporate both periods when preparing the balance sheet to track the development of the company's assets and liabilities from year to year. The income statement reveals that the company has earned a profit of 200 000 at the end of the account period. This entire profit is allocated to the company's retained earnings or equity earned. The values from the company's balance sheet and income statement can be utilized for further calculations of key figures such as profitability, liquidity, and solvency.



| Balance | 2023 | 2022 |
|---|---|---|
| Fixed assets | 13 000 000 | 15 000 000 |
| Currents assets | 7 200 000 | 5 000 000 |
| ***Total assets*** | ***20 200 000*** | ***20 000 000*** |
| Equity | 5 200 000 | 5 000 000 |
| Long term debt | 15 000 000 | 15 000 000 |
| Short term debt | 0 | 0 |
| ***Totalt equity and debt*** | ***20 200 000*** | ***20 000 000*** |

| Income Statement | |
|---|---|
| Sales revenue | 5 500 000 |
| Totalt operating income | 5 500 000 |
| | |
| Cost of goods | 2 075 000 |
| Depreciation | 2 000 000 |
| Other operating costs | 1 225 000 |
| Total operating costs | 5 300 000 |
| | |
| ***Operating results*** | ***200 000*** |

*Table 3 - Economic balance sheet and income statement*

# 5. Climate accounting

## 5.1 Carbon accounting

Similar to financial accounting, *carbon accounting* aims to quantify the impact of a company's operations. However, rather than focusing on the financial implications, carbon accounting assesses the impact these activities exert on the climate. This approach is a relatively new field, but has already become a valuable tool in the fight against climate change. Accurate carbon accounting provides the company with insights into its contributions to global warming and identifies areas where emissions reduction can be implemented. Understanding the company's environmental impact is crucial in today's climate economy, and for many stakeholders, a robust climate account holds equal significance to financial records. This evolving perspective reflects a growing recognition of the interrelationship between business operations and its environmental impact (Farbstein et al., 2023).

Carbon accounting determine the company's *carbon footprint,* and give insight into the sources of the emissions (Farbstein et al., 2023). A carbon footprint represents the overall volume of greenhouse gases produced by an individual or a company's activities (The Nature Conservancy, 2019). This includes both direct emissions, such as those from fossil fuel combustion, heating, and transportation, as well as indirect emissions required to produce electricity associated with goods and services consumed. Carbon footprints emphasize emissions linked to consumption rather than production, and thus includes emissions related to goods imported to a country, but manufactured elsewhere. Consequently, a country's carbon footprint might expand even if emissions within its border decrease (Selin, 2023).

### 5.1.1 How carbon accounting works

Carbon accounting depends on two categories of information: *business data* and *emission factor*s. Business data delineates the actions conducted by a company, which can be classified as either (1) *spend data*; how much money was paid to company x for a certain good or service, or (2) *activity data*; how many liters of fuel or kilograms of materials were bought. By combining these approaches, the hybrid model provides a more comprehensive and balanced overview of a company's carbon footprint. This methodology ensures a realistic and feasible approach to estimating emissions where direct data might lack. These data can further be categorized into different scopes, which we will delve into in the next subchapter (Farbstein et al., 2023).

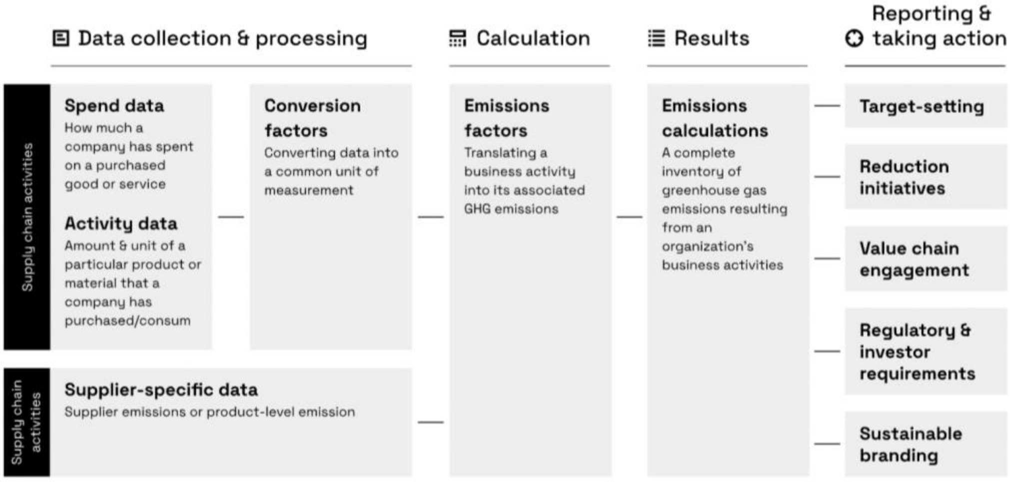


*Figure 4 - The carbon accounting process, from data collection to reporting (Farbstein et al., 2023)*

*Emission factors* constitute the second type of data necessary for carbon accounting. These factors delineate the volume of GHG emissions linked to a particular unit of business data. Once all the needed data is gathered, it can be converted into emissions statements. The process for this varies depending on the methodology applied (Farbstein et al., 2023).

### *5.1.2 Emission equations*

To show the total emissions of $CO_2$ equivalents from the steel mill, we can use the following equation:

$$E_{(i,t)} = E_{(combustion\ i,t)} + E_{(process\ i,t)}$$

where, *i* represents the steel mill, *t* represents year, and *E* represents total $CO_2$ emissions. $E_{combustion}$ is the total emissions from stationary combustion, while $E_{\text{process}}$ is the emissions from the industrial process (Lei et al., 2023).

Based on fuel consumption, we can estimate combustion-related emissions from the steel mill, using the equation:

$$E_{(combustion\ i,t)} = E_{(reheating\ furnaces)} + E_{(coke\ production\ i,t)} + E_{(pig\ iron\ making\ i,t)} + E_{(crude\ steel\ i,t)}$$

These emissions represent the energy-related $CO_2$ emissions. This includes emissions from reheating furnaces, coke production, pig iron making, and crude steel. Smelting iron ore with a high-carbon fuel and reductant, such as coke, produces pig iron as the end result (International Iron Metallics Association, 2018).

Furthermore, we can also estimate the steel mill's process-related emissions:

$$E_{(process\ i,t)} = E_{(Sinter\ i,t)} + E_{(DRI\ i,t)}$$

These emissions denote $CO_2$ emissions not associated with energy use, originating from *sinter making* and *direct reduction iron* (DRI) making processes. These equations provide insight into the source of $CO_2$ emissions within the steel production process.

## 5.2 Greenhouse Gas Protocol

The EU directive on sustainability reporting, CSRD, became effective in January 2023. Prior to this, it was not mandatory for EU entities to maintain climate accounts. However, many companies chose to do so to expand their customer base, attract investors and strengthen their brand. The most widely recognized framework for greenhouse gas accounting is the *Greenhouse Gas Protocol*, often abbreviated to the GHG protocol. This standard serves to identify significant emission sources and allows for consistent reporting of climate footprints (Emisoft, 2021). It is important to note that the GHG protocol does not directly record emissions, but rather categorizes and makes them summable.

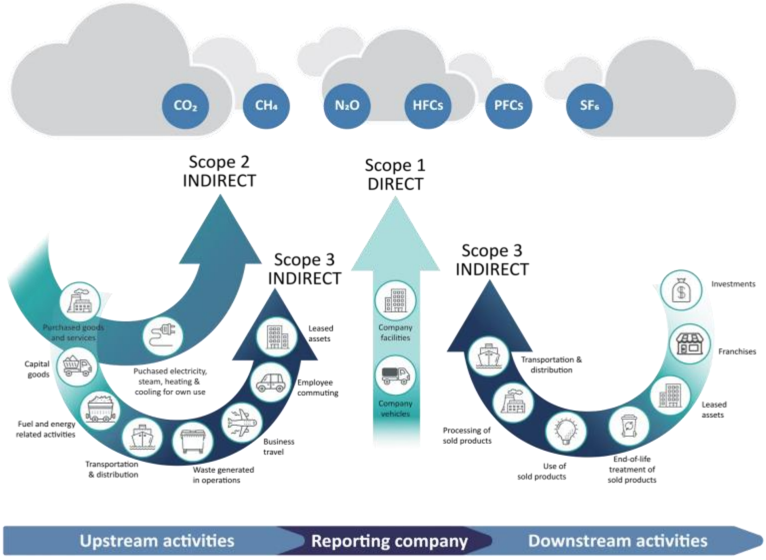


*Figure 5 - The GHG protocol (Farbstein et al., 2023)*

According to the GHG protocol, emissions must be reported across *three* distinct levels (Kaplan & Ramanna, 2021):

**Scope 1** is a company's direct emissions, where the company itself owns or controls the equipment. This mostly applies for emissions from the production or combustion of fuel in the company's vehicles. Reporting on this aspect of the climate statement is mandatory, leading many companies to focus on the reduction of scope 1 emissions.

**Scope 2** is an indirect emission from purchased energy. These emissions come from four categories: e*lectricity*, *district heating*, *district cooling*, and *steam*. For those who create energy, emissions from production are considered as scope 1, while for businesses who buy energy, these emissions are considered as scope 2. Emissions under this scope are mandatory to report on if you report in accordance with the GHG protocol.

**Scope 3** includes other indirect emissions, such as emissions linked to transport and travel. It is voluntary to report on emissions under this scope, even though this is often where the largest GHG emissions are located, with as much as 80 - 99 percent of a company's total emission footprint. It is recommended to estimate the indirect impact a company has, despite the difficulty of tracking emissions from multiple suppliers and customers across value chains.

This makes it almost impossible for a company to reliably estimate its scope 3 emissions. The *Carbon disclosure Project* (CDP), an international non-profit organization, states that less than half of the companies disclosing such information actively monitor and report their scope 3 emissions (Pucker, 2021).

Despite the GHG protocol being the standard methodology underlying most ESG standards, it reveals significant flaws. The same emissions are reported multiple times by different companies in the value chain, while some completely ignore emissions from their supply chain (Kaplan & Ramanna, 2021). In our case, consider the challenges faced by a manufacturer of steel. Scope 3 reporting requires the company to track all greenhouse gas emissions from the processes of its upstream suppliers, including extraction of raw materials and transport of these to the production facility. The company must also estimate the GHG impact of downstream activities, including transportation to the customer, production of the final product and further transport to the end customer (Kaplan & Ramanna, 2021). In theory, the value chain of the company's carbon footprint can become infinite.

In table 4, we have organized the environmental activities conducted at Stockholm Steel, detailing emissions across various scopes according to the GHG protocol. Similar to financial accounting, it is crucial to document all the environmental transactions to comprehend their impact on the company's environmental balance sheet.

| ***Scope*** | ***Emitting activity*** |
|---|---|
| ***Scope 1*** | *Coking and sintering from iron ore*<br>*Reduction of iron ore in a blast furnace*<br>*Burning of coal for heating and reduction reactions*<br>*Natural gas for heating and reduction reactions.* |
| ***Scope 2*** | *Electricity from the coal power plant* |
| ***Scope 3*** | *Extraction of iron ore and coal*<br>*Transportation of the materials* |

*Table 4 - Emitting activities sorted into scopes*

### *5.3 The environmental Balance Sheet and Income Statement*

As previously discussed, a traditional balance sheet delineates assets as the company's owned or controlled resources, while liabilities denote the company's obligations. The difference between liabilities and assets reveals the company's equity. In an *environmental balance sheet,* the aim is to account for environmental impacts in a manner similar to financial accounting. Presently, corporate reports on carbon emissions do not adhere to universally accepted accounting standards. The environmental accounting system outlined in the latter of this chapter, takes historical cost accounting rules as a template to generate a carbon emission (CE) balance sheet and flow statement.

On the asset side of the environmental balance sheet, we get an overview of the emissions the company "owns." This could include emissions directly from their production facilities or emissions transferred to them from suppliers. The liability side shows the company's cumulative direct emissions into the atmosphere, as well as the cumulative emissions in goods acquired, minus those sold to customers (Reichelstein, 2023). The balance equation for the environmental balance does not include equity but considers *carbon credits* on the liability side. Carbon credits can be seen as a way to balance or compensate for the liabilities associated with carbon emissions, which is a concept we will revisit in a later chapter of the thesis.
Emissions from the production process are categorized as direct emissions (DE), which act as liabilities, indicating the company's responsibility for these emissions. Other emissions, such as those related to purchased goods and services (ETI) or emissions associated with the final product sold (ETO), are also recorded as liabilities. This illustrates the inflow and outflow of emissions concerning the company and their economic transactions.

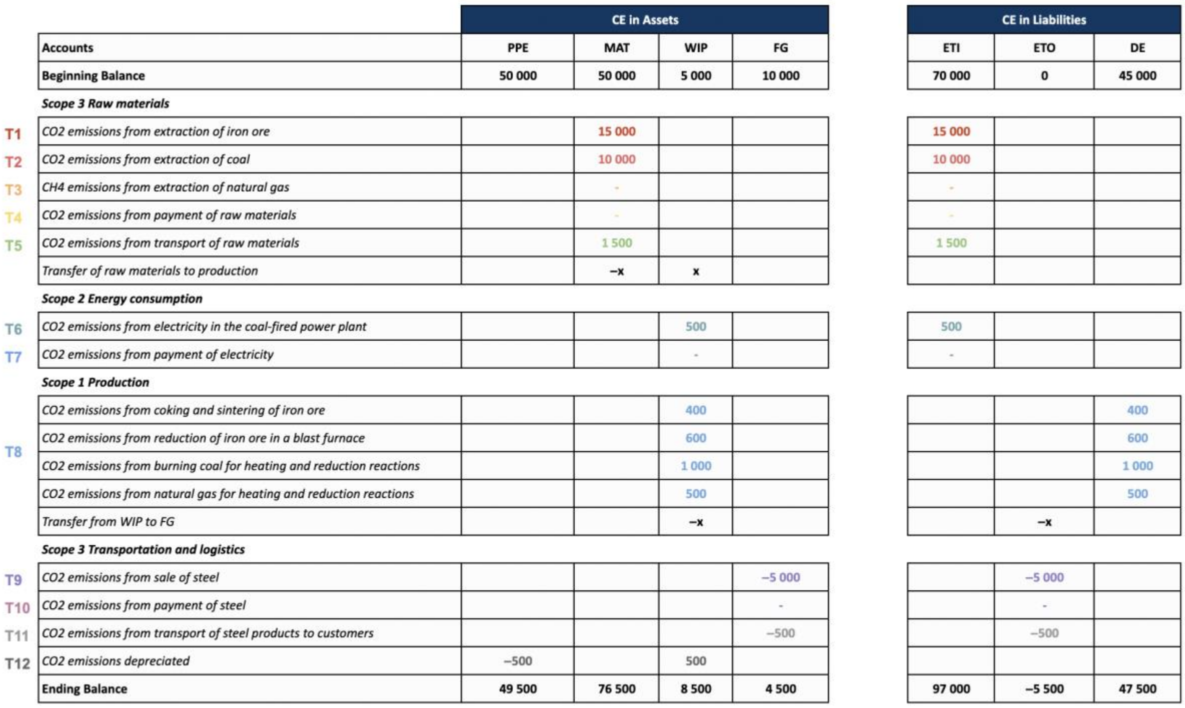
For instance, when Stockholm Steel acquires raw materials, the $CO_2$ emissions from the suppliers' production and transportation are incorporated into the company's CE balance sheet. These emissions become part of the company's assets and liabilities. When selling finished goods, a proportion of these production emissions are transferred out to the customer. This method not only enables companies to understand their direct emissions, but also emphasizes the significance of emissions related to the supply chain, procurement processes, and the lifecycle of their products. This aligns with the growing emphasis on corporate environmental responsibility and sustainability, allowing for formed decisions aimed at reducing environmental impacts across the value chain.

The table below shows the company's environmental transactions along with the associated emissions corresponding to each transaction. The environmental transactions are based on the financial ones from the previous chapter. Some of these transactions, such as payment for goods, will consequently not have any associated emissions.

| **Transactions** | **CO2 emissions (In tons)** |
|---|---|
| *Extraction of iron ore* | 15 000 |
| *Extraction of coal* | 10 000 |
| *Extraction of natural gas* | - |
| *Payment of raw materials* | - |
| *Transportation of raw materials* | 1 500 |
| *Electricity in the coal-fired power plant* | 500 |
| *Payment of electricity* | - |
| *Coking and sintering of iron ore* | 400 |
| *Reduction of iron ore in a blast furnace* | 600 |
| *Burning coal for heating and reduction reactions* | 1 000 |
| *Natural gas for heating and reduction reactions* | 500 |
| *Sale of steel* | -5 000 |
| *Payment of steel* | - |
| *Transportation of steel products to customers* | −500 |

*Table 5 - Environmental transactions*

In table 6, we have established an environmental balance sheet, by recording the aforementioned transactions following the principle of double-entry bookkeeping (Review appendix 2 for bookkeeping using T – accounts). The layout draws inspiration from the article *"Corporate Carbon Emission Statements"* authored by Stefan Reichelstein (2023), published by the University of Mannheim.



| | | CE in Assets | | | | CE in Liabilities | | |
|---|---|---|---|---|---|---|---|---|
| | **Accounts** | **PPE** | **MAT** | **WIP** | **FG** | **ETI** | **ETO** | **DE** |
| | **Beginning Balance** | **50 000** | **50 000** | **5 000** | **10 000** | **70 000** | **0** | **45 000** |
| | ***Scope 3 Raw materials*** | | | | | | | |
| T1 | *CO2 emissions from extraction of iron ore* | | 15 000 | | | 15 000 | | |
| T2 | *CO2 emissions from extraction of coal* | | 10 000 | | | 10 000 | | |
| T3 | *CH4 emissions from extraction of natural gas* | | - | | | - | | |
| T4 | *CO2 emissions from payment of raw materials* | | - | | | - | | |
| T5 | *CO2 emissions from transport of raw materials* | | 1 500 | | | 1 500 | | |
| | *Transfer of raw materials to production* | | −x | x | | | | |
| | ***Scope 2 Energy consumption*** | | | | | | | |
| T6 | *CO2 emissions from electricity in the coal-fired power plant* | | | 500 | | 500 | | |
| T7 | *CO2 emissions from payment of electricity* | | | - | | - | | |
| | ***Scope 1 Production*** | | | | | | | |
| T8 | *CO2 emissions from coking and sintering of iron ore* | | | 400 | | | | 400 |
| | *CO2 emissions from reduction of iron ore in a blast furnace* | | | 600 | | | | 600 |
| | *CO2 emissions from burning coal for heating and reduction reactions* | | | 1 000 | | | | 1 000 |
| | *CO2 emissions from natural gas for heating and reduction reactions* | | | 500 | | | | 500 |
| | *Transfer from WIP to FG* | | | −x | | | −x | |
| | ***Scope 3 Transportation and logistics*** | | | | | | | |
| T9 | *CO2 emissions from sale of steel* | | | | −5 000 | | −5 000 | |
| T10 | *CO2 emissions from payment of steel* | | | | - | | - | |
| T11 | *CO2 emissions from transport of steel products to customers* | | | | −500 | | −500 | |
| T12 | *CO2 emissions depreciated* | −500 | | 500 | | | | |
| | **Ending Balance** | **49 500** | **76 500** | **8 500** | **4 500** | **97 000** | **−5 500** | **47 500** |

*Table 6 - Environmental balance*

The balance shows carbon emissions linked to assets on the left side, and liabilities on the right side. Emissions related to assets are categorized into Plant, Property and Equipment (PPE), Materials (MAT), Work In Process (WIP), and Finished Goods (FIG). The beginning balance represents emissions carried over from the previous period. As ETO represents emissions transferred from the company to the buyer upon product sale, the starting balance is zero. The ending balance comprises the beginning balance plus all the transactions throughout the period, akin to the principles applied in financial accounting.

For the company to manufacture steel, they require raw materials such as iron ore and coal. These raw materials are sourced from mines by an external supplier. The emissions generated during this extraction process are transferred to Stockholm Steel upon their purchase of raw materials. This is illustrated in T1 and T2, where emissions are recorded as MAT on the asset side and ETI on the liabilities side. T3 is emissions from extraction of natural gas, specifically leakage of $CH_4$ emissions. There are no $CO_2$ emissions during this process. Since we are currently only recording $CO_2$ emissions, this transaction does not impact the carbon balance yet. The payment of the materials, T4, does not impact the carbon balance. Subsequently, the transportation of these raw materials to the production facility results in emissions (T5), similarly accounted for as in the extraction process. T5 will also emit $CH_4$, which we will be addressed in the next chapter. Emissions from these transactions are all within scope 3.

Indirect emissions stemming from the electricity in the steel mill's production are categorized under scope 2, recorded as WIP and ETI (T6 & T7). The emissions generated during production are categorized as scope 1 emissions (T8) and recorded under WIP on the assets side. These emissions, directly associated with the company's machinery, are entered as DE on the liabilities side. Upon completion of the steel production, the goods are slated for sale. At this stage, a portion of these emissions generated during steel production is transferred to the buyer, T9. The payment transaction (T10) does not result in emissions. Subsequently, Stockholm Steel transports the steel to the customer (T11), which entails emissions. T9 and T11 go under scope 3, and are entered on the left side as FG, and on the right as ETO. Towards the end, T12 illustrates depreciation. Given that the company has not procured any new machinery or equipment in this period, there are no transactions in PPE. However, the beginning balance in PPE undergoes depreciation. This deprecation solely impacts assets on the left side, PPE and WIP, and does not affect any accounts on the liability side.

Similar to the economic balance sheet, we utilize the ending balance (EB) to formulate a CE balance sheet with assets and liabilities, and an income statement detailing the $CO_2$ emissions from this period. We determine the company's total emissions by summing up DE and ETI, and then subtracting ETO. From the balance sheet we can see that the company has experienced an increase in emissions compared to the previous period. This indicates that the company needs to reduce emissions across the value chain.

**Balance sheet**

| Assets | 2023 | 2022 |
|---|---|---|
| PPE | 49 500 | 50 000 |
| MAT | 76 500 | 50 000 |
| WIP | 8 500 | 5 000 |
| FG | 4 500 | 10 000 |
| ***CE in assets*** | ***139 000*** | ***115 000*** |
| **Liabilities** | | |
| ETI | 97 000 | 70 000 |
| ETO | –5 500 | 0 |
| DE | 47 500 | 45 000 |
| ***CE in liabilities*** | ***139 000*** | ***115 000*** |

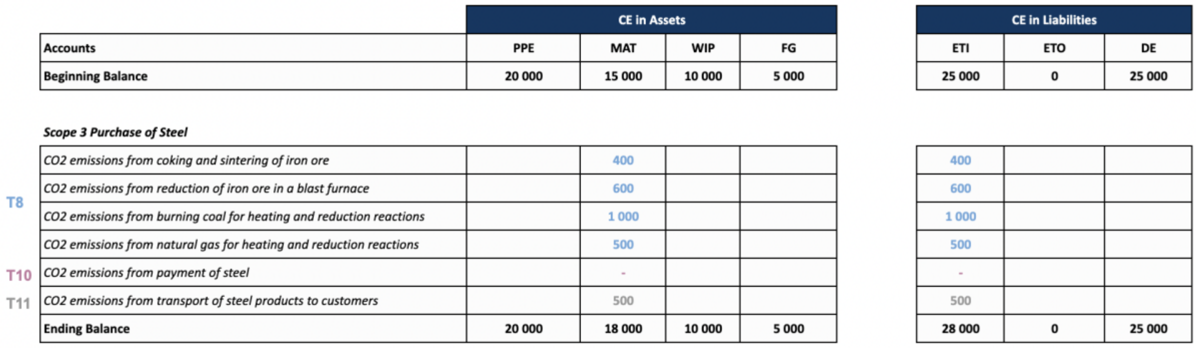
**Income Statement**

| | 2023 |
|---|---|
| ETI | 27 000 |
| DE | 2 500 |
| ETO | –5 500 |
| ***Total emissions*** | ***24 000*** |

*Table 7 – Environmental Balance sheet and Income Statement*

### 5.3.1 Emissions transferred out

To illustrate how the company's carbon footprint operates, we have created a simplified balance sheet. This reveals the transfer of outgoing emissions from Stockholm Steel to a construction company that acquires finished steel. When the construction company purchases steel, the emissions generated during the steel production process will be transferred to their carbon balance, in addition to emissions related to transportation. This demonstrates how emissions are not restricted to one location; they shift as goods are purchased and utilized. Understanding this concept enables a comprehensive understanding of the environmental impact of businesses, and emphasizes the significance of emissions reduction.



| | | CE in Assets | | | | CE in Liabilities | | |
|---|---|---|---|---|---|---|---|---|
| | **Accounts** | **PPE** | **MAT** | **WIP** | **FG** | **ETI** | **ETO** | **DE** |
| | **Beginning Balance** | **20 000** | **15 000** | **10 000** | **5 000** | **25 000** | **0** | **25 000** |
| | ***Scope 3 Purchase of Steel*** | | | | | | | |
| T8 | *CO2 emissions from coking and sintering of iron ore* | | 400 | | | 400 | | |
| | *CO2 emissions from reduction of iron ore in a blast furnace* | | 600 | | | 600 | | |
| | *CO2 emissions from burning coal for heating and reduction reactions* | | 1 000 | | | 1 000 | | |
| | *CO2 emissions from natural gas for heating and reduction reactions* | | 500 | | | 500 | | |
| T10 | *CO2 emissions from payment of steel* | | - | | | - | | |
| T11 | *CO2 emissions from transport of steel products to customers* | | 500 | | | 500 | | |
| | **Ending Balance** | **20 000** | **18 000** | **10 000** | **5 000** | **28 000** | **0** | **25 000** |

*Table 8 - Transferred emissions to the customer*

# 6. The conversion problem with multiple greenhouse gases

## *6.1 Emission metrics*

The focus in both research and political debate regarding emissions reduction has predominantly been on cutting $CO_2$ emissions from fossil fuels. In recent times, there has been an increased emphasis on the impact of other greenhouse gases, such as $CH_4$ (Lahn & Aamas, 2019). A crucial aspect to recognize, is that cutting one ton of $CO_2$ does not have the same significance as cutting one ton of $CH_4$. Consequently, it becomes essential to choose a climate parameter to quantify and compare the climate impacts of diverse emissions. *$CO_2$ equivalents* refers to the amount of $CO_2$ or other gases, in terms of the amount of $CO_2$ that would produce an equivalent climate impact (SSB, 2022).

To measure and compare several types of greenhouse gases, one can utilize what is known as *emission metrics*. These metrics function as an *"exchange rate"* in policies or when comparing emissions from different regions or sectors (Myhre et al., 2013). It is important to note that emission metrics do not define goals and policies, but serve as tools that enable evaluation and implementation of emissions policies. Converting $CH_4$ into $CO_2$ equivalents requires consideration of two aspects; (1) the chosen time horizon one wishes to compare, and (2) the specific changes in the climate system one is interested in evaluating. These aspects can for instance be temperature or radiative forcing. The selection of these parameters significantly influences the equivalence calculation between diverse greenhouse gases, recognizing their varying impact on climate over time.

### *6.1.1 Why we have chosen to use emission metrics*

The conversion problem is relevant for both physicists and economists, who tend to assess this issue from a different point of view. As economists, we address this matter from an economic standpoint and have thus concluded that emission metrics are most suitable for further analysis. Emission metrics are user-friendly, and do not require advanced software programs. In our thesis, we utilize the two widely recognized emissions metrics: *Global Warming Potential* (GWP) and *Global Temperature Change Potential* (GTP).

We have chosen not to look further into climate models due to their physics-centered approach rather than an economic perspective. Based on different scenarios of greenhouse gas emissions, these models provide predictions about future climate conditions. However, climate models are also a subject of uncertainty, and utilizing them necessitates complex computer systems and specific data to simulate the climate system (Reichle, p. 389, 2020).

## *6.2 Global Warming Potential*

In 1990, the *Intergovernmental Panel on Climate Change* (IPCC) introduced the Global warming potential as a method to compare different greenhouse gases. GWP compares the change in the radiation balance as a result of an emission over a given period of time, with time horizons of 20, 100 and 500 years. GWP's evaluation varies based on the chosen time horizon; shorter periods of time result in higher values for short-lived greenhouse gases (Lahn & Aamas, 2019). Consequently, when evaluating the impact of emissions over shorter periods, gases like $CH_4$ exhibit significantly higher values than $CO_2$.

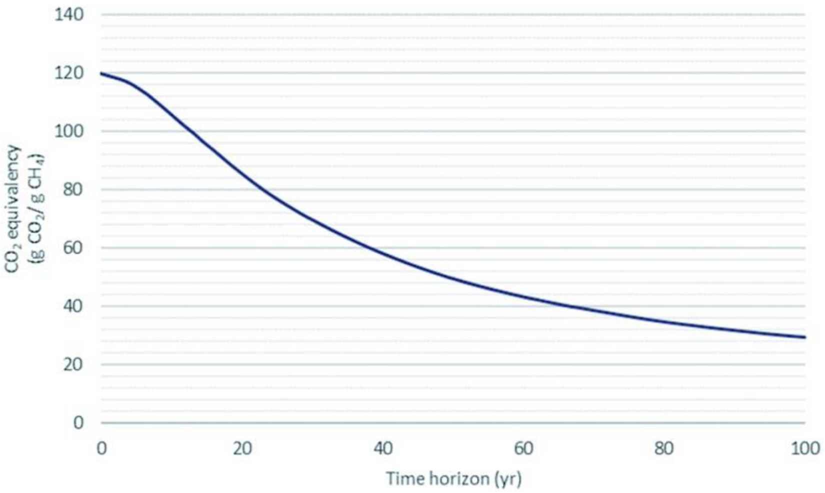


*Figure 6 - GWP of methane over different time horizons (Balcombe et al., 2018)*

When the Kyoto Protocol was adopted in 1997, it was necessary to establish a common exchange rate for different greenhouse gases. Among the three proposed time horizons within the GWP framework, the middle option was selected. GWP100 has since become the standard method for comparing different gases in climate policy and emissions trading (Lahn & Aamas, 2019).

The GWP concept acts as a comparative measure, assigning different greenhouse gases a warming potential in relation to $CO_2$, which is standardized at a value of 1. For instance, $CH_4$ has a $GWP_{100}$ of 28, indicating 1 ton of $CH_4$ is equivalent to 28 tons of $CO_2$ in its warming impact over a 100-year period. Hence, $CH_4$ per molecule has a significantly higher heat-capturing ability than $CO_2$. The GWP values are derived from the IPCC's fifth main report and serve as reference points in international reporting methodologies (Myhre et al., 2013). These standardized values enable consistent assessments across nations and industries, facilitating transparent comparisons of the warming potential of diverse greenhouse gases. These guide the development of focused climate policies and strategies.

| **Greenhouse gas** | **$GWP_{100}$, global** |
|---|---|
| Carbon Dioxide ($CO_2$) | 1 |
| Methane ($CH_4$) | 28 |

*Table 9 - GWP100*

$GWP_{100}$ assesses the climate effect of emissions from their release and projects this effect 100 years into the future. In comparison, $GWP_{20}$ concentrates on the energy absorbed over a 20-year period. Thus, $GWP_{20}$ prioritizes gases with shorter atmospheric lifetimes, emphasizing the immediate and near-term impacts without considering effects beyond the 20-year threshold. Due to this compressed timespan, gases such as $CH_4$ yield higher values under $GWP_{20}$ compared to $GWP_{100}$, which may have significant implications for climate policies focusing on short-term interventions and strategies.

| **Greenhouse gas** | **$GWP_{20}$, global** |
|---|---|
| Carbon Dioxide ($CO_2$) | 1 |
| Methane ($CH_4$) | 84 |

*Table 10 - GWP20*

### *6.2.1 Criticism of the Global Warming Potential*

A few years ago, a flaw in $GWP_{100}$ measurements was assessed by researchers based at the University of Oxford (Rocha, 2022). $GWP_{100}$ assumed that all greenhouse gases were stagnant in the atmosphere, meaning they remained there for centuries. What $GWP_{100}$ did not account for, was that $CH_4$, as a short-lived gas, was actively removed from the atmosphere relatively soon after being emitted. $CH_4$ emissions are an important contributor to climate change, but have a significantly different impact on global warming than $CO_2$.

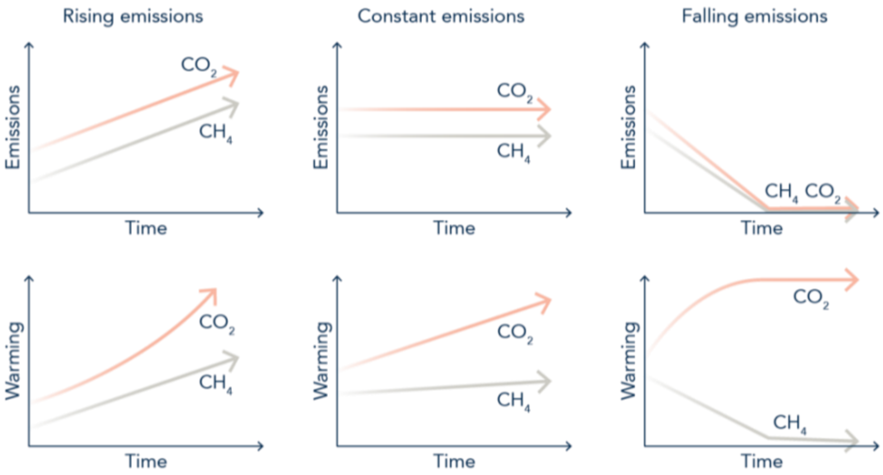


*Figure 7 - CO2 & CH4 emissions (Allen et al. 2018)*

When emissions increase, the higher concentrations of $CO_2$ and $CH_4$ in the atmosphere contribute to greater warming from both gases. However, a different scenario unfolds with consistent or decreasing emissions. Increasing $CH_4$ emissions cause significant warming, but solely during the period of increase. Constant $CH_4$ emissions cause little or no further warming, while decreasing $CH_4$ emissions have a cooling effect (Allen et al. 2018).

$GWP_{100}$'s flaw lies in its equivalence of $CH_4$ and $CO_2$ without considering their differing impacts on the environment. A new and extended version, *GWP**, has therefore been proposed. GWP* accounts for $CO_2$ and $CH_4$ emissions separately. University of Melbourne researchers Meinshausen & Nicholls (2022) recently assessed the practical implications of using GWP*. The study argues that GWP* is an interesting model for $CH_4$ emissions, but difficult to use in a regulatory environment. The study concludes that GWP* has a place in emissions reporting, just not as an official metric. We have therefore chosen not to use GWP* for further research in our thesis.

## 6.3 Global Temperature Change Potential

In 2005, Shine et al. introduced a new climate metric known as the *global temperature change potential* (GTP). The metric was proposed as a response to some of the criticism of GWP. Unlike GWP, measuring the radiative forcing over a specific time span following the emissions, GTP quantifies the temperature change at a specified point in time after the event of the emission. This allows for a nuanced assessment of the climate impact associated with emissions, by directly evaluating their contribution to temperature changes, rather than focusing solely on radiative forcing.

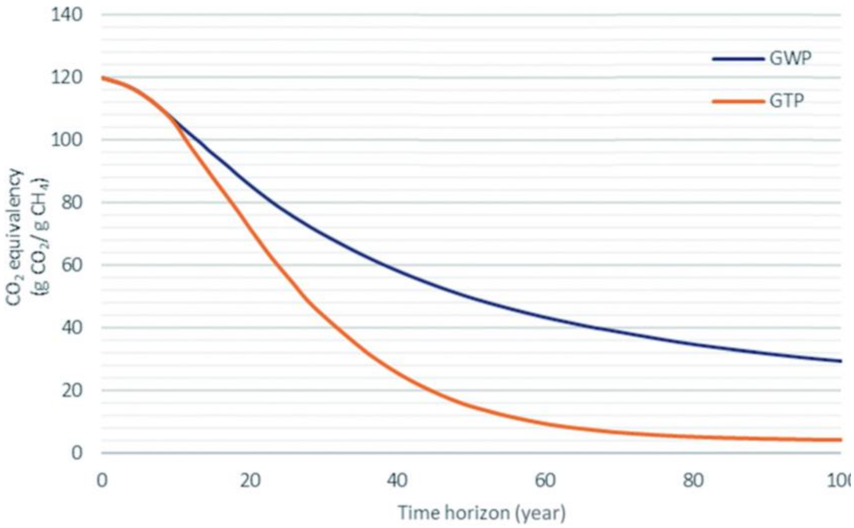


*Figure 8 - GTP compared to GWP over different time horizons (Balcombe et al., 2018)*

Figure 8 shows the global temperature change potential of $CH_4$ compared to the global warming potential, converted to $CO_2$ equivalents across different time horizons. GTP goes further down the cause-effect chain, providing an enhanced understanding of its impact on society. The introduction of GTP becomes significant within the context of the Paris Agreement's temperature goal, aiming to restrict global warming to 2 degrees above pre-industrial levels. By providing insights into the temperature effects linked to emissions, GTP presents a valuable tool for policymakers and climate scientists, striving to comprehend implications of greenhouse gas emissions on global temperature (Abernethy & Jackson, 2022).

In the same manner as GWP, the GTP values can be used for weighting the emissions to obtain $CO_2$ equivalents. We evaluate how emissions contribute to temperature effects in relation to $CO_2$, considering the designated time horizon (Myhre et al., 2013).

| **Greenhouse gas** | **$GTP_{100}$** |
|---|---|
| Carbon Dioxide ($CO_2$) | 1 |
| Methane ($CH_4$) | 4 |

*Table 11 - Global Temperature Change Potential, 100*

| **Greenhouse gas** | **$GTP_{20}$** |
|---|---|
| Carbon Dioxide ($CO_2$) | 1 |
| Methane ($CH_4$) | 67 |

*Table 12 - Global Temperature Change Potential, 20*

### *6.3.1 Criticism of the global temperature change potential*

GTP is a newer metric than GWP and has so far received less criticism from researchers. However, the calculation of GTP is more complicated than that for GWP, as it requires modeling of how much the climate system responds to increased concentrations of GHGs, and how fast (US EPA, 2023). This consequently brings more uncertainty, and the IPCC estimates an uncertainty of +/- 75 percent, in comparison to +/- 40 percent for GWP (Balcombe et al., 2018).

# 7. Converting $CH_4$ to $CO_2$ equivalents

## *7.1 $CH_4$ emissions in steel production*

As previously mentioned in the thesis, steel production does not solely result in $CO_2$ emissions. Emissions from extraction of coal (T2), extraction of natural gas (T3), and transportation (T5), will result in $CH_4$ emissions. Yet, these emissions have not been included in the environmental balance sheet, adhering to carbon accounting standards. This illustrates the practical challenge posed by multiple greenhouse gases.

| **Transactions** | **$CO_2$ emissions (In tons)** | **$CH_4$ emissions (In tons)** |
|---|---|---|
| *Emissions from extraction of coal* | 10 000 | **100** |
| *Emissions from extraction of natural gas* | - | **10** |
| *Emissions from transportation of raw materials* | 1 500 | **30** |

*Table 13 - Emissions of CH4 in the steel production*

Table 13 displays emissions of both $CO_2$ and $CH_4$ associated with the three transactions. Although the measured volume of $CH_4$ emissions is notably lower in terms of tons, their potency relative to $CO_2$ is significantly higher. As our focus extends to reporting on $CH_4$ emissions, converting these emissions into a standardized unit becomes imperative for facilitating comparison with $CO_2$ emissions. In this section of the assignment, we will apply the different metrics discussed in the previous chapter.

## *7.2 $GWP_{100}$*

$GWP_{100}$ remains the standardized method used for reporting $CH_4$ emissions to date, and we choose to use this method for comparison first. We have previously observed that $GWP_{100}$ values assign a $CO_2$ value of 1, and $CH_4$ value of 28. We insert the number of emissions from table 13 together with the $GWP_{100}$ values, into the formula for calculating $CO_2$ equivalents, which is as follow;

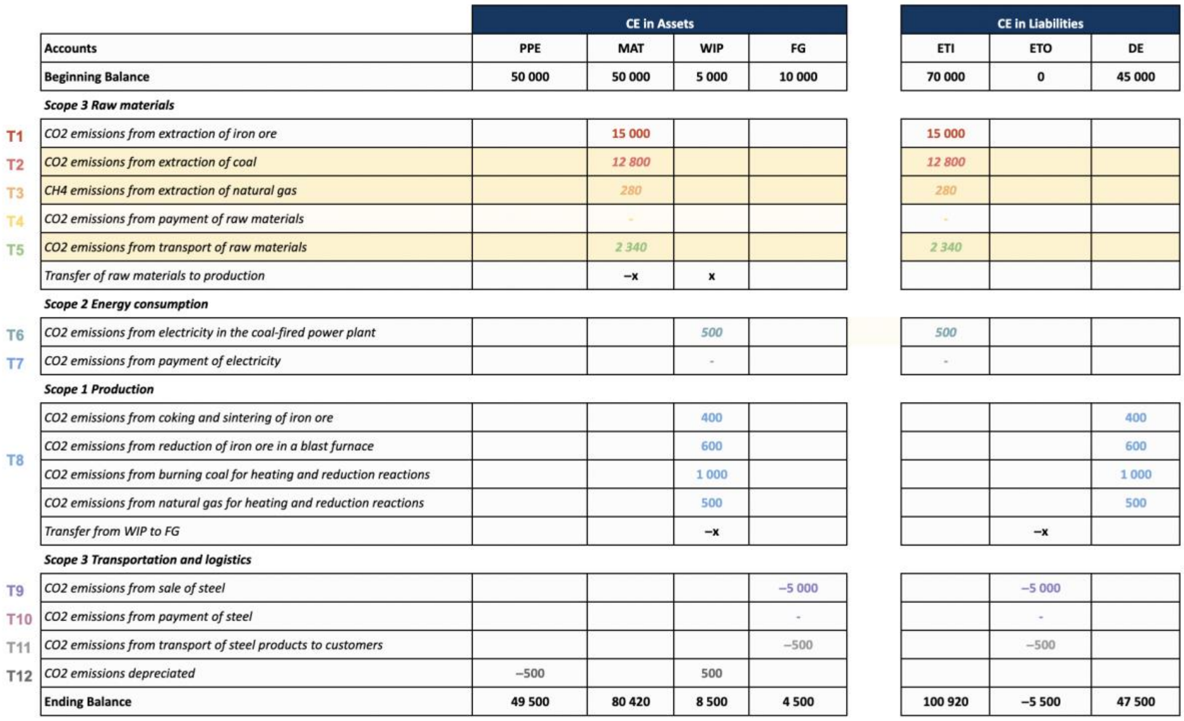
$$Tons\ CO_2\ equivalents\ (e) = tons\ CO_2 * GWP\ (_{100,\ CO2}) + tons\ CH_4 * GWP\ (_{100,\ CH4})$$

$$Tons\ CO2e = 10\ 000*1 + 100*28 = 12\ 800\ tons\ CO2e$$

$$Tons\ CO2e = 0*1 + 10*28 = 280\ tons\ CO2e$$

$$Tons\ CO2e = 1\ 500*1 + 30*28 = 2\ 340\ tons\ CO2e$$

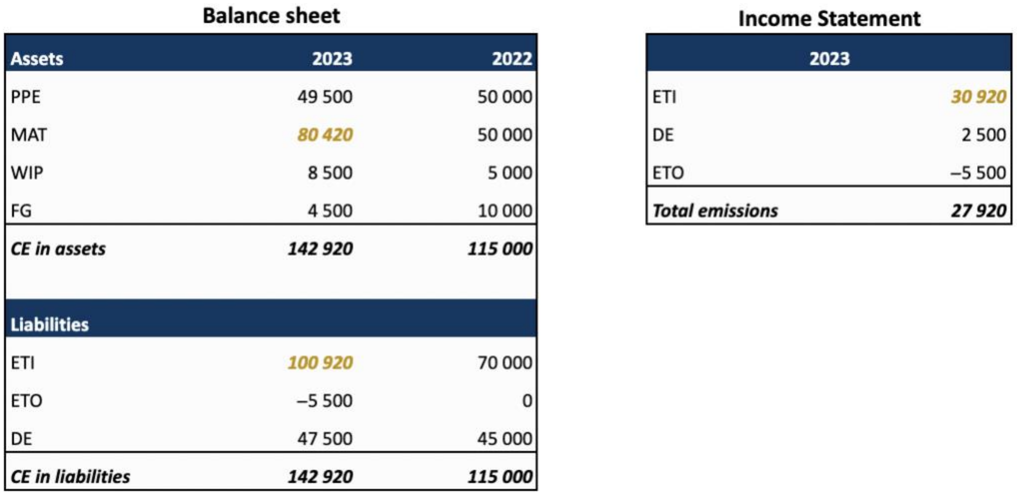
Now that we have converted $CH_4$ into $CO_2$ equivalents, we see that 100 tons, 10 tons and 30 tons of $CH_4$ correspond to 2 800, 280 tons, and 840 tons of $CO_2$, respectively. This implies that the total $CH_4$ emissions in the carbon balance amount to 3 920 tons $CO_2$e. These values are then added to the value of $CO_2$ in tons, providing the total number of $CO_2$ equivalents. We insert the new values into the balance sheet, which increases the carbon balance.



| | | CE in Assets | | | | CE in Liabilities | | |
|---|---|---|---|---|---|---|---|---|
| | **Accounts** | **PPE** | **MAT** | **WIP** | **FG** | **ETI** | **ETO** | **DE** |
| | **Beginning Balance** | **50 000** | **50 000** | **5 000** | **10 000** | **70 000** | **0** | **45 000** |
| | ***Scope 3 Raw materials*** | | | | | | | |
| T1 | *CO2 emissions from extraction of iron ore* | | 15 000 | | | 15 000 | | |
| T2 | *CO2 emissions from extraction of coal* | | *12 800* | | | *12 800* | | |
| T3 | *CH4 emissions from extraction of natural gas* | | *280* | | | *280* | | |
| T4 | *CO2 emissions from payment of raw materials* | | - | | | - | | |
| T5 | *CO2 emissions from transport of raw materials* | | *2 340* | | | *2 340* | | |
| | *Transfer of raw materials to production* | | **−x** | **x** | | | | |
| | ***Scope 2 Energy consumption*** | | | | | | | |
| T6 | *CO2 emissions from electricity in the coal-fired power plant* | | | *500* | | *500* | | |
| T7 | *CO2 emissions from payment of electricity* | | | - | | - | | |
| | ***Scope 1 Production*** | | | | | | | |
| T8 | *CO2 emissions from coking and sintering of iron ore* | | | 400 | | | | 400 |
| | *CO2 emissions from reduction of iron ore in a blast furnace* | | | 600 | | | | 600 |
| | *CO2 emissions from burning coal for heating and reduction reactions* | | | 1 000 | | | | 1 000 |
| | *CO2 emissions from natural gas for heating and reduction reactions* | | | 500 | | | | 500 |
| | *Transfer from WIP to FG* | | | **−x** | | | **−x** | |
| | ***Scope 3 Transportation and logistics*** | | | | | | | |
| T9 | *CO2 emissions from sale of steel* | | | | −5 000 | | −5 000 | |
| T10 | *CO2 emissions from payment of steel* | | | | - | | - | |
| T11 | *CO2 emissions from transport of steel products to customers* | | | | −500 | | −500 | |
| T12 | *CO2 emissions depreciated* | −500 | | 500 | | | | |
| | **Ending Balance** | **49 500** | **80 420** | **8 500** | **4 500** | **100 920** | **−5 500** | **47 500** |

*Table 14 - CO2 equivalents in the environmental balance sheet using  GWP100*

One of the criticisms of $GWP_{100}$ is that the metric does not take the short lifetime of $CH_4$ into account. By using a 100-year metric, we can measure the impact the emissions have on global warming in the long term. Greenhouse gases with a longer lifetime in the atmosphere have the greatest importance, and the focus will be on reducing the emissions of long-lived gases (Toutain, 2022). This metric thus favors the effect of $CO_2$ over $CH_4$.



**Balance sheet**

| **Assets** | **2023** | **2022** |
|---|---|---|
| PPE | 49 500 | 50 000 |
| MAT | 80 420 | 50 000 |
| WIP | 8 500 | 5 000 |
| FG | 4 500 | 10 000 |
| ***CE in assets*** | ***142 920*** | ***115 000*** |
| **Liabilities** | | |
| ETI | 100 920 | 70 000 |
| ETO | –5 500 | 0 |
| DE | 47 500 | 45 000 |
| ***CE in liabilities*** | ***142 920*** | ***115 000*** |

**Income Statement**

| | **2023** |
|---|---|
| ETI | 30 920 |
| DE | 2 500 |
| ETO | –5 500 |
| ***Total emissions*** | ***27 920*** |

*Table 15 - Balance sheet and Income Statement using GWP100*

In the balance sheet and income statement generated using $GWP_{100}$, we observe that the conversion of $CH_4$ to $CO_2$ equivalents increases emissions in MAT and ETI, compared to the original result in table 7.

## *7.3 $GWP_{20}$*

As previously mentioned, $GWP_{20}$ emphasized short-lived greenhouse gases as it does not account for impacts occurring beyond a 20-year time horizon. To accurately reflect $CH_4$'s shorter lifespan, we will use this metric to evaluate the difference in $CO_2$e conversion. $GWP_{20}$, like $GWP_{100}$, assigns a value of 1 to $CO_2$, but in this case the value for $CH_4$ is 84. We use the same values as in table 13 along with the new $GWP_{20}$ values, inserting these into the formula for conversion.

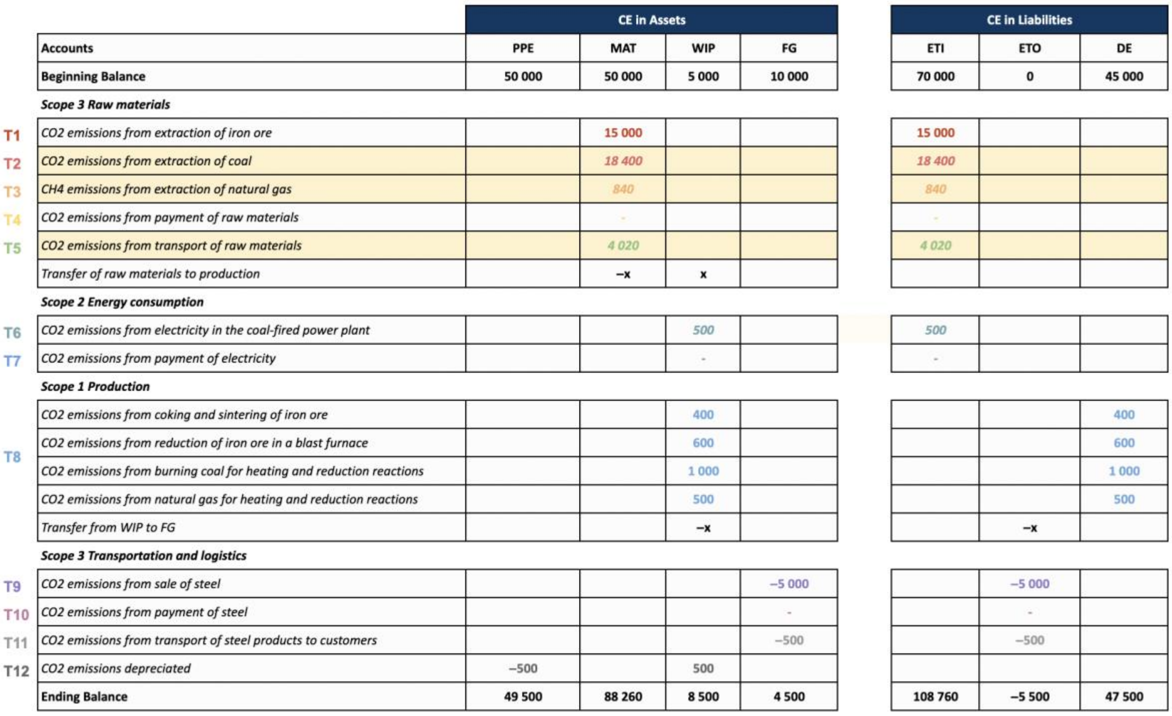
$$\text{Tons } CO_2 \text{ ekv.} = \text{tons } CO_2 * GWP\ (_{20,\ CO2}) + \text{tons } CH_4 * GWP\ (_{20,\ CH4})$$

$$\text{Tons } CO2e = 10\ 000*1 + 100*84 = 18\ 400 \text{ tons } CO2e$$

$$\text{Tons } CO2e = 0*1 + 10*84 = 840 \text{ tons } CO2e$$

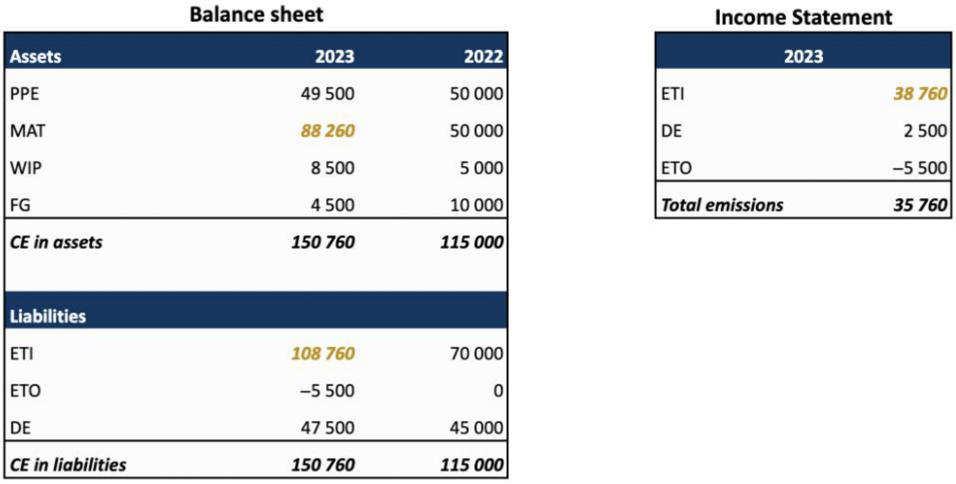
$$\text{Tons } CO2e = 1\ 500*1 + 30*84 = 4\ 020 \text{ tons } CO2e$$

In table 16 we get a higher carbon balance, because it is considered that $CH_4$ is much stronger in a 20-year perspective compared to a 100-year perspective. 100 tons, 10 tons, and 30 tons of $CH_4$, using $GWP_{20}$, are equivalent to 8 400, 840 tons, and 2 520 tons of $CO_2$e, respectively. The total amount of $CH_4$ constitutes 11 760 $CO_2$e.



| | | CE in Assets | | | | CE in Liabilities | | |
|---|---|---|---|---|---|---|---|---|
| | **Accounts** | **PPE** | **MAT** | **WIP** | **FG** | **ETI** | **ETO** | **DE** |
| | **Beginning Balance** | **50 000** | **50 000** | **5 000** | **10 000** | **70 000** | **0** | **45 000** |
| | ***Scope 3 Raw materials*** | | | | | | | |
| T1 | *CO2 emissions from extraction of iron ore* | | 15 000 | | | 15 000 | | |
| T2 | *CO2 emissions from extraction of coal* | | *18 400* | | | *18 400* | | |
| T3 | *CH4 emissions from extraction of natural gas* | | *840* | | | *840* | | |
| T4 | *CO2 emissions from payment of raw materials* | | - | | | - | | |
| T5 | *CO2 emissions from transport of raw materials* | | *4 020* | | | *4 020* | | |
| | *Transfer of raw materials to production* | | –x | x | | | | |
| | ***Scope 2 Energy consumption*** | | | | | | | |
| T6 | *CO2 emissions from electricity in the coal-fired power plant* | | | *500* | | *500* | | |
| T7 | *CO2 emissions from payment of electricity* | | | - | | - | | |
| | ***Scope 1 Production*** | | | | | | | |
| T8 | *CO2 emissions from coking and sintering of iron ore* | | | 400 | | | | 400 |
| | *CO2 emissions from reduction of iron ore in a blast furnace* | | | 600 | | | | 600 |
| | *CO2 emissions from burning coal for heating and reduction reactions* | | | 1 000 | | | | 1 000 |
| | *CO2 emissions from natural gas for heating and reduction reactions* | | | 500 | | | | 500 |
| | *Transfer from WIP to FG* | | | –x | | | –x | |
| | ***Scope 3 Transportation and logistics*** | | | | | | | |
| T9 | *CO2 emissions from sale of steel* | | | | –5 000 | | –5 000 | |
| T10 | *CO2 emissions from payment of steel* | | | | - | | - | |
| T11 | *CO2 emissions from transport of steel products to customers* | | | | –500 | | –500 | |
| T12 | *CO2 emissions depreciated* | –500 | | 500 | | | | |
| | **Ending Balance** | **49 500** | **88 260** | **8 500** | **4 500** | **108 760** | **–5 500** | **47 500** |

*Table 16 - CO2 equivalents in the environmental balance sheet using GWP20*



**Balance sheet**

| **Assets** | **2023** | **2022** |
|---|---|---|
| PPE | 49 500 | 50 000 |
| MAT | *88 260* | 50 000 |
| WIP | 8 500 | 5 000 |
| FG | 4 500 | 10 000 |
| ***CE in assets*** | ***150 760*** | ***115 000*** |
| | | |
| **Liabilities** | | |
| ETI | *108 760* | 70 000 |
| ETO | –5 500 | 0 |
| DE | 47 500 | 45 000 |
| ***CE in liabilities*** | ***150 760*** | ***115 000*** |

**Income Statement**

| | **2023** |
|---|---|
| ETI | *38 760* |
| DE | 2 500 |
| ETO | –5 500 |
| ***Total emissions*** | ***35 760*** |

*Table 17 - Balance sheet and Income Statement using GWP20*

## 7.4 $GTP_{100}$

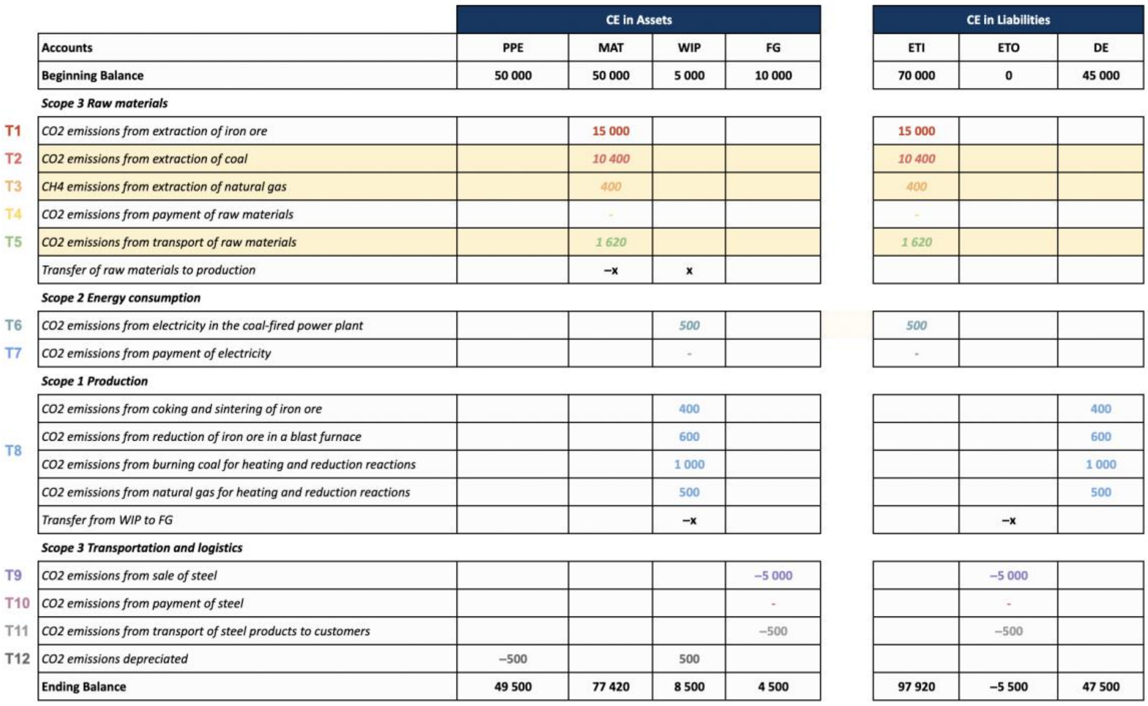
GWP as a metric has received a lot of criticism, and we therefore want to look at differences by using a more recently recommended weighting factor, GTP. This metric looks at temperature change instead of radiative forcing, yet the selection of a time horizon is still necessary in this context. The formula for conversion is the same as for GWP, but the GTP value is much lower. $GTP_{100}$, like GWP, has a value of 1 for $CO_2$, but here, 1 ton of $CH_4$ is equivalent to 4 tons of $CO_2$.

$$Tons\ CO_2\ ekv. = tons\ CO_2 * GTP\ (_{100,\ CO2}) + tons\ CH_4 * GTP\ (_{100,\ CH4})$$

$$Tons\ CO2e = 10\ 000*1+100*4= 10\ 400\ tons\ CO2e$$

$$Tons\ CO2e = 0*1+10*4= 400\ tons\ CO2e$$

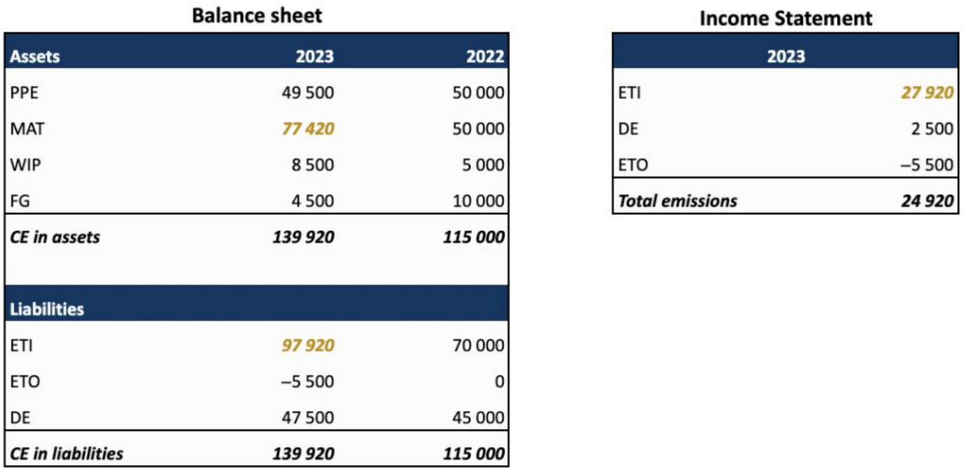
$$Tons\ CO2e = 1\ 500*1+30*4= 1\ 620\ tons\ CO2e$$



| | | CE in Assets | | | | CE in Liabilities | | |
|---|---|---|---|---|---|---|---|---|
| | **Accounts** | **PPE** | **MAT** | **WIP** | **FG** | **ETI** | **ETO** | **DE** |
| | **Beginning Balance** | **50 000** | **50 000** | **5 000** | **10 000** | **70 000** | **0** | **45 000** |
| | ***Scope 3 Raw materials*** | | | | | | | |
| T1 | *CO2 emissions from extraction of iron ore* | | 15 000 | | | 15 000 | | |
| T2 | *CO2 emissions from extraction of coal* | | *10 400* | | | *10 400* | | |
| T3 | *CH4 emissions from extraction of natural gas* | | *400* | | | *400* | | |
| T4 | *CO2 emissions from payment of raw materials* | | - | | | - | | |
| T5 | *CO2 emissions from transport of raw materials* | | *1 620* | | | *1 620* | | |
| | *Transfer of raw materials to production* | | **–x** | **x** | | | | |
| | ***Scope 2 Energy consumption*** | | | | | | | |
| T6 | *CO2 emissions from electricity in the coal-fired power plant* | | | *500* | | *500* | | |
| T7 | *CO2 emissions from payment of electricity* | | | - | | - | | |
| | ***Scope 1 Production*** | | | | | | | |
| T8 | *CO2 emissions from coking and sintering of iron ore* | | | 400 | | | | 400 |
| | *CO2 emissions from reduction of iron ore in a blast furnace* | | | 600 | | | | 600 |
| | *CO2 emissions from burning coal for heating and reduction reactions* | | | 1 000 | | | | 1 000 |
| | *CO2 emissions from natural gas for heating and reduction reactions* | | | 500 | | | | 500 |
| | *Transfer from WIP to FG* | | | **–x** | | | **–x** | |
| | ***Scope 3 Transportation and logistics*** | | | | | | | |
| T9 | *CO2 emissions from sale of steel* | | | | –5 000 | | –5 000 | |
| T10 | *CO2 emissions from payment of steel* | | | | - | | - | |
| T11 | *CO2 emissions from transport of steel products to customers* | | | | –500 | | –500 | |
| T12 | *CO2 emissions depreciated* | –500 | | 500 | | | | |
| | **Ending Balance** | **49 500** | **77 420** | **8 500** | **4 500** | **97 920** | **–5 500** | **47 500** |

*Table 18 - CO2 equivalents in the environmental balance sheet using GTP100*

We get a smaller amount of $CO_2e$ by using $GTP_{100}$ instead of $GWP_{100}$, which tells us that the impact of $CH_4$ is lower if we look at temperature change rather than radiative forcing. Here we have a total $CH_4$ emission equivalent to 560 tons $CO_2e$.



**Balance sheet**

| **Assets** | **2023** | **2022** |
|---|---|---|
| PPE | 49 500 | 50 000 |
| MAT | ***77 420*** | 50 000 |
| WIP | 8 500 | 5 000 |
| FG | 4 500 | 10 000 |
| ***CE in assets*** | ***139 920*** | ***115 000*** |
| **Liabilities** | | |
| ETI | ***97 920*** | 70 000 |
| ETO | –5 500 | 0 |
| DE | 47 500 | 45 000 |
| ***CE in liabilities*** | ***139 920*** | ***115 000*** |

**Income Statement**

| | **2023** |
|---|---|
| ETI | ***27 920*** |
| DE | 2 500 |
| ETO | –5 500 |
| ***Total emissions*** | ***24 920*** |

*Table 19 - Balance sheet and Income Statement using GTP100*

When employing GTP100, there is also a rise in emissions compared to the original table 7. However, this increase is notably less significant than when utilizing GWP.

## 7.5 $GTP_{20}$

Similar to GWP, we also examine GTP's application across various time horizons, as $GTP_{20}$ accounts for more short-lived greenhouse gases. $GTP_{20}$ has a value of 1 for $CO_2$ and 67 for $CH_4$. This is a considerably higher value compared to $GTP_{100}$, indicating that emissions have a greater impact on temperature changes over shorter time periods.

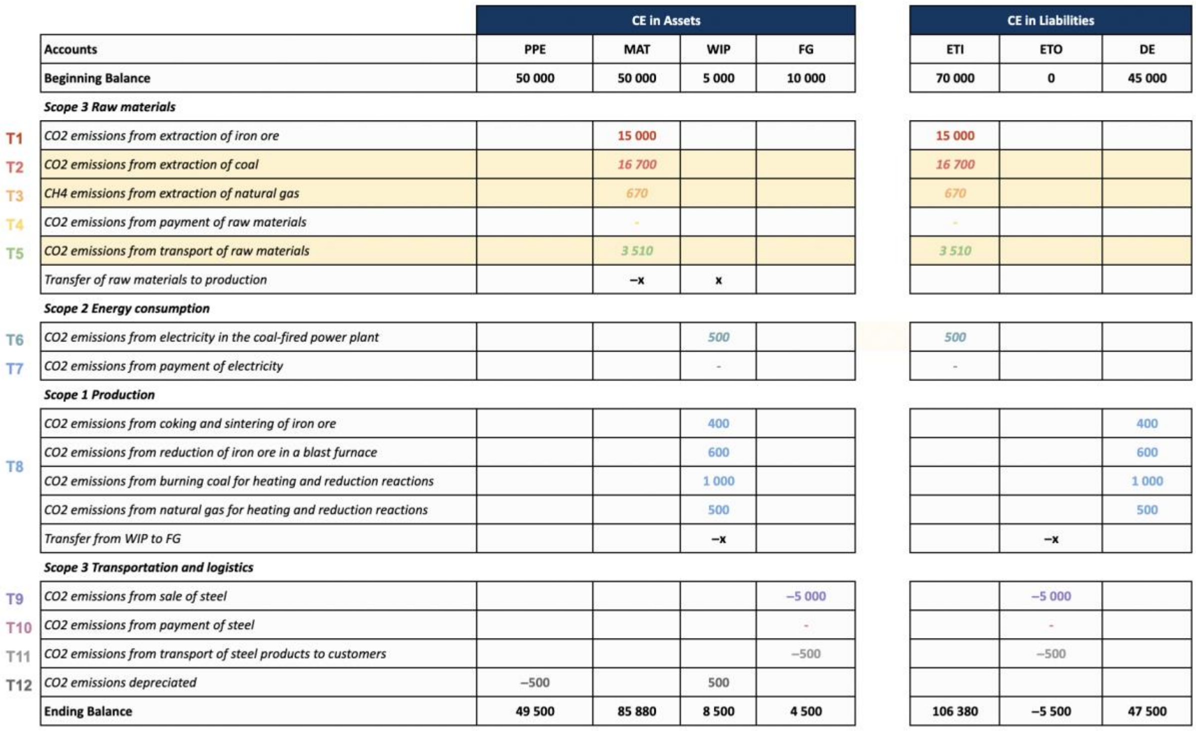
$$\textit{Tons } CO_2 \textit{ ekv.} = \textit{tons } CO_2 * GTP\ (_{20,\ CO2}) + \textit{tons } CH_4 * GTP\ (_{20,\ CH4})$$

$$\textit{Tons CO2e} = 10\ 000*1+100*67 = \textit{16 700 tons CO2e}$$

$$\textit{Tons CO2e} = 0*1+10*67 = \textit{670 tons CO2e}$$

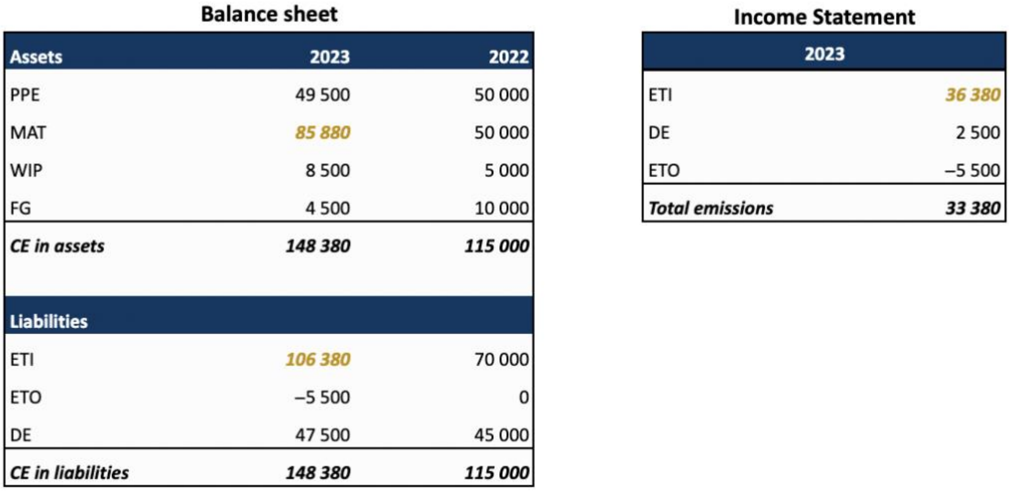
$$\textit{Tons CO2e} = 1\ 500*1+30*67 = \textit{3 510 tons CO2e}$$

Similar to GWP, a shorter time horizon with GTP will amplify the effect of CH4, and hence increase the amount of $CO_2$ equivalents. $CH_4$ emissions here constitute 9 380 tons CO2e.



|  |  | CE in Assets |  |  |  | CE in Liabilities |  |  |
|---|---|---|---|---|---|---|---|---|
|  | **Accounts** | **PPE** | **MAT** | **WIP** | **FG** | **ETI** | **ETO** | **DE** |
|  | **Beginning Balance** | **50 000** | **50 000** | **5 000** | **10 000** | **70 000** | **0** | **45 000** |
|  | ***Scope 3 Raw materials*** |  |  |  |  |  |  |  |
| T1 | *CO2 emissions from extraction of iron ore* |  | 15 000 |  |  | 15 000 |  |  |
| T2 | *CO2 emissions from extraction of coal* |  | *16 700* |  |  | *16 700* |  |  |
| T3 | *CH4 emissions from extraction of natural gas* |  | *670* |  |  | *670* |  |  |
| T4 | *CO2 emissions from payment of raw materials* |  | - |  |  | - |  |  |
| T5 | *CO2 emissions from transport of raw materials* |  | *3 510* |  |  | *3 510* |  |  |
|  | *Transfer of raw materials to production* |  | **−x** | **x** |  |  |  |  |
|  | ***Scope 2 Energy consumption*** |  |  |  |  |  |  |  |
| T6 | *CO2 emissions from electricity in the coal-fired power plant* |  |  | *500* |  | *500* |  |  |
| T7 | *CO2 emissions from payment of electricity* |  |  | - |  | - |  |  |
|  | ***Scope 1 Production*** |  |  |  |  |  |  |  |
| T8 | *CO2 emissions from coking and sintering of iron ore* |  |  | 400 |  |  |  | 400 |
|  | *CO2 emissions from reduction of iron ore in a blast furnace* |  |  | 600 |  |  |  | 600 |
|  | *CO2 emissions from burning coal for heating and reduction reactions* |  |  | 1 000 |  |  |  | 1 000 |
|  | *CO2 emissions from natural gas for heating and reduction reactions* |  |  | 500 |  |  |  | 500 |
|  | *Transfer from WIP to FG* |  |  | **−x** |  |  | **−x** |  |
|  | ***Scope 3 Transportation and logistics*** |  |  |  |  |  |  |  |
| T9 | *CO2 emissions from sale of steel* |  |  |  | −5 000 |  | −5 000 |  |
| T10 | *CO2 emissions from payment of steel* |  |  |  | - |  | - |  |
| T11 | *CO2 emissions from transport of steel products to customers* |  |  |  | −500 |  | −500 |  |
| T12 | *CO2 emissions depreciated* | −500 |  | 500 |  |  |  |  |
|  | **Ending Balance** | **49 500** | **85 880** | **8 500** | **4 500** | **106 380** | **−5 500** | **47 500** |

*Table 20 - CO2 equivalents in the environmental balance sheet using GTP20*



**Balance sheet**

| **Assets** | **2023** | **2022** |
|---|---|---|
| PPE | 49 500 | 50 000 |
| MAT | *85 880* | 50 000 |
| WIP | 8 500 | 5 000 |
| FG | 4 500 | 10 000 |
| ***CE in assets*** | ***148 380*** | ***115 000*** |
| **Liabilities** | | |
| ETI | *106 380* | 70 000 |
| ETO | –5 500 | 0 |
| DE | 47 500 | 45 000 |
| ***CE in liabilities*** | ***148 380*** | ***115 000*** |

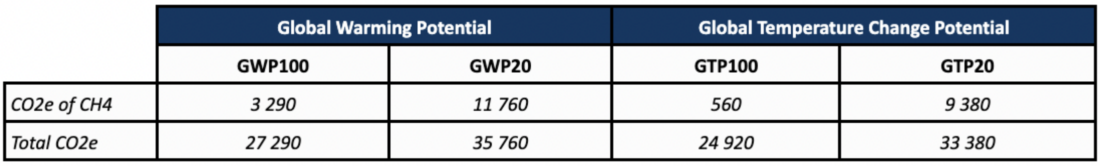
**Income Statement**

| | **2023** |
|---|---|
| ETI | *36 380* |
| DE | 2 500 |
| ETO | –5 500 |
| ***Total emissions*** | ***33 380*** |

*Table 21 - Balance sheet and Income Statement using GTP20*

## 7.6 Comparison of different emissions metrics

The amount of $CO_2e$ varies significantly depending on the time horizon used for calculation. When comparing different time horizons, such as 20 years versus 100 years as applied in this thesis, consideration is given to how various greenhouse gases diminish in the atmosphere over time. When a longer period of 100 years is utilized, the calculated $CO_2e$ decreases because it is considered that $CH_4$ degrades over time. $CH_4$ will thus have a greater impact on the $CO_2e$ amount when using a shorter time horizon of 20 years.



| | **Global Warming Potential** | | **Global Temperature Change Potential** | |
|---|---|---|---|---|
| | **GWP100** | **GWP20** | **GTP100** | **GTP20** |
| *CO2e of CH4* | *3 290* | *11 760* | *560* | *9 380* |
| *Total CO2e* | *27 290* | *35 760* | *24 920* | *33 380* |

*Table 22 - Comparison of CO2e using different emission metrics*

The amount of $CO_2e$ also varies depending on whether GWP or GTP is used, with GTP providing a lower value. GTP takes more direct account of a gas' duration in the atmosphere, in addition to its impact on temperature. This yields a significantly lower value than when using GWP.

## *7.7 Measures for emissions reduction*

As a company utilizes carbon accounting to gain a more comprehensive understanding of its carbon footprint, this enhanced insight demands subsequent actions towards reduction. Within the crucial goal of limiting environmental impact, implementing effective measures for emissions reduction serves as a fundamental aspect. This section delineates a comprehensive variety of initiatives aimed at reducing carbon footprints across various sectors. By examining the various regulations, we identify those particularly important in reducing the overall carbon balance of a steel company.

### *7.7.1 Climate quotas*

Achieving net zero relies on the implementation of regulated emission permits, particularly within the industrial sectors. *The EU Emissions Trading System* (EU ETS) operates by establishing a ceiling, defining the maximum volume of $CO_2$ equivalents permissible for emissions annually. Each climate quota within this system gives permission to emit *one* metric ton of $CO_2$ equivalents. Over time, this ceiling is systematically lowered, aiming to curtail overall emissions (Miljødirektoratet, n.d.).

The purpose of the EU ETS is for European countries to collaborate on reducing greenhouse gas emissions where it is most cost-effective, aiming to cut emissions from regulated entities by 62 percent within 2030. If the quota price is high, companies will be pressured to reduce emissions. Surplus quotas can be sold to businesses struggling to reduce their emissions. This mechanism effectively imposes a cost on emissions, while turning emissions reduction into a source of revenue (Andreassen, 2023).

For the system to function optimally, the ceiling must not be set higher than the total amount of emissions. The EU has for a long time had a significant surplus of quotas, which has contributed to keeping the price of quotas low. This is partly due to the financial crisis in 2008 and 2009, during which significant portions of European industry shut down, resulting in lower demand for emissions quotas than expected (Miljødirektoratet). With a low emission price, companies did not have clear enough incentives to transition towards a low-emission society. However, the price of $CO_2$ has significantly surged since 2017, leading to substantial reductions in emissions. Notably, in 2023 the EU carbon price exceeded 100 EUR a ton for the first time (Hodgson & Sheppard, 2023). This leads to the system functioning as it was originally intended.

*Figure 9 - EU carbon price (Sheppard, 2020)*

Although climate quotas contribute to emissions reduction, there are several challenges associated with the system. One of these challenges is emission shifting, where countries or companies attempt to lower their emissions by relocating production to countries with fewer and less strict emission regulations. This phenomenon is known as *carbon leakage*, signifying how the climate policies of one or more countries result in increased emissions in other regions (SSB, 2015). To prevent carbon leakage, the EU has provided free quotas to industries that are particularly vulnerable to competition.

In recent times, the EU has proposed the implementation of carbon tariffs as part of the “fit for 55” policy. The *Carbon Border Adjustment Mechanism* (CBAM) involves imposing tariffs on energy-intensive materials such as steel, iron, and aluminum. The phased introduction of CBAM is slated to begin gradually from 2026 onwards and will replace the free allocation of quotas (European Commission, 2023-b). Over time, the EU ETS has resulted in an overall reduction of quota-obligated emissions in Europe, but more measures are needed towards the goal of net zero.

### 7.7.2 Carbon offsets

In energy-intensive industries, achieving substantial emissions reduction within a short time period often proves to be challenging. Companies facing difficulties in reducing their emissions may therefore turn to an alternative solution. Natural processes, such as afforestation or the adoption of renewable energy, offer avenues to remove or capture emissions from the atmosphere. Industries with substantial emissions thus have the option to procure *carbon offsets* from environmentally conscious companies. This practice allows companies to offset emissions they cannot reduce on their own. Consequently, they can maintain similar emission levels while simultaneously reducing their overall carbon footprint (Kaplan et al., 2023).

The voluntary carbon market is indeed voluntary and does not involve permits; it is about companies' desire to reduce emissions. Compensation for one ton of $CO_2e$ is referred to as a credit. It is important to distinguish from the regulated carbon market, where the permission to emit one ton of $CO_2$ equivalents is defined as a quota, such as the EU ETS. Quotas exist in a certain quantity, but since the voluntary market is unregulated, there is no limit on the number of credits that can be created or sold (Flaaen, 2021).

A widely debated issue associated with the utilization of carbon offsets pertains to their accounting methods. The carbon trading market faces inefficiencies, with numerous traded offsets failing to deliver as anticipated. This can potentially lead to greenwashing, and consequently, the transparency and reliability of these declarations remain inadequate. Companies acquiring carbon credits must carefully assess the specific details and conditions to ascertain proper accounting practices (Carlson, 2023). Due to the limited suitability of methods to record offsets, we have intentionally omitted the incorporation of any carbon offsets in the environmental balance sheet of Stockholm Steel.

### 7.7.3 Carbon Capture and Storage

To decarbonize industries and the overall energy system, it is necessary to incorporate all technology available. *Carbon Capture and Storage* (CCS) is a technology which can capture up to 90 percent of $CO_2$ emissions produced by fossil fuels in electricity generation and industrial processes. This technology prevents $CO_2$ from entering the atmosphere, by capturing the emissions and permanently storing it underground. CCS is one of few technological solutions that can significantly reduce emissions from industrial activities using coal or gas power, keeping $CO_2$ that would otherwise worsen climate change, away from the atmosphere (Equinor, n.d.). This is particularly crucial for industries such as the steel industry, which accounts for significant portions of the world’s $CO_2$ emissions.

CCS consists of three main phases: *capture*, *transport*, and *storage*. At capture, $CO_2$ is separated from other gases produced at large processing plants such as coal and gas power plants, steelworks, and cement factories. In the next phase, the separated $CO_2$ gas will be compressed and transported through pipelines, trucks, ships, or other storage methods. Finally, $CO_2$ is injected into underground reservoirs, at least one kilometer deep (Equinor, n.d.). This process is illustrated in figure 10.

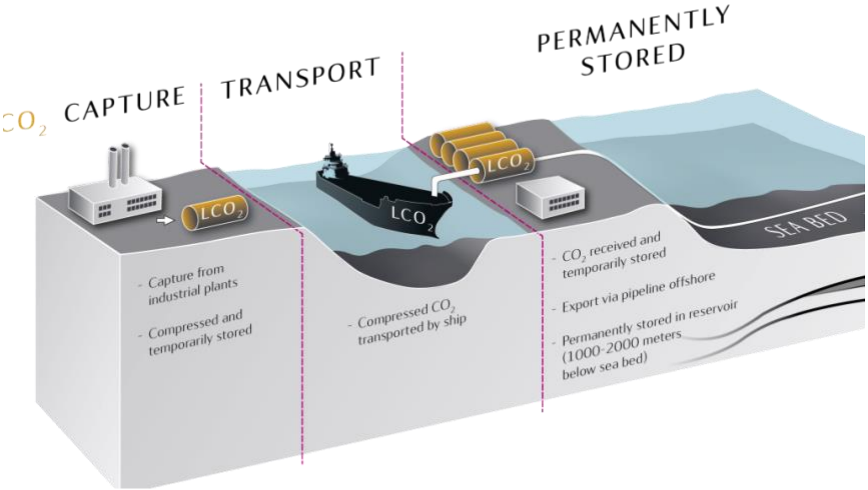


*Figure 10 - Carbon Capture and Storage process (Patonia, 2022)*

*The Northern Lights project* aims to establish a European network for transporting and storing $CO_2$. Its unique transport solution, using ships to carry $CO_2$ from capture facilities to the storage site, enables the reception of substantial $CO_2$ volumes from across Europe. A value chain for $CO_2$ transport and storage will also facilitate large-scale production of clean hydrogen from natural gas. This is crucial to secure a future for the assets in a low-emission society (NHO, n.d.).

### 7.8 Depreciation of greenhouse gas emissions

*Depreciation* refers to the allocation of a cost across multiple years in the accounting records, gradually reducing the value (Warnes, 2022). In the context of climate accounting, we refer to depreciation as to how we account for and address the long-term effect of emissions on the environment. If the climate statement contains $CO_2$ equivalents of $CH_4$ in addition to $CO_2$ emissions, we will have problems with depreciating the total amount, as $CO_2$ and $CH_4$ have different lifetimes. Converting emissions to the same unit will thus not solve all the challenges linked to accounting for different greenhouse gases.

If not consistently replenished, $CH_4$ diminishes in the atmosphere in relation to its concentration, resulting in an exponential decrease. In mathematics, *exponential decay* refers to the gradual decrease of a quantity at a constant percentage rate across a specific duration. In comparison, linear decay decreases evenly (Ledwith, 2019). Exponential decay can be expressed by the formula:

$$y = a(b)^x$$

Where, *y* is the final amount, *a* the initial amount, *b* is the decay factor, and *x* is the amount of time that has passed. We find the decay factor *b* by taking 1 - r, where *r* is the decay rate. In our case, we aim to determine the extent of emissions depreciation over intervals of 20, 50, and 100 years. Since $CO_2$ emissions remain in the atmosphere for thousands of years, it is considered to have such an extended decay time that it is not precisely quantified, and can be interpreted as "infinite" (Moseman, 2022). Here, we will thus examine only the degradation of $CH_4$ emissions, converted to $CO_2$ equivalents.

To apply this formula, the initial step is to determine the decay rate *r*. We calculate this by taking *1 / mean lifetime*. When it comes to anthropogenic emissions, the lifespan does not determine the point at which all emissions vanish from the atmosphere; rather, it signifies the duration until *37 percent* of the original emissions persist (Myhre, 2019). $CH_4$ has a mean lifetime of 12,4 years, which gives us:

$$b = 1 - \frac{1}{12.4}$$

$$b = 0.9194$$

Now that we have calculated the decay rate, we have all the necessary values to apply the exponential formula. The initial values *a* are retrieved from the calculation of $CH_4$ to $CO_2$ equivalents from subchapter 7.2, where the total amount of $CH_4$ emissions is equivalent to 3 290 tons of $CO_2$e. We assume these emissions stem from year 1, and aim to analyze their evolution over various time frames, provided the company does not generate any additional emissions.

$$y_{20} = 3290(0.9194)^{20}$$

$$y_{20} = 612.7536$$

Over the lifespan of $CH_4$, there will be approximately 3 290 x 0.37 = 1217 $CO_2$e remaining. This aligns with the value we obtained from the calculation above, considering this is about twice as long a period. Over a period of 100 years, we assume that the majority of the emissions will have decayed.

$$y_{100} = 3290(0.9194)^{100}$$

$$y_{100} = 0.7373$$

We will now use the $CO_2$e value calculated by $GWP_{20}$, an emission metric that is said to consider the shorter lifespan of $CH_4$ more effectively. The initial values are significantly higher with $GWP_{20}$, because it emphasizes $CH_4$'s immediate and stronger impact over a shorter time frame. In comparison, $GWP_{100}$ spreads the impact of $CH_4$ emissions more evenly over a longer period.

$$y_{20} = 11760(0.9194)^{20}$$

$$y_{20} = 2190.2683$$

As the initial value here is considerably higher after a 20-year period, we will retain a notably greater amount of $CO_2e$ compared to $GWP_{100}$ values. Given $GWP_{20}$'s improved consideration of $CH_4$, it is reasonable to assume that this also provides a better representation of its decay. The contrast between $GWP_{100}$ and $GWP_{20}$ values will not be as significant when using a 100-year time frame.

$$y_{100} = 11760(0.9194)^{100}$$

$$y_{100} = 2.6355$$

In summary, the choice between $GWP_{20}$ and $GWP_{100}$ metrics alters the perceived decay of $CO_2e$ over 20 and 100-year periods. The outcome is primarily influenced by their differing approaches in accounting for $CH_4$'s varying impact across time frames. Finally, we will also illustrate how the exponential decay calculation differs when using GTP values, notably lower than GWP.

$$y_{20} = 560(0.9194)^{20}$$

$$y_{20} = 104.2985$$

$$y_{100} = 560(0.9194)^{100}$$

$$y_{100} = 0.1255$$

## *7.9 Limitations and future research*

In this subchapter, we will address the limitations of our study and delineate potential paths for future research. The topic we address in this master's thesis is a relatively new field, therefore there is a limited body of research available for reference. When establishing the environmental balance sheet, our approach mainly relies on Reichelstein's (2023) study on *Corporate Carbon Emissions Statements*. Since our thesis is not grounded in actual data, the calculations may not necessarily reflect realistic values in the same manner as if the figures were derived from an actual steel company's emission.

Furthermore, a challenge encountered in converting $CO_2$ equivalents is accurately estimating the degradation of diverse greenhouse gases in the atmosphere over extended periods. We found few examples of such calculations and opted to use a general mathematical formula for exponential decay. We acknowledge the absence of a standardized method for calculating the degradation of $CO_2$ equivalents at present.

# 8. Conclusion and further recommendations

In this thesis, we have produced an environmental balance sheet and income statement. In this regard, we have examined the use of the two most popular emission metrics, and analyzed their advantages and limitations, concerning $CO_2$ and $CH_4$. Which metric should be used depends on several value choices and what the purpose analysis is - there is no single emission metric that is suitable for any scenario or situation.

An important thing to consider is that emissions of $CH_4$ are almost transient, while $CO_2$ emissions are persistent. When assessing time horizons, one should therefore not lose focus on eliminating $CO_2$ emissions, as this is essential for the climate to stabilize. If one chooses to use a shorter time horizon with respect to $CH_4$, the result should therefore be tempered with a longer time horizon. Based on the Paris Agreement, and the goal of limiting global warming to below 2 degrees, as well as accomplishing net zero by 2050, it would be advisable to use a shorter time horizon, as it looks at the effect of emissions during this period. A temperature-based metric such as GTP, would be more suitable with a temperature-based climate target. However, it is important to note that the damage due to climate change can increase faster than the temperature itself.

Using weighting factors such as $GWP_{100}$ or $GTP_{100}$ is often the simplest option, as these metrics are easy to apply. However, these metrics hide information that could be relevant for regulations and policy recommendations. The impact of each greenhouse gas on the climate may be significantly different, something that is not revealed by such a simplification. It would be most precise to report on $CO_2$ and $CH_4$ separately, which is practically difficult to do. If the value of the calculated $CO_2$ equivalent greatly affects the result, we recommend that both shorter and longer horizons are used to assess the impact.

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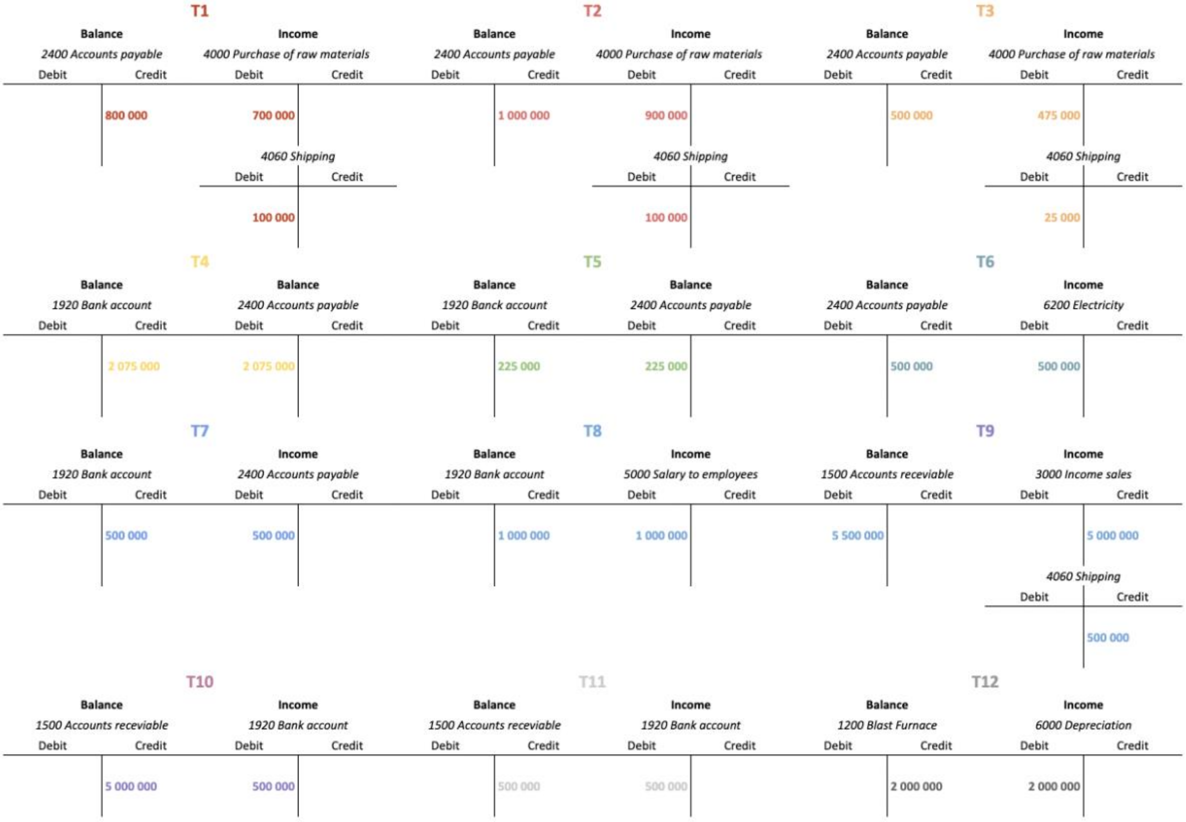
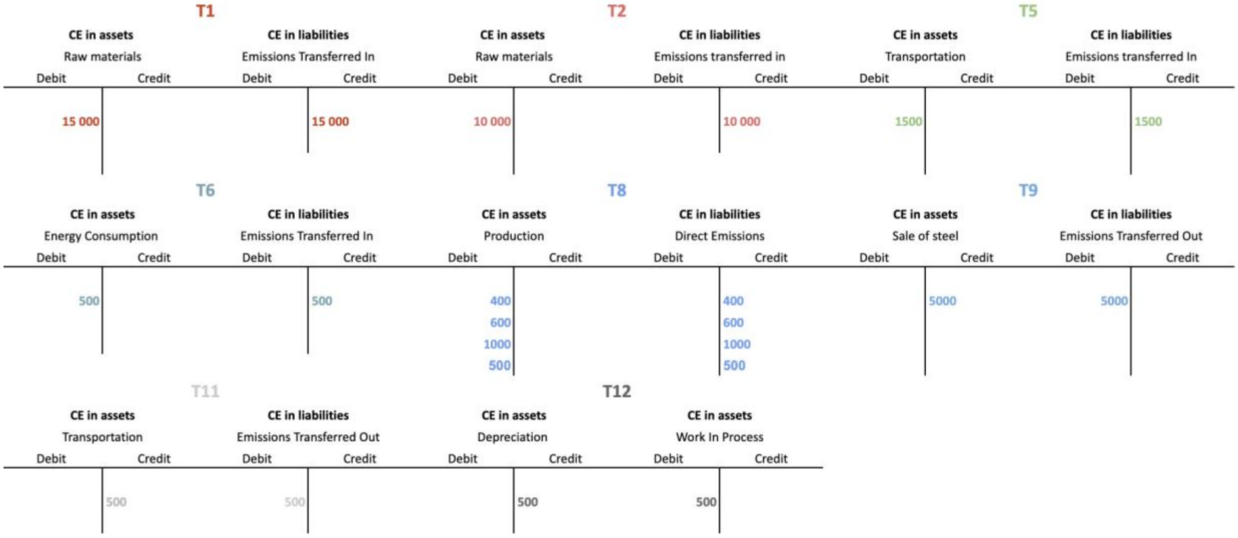
# 10. Appendix:

Appendix 1: T – accounts, financial balance



| | | | Debit | Credit |
|---|---|---|---|---|
| T1 | Balance | 2400 Accounts payable | | 800 000 |
| | Income | 4000 Purchase of raw materials | 700 000 | |
| | | 4060 Shipping | 100 000 | |
| T2 | Balance | 2400 Accounts payable | | 1 000 000 |
| | Income | 4000 Purchase of raw materials | 900 000 | |
| | | 4060 Shipping | 100 000 | |
| T3 | Balance | 2400 Accounts payable | | 500 000 |
| | Income | 4000 Purchase of raw materials | 475 000 | |
| | | 4060 Shipping | 25 000 | |
| T4 | Balance | 1920 Bank account | | 2 075 000 |
| | Balance | 2400 Accounts payable | 2 075 000 | |
| T5 | Balance | 1920 Banck account | | 225 000 |
| | Balance | 2400 Accounts payable | 225 000 | |
| T6 | Balance | 2400 Accounts payable | | 500 000 |
| | Income | 6200 Electricity | 500 000 | |
| T7 | Balance | 1920 Bank account | | 500 000 |
| | Income | 2400 Accounts payable | 500 000 | |
| T8 | Balance | 1920 Bank account | | 1 000 000 |
| | Income | 5000 Salary to employees | 1 000 000 | |
| T9 | Balance | 1500 Accounts receviable | 5 500 000 | |
| | Income | 3000 Income sales | | 5 000 000 |
| | | 4060 Shipping | | 500 000 |
| T10 | Balance | 1500 Accounts receviable | | 5 000 000 |
| | Income | 1920 Bank account | 500 000 | |
| T11 | Balance | 1500 Accounts receviable | | 500 000 |
| | Income | 1920 Bank account | 500 000 | |
| T12 | Balance | 1200 Blast Furnace | | 2 000 000 |
| | Income | 6000 Depreciation | 2 000 000 | |

Appendix 2: T – accounts, carbon emissions



| | | | Debit | Credit |
|---|---|---|---|---|
| T1 | CE in assets | Raw materials | 15 000 | |
| | CE in liabilities | Emissions Transferred In | | 15 000 |
| T2 | CE in assets | Raw materials | 10 000 | |
| | CE in liabilities | Emissions transferred in | | 10 000 |
| T5 | CE in assets | Transportation | 1500 | |
| | CE in liabilities | Emissions transferred In | | 1500 |
| T6 | CE in assets | Energy Consumption | 500 | |
| | CE in liabilities | Emissions Transferred In | | 500 |
| T8 | CE in assets | Production | 400<br>600<br>1000<br>500 | |
| | CE in liabilities | Direct Emissions | | 400<br>600<br>1000<br>500 |
| T9 | CE in assets | Sale of steel | | 5000 |
| | CE in liabilities | Emissions Transferred Out | 5000 | |
| T11 | CE in assets | Transportation | | 500 |
| | CE in liabilities | Emissions Transferred Out | 500 | |
| T12 | CE in assets | Depreciation | | 500 |
| | CE in assets | Work In Process | 500 | |