MAB MAANDBLAD VOOR ACCOUNTANCY EN BEDRIJFSECONOMIE

Maandblad voor Accountancy en Bedrijfseconomie 99(5) (2025): 295–310
DOI 10.5117/mab.99.171609

Research Article

Companies' roads to a net-zero greenhouse gas footprint and related disclosure quality in their corporate reports

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Received 9 September 2025 | **Accepted** 7 October 2025 | **Published** 4 December 2025

Abstract

This article focusses on the quality of greenhouse gas emission related disclosures of heavy greenhouse gas emitting companies. Despite the fact that in many EU-countries the transposition of the CSRD in national law was still not completed, almost all companies in our sample applied the CSRD accompanied by a review opinion providing limited assurance. While a strong majority disclose (intermediate) goals for reducing greenhouse gas emissions, we see a variation in the year selected as reference for measuring the reduction. Our findings suggest that the comparability of corporate reports is currently impaired by variations in entities' reporting scope, classification policies, measurement methods and disclosure practices. All assurance reports on sustainability reports were unqualified in our sample. The attention of the auditor for the impact of carbon emissions and related commitments is significant.

Relevance to practice

This study provides the reader with an overview of the disclosure quality of greenhouse gas policies, targets and details among a sample of the 35 European listed companies within heavy GHG-emitting industries. Areas for improvement are identified and good examples are highlighted and discussed to stimulate improvements in future reporting quality.

Keywords

Greenhouse gas emissions, disclosure quality, net-zero targets, climate neutrality, CSRD, carbon credits, assurance reports

1. Introduction

The European Union (EU) has committed itself to become climate neutral by 2050 according to the European Green Deal which is the EU's strategy to meet the goals of the Paris 2016 Treaty (UN 2015). The aim of this legally binding international treaty is to limit the rise of the global surface temperature to well below 2°C above pre-industrial levels and preferably limit the increase to a 1.5°C rise. To stay below this 1.5°C threshold, greenhouse gas emissions[1] need to be reduced by roughly 50% in 2030.

Climate neutrality is described by the United Nations (UN) as the idea of achieving net zero greenhouse gas (GHG) emissions by balancing those emissions so they are equal to, or less than, the emissions removed. It also means taking into account regional or local biogeophysical effects of human activities.[2] This explains the term 'net-zero' which is described by the UN as cutting carbon emissions to a small amount of residual emissions that can be absorbed and durably stored by nature and other carbon dioxide removal measures, leaving zero in the atmosphere.[3] This description shows that net zero goes beyond climate neutral. Entities would not be able to claim being net zero by simply acquiring massive amounts of carbon credits,[4] even if that would mean the net emission is zero. To reach the goal of the Paris Treaty (UN 2015), the net emission of greenhouse gases should be significantly reduced in order to mitigate the risk of climate warming.

Reducing net emissions requires a change in behaviour by emitters. This can be achieved by mandating such, or by incentives. The latter can be done by governments through monetary or other penalties/benefits such as carbon pricing. The EU realised that mandating would lead to unwanted interference in the free market and that the amounts involved are too large to be financed through government subsidies/penalties alone. So although these measures were taken, for example through an EU emission trading scheme that was introduced in 2005 and applied by more and more companies which will be discussed later, the EU decided to involve the EU capital market and incentivise it to finance emission-friendly investments. This requires transparency around greenhouse gas emissions and pressure on companies to reduce those emissions and on financiers to prefer emission-friendly investments. It also relies on other stakeholders such as NGOs and consumer (organisations) to hold emitters accountable. This all explains why the EU needed sustainability reporting by companies as well as regulations for investments in sustainable projects (sustainable finance). In this research we will focus on the role of transparency around greenhouse gas emissions and emission rights as instruments to incentivise emission reduction behaviour.

The EU already required large listed entities to disclose information about sustainability as part of the Non-Financial Reporting Directive (NFRD). However, this Directive only mentioned the broad topics that companies needed to address in their annual management report. There were no detailed requirements on what to disclose about these broad topics and it did not specifically address greenhouse gas emission (reduction). As part of the broader European Green Deal the EU replaced the NFRD with the Corporate Sustainability Reporting Directive (CSRD) aiming to enhance transparency and accountability regarding companies' environmental, social, and governance (ESG) practices. Specific disclosure requirements – such as reduction targets set by companies and action plans to reach these targets – are set through a Delegated Act that comprises 12 European Sustainability Reporting Standards (ESRSs). The date of application of the CSRD and the ESRSs is financial years starting on or after 1 January 2024 for large public interest entities. Since this research addresses the 2024 annual reports of large listed entities, we will not go into the details of the CSRD requirements for other companies, nor address the Omnibus discussions about the reduction of the administrative burden caused by sustainability reporting in accordance with the CSRD.[5] The CSRD requires a sustainability report as a separate section of the management board report. Additionally, it requires that this sustainability report receives (at least) limited assurance from an external auditor.

It is important to note that the CSRD was required to be transposed into the law of EU member states by July 6, 2024. However, many EU-countries, including the Netherlands, did not complete the transposition before the 2024 financial statements of the first companies in scope of the CSRD were issued.

Nevertheless, most of the companies included in our survey that were not required (yet) to apply the CSRD/ESRSs and were still subject to the NFRD, decided to voluntarily apply the new requirements of the CSRD/ESRSs in their 2024 annual report and to have the consequential separate sustainability section of the management board report reviewed by an external party.

In our contribution we will focus especially on greenhouse gas emission related disclosures of companies falling (formally) in scope of the CSRD, in particular those areas that have already been flagged as important by financial statement supervisory authorities such as the Dutch Financial Markets Authority (AFM) and ESMA as European coordinator of supervisory authorities.[6]

This study is structured as follows; in section 2 more background will be provided to mandatory and voluntary GHG schemes and instruments. In section 3 we continue with the relevant parts of the CSRD/ESRSs that require greenhouse gas related disclosures. In section 4 the sample of this study, the descriptive statistics and the disclosure elements examined are described. The outcomes of our empirical examination are described in section 5 in which also good practices are shown and discussed. Section 6 is dedicated to the assurance provided by the auditor with respect to the sustainability part of the management board report and any emission related references in the auditor report to the financial statements. This study is concluded by section 7, in which we provide concluding remarks and give recommendations to further improve the quality of corporate reporting in the area of our investigation.

2. Carbon markets, greenhouse gas emissions, policies schemes and instruments

Market-based mechanisms to support climate change mitigation action find their origins in the 1997 Kyoto Protocol (UN 1997), the first international agreement that sought to operationalise GHG reduction actions. The Kyoto Protocol set a per-country cap for carbon emissions. The Paris 2016 Treaty went a step further and established a more inclusive framework with nationally determined contributions from all participating countries. This Paris Treaty is considered to have superseded the Kyoto Protocol as the primary global instrument for mitigating climate change.

The treaties and the (net zero) targets set for the participating countries resulted in the establishment of carbon markets aiming to reduce GHG emissions by establishing a price on the GHG emissions with two types of market-based instruments:

(1) emission allowances, which are tradeable permits to emit one metric ton of carbon dioxide (CO2) equivalent GHG[7] per allowance, and
(2) carbon credits, which each represent one metric ton of carbon dioxide equivalent GHGs reduced or removed from the atmosphere.

A discussion paper of IOSCO (2022) distinguishes three types of carbon markets:

(1) Compliance markets – also called 'cap-and-trade'- or emissions trading system (ETS) markets, as they are set by 'cap-and-trade' regulations at regional, national and state levels. In these markets, carbon allowances are issued by regional, national and international governmental organizations and then are traded in a secondary market. These markets are designed to assist climate policy in promoting emission reductions.
(2) Voluntary markets – where entities buy carbon credits to offset some or all of their own carbon emissions. These carbon credits are issued in relation to climate change mitigation projects, either through carbon removals and through emissions reductions. These markets are largely unregulated at present.[8]
(3) Compliance *offset* markets – a regulated system where companies, mandated by law, can purchase carbon credits to offset their own emissions. These are markets falling under Article 6.4 of the Paris Agreement[9]; with the United Nations acting as the supervisory authority.

A key difference between compliance and voluntary markets is that compliance markets exist as mandatory schemes, with companies within scope being obliged to redeem emissions allowances to cover their GHG emissions or to acquire allowances in the market (or pay a fine) in case the company falls short of allowances to cover the actual GHG emissions. On the other hand, voluntary markets allow companies, governments and others to purchase carbon credits on a voluntary basis, for example, to meet own set environmental goals.

To reduce greenhouse gas emissions, both gross and net, strategies focus on reducing emissions at their source (gross) and offsetting remaining emissions through various methods in order to reduce net emissions. Gross emission reductions involve minimizing the total amount of GHGs released into the atmosphere, while net emission reductions consider the balance *after* taking into account offsetting activities.[10]

As mentioned in the introduction, the EU ETS is a cap-and-trade scheme that was launched already in 2005. The ESMA has observed that more listed companies across different industries under their supervision are entering into these schemes (ESMA 2024a). A cap or limit is set on the total amount of specific greenhouse gases that can be emitted. The cap is reduced over time so that total emissions fall. An entity must surrender enough allowances (either received or acquired) to cover its emissions production on a yearly basis, otherwise fines are imposed. If an entity reduces its emissions more than the reduced cap, it can keep the spare allowances to cover its future needs or sell them to another party that is short of allowances. Entities can therefore trade emission allowances with one another. Voluntary carbon credits or offsets from outside the EU ETS are not accepted for compliance.[11] If companies' emissions exceed the number of allowances they hold, they have two options: (1) either purchase more allowances in the open EU ETS market or (2) pay a financial penalty which price is currently substantially higher than the allowance market price.

3. Urge for transparency and relevant disclosure requirements

Across various recent publications including its enforcement priorities for the reporting year 2024[12], ESMA has highlighted that companies need to consider the impacts of how climate-related matters are accounted for in financial statements prepared in accordance with IFRS Accounting Standards and urged listed companies under their supervision to provide robust related disclosures. Among the topics addressed in such prior publications, ESMA has called for increased attention to the accounting and financial reporting ramifications that stem from companies' efforts to reduce GHG emissions in conjunction with their response to targets set under the Paris Agreement.

In addition, the AFM (2024) urges listed companies to be transparent about net zero targets. Based on a thematic review of 27 corporate reports of Dutch based listed companies (reporting year 2022), the AFM concluded that companies were on the right track in their annual reports in substantiating their net zero targets until 2030 but concluded also that the path to 2050 remains vague.

Also IOSCO in its discussion paper (2022) calls for accurate, transparent, and complete disclosures related to the actual emissions output and contrast or compare the use of carbon credits across individual firms, sectors, regions, and time horizons.

With regard to the CSRD and related ESRSs, ESRS E1 'Climate Change', mandates detailed disclosures related to climate change, including greenhouse gas (GHG) emissions. These disclosures are closely aligned with the GHG Protocol, the globally recognized standard for measuring and reporting GHG emissions, and also with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations, which focus on financial risks and opportunities related to climate change. One of the objectives of ESRS E1 is to enable users of sustainability statements to understand the company's past, current, and future mitigation efforts, including its plans and the capacity to adapt its strategy and business model, to be compatible with the limiting of global warming to 1.5°C. In ESRS E1 these requirements can specifically be found in disclosure requirement E1-4 'Targets related to climate change mitigation and adaptation' both in the main text of the standard (par. 30–34) and in the application requirements (AR) included in Appendix A of the standard (AR 23–31).

4. Research sample and characteristics

To examine corporate disclosures related to GHG emissions, emission reduction initiatives, and the accounting treatment of offsetting instruments (i.e., GHG emission allowances), this study focuses on entities with the highest levels of GHG emissions. GHG emissions include various gases like methane and nitrous oxide. They are commonly reported in CO2 equivalents (their global warming potential is translated into CO2 equivalent based upon standardized measures), enabling CO2 equivalents to measure the total GHG emissions. Therefore, in the remainder of the text the two terms are used interchangeably. The Carbon Tracker Initiative,[13] an independent financial think tank that assesses the implications of the energy transition on financial markets and fossil fuel investments, publishes the 'Flying Blind report series',[14] which identifies the 140 largest GHG-emitting companies globally. This list serves as a starting point for our sample selection.

Given the diversity of regulatory frameworks governing emissions disclosures across jurisdictions, we refined our sample to include only those entities headquartered within the European Union except for two non-EU companies materially applying the CSRD/ESRSs (see next paragraph). Applying this geographic filter reduces the initial list to 37 entities.

Of these 37 entities, one has been delisted and is therefore not currently subject to the CSRD. Another entity, although included in the original list, is listed in the United States and thus also falls outside the scope of the CSRD.

Among these 35 remaining entities, two are headquartered in Switzerland and one in Norway. As Norway is part of the European Economic Area (EEA) it must incorporate all EEA-relevant EU directives into its domestic legislation including the CSRD. The Swiss companies involved (Nestlé, Holcim) apply (parts of) the CSRD/ESRSs in order to comply with the requirement in Swiss law to disclose material non-financial information. Consequently, these entities have been retained in the final sample for further analysis. We refer to Appendix 1 for the list of companies that are selected in our sample which also includes their country of incorporation and industry.

To indicate the relevance of this sample for global emissions Table 1 provides an overview of emissions reported by these 35 companies. As Table 1 shows, not all companies report Scope 1, 2 or 3 emissions or did not provide Scope 2 information on a location- and market-base. Scope 1 covers direct emissions from owned or controlled sources, Scope 2 includes indirect emissions from purchased energy, and Scope 3 encompasses all other indirect emissions across the value chain. The table indicates how many companies reported each metric. Together these companies reported more than 5bn tons of CO2 equivalents emissions in the current year (Scope 1, 2 and 3). It should be noted that simply adding up the emissions amounts leads to double-counting to the extent these 35 companies are part of each other's value chain. For example, the Scope 2 emissions of a production company may be part of the Scope 3 emissions of the supplying energy company. To put the total amount of emissions in perspective, the International Energy Agency[15] (IEA) uses an estimate of total CO2 equivalent emissions in 2024 of 37.4bn tCO2. One cannot easily compare the two as the measurement methods may not be the same. However, it shows that the 35 companies in our survey alone cover a not insignificant portion of global annual emissions. As can be expected the vast majority of emissions (86% of market-based emissions) are Scope 3 emissions (relating to the value chain) rather than Scope 1 and 2 emissions (own operations or purchased power and heat).

While almost all companies in our sample use the CSRD/ESRSs as a basis for their sustainability report, *formally* many companies did not have to comply with this framework in their 2024 report due to the fact that the CSRD in their home countries had not been transposed into the national law yet by the time the annual reports were issued.[16] In many EU-countries the transposition was still in a draft phase which caused uncertainty during the preparation of the 2024 sustainability reports because the draft law could have been finalised before the date of issue of the financial statements. Many companies decided to mitigate this uncertainty by already applying CSRD/ESRS. This was also the recommendation of the professional body for accountants in the Netherlands (NBA) which was published by means of an audit alert in December 2024.[17] Table 2 presents the sustainability reporting frameworks applied by the entities in the sample. A substantial majority (86%) report under the CSRD and the ESRS. Notably, two entities, one from Germany and one from Sweden, continue to apply the Global Reporting Initiative (GRI) standards. In these countries, CSRD/ESRS requirements had not yet become mandatory at the time of

Table 1. Emissions reported by surveyed companies.

	Number of companies reporting	Total reported emissions (million tCO2eq)	Average emissions (million tCO2eq per company)	Median emissions (million tCO2eq per company)	Low (million tCO2eq per company)	High (million tCO2eq per company)
Gross Scope 1	34	644.9	18.97	9.63	0.21	97.00
Gross Scope 2 location-based	31	66.9	2.16	1.00	0.00	20.68
Gross Scope 2 market-based	33	64.3	1.95	0.86	0.00	20.06
Gross Scope 3	34	4,295.2	126.33	73.01	8.38	474.69
Total location-based	31	4,743.2	153.01	108.33	11.91	475.46
Total market-based	34	5,004.4	147.19	108.85	11.34	475.31

publication, as described above. Additionally, one entity from Luxembourg still reports under the NFRD, and two entities, one from Switzerland and one from Germany, use a hybrid approach, combining elements from multiple frameworks. This variation highlights the transitional phase in sustainability reporting practices across Europe.

Table 2. Sustainability reporting frameworks applied by sampled entities (due to rounding, total does not add up to 100%).

Reporting framework	Number	Percent
CSRD/ESRS	30	86%
GRI	2	6%
NFRD	1	3%
Other	2	6%
Total	35	100%

The CSRD requires companies to explain how their action plans and targets (if any) align with limiting global warming to 1.5°C. Companies can use the Science Based Targets initiative (SBTi) as a way[18] to demonstrate that their targets are science-based and aligned with CSRD requirements. SBTi is a globally recognized framework that enables companies to set greenhouse gas emissions reduction targets aligned with climate science and the goals of the Paris Agreement. For readers of sustainability reports, SBTi-checked targets show that the disclosed goals are not only ambitious but also scientifically grounded and externally validated. A majority of 69% of the entities have their goals checked by SBTi. The remaining 31% of the entities have not (yet) undergone SBTi (or other external science-based) validation, which may reflect differences in reporting maturity, strategic priorities, or timing of target setting.

5. Analysis on the disclosure quality of the greenhouse gas footprint

Given the market authorities' urges for transparency on the greenhouse gas targets set by the listed companies (see section 3), it is interesting to examine whether this transparency has been provided by the companies in our research sample. ESRS E1 Section 4 (par. 32) requires that the company shall disclose whether and how it has set GHG emissions reduction targets and/or any other targets to manage material climate-related impacts, risks and opportunities. *If* the company has set GHG emission reduction targets, paragraph 34 of ESRS E1 demands detailed follow-up disclosures about these targets. E.g. the ESG reduction targets should be disclosed in absolute value and separately or combined for Scope 1, 2 and 3 GHG emissions.[19] Target values should be set for the year 2030 and, if available, for the year 2050 together with the disclosure whether the GHG emission reduction targets are science-based and compatible with limiting global warming to 1.5°C. Also, the base year and baseline value serving as a historical reference point (or state)[20] against which current emissions should be compared, should be disclosed together with the expected decarbonisation levers[21] and their overall quantitative contributions to achieve the GHG emission reduction targets.

To assess the quality and completeness of sustainability disclosures, we have used the disclosure requirements of ESRS E1-4 'Targets related to climate change mitigation and adaptation' as an important basis for our analysis, where we interpret quality as the degree to which disclosures are specific, measurable, and consistent with regulatory standards and stakeholder expectations. We will also look into the financial statements with a specific focus on the accounting policies used and the quality of disclosure of ETS-related instruments, including granted and purchased rights, liability recognition, and presentation aspects. Given that there is currently no prescribed accounting method for ETSs, our analysis aims to explore the extent to which entities adopt different accounting approaches and whether a dominant or commonly accepted method has emerged in practice.

5.1. Disclosure of emission reduction targets

We start with discussing the net-zero goals that entities have set. Net-zero targets represent a pivotal element of corporate climate strategy, signalling long-term commitments to GHG emissions in line with global climate objectives. Three companies did not commit to a net zero target. Most entities have set their net-zero goals for the year 2050. However, a significant portion of the sample has adopted more ambitious timelines, with target years ranging from 2045 to as early as 2038. Among these, the year 2040 emerges as a particularly common choice, indicating a growing trend toward accelerated decarbonization. On the other hand, two companies that stated to have an overall net zero target subsequently caveated this by formulating reduction goals that only comprise certain categories of Scope 3 emissions or the Scope 3 emissions for only part of their activities. The variations in target years are detailed in Table 3, which provides an overview of the net-zero timelines across the sample. Importantly, all entities explicitly state that their net-zero goals are aligned with the Paris Agreement.

It should be noted that the majority of companies report only absolute net zero emission targets whereas three companies use only carbon intensity or relative net zero targets[22] and nine companies use a combination

Table 3. Net-zero target years of sampled entities (due to rounding, total does not add up to 100%).

Year	Number	Percent
2050	20	57%
2045	2	6%
2040	8	23%
2039	1	3%
2038	1	3%
No year for net zero defined	2	6%
No goals disclosed	1	3%
Total	35	100%

of absolute and relative net zero targets (e.g., per megajoules of energy produced). While relative goals (like CO2eq per passenger-kilometre for airlines) can be useful for benchmarking within industries, they complicate cross-sector comparisons. Moreover, ESRS E1-4 paragraph 34(a) explicitly requires entities to disclose GHG emission reduction targets in absolute terms, either in tonnes of CO2 equivalent or as a percentage reduction from a base year, and where relevant, in intensity terms.

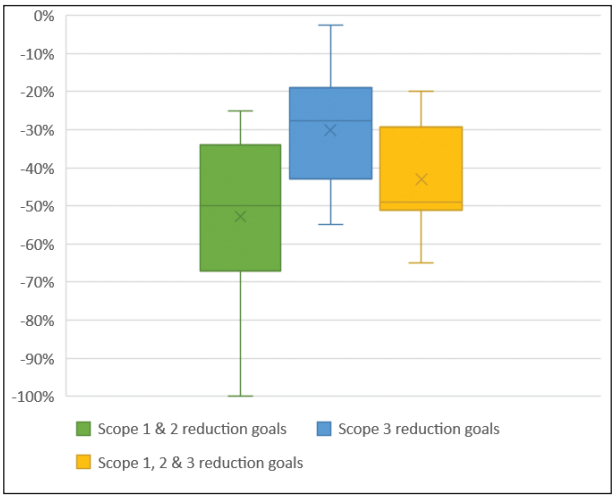
All entities in the sample except two have also set intermediate emission reduction goals, which serve as important milestones for tracking progress. The majority of these targets are set for the year 2030, with a few exceptions extending to 2032, 2033, and 2035. While net-zero goals tend to be comparable due to their alignment with the Paris Agreement, intermediate goals are more difficult to compare across entities as they tend to be entity-specific, covering only some scopes or combinations of scopes, some categories and some activities or some parts of the emissions. Table 4 summarizes the findings in respect of absolute and intensity intermediate goals. Interestingly, some companies use a lot of intermediate goals (up to seven).

Most entities have set combined intermediate emission targets for Scope 1 and 2 emissions, while also defining separate goals for Scope 3. Specifically, 86% of the entities disclose intermediate Scope 1 & 2 targets, 60% report intermediate Scope 3 targets and 34% disclose intermediate targets for the total of Scope 1, 2 and 3. Nearly all of these goals are expressed as gross reductions, rather than net values. However, the magnitude of these reduction targets varies significantly across entities. As shown in Figure 1, the average reduction target for Scope 1 and 2 by 2030 is approximately 50%, while Scope 3 targets average around 35%. The boxplots illustrate the substantial variance in ambition levels, which we attribute to the large differences in emission reduction goals across entities. This variation likely reflects underlying differences in industry context, operational boundaries, and strategic priorities.

Table 4. Intermediate emission reduction goals.

	Absolute	Intensity	Total
Number of goals	67	35	102
Average	1.9	1	2.9
Median	2	1	2
Minimum	0	0	0
Maximum	5	6	7

Figure 1. Distribution of Intermediate Emission Reduction Goals by Scope.



To benchmark progress toward their emission reduction targets, entities establish a base year, which serves as the reference point from which reductions are measured. These base years are critical for assessing the trajectory of climate goals and assessing whether entities are on track in meeting their targets. What stands out in this research is the considerable heterogeneity in the selection of base years across the sample. As illustrated in Figure 2, base years range from 2015 to 2023, with 2018 and 2019 emerging as the most frequently chosen. Two companies use two different base years for different targets. This considerable heterogeneity in chosen base years hinders the comparison between companies in analysing the effectiveness and magnitude of their emission reduction efforts to attain (intermediate) Paris targets.

Figure 2. Distribution of base years for emission reduction targets.

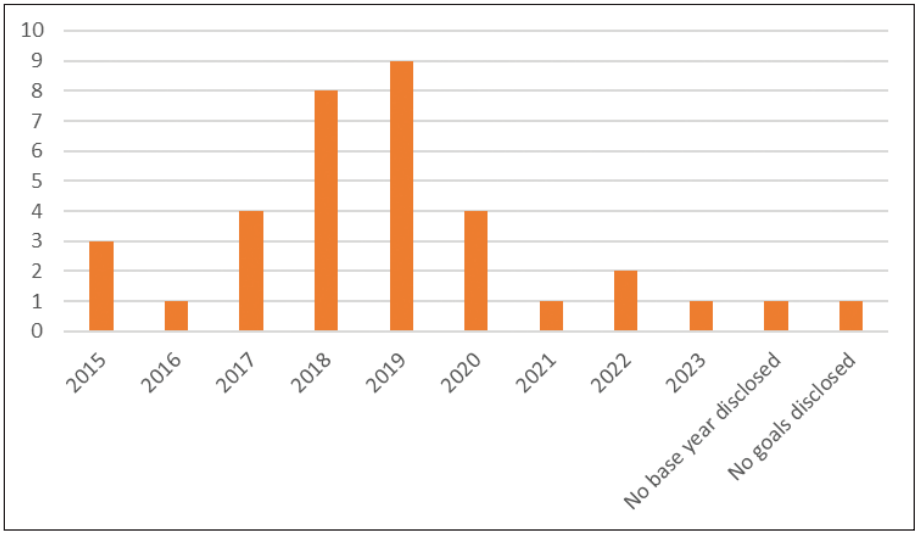
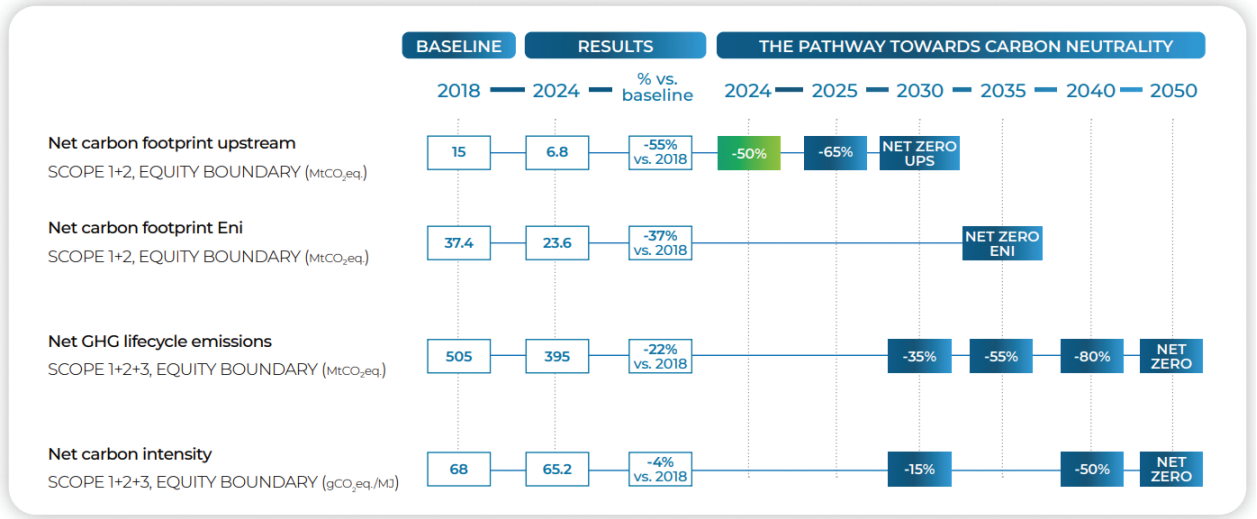


Figure 3 illustrates a strong example of transparent GHG emission reporting, as presented by Eni. The figure begins with the disclosure of the baseline year, including the total GHG emissions recorded in that year. This establishes a clear reference point for evaluating progress. Eni then presents the results for 2024, showing both the absolute emissions and the reduction achieved relative to the baseline. This is visually juxtaposed with the projected pathway toward carbon neutrality, enabling readers to quickly assess whether the company is on track to meet its long-term climate goals. Importantly, Eni has applied this structure to each of the four climate-related goals it has set, offering a consistent and comprehensive view of its progress. Eni also discloses the GHG boundary used. The GHG boundary defines which emissions are included in an entity's reporting scope and which emissions might be considered direct or indirect. Common boundaries used are 'equity share', 'operational control' and 'financial control'.[23]

Given the different potential outcomes of these boundaries, it is important that stakeholders are aware of the approach chosen.

Compared to GHG removal and storage, carbon credits are more commonly used by entities in the sample to offset emissions. Specifically, 43% of the entities report using carbon credits as part of their climate strategy. However, the magnitude of these credits is generally limited relative to their total emissions, indicating that credits play a supplementary rather than central role in current reduction efforts. The carbon credits are also validated by third parties. It is noteworthy that most entities have set gross reduction goals for 2030, meaning that carbon credits do not contribute to achieving these intermediate

Figure 3. Good practice disclosure on emission reduction targets: Eni Annual Report 2024, p. 153.



5.2. Emission reduction measures

Once companies identify emission reduction as a strategic priority, often linked to long-term value creation or regulatory compliance, they typically establish specific targets, which then guide the selection of measures and tools to achieve those goals. This subsection explores the measures taken to achieve these reductions, including absolute emission cuts, GHG removals and storage[24], and the use of verified carbon credits.

While most entities focus on operational reductions and offsetting strategies to meet their climate targets, the use of GHG removal and storage remains limited across the sample. Only 14% of the entities report employing GHG removal and storage as part of their emission reduction strategy. Given the central role that removals and storage are expected to play in achieving net-zero emissions, particularly in the final stretch toward meeting the 2050 Paris-aligned climate objectives, we would have anticipated a higher adoption rate. The current low uptake suggests that the path to 2050 may be challenging, as reliance on GHG removals is likely to increase significantly in the coming years. Moreover, when these measures are used, the reported volumes are relatively small, typically below 0.05 MtCO2eq, indicating that removals currently play a minor role in overall reduction efforts. However, in all cases where GHG removals are disclosed, the reductions are certified by third-party organizations.[25]

targets. Instead, credits are often positioned as a future tool to help meet net-zero goals, particularly for hard-to-abate emissions. Among entities not currently using carbon credits, a majority disclose intentions to adopt them in the near future, suggesting a growing reliance on market-based mechanisms as net-zero deadlines approach.

Figure 4 showcases Bayer's approach to disclosing GHG removals and mitigation projects, aligning with the ESRSs. A key strength of Bayer's reporting is the clear labelling of disclosures according to the relevant ESRS standard. In the context of GHG removals and mitigation, Bayer provides detailed data on the voluntary carbon credits it has purchased. Notably, the report includes comparative figures from the previous year, offering a valuable reference point for assessing progress. Bayer further specifies that all purchased credits originate from nature-based solutions. The report also clarifies that these projects are located outside the European Union, placing them outside

Figure 4. Good practice disclosure on emission reduction measures: Bayer Annual Report 2024, p. 152.

GHG removals and GHG mitigation projects financed through carbon credits [E1-7]

Our focus is on reducing our greenhouse gas emissions and on the associated targets and actions. We also participate in voluntary carbon markets.

Within the scope of our activities on the voluntary carbon markets, we offset 0.71 million metric tons of CO_2 equivalents in 2024 (2023: 0.6 million metric tons of CO_2 equivalents). We exclusively purchased certificates from nature-based solutions in 2024. 57% of the CO_2 certificates originated from projects aimed at reducing CO_2 emissions. Through the purchase of CO_2 certificates, we supported projects aimed at carbon reduction and capture. All certificates we purchased in 2024 were used for that year. The projects are implemented in the following countries: Brazil, Colombia, Indonesia, Malawi, Sierra Leone, the United States and Uruguay. No projects were supported in the European Union. All of our certificates lie outside the scope of corresponding adjustments for trade in carbon credits between governments.

We have defined the following specific criteria for our purchase of certificates from climate protection projects with the goal of a high standard that we will constantly improve and further develop. These criteria comprise transparency, additionality, permanence, measurability, quality/standards, innovation, impact, co-benefits, no leakage, no double counting and no net harm.

In 2024, 100% (2023: 100%) of our purchased certificates were verified according to external standards such as Verified Carbon Standard (VCS), CCB or EcoRegistry. We obtain the opinion of an independent external service provider to assess their quality and integrity.

the scope of compliance-based cap-and-trade schemes and confirming their classification as voluntary credits. To ensure credibility, Bayer discloses that all credits are verified by independent third-party standards.

5.3. On track to meet the reduction targets?

As discussed before, of the 35 companies only one has no carbon reduction targets at all whereas two more have no net zero goal. Intermediate targets have been committed to by 33 of the 35 companies. Having concrete targets, particularly if they are SBTi approved, is a good step. However, meeting the target is more important. This raises the question whether these companies are on track to meet the targets they committed to. The answer to this question is not simple as the pathway to net zero (or even intermediate targets) may not be a smooth glidepath between a baseline emission in the base year to the 2024 actual emissions and then to a target emission in the target year. This is illustrated by Holcim when they explain that they expect the emissions to even increase till 2033 before they will decrease. However, one would expect the emissions relevant to the targets to reduce and to reduce directionally to the target in the target year.

In order to provide some indication of whether companies are on track we have looked at the targets as defined by the companies themselves, split between (i) intermediate and (ii) ultimate net zero targets and finally we added (iii) the goal to reduce total Scope 1, 2 and 3 emissions to net zero (allowing for a maximum of 10% offsetting of the residual emissions). The latter analysis allows us to apply a uniform method to assess whether a company is on track to meet the absolute net zero target by 2050 and is necessary because companies have used a range of different definitions of net zero targets (see end of section 4 and previous subsections). In each of these three cases of defined targets we compared the baseline amount, the amount in 2024 and the target amount, assuming a linear relationship over time. This allows us to assess whether the actual amount in 2024 is below or above the target line that can be drawn between the baseline amount in the base year and the target amount in the target year. We acknowledge that this is not a perfect method to determine whether a company is on track to meet its targets, but at least it provides some indication. In total we assessed this for each of the 102 intermediate and 32 net zero ultimate targets as defined by companies themselves as well as for the total Scope 1, 2 and 3 emissions of each of the 35 companies. This adds up to 169 analyses. However, not all companies provide the necessary information to make this assessment. Table 5 provides a summary of findings.

Table 5. Tracking companies' carbon reduction targets.

	Company's intermediate targets		Company's ultimate net zero targets		Uniformly defined net zero target	
	Number	Percent	Number	Percent	Number	Percent
On track to meet target	12	34%	9	26%	15	43%
Some goals are, others are not on track (only relevant where companies had multiple intermediate targets or multiple net zero targets)	14	40%	11	31%	N/A	N/A
Not on track to meet target	4	11%	6	17%	9	26%
Whether on track or not cannot be determined because of missing data such as actuals for 2024 or baseyear/baseline data	3	9%	6	17%	11	31%
Not applicable since no target defined	2	6%	3	9%	N/A	N/A
Total	35	100%	35	100%	35	100%

The table paints a diverse picture. However, some conclusions can be drawn.

5.3.1. Conclusions

First, only a minority (43%) of the companies is on track to meet the absolute Scope 1, 2 and 3 emission reduction targets compared to their baseline to become net zero by 2050. Also, if we look at the targets the companies have set themselves, a minority reports data that show they are on track on all of their targets (both intermediate and ultimate net zero targets). This may be an indication that the efforts made so far may not be enough to meet the net zero targets and a step-up is needed. It may also indicate that the efforts made so far only take effect in the longer run.

Second, meeting intermediate targets seem to be more promising than meeting ultimate net zero targets. This is not surprising given the horizon is shorter and companies will have a better insight in the impact of short term measures to reduce carbon emissions. On the other hand, it may be a signal that the intermediate targets have been set such that they can be met more easily, pushing back into future the more difficult measures to reach net zero or as Heidelberg Materials[26] put it, relying on break-through technology for the period between intermediate target and net zero target.

Third, in many cases the analysis could not be performed due to missing data such as 2024 actuals or base year or baseline amounts for the targets or Scope 1, 2 and 3 emissions. This is concerning as either these data may not have been collected, or they have been collected but not disclosed. Either way, this seems like a missed opportunity to manage carbon emission reduction and inform stakeholders about progress made.

Fourth, the ultimate net zero targets formulated by the companies themselves seem to be better on track than the uniform absolute net zero target of total Scope 1, 2 and 3 emissions we used, even allowing for a maximum of 10% offset of residual emissions in the latter. This is probably due to different GHG boundaries used. We refer to section 5.1.

5.4. Participation in emissions trading schemes

In addition to voluntary measures, many entities are subject to regulatory frameworks such as the EU ETS or other mandatory cap-and-trade schemes. This subsection evaluates whether entities participate in such schemes and the proportion of their Scope 1 emissions that fall under these regulatory caps.

The extent to which entities' Scope 1 emissions fall under the EU ETS varies significantly across the sample. As shown in Table 6, there is considerable heterogeneity. For some entities, nearly all Scope 1 emissions are covered by the EU ETS, while for others, coverage is as low as 5%. Based on the underlying data used to construct Table 6, we find that, on average, approximately 60% of Scope 1 emissions is subject to the EU ETS. This variation reflects differences in industry exposure, operational geography, and regulatory scope.

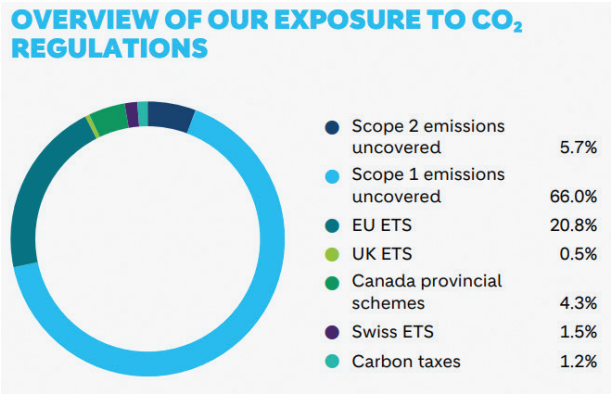
In addition to the EU ETS, several entities are subject to other national or regional emissions trading schemes. Within the sample, entities report participation in ETSs from the United Kingdom, Switzerland, Canada, Brazil, Mexico, China, and South Korea. However, while EU ETS participation is typically disclosed in detail, often within the emissions table per scope as required by ESRS E1-6, disclosures related to other ETSs are generally sparse or absent. There is clear room for improvement in this area, as comprehensive disclosure of all ETS-related emissions would enhance the credibility and completeness of sustainability reporting including the financial risks involved.

Table 6. Proportion of Scope 1 emissions accounted for within the EU ETS framework (due to rounding, total does not add up to 100%).

Bracket	Number	Percent
[0%, 25%)	5	14%
[25%, 50%)	7	20%
[50%, 75%)	8	23%
[75%, 100%]	11	31%
Not disclosed	4	11%
Total	35	100%

Figure 5 presents an example from Holcim's integrated annual report, demonstrating best practice in disclosing exposure to emissions trading schemes. Holcim provides a clear graphical breakdown of its relative CO2 emissions, distinguishing between emissions covered under various ETSs and those that remain uncovered. This visual segmentation allows readers to quickly understand the extent to which Holcim's emissions are regulated and the jurisdictions in which these regulations apply. The figure further enhances transparency by quantifying Holcim's exposure to each ETS in relative CO2 terms. This enables stakeholders to assess the regulatory landscape the entity operates within and to evaluate potential financial and operational risks associated with carbon pricing.

Figure 5. Good practice disclosure on participation in emissions trading schemes: Holcim Integrated Annual Report 2024, p. 219.



5.5. Accounting policies for cap-and-trade instruments

This subsection investigates how entities account for ETS-related assets and liabilities, including the measurement of granted and purchased emission rights, the presentation of these rights in financial statements, and the recognition of liabilities when emissions exceed allocated rights. The accounting treatment is, in principle, influenced by the entity's role within the ETS, whether as a regulated emitter, a provider of emission reductions, or a market participant, and by the specific rights and obligations assigned under the scheme.

Entities participating in the emissions trading schemes may receive emission allowances free of charge. Under the EU ETS, this free allocation is primarily designed to prevent carbon leakage and support sectors that are energy-intensive or exposed to international competition. The system operates on a cap-and-trade basis, where a cap is set on the total amount of greenhouse gases that can be emitted by covered entities. Over time, this cap is gradually reduced to drive overall emissions down. Correspondingly, the number of allowances allocated for free also decreases, encouraging companies to invest in low-carbon technologies and improve energy efficiency.

The accounting treatment of these allowances under IFRS remains unsettled due to the absence of a dedicated standard.[27] Big Four accounting firms note that entities typically choose between accounting for allowances as intangible assets under IAS 38 or as inventories under IAS 2, with allowances received for free often measured at either fair value or a nominal amount, depending on the chosen accounting policy and interpretation of IAS 20 on government grants (PwC 2021; EY 2022; KPMG 2025). However, diversity in practice exists, particularly regarding subsequent measurement and recognition of liabilities when emissions exceed allowances.

If the emission rights are held by a broker/trader, we expect these to be presented as inventory with measurement at cost or fair value less costs to sell, with realised and unrealised changes in value recognised in P&L. If the rights are not held for trading, i.e., no broker/dealer, we find these rights to be presented as inventory, intangible asset or other assets and measured applying either the *government grant model* or *net liability approach*.

The *government grant model* recognises emission rights acquired for free at initial fair value with a corresponding liability to the same amount. Emission rights acquired in the market are initially measured at cost. Subsequent measurement is at cost (the revaluation model may be applied if emission rights are presented as intangibles, but we have not observed this policy in our sample and we expect this to be rare in practice).

The *net liability approac*h recognises emission rights at cost (so zero for emission rights received for free) and only recognises a liability if emissions exceed emission rights received for free. In that case the liability is measured at the carrying amount of the emission rights in stock or at fair value to the extent the company does not possess the emission rights yet.

In ESMA (2024a), the ESMA does not prescribe a specific accounting methodology for the recognition and measurement of emission allowances received under the EU ETS. In its public statements, ESMA encourages entities to develop accounting policies that are consistent with existing IFRS standards and tailored to the specific features of the carbon pricing scheme in which they participate. Entities are expected to clearly disclose the accounting treatment applied to emission allowances, including how assets and liabilities are recognized, measured, and presented in the financial statements.

The analysis of the financial statements reveals that 34% of the entities do not disclose their accounting policy related to emission rights. Given that the financial impact of emission rights can be material, especially in the near future, this lack of disclosure suggests that there is significant room for improvement in the quality and consistency of reporting practices.

With respect to allowances received for free under the EU ETS, there is limited diversity in accounting treatment. Of the 21 entities that disclose their accounting policies, 19 recognize the allowances received for free at nil value upon initial recognition. Only two entities adopt the government grant approach, recognizing the allowances initially at fair value based on prevailing market prices.

With respect to the accounting treatment of purchased emission rights, all entities recognize these at cost upon initial recognition. However, there is considerable variation in how these instruments are classified in the statement of financial position, as can be observed in Table 7. One-third of the entities classify emission rights as inventory, consistent with the inventory model. A larger portion, 43%, classifies them as intangible assets, following the intangible asset model. The remaining 24% categorizes the emission rights under other assets, which is often due to the perceived immateriality of these rights in the context of the overall financial statements.

Table 7. Classification of emission rights in the statement of financial position.

Classification	Number	Percent
Inventory	7	33%
Intangible assets	9	43%
Other asset	5	24%
Total	21	100%

Only 51% of the entities discloses the impact of emission rights on their liabilities. This relatively low percentage is notable given that any entity exceeding its allocated emission rights is required to purchase additional allowances on the market, thereby incurring a liability. As such, we would have expected a higher proportion of entities to reflect this potential obligation in their disclosures. Apparently, companies either reduce their emissions sufficiently in order to avoid a shortage, or they buy additional credits in the market prior to the balance sheet date. Among those that do, all indicate that any liability arising from exceeding the emission cap will be measured at market value.

Here too, classification practices vary, 78% of the entities classify such liabilities as provisions, while the remaining 22% report them as other or current liabilities.

These findings suggest that the comparability of financial statements is currently impaired by variations in classification and disclosure practices. While the amounts involved may not yet be material under the cost model, many entities expect the volume of purchased emission rights to increase in the future. As such, the financial significance of these instruments is likely to grow. To enhance comparability and transparency, it may be appropriate for standard setters to consider mandating a standardized classification framework for both emission rights and related liabilities.

Figure 6 highlights TotalEnergies' approach to disclosing accounting policies related to instruments derived from the EU ETS. Despite its brevity, the policy effectively communicates all essential elements of how TotalEnergies accounts for ETS-related instruments. The disclosure covers the treatment of emission allowances received free of charge, as well as those purchased on the market. It explains how these rights are presented in the financial statements, the conditions under which provisions are recognized, and the measurement used. Furthermore, TotalEnergies distinguishes between standard transactions and forward contracts, noting that these are accounted for differently, an important nuance for understanding the financial implications of carbon trading activities.

Figure 6. Good practice disclosure on accounting policies for cap-and-trade instruments: TotalEnergies Universal Registration Document 2024, p. 478.

Carbon dioxide emission rights generated as part of the EU Emission Trading scheme (EU ETS)

In the absence of a current IFRS standard or interpretation on accounting for emission rights of carbon dioxide generated as part of the EU Emission Trading scheme (EU ETS), the following principles are applied:

- emission rights are managed as a cost of production and as such are recognized in inventories:
  - emission rights allocated for free are booked in inventories with a nil carrying amount,
  - purchased emission rights are booked at acquisition cost,
  - sales or annual surrender of emission rights result in decreases in inventories valued at weighted-average cost,
  - if the carrying amount of inventories at closing date is higher than the market value, an impairment loss is recorded;
- if emission rights to be surrendered at the end of the compliance period are higher than emission rights (allocated and purchased), the shortage is accounted for as a liability at market value;
- forward transactions are recognized at their fair market value in the balance sheet. Changes in the fair value of such forward transactions are recognized in the statement of income, unless hedge accounting has been applied.

A key observation in current reporting practices is the limited integration between sustainability disclosures and the financial statements. In many cases, emissions allowances are only briefly mentioned in the accounting policies, with no further elaboration or quantitative disclosure in the notes to the financial statements. This lack of transparency hinders stakeholders' ability to assess the financial implications of a company's environmental impact. An exception to this observation is Repsol, which provides a more integrated approach. As illustrated in Figure 7, Repsol discloses a detailed movement schedule of its emissions allowances within the financial statements. This disclosure creates a tangible link between the financial and sustainability reports, enabling users to reconcile the financial treatment of emissions allowances with the entity's reported GHG emissions. We recommend that entities adopt similar practices by including movement schedules for emissions allowances in their financial statements.

6. Assurance provided

6.1. Level of assurance

The quality of information is enhanced by third party assurance of that same information. In this section we discuss the assurance provided, if any, on the relevant sections of the sustainability report and the financial statements of the companies surveyed. As mentioned before, the CSRD requires the sustainability section of the management report to receive (at least) limited assurance from an external party.[28] Limited assurance is a lower level of assurance than reasonable assurance, which is required for annual financial statements of listed entities. Limited assurance is often referred to as a review whereas reasonable assurance is referred to as an audit.[29] The CSRD expects the assurance to be provided by the statutory auditor of the financial statements that accompany the sustainability report. However, Member States may allow a statutory auditor or an audit firm other than the one carrying out the statutory audit of the financial statements to perform the review of the sustainability report. Member States may also allow an independent assurance services provider (IASP) established in their territory to perform the review, provided such IASP is subject to equivalent requirements as statutory auditors.

Although this is the first time such requirement is introduced at an EU level, many companies already had certain sustainability information, amongst which emission data, reviewed or audited by an external party. This was done either voluntarily or due to national regulation.

Figure 7. Good practice disclosure on emission allowances: Repsol Group consolidated financial statements 2024, p. 72.

CO2 allowances [no. of allowances]	2024	2023
Opening balance	**12,136,547**	**13,098,227**
CO2 allowances received free of charge	7,268,775	7,588,574
CO2 allowances acquired on the market	6,643,330	7,204,218
CO2 allowances sold on the ETS market	(6,688,400)	(2,673,777)
CO2 allowances offset	(12,241,753)	(13,080,695)
Closing balance	**7,118,499**	**12,136,547**

All companies in our research received an unqualified opinion on the 2024 financial statements, which means that reasonable assurance was provided by the auditor on the information in the financial statements, including information about the emission rights and any other information in the financial statements referred to in this article.

In Table 8 an overview is provided of the level of assurance provided on the sustainability report of the surveyed companies, including the emission data. In all cases the assurance is provided by the statutory auditor of the financial statements.[30] This shows that although in some countries it is allowed to ask an external party that is not the statutory auditor of the financial statements to perform the limited assurance on the sustainability report, apparently this option is not used by the large, listed entities in our sample. Possible explanations are the fact that the statutory auditor of the financial statements is already familiar with the entity, allowing for lower fees compared to a party that has to start from scratch. Another reason could be that the statutory auditor already has to perform a number of procedures to make sure the management report, including the sustainability report, does not contain errors or inconsistencies with the financial statements. So, hiring another party to review the sustainability report inevitably leads to duplication of effort.

Table 8. Assurance provided on sustainability report (due to rounding, total does not add up to 100%).

Level of assurance	Reporting framework	Number	Percent
Limited assurance on sustainability report + reasonable assurance on selected information	CSRD/ESRS	7	20%
Limited assurance on complete sustainability report	CSRD/ESRS	21	60%
	GRI	1	3%
	Total	22	63%
Limited assurance on selected information	CSRD/ESRS	1	3%
	GRI	1	3%
	NFRD	2	6%
	Own reporting framework	1	3%
	Total	5	15%
No assurance	Own reporting framework	1	3%
Total		35	100%

Most companies (21) applied the CSRD/ESRS framework and received limited assurance on the whole sustainability report. Seven companies that applied the CSRD/ESRS framework went beyond the minimum requirements and asked for reasonable assurance on selected disclosures. And five companies that were not subject to the CSRD (yet) and applying various reporting frameworks asked for limited assurance on selected sustainability information. To assess what this means for the assurance provided on the emission data referred to in this article we looked at the selected datapoints that received additional assurance to understand what level of assurance the emission data of the surveyed companies received. Table 9 provides a summary of the assurance provided for Scope 1, 2 and 3 emission data of the surveyed companies. In general, the emission data did receive assurance, be it limited assurance. Assurance on Scope 3 emissions is only slightly less than it is for Scope 1 and 2, despite the fact that Scope 3 emission disclosures are harder to collect and generally less reliable and more subjective, so harder to provide assurance on.

Table 9. Level of assurance for certain emission data.

Assurance	Scope		
	1	2	3
Reasonable	4	4	2
Limited	29	29	30
None	2	2	2
Not disclosed	0	0	1
Total	35	35	35

6.2. Audit reports on financial statements

All audit reports on financial statements of the surveyed companies were unqualified and there were no 'emphasis of matter' (EOM) paragraphs[31] on emissions or emission rights. However, 21 audit reports contained a total of 31 'key audit matter' (KAM) paragraphs relating to the topics addressed in this article, i.e. carbon reduction commitments, carbon reduction requirements and/or emission rights. Table 10 provides the number of KAM's per audit report and Table 11 provides an overview of the topics addressed in the KAMs.

Table 10. Number of KAMs per audit report.

KAMs per audit report addressing carbon reduction, carbon requirements and/or emission rights	Number	Percent
0	14	40%
1	15	43%
2	4	11%
3	1	3%
5	1	3%
Total	35	100%

Not surprisingly, the item addressed most is the impact of the energy transition including the related carbon commitments and carbon requirements on the impairment testing of non-current assets including goodwill, intangible assets, property plant and equipment as well as equity-accounting investments.

The findings show that 60% of the auditors included a KAM specifically addressing emissions and emissions rights. This is high but should not be a surprise given that the population covers companies with high emissions of greenhouse gases. This has led to sometimes elaborate explanations in the audit report on the risks involved and the process the auditor has gone through to assess the risks and the acceptability of the judgements and estimates applied by management. We want to mention in particular the KAMs of auditors that focus the reader's attention to the judgements of management deviating

Table 11. Topics addressed in KAMs.

Line-items	Topic	Risk	Number	Percent
All		Overall impact climate change and carbon reduction on financial statements	2	6%
Non-current assets	Impairment	Impact carbon reduction commitments and carbon requirements on recoverability	16	52%
	Residual lives	Impact carbon reduction commitments and carbon requirements on useful life of assets	3	10%
	Residual value	Impact carbon reduction requirement on expected value of leased products in automotive	3	10%
Provisions and contingent liabilities	Recognition and measurement	Impact carbon reduction commitments and requirements on asset retirement obligations	2	6%
		Uncertainty lawsuits relating to emissions of diesel engines	2	6%
Hydrocarbon reserves	Valuation	Impact energy transition on valuation of hydrocarbon reserves and mineral assets	2	6%
Disclosures	General	Description of impact climate change including carbon reduction commitments and requirements on financial statements as a whole	1	3%
Total			31	100%

from scenarios developed by international organisations and how the auditor got comfortable that this would *not* lead to a qualification. For example, the auditor of Repsol highlights that management used scenarios that are not consistent with the 'Fit for 55' package of measures announced by the European Commission and Repower EU Roadmap.[32] The most elaborate discussion of the topic was found in the audit report of OMV where the auditor included five KAM's covering 7 pages all relating to the impact of energy transition and carbon commitments.

6.3. Assurance reports on sustainability statements

All assurance reports on sustainability reports were unqualified. However, several auditors have raised the attention to specific elements in the sustainability reports. International Standard on Assurance Engagements 3000, which was generally used for limited assurance engagements, provides the possibility to include an EOM paragraph in the assurance report. We found EOM's in nine assurance reports, eight of which were of French companies or of companies with a French background[33].

The topics mentioned in the EOMs include, amongst others:

- Methodological considerations applied by management when preparing the sustainability report with reference to the specific paragraph where they are described.
- The fact that these requirements are new so there is no uniform practice and no historical information, leading to reduced comparability over time and across entities.
- The disclosures contain inherent judgements and uncertainties.
- The double materiality analysis and the analysis of impact, risks and opportunities is highly judgemental and only contains what management considers most important, so is not exhaustive. It is also an assessment at a point in time and therefore subject to change.
- Challenges in obtaining the necessary data.
- Location of the information (in this case the company has disclosed the sustainability report as a separate document rather than as part of the management report).

7. Conclusion

In this study we have focussed on corporate disclosures related to GHG emissions, emission reduction initiatives, and the accounting treatment of offsetting instruments amongst a sample of entities with high levels of GHG emissions. The reporting year 2024 marks for many companies a situation of regulatory uncertainty since in many home countries of our sample the CSRD has not been transposed timely in national law. Nonetheless, almost all companies in our sample use CSRD/ESRS as their reporting base, though we see variations with companies applying the GRI, NFRD and elements of these and other regulatory frameworks.

While most companies report net zero emission targets (and intermediate emission targets) we see a wide variation in the choice of the measurement method, the scope and the base year serving as reference point for measuring the reduction in GHG emissions, which complicates the comparison between companies in assessing their GHG reduction performances.

We found that the use of GHG removal and storage remains limited across the sample, contrary to carbon credits which are more commonly used by entities in our sample to offset emissions. The magnitude of these credits is still generally limited relative to their total emissions, indicating that credits currently play a supplementary role which in the context of (EU) ETS might change in future years.

Though with some reluctance given the inherent limitations of doing desk research, we conclude that only a minority (43%) of the companies seemed to be on track to meet the absolute Scope 1, 2 and 3 emission reduction target compared to their baseline to become net zero by 2050.

We see a large variation in the classification of emission rights on the asset side and emission right related obligations on the liability side of the balance sheet. Also the disclosure quality varies which all together hinders the comparability of the corporate reports.

Most companies received limited assurance on the whole sustainability report. Seven companies that applied the CSRD/ESRS framework went beyond the minimum requirements and asked for reasonable assurance on selected disclosures. In general the emission data did receive assurance, be it limited assurance. The assurance was provided by

the statutory auditor of the financial statements. In the sustainability reports, the audit reports were unqualified, though mainly in the reports of the French companies several 'emphasis of matters' (EOMs) were identified by the auditors.

We have observed many 'key audit matters' (KAM) relating to the topics addressed in this article in the audit reports on the financial statements, many of which related to impairment testing. The attention of the auditor for the impact of carbon emissions, carbon reduction commitments and climate change in general is significant and has led to sometimes elaborate explanations in the audit report.

This study reveals also other elements that can be used as areas for companies to improve reporting and disclosure practices.

- 31% of the entities in our sample have not (yet) undergone SBTi validation; it goes without saying that a lower percentage is expected or alternatively a disclosure why this process is so difficult or delayed;
- While intensity goals like emissions per unit of output, can serve as useful additional tool, disclosures of absolute reductions are also required to facilitate cross-sectoral analysis and alignment with ESRS E1 and the Paris Treaty goals.
- A clear policy on the reporting boundary for GHG emission purposes should be disclosed as this can impact the volume of – and distinction between – direct and indirect emissions.
- In many cases, our analysis was hindered due to missing data such as 2024 GHG actuals or base year or baseline amounts for the targets or Scope 1, 2 and 3 emissions.
- Despite the lack of specific IFRS requirements, 34% of the entities do not disclose their accounting policy related to emission rights in the financial statements. And only 51% of the entities discloses the impact of emission rights on their liabilities.
- We observe a limited integration between sustainability disclosures and the financial statements in the context of GHG emissions. In many cases, emissions allowances are only briefly mentioned in the accounting policies, with no further elaboration or quantitative disclosure in the notes to the financial statements.

Deliberately, we have added seven figures showing good examples addressing many of the above shortcomings. We hope that this research, also taking into account these examples, will contribute to further reporting quality.

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Acknowledgements

The authors would like to thank Avinash Karuvelil (EY) for his contribution to the empirical research.

Notes

1. Greenhouse gas (GHG) emissions refer to the release of gases into the Earth's atmosphere that trap heat and contribute to the greenhouse effect, leading to global warming and climate change. These gases, such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), absorb infrared radiation emitted from the Earth's surface, preventing it from escaping into space and as a consequence warming the planet.
2. United Nations, A Beginner's Guide to Climate Neutrality | UNFCCC (https://unfccc.int/news/a-beginner-s-guide-to-climate-neutrality).
3. United Nations, Net Zero Coalition | United Nations (https://www.un.org/en/climatechange/net-zero-coalition).
4. A carbon credit represents one metric ton of carbon dioxide equivalent GHGs reduced or removed from the atmosphere.
5. In this regard an EU-'Stop-the-Clock Directive' (EU 2025/794) came into force on 17 April 2025. This Directive postpones by two years the start date of current CSRD requirements for the 'second wave' of companies (large companies and the parent companies of large groups that did not fall under the scope of the first wave of reporting as of financial year 2024), from financial year 2025 to financial year 2027. Similarly, the start date for the 'third wave' (listed SMEs, small and non-complex credit institutions, and captive insurance and reinsurance companies) is postponed from financial year 2026 to financial year 2028. Entered into force on 17 April 2025. The Directive is part of a broader Omnibus package aimed at amending European sustainability legislation to ensure that regulatory requirements do not hinder the EU's competitiveness.
6. AFM (2024) and ESMA (2024a, 2024b).
7. A CO2 equivalent (CO2eq) is a unit of measurement that standardizes the impact of different greenhouse gases (like methane (CH4) and nitrous oxide (N2O)) on global warming by expressing them in terms of the warming potential of carbon dioxide (CO2). This allows for a unified comparison of various greenhouse gas emissions, regardless of the specific gas, making it easier to understand and manage their over-

all contribution to climate change. To compare these gases, scientists use a metric called Global Warming Potential (GWP). GWP is a ratio that compares the warming effect of a gas to that of CO2 over a specific period (usually 100 years).

8. In these voluntary carbon markets, carbon credits are issued by independent standard-setting organizations, often called carbon standards or registries. These are non-governmental initiatives that set the rules for how emission reductions or removals are measured, verified, and certified.
9. At their third session the Parties to the Paris Agreement (CMA), adopted Decision 3/CMA.3 containing the rules, modalities and procedures for a carbon crediting mechanism established by Article 6, paragraph 4, of the Paris Agreement. The CMA also designated a 12-member body (Article 6.4 Supervisory Body) to supervise the mechanism under the authority and guidance of the CMA and be fully accountable to the CMA.
10. Key strategies include transitioning to renewable energy, improving energy efficiency, adopting circular economy practices, utilizing carbon capture and storage technologies and acquiring emission-compensating carbon credits.
11. The European Commission proposed on 2 July 2025 changes to the EU ETS, including a limited role for high-quality international carbon credits outside the EU, integrating permanent European carbon removals into the system, and greater flexibility across sectors and member states. Also a 2040 EU climate target of 90% reduction in net greenhouse gas emissions, compared to 1990 levels, was proposed.
12. See ESMA 2024a. In their public statement about enforcement priorities for the financial year 2024 (ESMA 2024b), ESMA explicitly refers to this statement ‘Clearing the smog: Accounting for Carbon Allowances in Financial Statements’.
13. https://data.carbontracker.org.
14. https://carbontracker.org/reports/flying-blind-in-a-holding-pattern.
15. The International Energy Agency (IEA) is a Paris-based autonomous intergovernmental organization, established in 1974, that provides policy recommendations, analysis and data on the global energy sector.
16. See for the CRSD transposition status in the EU/EEA: https://accountancyeurope.eu/publications/csrd-transposition-tracker. Formally this means that the Non-Financial Reporting Directive (2014/95/EU) as transposed into the national laws is still relevant for these companies in their 2024 reports as the companies in our sample all fell into the scope of the NFRD. Since the CSRD/ESRSs is far more extensive than the NFRD, the CSRD can effectively and voluntarily be used as replacement.
17. NBA Alert 49 CSRD en assurance. Found at: alert-csrd-en-assurance-2024.pdf
18. The SBTi – though currently the most recognized global standard for setting science-based climate targets – is not exclusively mentioned in the CSRD/ESRS E-1. So, also other science based validation initiatives might be used.
19. Scope 1, 2, and 3 emissions are categories used to classify a company’s greenhouse gas emissions, as defined by the GHG Protocol. Scope 1 emissions are direct emissions from sources owned or controlled by the company, like fuel combustion in its vehicles or facilities. Scope 2 emissions are indirect emissions from purchased electricity, steam, heating, and cooling. Scope 3 emissions are all other indirect emissions that occur in the company’s value chain, both upstream and downstream, and are often the largest source of emissions for many companies.
20. In GHG accounting, the base year is a historical reference point (year or average of years) against which current emissions are compared to track progress in reducing greenhouse gas emissions. The baseline (or baseline scenario) is a hypothetical projection of what emissions would have been in the absence of a specific project or intervention. It serves as a benchmark for assessing the effectiveness of emission reduction efforts.
21. Decarbonisation levers are essentially tools or mechanisms used to lower an organization’s carbon footprint (rather than simply offsetting emissions through carbon credits), and they can be applied across various aspects of the business, from energy consumption to supply chain management. E.g. implementing measures to reduce energy consumption in buildings and operations or shifting to solar, wind, or other renewable energy sources.
22. A carbon intensity net zero target focuses on reducing the ratio of greenhouse gas (GHG) emissions to economic or production output, aiming for a more efficient output per unit of emissions, whereas a normal (or absolute) net zero target requires that the total amount of GHG emissions released equals the amount removed from the atmosphere. The key difference is that a carbon intensity target can be met even if overall emissions grow, as long as efficiency improves, while an absolute net zero target requires a reduction in total emissions.
23. *Equity Share Boundary*: Emissions are accounted for based on the proportion of equity held in an operation. If a company owns 40% of a joint venture, it reports 40% of the emissions from that venture. If a company owns 70% in a subsidiary, it reports 70% of the emissions of the subsidiary.
    Operational Control Boundary: Emissions are reported from operations over which the company has full authority to introduce and implement policies. This includes facilities where the company can dictate environmental practices, regardless of ownership share.
    Financial Control Boundary: Emissions are included from operations where the company has the ability to direct financial and operating policies, typically aligned with accounting consolidation rules like IFRS 10 ‘Consolidated Financial Statements’.
24. Refers to the capture and long-term containment of greenhouse gases to prevent them from entering or remaining in the atmosphere and contributing to climate change. Examples are geological storage using depleted oil and gas field or biological storage using natural sinks.
25. Third-party certification provides assurance to stakeholders that the claimed reductions are real, measurable, and verified according to recognized standards.
26. Heidelberg Materials, Annual report 2024, p. 118.
27. Historically, IFRIC 3 ‘Emission Rights’ provided guidance by requiring recognition of allowances as intangible assets at fair value and a liability for emissions incurred. However, IFRIC 3 was withdrawn in 2005 due to concerns about mismatches in timing between asset recognition and liability recognition, leaving a gap in authoritative guidance.
28. Art. 34 par. 1 (ii)(aa) of Directive 2013/34/EU on the annual financial statements, consolidated financial statements and related reports of certain types of undertakings).
29. The International Auditing and Assurance Standards Board (IAASB) has issued standards for audits and reviews and recently issued International Standard on Sustainability Assurance (ISSA) 5000 ‘General Requirements for Sustainability Assurance Engagements’, which specifically addresses the procedures to be followed as part of a review or audit of sustainability reports. According to the CSRD, by 1 October 2026

the European Commission must set limited assurance standards setting out the procedures that the auditor and the audit firm shall perform when providing limited assurance on sustainability reports. By 1 October 2028 the European Commission must set reasonable assurance standards (Art. 26a of EU Directive 2006/43/EC on statutory audits of annual accounts and consolidated accounts).

30. In two cases it is one of the two joint auditors for the financial statements that provided the limited assurance on the sustainability report.
31. A paragraph included in the auditor's report that refers to a matter appropriately presented or disclosed in the financial statements that, in the auditor's judgment, is of such importance that it is fundamental to users' understanding of the financial statements.
32. Another example can be found in the audit report of Equinor regarding commodity price assumptions applied in value-in-use impairment testing.
33. Some auditors, again mainly French, also included a paragraph highlighting certain elements and how they were addressed during the review/audit. These paragraphs contain an elaborate description of the procedures followed in response to those elements. The texts of these paragraphs are similar as they are all based upon a template provided by a document issued by H2A (Haute Autorité de l'Audit), the French audit regulator.

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Appendix 1

Table A1. List of sampled entities.

Company Name	Country	Sector
A.P. Møller - Mærsk	Denmark	Transport
Air France–KLM SA	France	Transport
Air Liquide SA	France	Industrials
Airbus	The Netherlands	Transport
Arcelor Mittal	Luxembourg	Industrials
BASF	Germany	Industrials
Bayer	Germany	Industrials
BMW	Germany	Transport
CEZ	Czech Republic	Energy
Danone	France	Consumer goods
E.on	Germany	Energy
ENEL	Italy	Energy
Engie	France	Energy
ENI SpA	Italy	Energy
Equinor	Norway	Energy
Fortum Oyj	Finland	Energy
Heidelberg Materials AG	Germany	Industrials
Holcim	Switzerland	Industrials
Iberdrola SA	Spain	Energy
Mercedes Benz Group AG	Germany	Transport
Naturgy Energy Group SA	Spain	Energy
Nestlé	Switzerland	Consumer goods
OMV AG	Austria	Energy
PGE Polska Grupa Energetycza SA	Poland	Energy
Renault SA	France	Transport
Repsol	Spain	Energy
RWE	Germany	Energy
Saint-Gobain SA	France	Industrials
Siemens	Germany	Industrials
SSAB AB	Sweden	Industrials
Stellantis	The Netherlands	Transport
Thyssen Krupp AG	Germany	Industrials
Totalenergies SE	France	Energy
Volkswagen AG	Germany	Transport
Volvo AB	Sweden	Transport