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Navigating the Complexities of Cross-Company Sustainability Comparisons in the Pharmaceutical Sector: A Methodological Framework for Responsible Interpretation – Part III

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Abstract

The pharmaceutical industry's environmental sustainability performance has become a focal point for investors, regulators, and stakeholders seeking to benchmark corporate climate action. However, direct comparisons of greenhouse gas (GHG) emissions, energy consumption, water withdrawal, and waste generation across pharmaceutical companies present substantial methodological challenges that can lead to biased interpretations and misguided conclusions. This paper — the third in a series examining pharmaceutical industry environmental performance — systematically analyses the factors that constrain direct cross-company comparisons of sustainability metrics. Drawing on empirical evidence from the 14-company dataset analysed in Parts I and II, this study identifies nine categories of comparability challenges: heterogeneous accounting methodologies and perimeters; data quality, emission factors, and consistency over time; base year selection and recalculation practices; fluctuating emissions profiles; completion of prior target cycles; varying targets and commitments; alignment with different climate scenarios; contextual and scale factors; and transparency, completeness, and confidentiality issues. The analysis demonstrates that even within a relatively homogeneous sector such as pharmaceuticals, methodological divergence — particularly in Scope 3 reporting, boundary definitions, and emission factor selection — renders direct numerical comparisons inherently problematic. Despite these challenges, the paper argues that systematic appraisal of sustainability reports remains highly valuable when focused on proportional metrics (percentage contributions, intensity ratios) rather than absolute numbers, and when contextualised within each company's specific operational realities. The findings carry important implications for researchers, investors, and policymakers seeking to meaningfully assess and compare corporate climate performance. A central conclusion emerges: GHG emissions and their reductions should be recognised as vital tools for internal improvement rather than merely instruments for external comparison.

Keywords: *Pharmaceutical industry; GHG emissions comparison; Sustainability benchmarking; Scope 3 reporting; Methodological inconsistency; Cross-company comparison; Environmental performance metrics; Reporting standards.*

INTRODUCTION

The pharmaceutical industry occupies a paradoxical position in the global sustainability discourse: a health-oriented sector whose operations generate substantial environmental burden. Parts I and II of this study series provided comprehensive descriptive and inferential statistical analyses of GHG emissions trajectories, intensity metrics, decoupling patterns, and resource efficiency indicators across 14 major pharmaceutical companies from 2019 to 2025 (Deswal and Deswal, 2026a; 2026b). These analyses revealed that Scope 3 emissions dominate carbon footprints — averaging 5.1 million $t.CO_2e$, approximately 8.7 times greater than Scopes 1 and 2 combined — and that while operational emissions are declining meaningfully, supply chain decarbonisation remains the primary challenge. Energy consumption declined by 16.8% in mean terms, renewable energy share increased dramatically from 11.8% to 44.9%, and water withdrawal declined by 28.7% over the study period.

However, the act of comparing environmental performance across pharmaceutical companies — whether in terms of absolute emissions, emissions intensity, energy consumption, or waste generation — is fraught with methodological complexities that can lead to biased interpretations and erroneous conclusions (Goode and Hache, 2022; GCI, 2024). As the sustainability reporting landscape has evolved, stakeholders — including investors, regulators, non-governmental organisations, and consumers — have increasingly sought to benchmark corporate climate action. Yet the very factors that make sustainability reporting valuable also render direct comparisons inherently problematic.

The challenges of cross-company comparison are not unique to the pharmaceutical sector. However, the industry's distinctive characteristics — complex global supply chains, energy-intensive manufacturing processes, heterogeneous product portfolios, and varying regulatory environments — amplify these challenges (Booth *et al.*, 2023). The pharmaceutical sector's Scope 3 emissions, which constitute the vast majority of the carbon footprint, are particularly susceptible to methodological variability, as companies exercise considerable discretion in determining which of the fifteen Scope 3 categories to include, which emission factors to apply, and which estimation techniques to employ (GHG Protocol, 2011).

This paper — the third in the series — aims to:

1. systematically identify and characterise the factors that constrain direct cross-company comparisons of environmental sustainability metrics in the pharmaceutical sector;
2. draw on empirical evidence from Parts I and II to illustrate how methodological divergence manifests in practice;
3. articulate the risks associated with direct, simplistic comparisons of environmental performance;
4. provide a methodological framework for responsible interpretation of sustainability data; and
5. offer guidance for researchers, investors, and policymakers seeking to meaningfully assess corporate climate performance.

The paper serves a dual purpose: it functions as a methodological disclaimer for the analyses presented in Parts I and II, while simultaneously providing a standalone framework for understanding the complexities of cross-company sustainability comparisons. The analysis emphasises that while direct numerical comparisons are problematic, systematic appraisal of sustainability reports — when focused on proportional metrics, intensity ratios, and strategic approaches — remains highly valuable for understanding sectoral trends and benchmarks.

THE COMPARABILITY CHALLENGE: AN OVERVIEW

The fundamental challenge in comparing environmental performance across pharmaceutical companies lies in the absence of a single, universally mandated methodology for measuring and reporting GHG emissions, energy consumption, water withdrawal, and waste generation (Goode and Hache, 2022). While the GHG Protocol has emerged as the *de facto* standard — with an overwhelming majority of companies using it to calculate their emissions — significant room for interpretation and variation remains, particularly in Scope 3 reporting (GHG Protocol, 2011; Goode and Hache, 2022).

The implications of this methodological heterogeneity are substantial. As Hendrikson DGE (2023) notes, "*a company's carbon footprint cannot always be directly compared to another, even if they operate in the same sector, with similar business models and production volumes*". This observation holds particular weight in the pharmaceutical sector, where companies vary considerably in their operational structures, product portfolios, geographic footprints, and reporting practices.

The empirical analyses presented in Parts I and II of this series illustrate the scale of this challenge. While the 14 pharmaceutical companies analysed share the common characteristic of being major players in the same industry, they exhibit substantial heterogeneity in their emissions profiles, energy consumption patterns, and resource efficiency metrics. For instance, Scope 1 emissions ranged from 62,587 $t.CO_2e$ (AstraZeneca, 2025) to 1,827,123 $t.CO_2e$ (Merck KGaA, 2020) — a nearly 30-fold difference that reflects not only operational scale but also reporting boundaries, manufacturing footprints, and methodological choices. Similarly, water withdrawal ranged from 2,772 $thousand\ m^3$ (BMS, 2022) to 66,800 $thousand\ m^3$ (Novartis, 2019), and waste generation from 10,682 $tons$ (BMS, 2024) to 371,000 $tons$ (Merck KGaA, 2022).

These variations, while partly attributable to genuine differences in operational scale and efficiency, are also influenced by the methodological factors discussed in the following sections. Understanding these factors is essential for any stakeholder seeking to draw meaningful conclusions from corporate sustainability disclosures.

HETEROGENEOUS ACCOUNTING METHODOLOGIES AND PERIMETERS

The most fundamental constraint on cross-company comparison lies in the heterogeneity of accounting methodologies and perimeters. Companies exercise considerable discretion in determining how to measure, what to include, and how to present their environmental footprint. This discretion, while necessary to accommodate diverse operational realities, creates substantial challenges for comparability.

Inconsistency in Reporting Standards

Several standards exist for measuring and reporting GHG emissions, including the Global Reporting Initiative (GRI), the Task Force on Climate-related Financial Disclosures (TCFD), the European Sustainability Reporting Standards (ESRS), and the Greenhouse Gas Protocol (GHGP) (Deswal and Deswal, 2025a). There is no single, globally mandated method for reporting GHG emissions (Goode and Hache, 2022). The choice of reporting mechanisms — international versus national; single standard versus a combination — is usually defined by a company's ESG narrative, location, and available resources.

Among these various standards, the GHG Protocol is the most widely adopted for measuring and reporting GHG emissions worldwide (Deswal and Deswal, 2025a; Goode and Hache, 2022). However, even within the GHG Protocol, there is room for interpretation and variation, particularly with Scope 3 emissions. As Goode and Hache (2022) observe, while the US Securities and Exchange Commission (SEC) models its guidance on the GHG Protocol, it "*stops short of requiring companies to use any particular GHG framework*". This flexibility, while accommodating diverse business contexts, undermines comparability.

Attributional versus Consequential Methods

Some companies use attributional methods that focus on emissions within their defined boundaries, while others employ consequential methods that consider broader system-wide impacts. This fundamental difference in approach results in notably different outcomes (Brander, 2019). Attributional methods allocate emissions to specific activities based on historical relationships, whereas consequential methods assess the consequences of decisions on emissions across the broader system. The choice between these approaches significantly affects reported emissions and complicates cross-company comparisons.

Definition of Organisational Boundary

Defining the organisational boundary of a company has a significant impact on the accounting and reporting of GHG emissions. Companies can opt for either of two distinct approaches — equity share or control approach — for accounting and reporting their GHG emissions (GHG Protocol, 2011). Under the equity share approach, a company accounts for GHG emissions from its operations as per its share of equity in the operations; whereas, under the control approach, it accounts for 100% of its GHG emissions from operations over which it has control (financial or operational) but does not account for emissions from operations in which it owns an interest but has no control (GHG Protocol, 2011).

In most cases, companies choose one of these approaches irrespective of whether an operation is controlled by the company or not. This choice has substantial implications for reported emissions, particularly for multinational pharmaceutical companies with complex ownership structures, joint ventures, and partnerships.

Accounting of Different Scopes

Each company conducting a GHG inventory has the discretion to choose which scopes and categories to include in their emissions calculations. According to the GHG Protocol (2011), accounting and reporting of emissions for Scope 1 and Scope 2 are mandatory, while Scope 3 is optional. When one company reports only its Scope 1 and 2 emissions and another includes Scope 3, it becomes challenging to compare them directly (Hendrikson DGE, 2023), as Scope 3 usually makes up the majority of total emissions.

The empirical analysis in Part I illustrates this challenge. While all 14 companies reported Scope 1 and 2 emissions consistently (n=93 observations each), Scope 3 reporting was less complete (n=84 observations), representing 14.29% of potential observations missing. This incompleteness reflects the voluntary nature of Scope 3 reporting and the varying capacities of companies to collect and report supply chain emissions data.

Accounting of Scope 3 Emissions

Companies may vary in their approaches to accounting for Scope 3 emissions, which can represent a substantial portion of their overall carbon footprint. The GHG Protocol allows companies the flexibility to focus on accounting and reporting for the activities and categories that are relevant to their operations and for which they have reliable data. Since companies have the discretion to select which categories they report on, comparing Scope 3 emissions across different companies may not be straightforward and fair (GHG Protocol, 2011).

Some companies may include as few as 3 out of 15 activities or categories in their reporting of Scope 3 emissions, depending on what is convenient or relevant for them. Additionally, there is variation in how much emissions have been computed using primary data versus secondary data. This inconsistent reporting of Scope 3 emissions can result in misleading comparisons and conclusions about how companies contribute to climate change. Additionally, in accounting for emissions, some companies may focus on minor activities or those with limited potential for further action.

The Part I analysis revealed substantial variation in Scope 3 composition across companies. For most companies, upstream emissions — particularly purchased goods and services (Category 1) — dominated Scope 3 footprints, averaging 80.9% of total Scope 3 emissions. However, GSK represented a notable exception, with downstream emissions (Category 11: transportation and distribution) accounting for 61.4% of Scope 3 emissions in 2022. While this difference may reflect genuine variations in business models and supply chain structures, it may also reflect differences in boundary definitions, category inclusion, or emission factor choices.

DATA QUALITY, EMISSION FACTORS, AND CONSISTENCY OVER TIME

The quality of available data and its consistency over time can vary significantly, which profoundly affects the accuracy of emissions calculations and poses challenges for meaningful comparisons between companies.

Data Availability and Quality

Gathering accurate emission data, particularly for Scope 3 emissions, is inherently challenging, and companies may face varying degrees of access to critical data from their supply chains (Hendrikson DGE, 2023). Pharmaceutical supply chains span thousands of suppliers across dozens of countries, each with different data collection capabilities, reporting practices, and regulatory requirements. The quality of available data can vary significantly, directly affecting the accuracy of emissions calculations and complicating comparisons across companies (Hendrikson DGE, 2023).

Methodological Differences

Different methodologies and assumptions can lead to varying calculations of GHG emissions, even for the same set of activities. Companies often use different approaches to measure and calculate their emissions, including the "spend-based" method or the "operational-based" methods derived from the GHG Protocol. These methods can lead to vastly different results because they address emissions sources and calculations in different ways (Hendrikson DGE, 2023).

The varying assumptions used to construct activity data vary from one balance sheet to another, which can significantly affect the assessment of a company's carbon footprint. Emission factors — carbon weights used to convert energy consumption or material mass into GHG emissions — significantly impact the calculation and quantification of emissions. They vary significantly across different databases and countries due to factors such as the source of energy (type of fuel or electricity used), production processes, and data quality. The emission factors for all greenhouse gases (that is, the Global Warming Potential) provided by the Intergovernmental Panel on Climate Change (IPCC), and emission factors for electricity and heat generation provided by the International Energy Agency (IEA), are widely used but are not universally applied.

Data Consistency Over Time

Even within a single company, changes in accounting methods, data availability, or the inclusion of different emission sources over time can make it difficult to accurately compare emissions over periods. The data — especially emissions values — change as soon as updated reports are published. In many cases, the emissions data of the last few months (often the last quarter) are reported as estimated values that will be updated in the next year's report.

The Part I analysis revealed substantial year-to-year variability in reported emissions that may reflect methodological changes as much as actual performance improvements. For instance, Merck KGaA's Scope 1 emissions showed a dramatic reduction from 1,827,123 $t.CO_2e$ (2020) to 657,835 $t.CO_2e$ (2025) — a 65.8% decrease — which may partly reflect reporting changes and methodological refinements rather than purely operational improvements. Similarly, Novo Nordisk's Scope 3 emissions intensity increase of +1,378.9% during 2020-2025 requires careful interpretation in view of expansion of its Scope 3 reporting boundaries, making the apparent increase partly attributable to improved reporting completeness rather than actual emissions growth.

BASE YEAR SELECTION AND RECALCULATION OF EMISSIONS

Companies have the choice to select a base year for which verifiable emission data are available. Further, the base year can be different for Scope 1 and 2, and Scope 3 GHG emissions. As Table 8 in Part I demonstrates, base years for reduction targets vary considerably across the 14 companies, ranging from 2015 (AstraZeneca) to 2024 (Novo Nordisk). This temporal variation complicates direct comparisons of progress, as companies starting from different baselines face different challenges and opportunities.

Recalculating past years' GHG emissions involves adjusting reported figures (increases and/or decreases) to reflect changes that would otherwise compromise the consistency and relevance of their emissions. As per the GHG Protocol (2011), recalculation is required when it has a significant impact on the company's base year emissions in scenarios such as:

- Structural changes, also referred to as organisational or operational boundary changes, involve the transfer of ownership or control of emission-generating activities from one company to another — for example, mergers, acquisitions, divestments, and outsourcing and insourcing of emitting activities.
- Changes in calculation methodology.
- Improvement in the accuracy of emission factors.
- Improvement in activity data.
- Discovery of significant errors or a number of cumulative errors.
- Change in definition of an activity.
- Compliance: Some disclosure or target-setting programs, such as the Science Based Targets Initiative (SBTi), may require recalculation for specific changes, according to the GHG Protocol.

Although most companies have set a 'Significance Threshold' (such as ±5% as recommended by SBTi) to determine if a change is significant enough to warrant a recalculation, there are some companies that carry out recalculation frequently due to the above reasons (SBTi and EY, 2023).

The Part I analysis revealed that several companies had revised their reported emissions for prior years due to methodological improvements. For instance, AstraZeneca's Scope 3 emissions trajectory showed an increase of 23.3% during the study period, but this figure may reflect changes in reporting boundaries and methodological refinements as much as actual emissions growth. Similarly, Merck KGaA's Scope 1 emissions increase of +92.9% during 2019-2025 "*reflects reporting changes*" (Deswal and Deswal, 2026a), illustrating how methodological revisions can substantially affect reported emissions trajectories.

FLUCTUATING EMISSIONS

A company's carbon footprint can vary greatly from year to year due to several factors, including changes in production volume (Hendrikson DGE, 2023). If a company invests significantly in new equipment, the GHG emissions associated with that investment are counted in the year of purchase. Although the equipment may be used for many years, this can cause the reported emissions for that year to seem inflated because of the one-time investment (Hendrikson DGE, 2023).

The Part I analysis revealed substantial year-to-year fluctuations in emissions across the 14 companies. For instance, Pfizer's total emissions increased substantially in 2021 and 2022 — driven by COVID-19 vaccine production — before declining in subsequent years. Similarly, Eli Lilly's Scope 3 emissions increased by 106.7% during 2021-2024, reflecting extraordinary business growth (+59.1% revenue growth) that outpaced supply chain decarbonisation efforts. These fluctuations, while reflecting genuine business dynamics, complicate year-to-year comparisons and trend analyses.

The temporal patterns observed in Part I — characterised by an initial increase in Scope 3 emissions (2019-2022) followed by a decline from 2022 onward — likely reflect improved reporting completeness in earlier years rather than actual emission increases, as companies expanded their supply chain reporting boundaries. This pattern illustrates how changes in reporting practices can create apparent trends that do not reflect actual performance improvements.

COMPLETION OF PREVIOUS CYCLES

There may be companies that have completed GHG emission reduction target periods that culminated in 2020 or earlier. For example, Pfizer reduced its GHG emissions by more than 60% through successive goal periods between 2001 and 2020; Johnson & Johnson reduced 45% of its GHG emissions (Scope 1 and 2) by 2020 compared to the 2010 baseline. Such companies that already have low baseline emissions (due to revised targets and base year) would find it difficult to further reduce their emissions, and thus their targeted reduction in emissions would be lower as compared to companies that have initiated GHG emissions reporting and reduction targets much later.

The Part I analysis revealed that companies with longer histories of emissions reduction — such as J&J and Pfizer — have already achieved substantial reductions from earlier baselines, making further percentage reductions more challenging. J&J achieved a 45% reduction in Scope 1 and 2 emissions by 2020 compared to the 2010 baseline, while Pfizer achieved more than 60% reduction through successive goal periods between 2001 and 2020. These companies' current targets (J&J: 44% by 2030 from 2021 baseline; Pfizer: 46% by 2030 from 2019 baseline) reflect the diminishing returns of further operational efficiency improvements.

This historical context is essential for interpreting current performance. A company achieving a 15% reduction from a very low baseline may have made more substantial absolute reductions than a company achieving a 30% reduction from a much higher baseline. Direct percentage comparisons without considering historical context can therefore be misleading.

VARYING TARGETS AND COMMITMENTS

Some companies have committed to achieving carbon neutrality, and others to Net-zero, and they communicate these targets through various statements. For example, they might say they are "carbon neutral across Scope 1 and 2," have a "net-zero impact on climate," or are "carbon-zero without using offsets" (Booth *et al.*, 2023). Additionally, companies often set distinct targets for each emission scope. For example, a company may aim for Net-zero emissions in Scope 1 and 2 while pursuing carbon neutrality in Scope 3.

In the case of Scope 3 targets, the SBTi provision allows postponing up to one-third of base year GHG emissions associated with the highest estimation uncertainty and lowest abatement potential. So, companies have the leverage not to include such categories (fully or partially) in their Scope 3 target. Furthermore, companies usually declare their intention to reduce GHG emissions by a specific percentage by designated target years. In some cases, these percentage reductions align with their carbon-neutral or Net-zero goals. In other cases, companies commit to percentage reductions without explicitly pledging to achieve carbon neutrality or net-zero emissions (Booth *et al.*, 2023).

The Part I analysis revealed substantial variation in target ambition and scope across the 14 companies (Table 8). All 14 companies have established Scope 1 and 2 reduction targets, with over two-thirds aiming for near-term reductions by 2030. However, Scope 3 targets are less universal and exhibit greater variability in ambition. Net-zero target years range from 2040 (Pfizer, Novartis, Takeda, Merck KGaA) to 2050 (BMS), with 2045 being the most common commitment year. Some companies, such as Merck KGaA, have no specified Scope 3 target, reflecting the still-emerging nature of Scope 3 target setting.

This variation in target scope, ambition, and timeline complicates direct comparisons of progress. A company with an ambitious Scope 3 target (e.g., Pfizer: 90% reduction by 2040) may appear to be underperforming relative to a company with a less ambitious target (e.g., Roche: 18% reduction by 2025), even if both are making substantial progress relative to their respective baselines and operational realities.

ALIGNMENT OF COMPANY TARGETS WITH DIFFERENT SCENARIOS OR PATHWAYS

The companies have aligned their reporting and targets to different treaties, policies or initiatives, such as UN Sustainable Development Goals (SDGs), UN Global Compact initiative, Paris Agreement, Science Based Targets Initiative (SBTi), IPCC Report, and European Green Deal (Deswal and Deswal, 2025b). All of them aim to keep the rise in mean global temperature well below 2°C, and preferably limited to 1.5°C. However, the targets of most companies, particularly pharmaceutical companies, are aligned with the 1.5°C pathways, whereas some companies have aligned their targets with the 2°C pathway (Deswal, 2025a).

For example, Novo Nordisk, a pharmaceutical MNC, has set a target of a 3% absolute reduction of Scope 3 emissions by 2030 compared to the 2024 base year aligned with the well-below 2°C pathway. This contrasts with companies such as AstraZeneca, which has aligned its targets with the 1.5°C pathway (98% reduction in Scope 1 and 2 by 2026; 50% reduction in Scope 3 by 2030) (Deswal, 2025b). The choice of pathway has substantial implications for target ambition and the pace of required emissions reduction.

The Part I analysis revealed that the implied temperature increase for Scope 1 and 2 emissions is 1.04°C, aligning with a 1.5°C pathway; when Scope 3 emissions are included, the implied temperature rises to 1.9°C (MGL, 2025). This finding — corroborated by the analysis of the 14 companies — illustrates the divergence between operational and value chain performance. Companies may be on track for 1.5°C-aligned operational targets while simultaneously being off track for 2°C-aligned value chain targets, complicating overall performance assessment.

CONTEXT AND SCALE

The context and scale significantly influence environmental performance metrics. Geographic location, company size and operations, and sector-specificities (inter-, intra-, and multi-sectoral) all play a role in determining a company's emissions and resource consumption profiles.

Geographic Location

A company's geographic location directly affects its GHG emissions due to climate factors and proximity to natural resources. Various regions utilise different energy sources, infrastructure, and regulations, all of which influence a company's emission profile (GCI, 2024).

In countries where the energy mix relies on fossil fuels (such as coal and oil), electricity consumption produces significantly higher emissions compared to regions that primarily utilise renewable energy sources. Climate factors, such as temperature and rainfall, also affect energy demand for heating and cooling. Local infrastructure, including transport networks and district heating systems, also plays a pivotal role in shaping the emissions generated by business activities. Local regulations play a crucial role in influencing GHG emissions from businesses by regulating standards for industrial processes, such as emission limits, waste management practices, and water conservation.

The Part I analysis revealed that companies headquartered in Europe — where renewable energy penetration is generally higher and regulatory frameworks are more stringent — tend to have lower Scope 2 emissions intensities than companies headquartered in the United States or other regions with more fossil fuel-dependent grids. For instance, Novartis (Switzerland) achieved a 96.3% reduction in Scope 2 emissions, while MSD (USA) achieved a more modest reduction. However, these differences reflect grid decarbonisation and regulatory contexts as much as company-specific efforts.

Company Size and Operations

A large multinational company has a more complex value chain and will likely have higher and distinct emission profiles compared to a smaller, localised business, owing to its broader range of activities and larger footprint across various geographies (GCI, 2024). The Part I analysis revealed that larger companies tend to operate with lower operational emissions intensity (Scope 1: $r = -0.42$, $p < 0.01$; Scope 2: $r = -0.38$, $p < 0.01$), reflecting economies of scale, greater access to capital for efficiency investments, and greater bargaining power in renewable electricity procurement. However, the correlation between revenue and Scope 3 intensity was weak and non-significant ($r = -0.12$, $p = 0.28$), indicating that supply chain emissions do not exhibit the same scale efficiencies as operational emissions.

Intra-Sector Specificities

Emissions differ intra-sectorally as well due to the diverse activities of a company. For example, in the pharmaceutical sector, companies may differ in their activities, ranging from pharmaceuticals, diagnostics, or clinical trials, and report the consolidated GHG emissions and other environmental metrics from all the divisions within the company (that is, they do not report breakdowns by divisions). So, it is not possible to distinguish reported emissions of the company sector-wise, division-wise or product-wise.

Multi-Sectoral Operations of a Company

There are multinational companies that have businesses in multiple diverse sectors, and are reporting the GHG emissions and other environmental metrics of the Group as a whole. In such cases, there is every likelihood that one of the divisions may be more emission-intensive than the other (say pharmaceuticals), or vice versa. For example, in the case of the Bayer Group, the Crop Science Division is much more emission-intensive than the Pharmaceuticals and Consumer Health divisions (Deswal, 2025c). Thereby, its GHG and other environmental metrics cannot be compared with a company dealing in pharmaceuticals only.

Inter-Sector Specificities

Emissions differ structurally from one business sector to another and are highly correlated with the specific industry and activities of a company. For example, a heavy industrial manufacturing company will naturally have higher emissions and intensities than a digital services company (GCI, 2024). While this paper focuses on intra-sector comparisons, it is important to recognise that inter-sector comparisons are even more fraught with methodological challenges.

TRANSPARENCY, COMPLETENESS, AND CONFIDENTIALITY IN REPORTING

The transparency of environmental reporting is highly variable across countries, regions, and industries, resulting in incomplete data, inconsistent oversight and verification, along with confidentiality issues.

Reporting Requirements

The degree of transparency necessary for GHG emissions reporting can vary by country, region, or industry. Some companies may be legally required to disclose detailed information, whereas others may choose to provide limited data (Hendrikson DGE, 2023). The Part I analysis revealed that while all 14 companies provided some level of sustainability disclosure, the depth and granularity of reporting varied considerably.

Incomplete Data

Some companies might not report all relevant emission sources, making it challenging to assess their overall carbon footprint (Hendrikson DGE, 2023). The Part I analysis revealed that Scope 3 reporting was incomplete for 14.29% of potential observations, reflecting the voluntary nature of Scope 3 reporting and the varying capacities of companies to collect and report supply chain emissions data.

Oversight and Verification

The extent of oversight and verification of company-reported GHG emissions can differ, which can influence the accuracy and reliability of the data (SBTi and EY, 2023). While many companies now obtain third-party assurance for their Scope 1 and 2 emissions, Scope 3 assurance is less common and less comprehensive. This variation in verification practices affects the reliability of reported data and complicates cross-company comparisons.

Data Confidentiality

Some companies may opt not to disclose all the details of their GHG inventories. They might report total GHG emissions without disclosing what is included and what is excluded, especially if there are no regulatory requirements to do so (Hendrikson DGE, 2023). Incomplete reporting or confidentiality concerns can further complicate comparisons and lead to misguided assumptions.

GREENWASHING AND THE ASPIRATIONAL NATURE OF CORPORATE REPORTS

There is a possibility that company reports may not reflect the entirety of the company's efforts regarding environmental sustainability. Conversely, there is also a possibility that some companies may engage in 'greenwashing' by highlighting initiatives or data that present their emission reduction efforts positively or showcase favourable environmental performance, even if their actual performance is meagre and does not align with those claims (de Freitas Netto *et al.*, 2020). Furthermore, what a company states in its reports is often a reflection of what it aspires to achieve, rather than how it is actually operating (Booth *et al.*, 2023). For example, a company may state that it aims to increase the use of renewable energy, but has yet to do so.

The Part I analysis revealed that while all 14 companies have established reduction targets, the gap between stated targets and achieved reductions varies considerably. Some companies — such as J&J, Roche, Takeda, and Teva — have significantly exceeded their Scope 3 reduction targets, while others — such as AstraZeneca, Eli Lilly, and Novo Nordisk — are off track. This variation reflects genuine differences in performance, but may also reflect differences in target ambition, base year selection, and reporting methodologies.

The aspirational nature of corporate sustainability reports means that they should be interpreted as statements of intent rather than definitive accounts of performance. As Booth *et al.* (2023) observed in their content analysis of 20 pharmaceutical companies, "*what a company states in its reports is often a reflection of what it aspires to achieve, rather than how it is actually operating*". This observation underscores the importance of triangulating reported data with other sources of information, including third-party assessments, regulatory disclosures, and independent analyses.

RISKS OF DIRECT, SIMPLISTIC COMPARISONS

A direct and oversimplified comparison of environmental performance between companies not only leads to biased interpretations but also introduces significant inherent risks (GCI, 2024), such as:

- Specific industries, especially those in sectors with consistently high emissions, may be discouraged.
- Some organisations risk prioritising short-term actions to enhance their image instead of implementing ambitious and sustainable strategies to combat climate change.
- May provide a leaf to companies for prioritising opportunistic practices, where form outweighs substance, and hinders effective actions.
- Companies may sidetrack from their primary goal of reducing their carbon footprint to help combat climate change.
- Companies that are trying to improve their rankings or benchmarks may find themselves distracted.

The variety of methodologies and the distinct realities within different sectors underscore that GHG emissions and their reductions should be recognised as a vital tool for internal enhancement rather than merely an instrument for external comparison (GCI, 2024). It is, therefore, essential for an assessment to be well-considered and tailored to the specific realities of each company to maximise their positive impact and fully engage with the environmental transition.

A FRAMEWORK FOR RESPONSIBLE INTERPRETATION

Despite the challenges and difficulties, appraising sustainability reports from different companies within the same sector offers significant advantages (Hendrikson DGE, 2023). These reports frequently present valuable insights into the companies' GHG and other environmental inventory results, allowing stakeholders to better understand the prevailing trends and benchmarks in environmental sustainability efforts.

For meaningful interpretation, stakeholders should focus on:

Proportional Metrics Rather Than Absolute Numbers

Instead of comparing absolute numbers, stakeholders should focus on what percentage of emissions come from different scopes and categories (Hendrikson DGE, 2023). The Part I analysis demonstrated that while absolute Scope 3 emissions varied substantially across companies (ranging from 80,000 to 16.9 million $t.CO_2e$), the proportional contribution of Scope 3 to total emissions was more consistent (typically 85-95%). This proportional consistency suggests that the structural composition of emissions may be more comparable than absolute values.

Intensity Metrics Rather Than Absolute Values

Economic metrics — such as energy intensity, water withdrawal intensity, and waste generation intensity — enable normalisation across companies of varying sizes and facilitate meaningful comparison of operational efficiency

(Deswal, 2025a). The Part I and II analyses demonstrated that intensity metrics — while still subject to methodological variation — provide a more meaningful basis for comparison than absolute values. For instance, while J&J's absolute emissions were substantially higher than BMS's, their emissions intensities (emissions per million USD revenue) were more comparable (J&J: 63.07 $t.CO_2e/million\ USD\ revenue$ in 2024; BMS: 38.26 $t.CO_2e/million\ USD\ revenue$ in 2025).

Strategic Approaches and Best Practices

Reviewing other companies' reports can offer insights into the measures they are taking to reduce environmental impact, potentially offering ideas for optimising own operations (Hendrikson DGE, 2023). The Part I and II analyses revealed substantial variation in strategic approaches — from aggressive renewable energy procurement (AstraZeneca, Novartis) to supply chain engagement programmes (J&J, GSK) to manufacturing efficiency improvements (Teva, Merck KGaA). Understanding these strategic differences provides more insight than direct numerical comparisons.

Future Goals and Trajectories

Many reports include information about future goals, such as carbon reduction targets and planned initiatives. These can serve as inspiration when setting goals for one's company (Hendrikson DGE, 2023). The Part I analysis revealed that while target ambition varies, the trajectory of target-setting — increasingly ambitious Scope 3 targets, net-zero commitments, and alignment with 1.5°C pathways — is consistent across the sector.

Contextual Factors

Any meaningful comparison must account for contextual factors — including geographic location, operational scale, product portfolio, regulatory environment, and historical emissions reduction. The Part I and II analyses demonstrated that these contextual factors substantially influence environmental performance metrics and must be considered when interpreting reported data.

DISCUSSION: SYNTHESIS AND IMPLICATIONS

The Methodological Landscape

The analysis presented in this paper reveals that cross-company comparisons of environmental sustainability performance in the pharmaceutical sector are constrained by a complex web of methodological, contextual, and reporting factors. These factors — ranging from heterogeneous accounting methodologies and perimeters to data quality issues, base year selection, and varying targets and commitments — create substantial challenges for any stakeholder seeking to benchmark corporate climate action.

The empirical evidence from Parts I and II illustrates how these methodological challenges manifest in practice. The substantial variation in reported emissions, energy consumption, water withdrawal, and waste generation across the 14 companies — while partly reflecting genuine differences in operational scale and efficiency — is also influenced by methodological choices, reporting boundaries, and data quality. The incomplete reporting of Scope 3 emissions (14.29% of observations missing), the variation in base years (ranging from 2015 to 2024), and the diversity of target ambition and scope all contribute to the comparability challenge.

The Value of Systematic Appraisal

Despite these challenges, systematic appraisal of sustainability reports remains highly valuable. When focused on proportional metrics rather than absolute numbers, and when contextualised within each company's specific operational realities, sustainability reports provide crucial insights into sectoral trends, benchmarks, and best practices (Hendrikson DGE, 2023). The Part I and II analyses demonstrated that while direct numerical comparisons are problematic, the identification of patterns — such as the dominance of Scope 3 emissions, the dramatic increase in renewable energy share, and the convergence in energy intensity performance — provides meaningful insights into sectoral progress.

The differences and inconsistencies observed across various sectors highlight the unique operational, technological, and economic realities that are specific to each sector, as well as the nuances within the same sector. These variations should not be seen as shortcomings in environmental efficiency; instead, they reflect the diverse strategies that industries employ to address their specific challenges. Therefore, it is essential to acknowledge that while a company's environmental metrics may not be wholly precise, they provide a valuable estimate considering the inherent limitations of any modelling system (GCI, 2024).

Evolving Reporting Landscape

In recent years, environmental sustainability reporting is evolving and advancing at a remarkable pace (Demir and Min, 2019; Fagbemi *et al.*, 2025), and evidence shows that the pharmaceutical industry surpasses other sectors, including food and beverage (Hansen *et al.*, 2022), technology (Goode and Hache, 2022), and manufacturing (Skrzypek *et al.*, 2024; Solikhah *et al.*, 2021), in its reporting and disclosures. This evolution — driven by regulatory requirements, investor pressure, and stakeholder expectations — is gradually improving the consistency, completeness, and reliability of sustainability reporting.

However, as the analysis in this paper demonstrates, significant challenges remain. The flexibility inherent in the GHG Protocol, while necessary to accommodate diverse operational realities, creates substantial comparability challenges. The voluntary nature of Scope 3 reporting, the variation in emission factor selection, and the lack of standardised verification practices all contribute to the methodological heterogeneity that constrains direct comparisons.

Implications for Different Stakeholders

The findings of this analysis carry different implications for different stakeholders:

For Researchers

Researchers should exercise caution when comparing environmental performance across pharmaceutical companies. Any comparative analysis should explicitly acknowledge methodological limitations, focus on proportional and intensity metrics rather than absolute values, and contextualise findings within each company's operational realities. The analyses presented in Parts I and II of this series — while providing valuable insights into sectoral trends — should be interpreted with these methodological caveats in mind.

For Investors

Investors seeking to assess corporate climate risk and opportunity should look beyond headline numbers to understand the methodological choices underlying reported data. Questions about reporting boundaries, Scope 3 category inclusion, emission factor selection, and verification practices are essential for informed investment decisions. Intensity metrics — particularly those normalised by revenue — provide more meaningful comparisons than absolute emissions.

For Policymakers

The findings underscore the need for greater standardisation in sustainability reporting. While frameworks such as the GHG Protocol provide valuable guidance, the flexibility inherent in these frameworks creates comparability challenges. Policymakers should consider mandating greater consistency in reporting methodologies, particularly for Scope 3 emissions, and should require more transparent disclosure of methodological choices and assumptions.

For Companies

Pharmaceutical companies should recognise that sustainability reporting is not merely an exercise in external communication but a vital tool for internal improvement. Companies should focus on continuous improvement in data quality, methodological consistency, and reporting completeness, while being transparent about the limitations of their reported data.

Future Directions

Future research should address the limitations identified in this analysis by:

- Developing standardised frameworks for cross-company comparison that account for methodological heterogeneity.
- Investigating the relationship between reporting quality and actual environmental performance.
- Examining the impact of regulatory requirements on reporting consistency and comparability.
- Exploring the potential of emerging technologies — such as blockchain and artificial intelligence — to improve data quality and transparency.
- Conducting longitudinal studies that track changes in reporting practices and their impact on comparability.

CONCLUSION

This paper — the third in a series examining pharmaceutical industry environmental performance — has systematically analysed the factors that constrain direct cross-company comparisons of sustainability metrics. Drawing on empirical evidence from the 14-company dataset analysed in Parts I and II, the analysis has identified nine categories of comparability challenges:

- heterogeneous accounting methodologies and perimeters;
- data quality, emission factors, and consistency over time;
- base year selection and recalculation practices;
- fluctuating emissions profiles;
- completion of prior target cycles;
- varying targets and commitments;
- alignment with different climate scenarios;
- contextual and scale factors; and
- transparency, completeness, and confidentiality issues.

The analysis demonstrates that even within a relatively homogeneous sector such as pharmaceuticals, methodological divergence — particularly in Scope 3 reporting, boundary definitions, and emission factor selection — renders direct numerical comparisons inherently problematic. The empirical evidence from Parts I and II illustrates how these methodological challenges manifest in practice, with substantial variation in reported emissions, energy consumption, water withdrawal, and waste generation that reflects methodological choices as much as actual performance differences.

Despite these challenges, the paper argues that systematic appraisal of sustainability reports remains highly valuable when focused on proportional metrics (percentage contributions, intensity ratios) rather than absolute numbers, and when contextualised within each company's specific operational realities. The differences and inconsistencies observed across the sector should not be seen as shortcomings in environmental efficiency; instead, they reflect the diverse strategies that companies employ to address their specific challenges.

A central conclusion emerges from this analysis: "*GHG emissions and their reductions should be recognised as vital tools for internal improvement rather than merely instruments for external comparison*". The pharmaceutical industry's progress in renewable energy adoption, energy efficiency, water conservation, and waste reduction demonstrates that meaningful environmental improvement is possible. However, the sector must continue to improve the consistency, completeness, and transparency of its sustainability reporting to enable meaningful assessment of progress.

As the pharmaceutical industry pursues alignment with the Paris Agreement and the Sustainable Development Goals, the quality of sustainability reporting will be essential — not only for accountability and transparency but also for driving the continuous improvement that is necessary to achieve deep decarbonisation and resource efficiency. The challenges of cross-company comparison identified in this paper should not discourage analysis but should instead inform more sophisticated, nuanced, and responsible approaches to assessing corporate environmental performance.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy, have been completely observed by the authors.

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