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Mind the gap: To what extent are Danish early adopters of science-based targets addressing impacts across their products´ life cycles?

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Abstract: Value chain emissions constitute the largest share of most company's greenhouse gas (GHG) inventory, making their reduction essential for achieving science-based targets (SBTs) and supporting global climate goals. This study analyses the decarbonization efforts of six Danish early adopters of SBTs, focusing on their strategies to reduce emissions across product life cycles and value chains. Based on publicly disclosed data from company reports and responses to the CDP Climate Change Questionnaires, the findings reveal a primary focus on Scope 1 and 2 emissions, with limited efforts targeting value chain emissions (i.e., Scope 3) during the early years following target setting. The study highlights significant gaps between the reductions required to meet targets and the reported impact of current and planned strategies, with shortfalls ranging from 17% to 75% of current inventory levels. Additionally, the study highlights inconsistencies and gaps in company disclosures making it difficult to assess actual progress. To close these gaps, there is a need for more knowledge on how companies can accelerate value chain decarbonization - such as through circular economy strategies - and improved transparency in reporting. Enhanced corporate action and disclosure are critical to aligning with SBT commitments and ensuring meaningful climate progress.

Introduction

Companies play a critical role to mitigate climate change (Bjørn, Tilsted, et al., 2022; Krabbe et al., 2015; United Nations' High-Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities, 2023) by implementing strategies to enable operating within planetary boundaries (Moshrefi et al., 2020, 2021). The Science-Based Targets initiative (SBTi) offers a framework for aligning corporate strategies with environmental needs (SBTi, 2023b, 2024c), facilitating a shift from relative to absolute sustainability (Bjorn et al., 2020; Hauschild et al., 2020). This involves addressing direct emissions (Scope 1), indirect emissions from energy use (Scope 2), and value chain emissions (Scope 3) from product life cycles (Callahan et al., 2011). Despite significant momentum in companies setting science-based targets (SBTs), implementation lags behind (Aldy et al., 2023; Bjørn, Lloyd, et al., 2022; Day et al., 2023; Dietz et al., 2018), particularly for Scope 3 emissions (Giesekam et al., 2021; SBTi, 2023a). Upstream and downstream scope 3 emissions are defined by the impacts across the lifecycle of a product and dominate manufacturing company greenhouse gas (GHG) inventories (CDP, 2023b; SBTi, 2023a) and are crucial to address. Achieving SBTs is further challenged by companies' revenue growth plans, linked with increased production volumes. Circular economy strategies offer an opportunity for implementing comprehensive changes in Scope 3 (Marini et al., 2024; The Danish Business Authority et al., 2023; Zomer et al., 2022). For example, extending product life can reduce Scope 3 emissions in purchased goods and end-of-life treatment (Blomsma et al., 2019; Marini et al., 2024). However, companies struggle with selecting and detailing these approaches effectively to meet their climate goals (Moshrefi et al., 2020, 2021; The Danish Business Authority et al., 2023; Zomer et al., 2022).

Danish companies have been among the early adopters of SBTs (SBTi, 2024c; UN Global Compact Network Denmark, 2023). This study seeks to clarify the current state of corporate climate action among Danish early adopters by

analysing published data. Specifically, this research examines current and planned decarbonization strategies for Scope 3 and evaluates their potential impact on meeting SBTs. The research question guiding this study is: *What decarbonization strategies related to Scope 3 are currently being implemented by companies with science-based targets, what future strategies are planned, and how do these align with the required reductions to meet their targets?*

Methods

The research involved three steps: 1. Selecting relevant companies and analysing their GHG inventory levels, 2. identifying implemented decarbonization strategies, and 3. evaluating planned strategies in relation to their targets.

In step 1, the six Danish companies that had SBTi-validated targets for at least three years and publicly available data in emission and revenue changes were selected (SBTi, 2024c). Data was primarily sourced from company annual reports, which provided information on revenue trends and Scope 1, 2, and 3 emissions. Incomplete company data (e.g., not including all Scope 3 sub-categories covered by a target), was supplemented with CDP Climate Change Questionnaire responses (CDP, 2023a), a disclosure platform endorsed by SBTi (SBTi, 2024b).

In step 2, the decarbonization strategies of each company were analysed using disclosed data from the CDP Climate Change Questionnaire question C4.3b: "*Provide details on the initiatives implemented in the reporting year in the table below*". This question details initiatives implemented during the year, including their estimated CO_2e savings and related GHG Scopes. As the question was introduced in 2019, the analysis spanned 2019–2022 to ensure consistency. Strategies were categorized into two groups: (A) Scope 1 and 2 and (B) Scope 3, to clarify for the share of efforts targeting the value chain. Discrepancies between CDP disclosures and company reports for the same years were documented to identify potential inconsistencies in reported data.

In step 3, data on planned reduction initiatives was analysed to assess the comprehensiveness of each company's strategies for achieving near-term SBTs (i.e., 5-10 years from the date the target is submitted following science-based reduction pathways (SBTi, 2024b)). The analysis was made based on CDP question C4.3a "*Identify the total number of initiatives at each stage of development, and for those in the implementation stages, the estimated CO_2e savings*". An optimistic scenario was applied to evaluate the potential impact during the transition period, assuming all initiatives would achieve the planned effect from year one, relative to the timeline for each company's short-term target. To enable comparison with estimated future emissions savings, supplier and intensity targets were converted to absolute terms, following assumptions that will be further outlined in Section 3.

Results and Discussion

This section addresses the research question by introducing the studied SBT (section 3.1), examining implemented decarbonization strategies (section 3,2), evaluating planned future strategies (section 3.3) and discussing limitations in disclosed data (section 3.4).

Introduction and stock take of the early Danish SBT adopters

In 2017, Carlsberg Group became the first Danish company to publish SBTs approved by SBTi (SBTi, 2024c). Novo Nordisk followed in 2018, and in 2020, four additional Danish companies joined the initiative: Rockwool Group (Rockwool), the Lego Group (Lego), Vestas Wind Systems (Vestas) and the Velux Group (Velux) (SBTi, 2024c). These six Danish early SBT adopters are all product manufacturers, representing diverse sectors such as pharmaceuticals, consumer goods, food and beverages, building products, and machinery. Now, more than three years after setting targets, data from the six companies provide an opportunity to evaluate the effectiveness of their strategies in reducing GHG emissions across their value chains.

Figure 1 shows GHG inventory trends from target publication to the latest reporting year. It highlights trends in direct emissions from Scopes 1, 2 and 3 (Callahan et al., 2011; WRI et al., 2004).

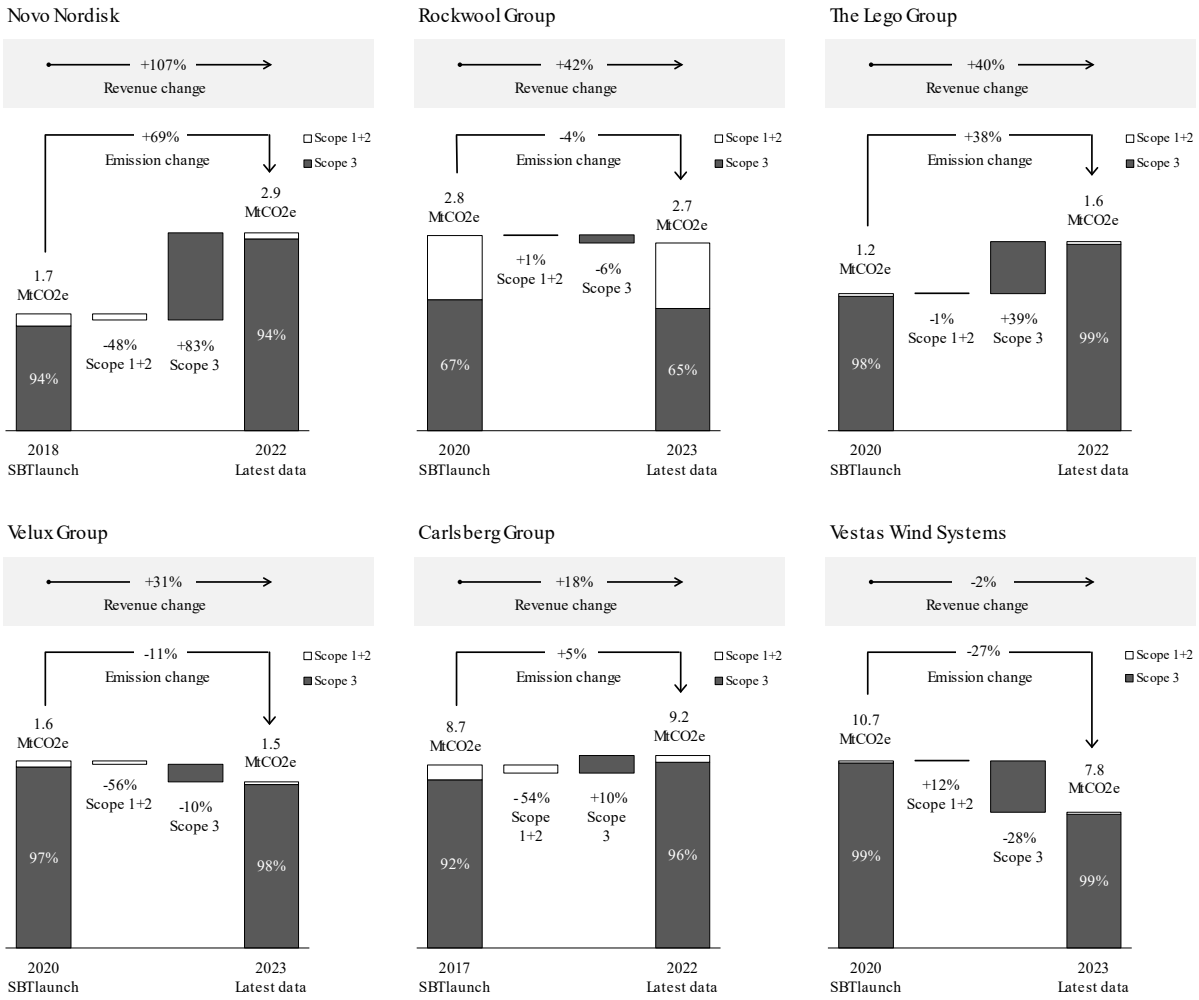

Figure 1. Emission development across GHG Scopes of the Danish early SBT adopters. *Emission data: Novo Emission data: Novo Nordisk and Carlsberg figures derive from CDP Climate Change Response Datasets (2018-2023) (CDP, 2023a) and figures for remaining companies stem from company sustainability reporting (Rockwool Group, 2024b; The Lego Group, 2021, 2023, 2024b; Velux Group, 2024a; Vestas Wind Systems, 2024b). Revenue data: Company annual reports (Carlsberg Group, 2024; Novo Nordisk, 2024; Rockwool Group, 2024a; The Lego Group, 2024a; Velux Group, 2024b; Vestas Wind Systems, 2024a).*

Scope 3, with dominate the six companies' inventories, comprising 67–99% of the emissions in the target year, remained largely unchanged. This observation aligns with studies emphasizing the substantial share of Scope 3 in most sectors, especially in manufacturing companies (CDP, 2022; Hertwich et al., 2018).

When analysing the development of the total company GHG inventories, only Vestas and Velux have reduced emissions since their SBTs were published. Rockwool's emissions have remained somewhat stable, while Carlsberg, Novo Nordisk, and Lego have all experienced increases in total emissions. Carlsberg's GHG inventory grew 5%, while Lego and Novo Nordisk grew 38% and 69%, respectively.

Examining what GHG Scopes drives the inventory development, increases in emissions for Carlsberg, Novo Nordisk, and Lego are solely driven by changes in Scope 3. While all three companies have reduced Scope 1 and 2 emissions, their Scope 3 emissions have increased—by 10% for Carlsberg, 38% for Lego, and 83% for Novo Nordisk. These increases align with sizable revenue growth during the same period, suggesting that higher sales volumes, likely tied to increased production, are driving up value chain emissions. Similarly, the decrease in Scope 3

emissions by Vestas is also tied to a reduction in revenue (although only minor) over the same period. Only Velux and Rockwool have markedly reduced their Scope 3 emissions despite revenue growth, indicating that they may have adopted effective decarbonization strategies.

This raises the question: What specific decarbonization strategies have these companies implemented to manage Scope 3 emissions, and how do these efforts align with the observed trends in their GHG inventories? Section 3.2 investigates the decarbonization strategies pursued by each company, focusing on the impact across their value chains.

Current decarbonization strategies across product life cycles

The analysis of the disclosed data, presented in Figure 2, finds that between 2019-2022, the six Danish companies concentrated primarily on reducing Scope 1 and 2 emissions, while taking relatively limited actions to address Scope 3, e.g. implement design strategies for minimizing the impact across the product life cycle. The vast majority of efforts address Scope 1 and 2 ranging from 89-100% of the estimated CO_2e savings over the four-year period. All companies disclose to have implemented low-carbon energy consumption initiatives, such as biogas, wind energy, solar panels, or entering power purchasing agreements for renewable energy. Additionally, energy efficiency improvements in building operations and production processes are common, including optimized facility management for heating and lighting, as well as production enhancements like process optimization, automation, and machinery upgrades. At the same time, initiatives targeting Scope 3 have been scarce. Four of the six companies—Novo Nordisk, Rockwool, Lego, and Velux—have not yet implemented initiatives addressing the life cycle of their products to decarbonize their value chains in Scope 3. Only Carlsberg and Vestas have addressed the value chain in their efforts, but these initiatives have had minimal impact compared to savings from other measures. Carlsberg reports that only 2% of its estimated CO_2e savings over the four-year period occurred in the value chain, specifically through material recycling. Vestas indicates that 11% of its reductions arrives from resource efficiency measures in the value chain, with no further disclosed details.

Decarbonization strategies			Estimated CO2e savings from 2019-2022 as diclosed to CDP, t. tonnes CO2e					
GHG scope	CDP initiative category	Details	Carlsberg	Novo Nordisk	Rockwool	Lego	Vestas	Velux (only 2021)
Emission savings occuring in Scope 1 and 2	Energy efficiency in buildings	Heating, Ventilation and Air Conditioning (HVAC)	0.5			0.4	3.8	
		Lightning			0.5	2.1	0.9	
		Insulation				0.2		
	Energy efficiency in production processes	Process optimization	26.7		16.7	0.2	0.1	
		Automation; Smart control system	1.7		1.1			
		Machine/equipment replacement			17.6	0.3		
		Electrification; Fuel switch			16.8	0.1		
		Other (compressed air, cooling technology etc.)	6.9	11.3	0.6	0.5	0.4	
	Low-carbon energy consumption	Biogas; Solid Biofuels	12.8				0.4	
		Wind			92.9		0.1	
		Solar PV					0.0	
		Other (Power Purchasing agreements)						45.0
	Low-carbon energy generation	Biogas; Solid Biofuels	0.9				0.4	
		Solar PV				5.3		
	Non-energy industrial process emissions	Substitution material with low financial impact.			6.1			
	Fugitive emissions reductions	-						
	Transportation	Company fleet vehicle replacement					0.5	
	Other, please specify	Energy savings programme	0.2	2.7				
Emission savings occuring in Scope 3	Transportation	-						
	Company policy or behavioural change	Resource efficiency					0.8	
	Waste reduction and material circularity	Product/component/material recycling	1.0					
	Other, please specify	-						
Total estimated CO2e savings from 2019-2022			50.5	14.0	152.2	9.1	7.4	45.0
%-share related to Scope 1 and 2			98%	100%	100%	100%	89%	100%
%-share related to Scope 3			2%	0%	0%	0%	11%	0%

Figure 2. Decarbonization strategies of the six first Danish SBT companies and their cumulative estimated CO_2e savings from 2019-2022 as disclosed to CDP. *Data: CDP Climate Change Response Datasets (2018-2023)* (CDP, 2023a)

Given the sizable proportion of Scope 3 emissions in corporate inventories compared to Scopes 1 and 2 (Figure 1), the lack of life cycle initiatives pose significant challenges for companies aiming to meet near-term targets (SBTi, 2023a). Energy efficiency measures, while important, are typically insufficient to achieve the reductions required to meet SBTs and often lead to increased consumption offsetting the intended emission reductions (Hauschild et al., 2017; Kara et al., 2018). Despite offering significant potential to address value chain emissions (Marini et al., 2024; The Danish Business Authority et al., 2023; Zomer et al., 2022), the implementation of circular economy strategies is often hindered by long timeframes and complex challenges (Bey et al., 2013; Geissdoerfer et al., 2023). The limited adoption of value chain initiatives could partly be explained by the extended lead times these strategies demand, leaving many still in the planning stage. To investigate this, Section 3.3 explores planned strategies and assesses their alignment with the reductions necessary to meet SBTs.

Future strategies and alignment with targeted reductions

In addition to strategies already implemented, the company's responses to the CDP's annual Climate Change Questionnaire also highlight emission reduction initiatives in different planning stages (question C4.3a). Although the specific strategies are not disclosed in detail, the responses categorize initiatives by maturity levels (i.e., "implementation commenced," "to be investigated," and "under investigation") and include an overall yearly CO_2e impact assessment for each stage.

Figure 3 compares the estimated total impacts of these disclosed future strategies with current emission inventory levels (Figure 1) and near-term targets, highlighting the gap towards achieving these targets. The analysis is based on two key assumptions:

1. *Immediate full impact of planned reduction initiatives.* The impacts were calculated under an optimistic scenario, assuming each initiative achieves full effectiveness immediately upon implementation from following year and until near-term target is reached. In reality, reductions will likely be lower, as many initiatives are still in the early phase - “to be investigated” - and because some initiatives will likely require time to reach full impact.

2. *Conversion of intensity and supplier engagement targets into absolute target levels.* To compare strategy impacts with inventory levels, intensity-based targets (Carlsberg and Vestas) and supplier engagement targets (Novo Nordisk) were converted into absolute terms. Near-term absolute target levels for intensity-based targets were assessed by projecting historical revenue trends from the base year to estimate production volumes for the target year. Since supplier engagement targets cannot directly be translated into an absolute measure, the 2030 target for Novo Nordisk was defined by assuming a linear reduction towards net-zero by 2045 — a target published in the company´s 2023 Annual Report but not currently approved by SBTi (Novo Nordisk, 2024; SBTi, 2024c).

Although these assumptions introduce a degree of uncertainty to the analysis, the overall conclusion is robust. The analysis shows that a substantial gap remains in meeting the near-term SBTs ranging from 17-75% of current GHG inventory levels across the studied companies. The estimated impacts of the currently planned strategies, according to disclosures, are modest for Rockwool and Lego (with 6% and 13% reductions respectively), and nearly negligible for Vestas, Carlsberg, and Novo Nordisk (with reductions of 1%, 1%, and 0%, respectively). These findings suggest that, despite several years into their climate transition efforts, these companies have yet to disclose sufficient strategies to meet their targets. Although the specific type of strategies being developed were not clarified in the disclosures, the small impact may indicate that currently planned reduction efforts are only to a small extent addressing the sizable emission in their value chains.

This raises the question of whether the shortfall is mainly due to inadequate current and planned strategies, or to disclosure limitations that fail to reflect actual company activities. This issue is discussed in Section 3.4.

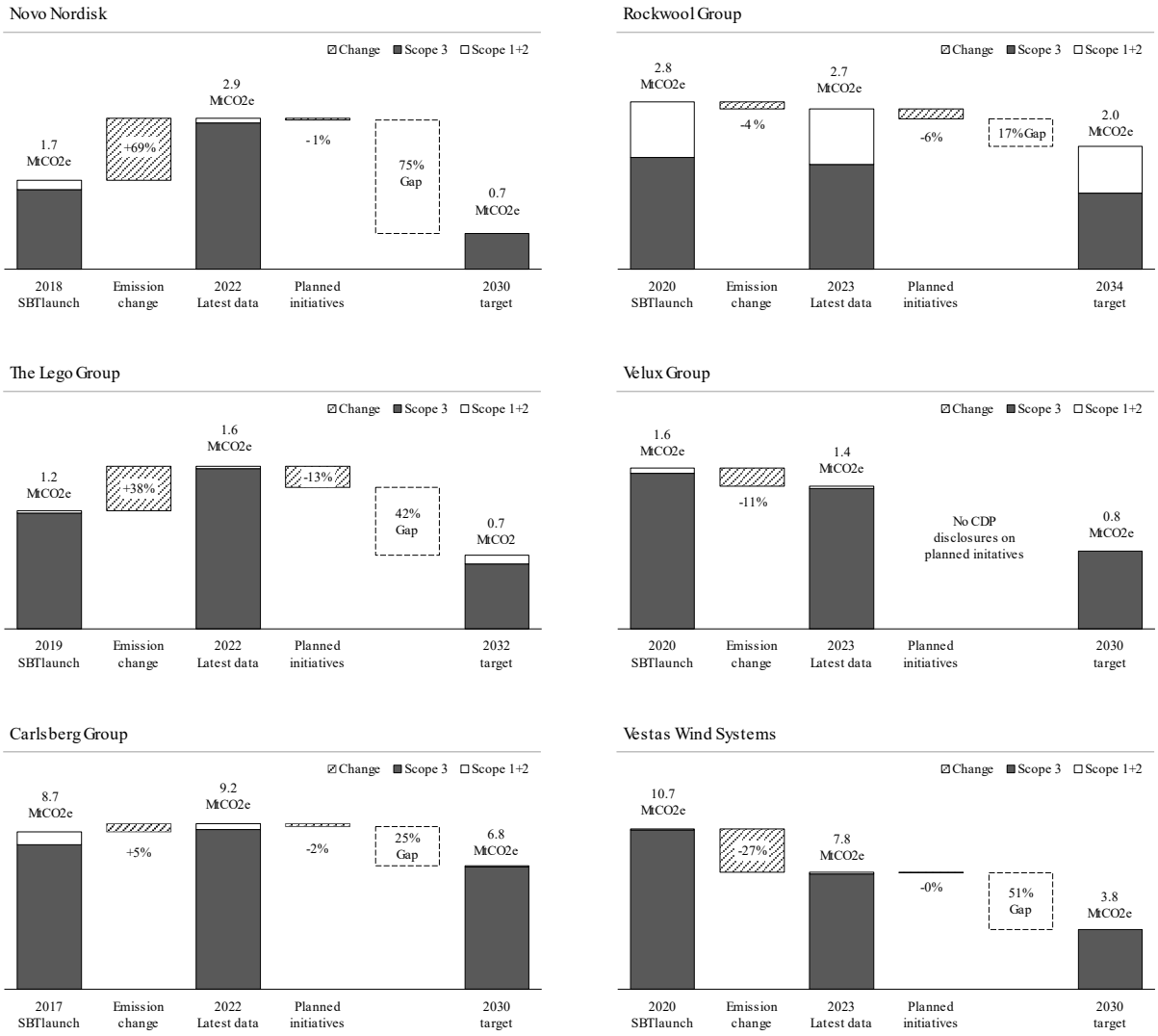

Figure 3. Comparison of estimated cumulative impacts of disclosed future strategies (planned initiatives) with current GHG inventory levels and near-term targets. *Emission data sources: Novo Nordisk and Carlsberg figures derive from CDP Climate Change Response Datasets (2018-2023) (CDP, 2023a) and figures for remaining companies stem from company sustainability reporting (Rockwool Group, 2024b; The Lego Group, 2021, 2023, 2024b; Velux Group, 2024a; Vestas Wind Systems, 2024b). Near-term target sources: SBTi webpage (SBTi, 2024c).*

Lack of action, deficient disclosure or both?

The data disclosed by the companies suggest trends but fall short of providing definitive conclusions due to possible limitations in the disclosures and deficiencies in the reported data. Firstly, many unanswered questions reveal significant gaps in the companies' responses to CDP's Climate Change Questionnaire. The most notable case is Rockwool, which left questions unanswered in 2019, 2020, and 2022, and offered only minimal reporting in 2021. Secondly, misalignment between reported emission trends over time (Figure 1) and disclosed actions (Figure 2) suggest that companies may not be reporting reduction initiatives comprehensively. The absence of Scope 3 initiatives is evident in the cases of Carlsberg, Novo Nordisk, and Lego, whose value chain emissions have also increased alongside revenue growth during their initial years with SBTs (Figure 1). In contrast, it remains unclear how Velux and Rockwool have reduced Scope 3 emissions despite revenue growth and without implementing value chain-specific strategies (Figure 2). While external factors such as energy grid changes, market dynamics, and value chain behaviour can influence GHG

inventories, these examples suggest a potential lack of transparency in disclosure. Thirdly, discrepancies between company reports and CDP disclosures (as also documented by other studies (Klaaßen et al., 2021)) suggest that additional emission reduction actions may exist even though they are not available in the CDP data. For example, Velux reports reductions achieved through factory electrification across four sites and the incorporation of non-virgin materials in its products within its annual reports; however, these details are not presented in the CDP disclosures (CDP, 2023a; Velux Group, 2024a). Similarly, Novo Nordisk's 2023 Annual Report highlights a major initiative requiring suppliers to transition to renewable energy and includes an assessment of its projected CO_2e impact. However, these details are absent from the company's disclosures on future initiatives in the CDP reporting (CDP, 2023a; Novo Nordisk, 2024).

These discrepancies between CDP data, achieved emission reductions, and figures reported in annual reports raise potential reliability issues suggesting that reporting may not fully represent actual actions. Possible reasons for these discrepancies include:

- **Challenges in quantifying future impact:** Companies may struggle to quantify the future impact of reduction strategies, which require aligning these strategies with revenue growth plans. This reflects findings from other studies, which highlight the current lack of methodologies for conducting future environmental impact assessments (de Bortoli et al., 2023; Moshrefi et al., 2022; SBTi, 2023a, 2024a).
- **Limitations in the disclosure standard:** The structure of the CDP questionnaire itself may also restrict comprehensive reporting. CDP categorizes initiatives into 9 main areas with 55 sub-categories, that are largely focused on Scope 1 and 2 emissions and offering limited options for Scope 3 specific actions (CDP, 2023a).
- **Internal reporting challenges:** Internal communication gaps may exist. For example, reporting teams might work separately from sustainability or R&D teams, limiting their ability to accurately translate strategic initiatives into required disclosures.

These limitations create uncertainty about data reliability, with the observed gaps of 17–75% between required emission reductions and reported impacts remaining ambiguous. It is unclear whether these discrepancies result from deficient reporting, insufficient actions, or both. The lack of transparency and clarity in companies' plans presents barriers to understand and verify progress toward climate goals. Without accurate tracking, companies have the flexibility to set SBTs without sufficient accountability, making it challenging to differentiate between those with robust transition strategies and those without - concerns echoed in several studies and frameworks (CDP, 2023b; Day et al., 2023; de Bortoli et al., 2023; Hans et al., 2023; Tilsted et al., 2023).

Conclusions

The study evaluates the decarbonization efforts of six Danish early adopters of SBTs, focusing on Scope 3 emissions across the life cycle. Publicly disclosed data from annual reports and CDP Climate Change Questionnaires show that while these companies actively reduce Scope 1 and 2 emissions, limited action is taken for Scope 3 reduction, despite its dominance in GHG inventories and direct link to revenue growth.

A significant gap between reductions required for near-term SBTs and the impact of disclosed future strategies is observed. Limited life cycle initiatives suggest companies are unlikely to meet climate goals without significantly strengthening efforts in this area. Additionally, incomplete reporting and inconsistencies between disclosed actions and reported reductions hinders assessing actual progress. This lack of clarity obscures whether gaps result from insufficient action, poor reporting, or both.

Closing the ambition-action gap requires companies to prioritize life cycle decarbonization through robust strategies, such as circular economy, addressing the entire value chain. Improved transparency via consistent reporting is essential for accurate progress tracking and accountability. Future research should explore barriers to implementing and disclosing life cycle initiatives, ensuring corporate actions align with SBT commitments and business growth plans.

References

Aldy, J. E., Bolton, P., Kacperczyk, M., & Halem, Z. M. (2023). Behind schedule: The corporate effort to fulfill climate obligations. *Journal of Applied Corporate Finance*, *35*(2), 26–34. doi: 10.1111/jacf.12560

Bey, N., Hauschild, M. Z., & McAloone, T. C. (2013). Drivers and barriers for implementation of environmental strategies in manufacturing companies. *CIRP Annals - Manufacturing Technology*, *62*(1), 43–46. doi: 10.1016/j.cirp.2013.03.001

Bjorn, A., Chandrakumar, C., Boulay, A. M., Doka, G., Fang, K., Gondran, N., Hauschild, M. Z., Kerkhof, A., King, H., Margni, M., McLaren, S., Mueller, C., Owsianiak, M., Peters, G., Roos, S., Sala, S., Sandin, G., Sim, S., Vargas-Gonzalez, M., & Ryberg, M. (2020). Review of life-cycle based methods for absolute environmental sustainability assessment and their applications. In Environmental Research Letters (Vol. 15, Issue 8). IOP Publishing Ltd. doi: 10.1088/1748-9326/ab89d7

Bjørn, A., Lloyd, S. M., Brander, M., & Matthews, H. D. (2022). Renewable energy certificates threaten the integrity of corporate science-based targets. *Nature Climate Change*, *12*(6), 539–546. doi: 10.1038/s41558-022-01379-5

Bjørn, A., Tilsted, J. P., Addas, A., & Lloyd, S. M. (2022). Can Science-Based Targets Make the Private Sector Paris-Aligned? A Review of the Emerging Evidence. *Current Climate Change Reports*, *8*(2), 53–69. doi: 10.1007/s40641-022-00182-w

Blomsma, F., Pieroni, M., Kravchenko, M., Pigosso, D. C. A., Hildenbrand, J., Kristinsdottir, A. R., Kristoffersen, E., Shabazi, S., Nielsen, K. D., Jönbrink, A.-K., Wiik, C., & McAloone, T. C. (2019). Developing a circular strategies framework for manufacturing companies to support circular economy-oriented innovation. *Journal of Cleaner Production*, *241*. doi: 10.1016/j.jclepro.2019.118271

Callahan, W., James Fava, S. A., Wickwire, S., Sottong, J., Stanway, J., & Ballentine, M. (2011). *Corporate Value Chain (Scope 3) Accounting and Reporting Standard Supplement to the GHG Protocol Corporate Accounting and Reporting Standard GHG Protocol Team*.

Carlsberg Group. (2024). *Annual Report 2023*.

CDP. (2022). *CDP Technical Note: Relevance of Scope 3 Categories by Sector CDP Climate Change Questionnaire*.

CDP. (2023a). *CDP 2023 Climate Change Response Dataset*.

CDP. (2023b). *Global supply chain report 2022 - Scoping out: Tracking nature across the supply chain* .

Day, T., Mooldijk, S., Hans, F., Smit, S., Posada, E., Skribbe, R., Woollands, S., Fearnehough, H., Kuramichi, T., Warnecke, C., Kachi, A., & Höhne, N. (2023). *Corporate Climate Responsibility Monitor 2023: Assessing the transparency and integrity of companies' emission reduction and net-zero targets*.

de Bortoli, A., Bjørn, A., Saunier, F., & Margni, M. (2023). Planning sustainable carbon neutrality pathways: accounting challenges experienced by organizations and solutions from industrial ecology. *International Journal of Life Cycle Assessment*, *28*(7), 746–770. doi: 10.1007/s11367-023-02147-z

Dietz, S., Fruitiere, C., Garcia-Manas, C., Irwin, W., Rauis, B., & Sullivan, R. (2018). An assessment of climate action by high-carbon global corporations. In Nature Climate Change (Vol. 8, Issue 12, pp. 1072–1075). Nature Publishing Group. doi: 10.1038/s41558-018-0343-2

Geissdoerfer, M., Santa-Maria, T., Kirchherr, J., & Pelzeter, C. (2023). Drivers and barriers for circular business model innovation. *Business Strategy and the Environment*, *32*(6), 3814–3832. doi: 10.1002/bse.3339

Giesekam, J., Norman, J., Garvey, A., & Betts-Davies, S. (2021). Science-based targets: On target? *Sustainability (Switzerland)*, *13*(4), 1–20. doi: 10.3390/su13041657

Hans, F., Woollands, S., Day, T., & Höhne, N. (2023). *The corporate climate accountability loop: Introducing key functions of an accountability system for corporate climate action, and selected spotlights on how to improve the status quo*.

Hauschild, M. Z., Herrmann, C., & Kara, S. (2017). An Integrated Framework for Life Cycle Engineering. *Procedia CIRP*, *61*, 2–9. doi: 10.1016/j.procir.2016.11.257

Hauschild, M. Z., Kara, S., & Røpke, I. (2020). Absolute sustainability: Challenges to life cycle engineering. *CIRP Annals*, *69*(2), 533–553. doi: 10.1016/j.cirp.2020.05.004

Hertwich, E. G., & Wood, R. (2018). The growing importance of scope 3 greenhouse gas emissions from industry. *Environmental Research Letters*, *13*(10). doi: 10.1088/1748-9326/aae19a

Kara, S., Hauschild, M. Z., & Herrmann, C. (2018). Target-driven Life Cycle Engineering: Staying within the Planetary Boundaries. *Procedia CIRP*, *69*, 3–10. doi: 10.1016/j.procir.2017.11.142

Klaaßen, L., & Stoll, C. (2021). Harmonizing corporate carbon footprints. *Nature Communications*, *12*(1). doi: 10.1038/s41467-021-26349-x

Krabbe, O., Linthorst, G., Blok, K., Crijns-Graus, W., Van Vuuren, D. P., Höhne, N., Faria, P., Aden, N., & Pineda, A. C. (2015). Aligning corporate greenhouse-gas emissions

targets with climate goals. *Nature Climate Change*, *5*(12), 1057–1060. doi: 10.1038/nclimate2770

Marini, M., Pigosso, D. C. A., Pieroni, M., & McAloone, T. C. (2024). To what extent are circular economy strategies accounted in science-based targets for carbon emission reduction? *Computers and Industrial Engineering*. doi: 10.1016/j.cie.2024.110594

Moshrefi, S., Abdoli, S., Kara, S., & Hauschild, M. (2020). Product portfolio analysis towards operationalising science-based targets. *Procedia CIRP*, *90*, 377–382. doi: 10.1016/j.procir.2020.02.127

Moshrefi, S., Kara, S., & Hauschild, M. (2021). Eco-efficiency limits of product technologies towards achieving science-based targets. *Procedia CIRP*, *98*, 488–493. doi: 10.1016/j.procir.2021.01.139

Moshrefi, S., Kara, S., & Hauschild, M. (2022). A framework for future-oriented environmental impact assessment of companies considering Science-Based Targets. *Journal of Cleaner Production*, *373*. doi: 10.1016/j.jclepro.2022.133719

Novo Nordisk. (2024). *Annual Report 2023*.

Rockwool Group. (2024a). *ROCKWOOL Annual Report 2023*.

Rockwool Group. (2024b). *ROCKWOOL Sustainability Report 2023*.

SBTi. (2023a). *Catalyzing value chain decarbonization: Corporate survey results*.

SBTi. (2023b). *SBTi corporate net-zero standard*.

SBTi. (2024a). *SBTi Aligning Corporate Value Chains Scope 3 Discussion Paper*.

SBTi. (2024b). *Scence Based Targets initiative; Corporate Net-Zero Standard V1.2*.

SBTi. (2024c, November 12). *https://sciencebasedtargets.org/companies-taking-action*.

The Danish Business Authority, UN Global Compact Network Denmark, & Transition ApS. (2023). *Reducing scope 3 emissions through circular economy initiatives*.

The Lego Group. (2021). *GHG Report 2020*.

The Lego Group. (2023). *GHG Report 2022*.

The Lego Group. (2024a). *Annual Report 2023*.

The Lego Group. (2024b). *Sustainability Progress 2023*.

Tilsted, J. P., Palm, E., Bjørn, A., & Lund, J. F. (2023). Corporate climate futures in the making: Why we need research on the politics of Science-Based Targets. *Energy Research and Social Science*, *103*. doi: 10.1016/j.erss.2023.103229

UN Global Compact Network Denmark. (2023). *COMMITMENT TO THE SCIENCE BASED TARGETS INITIATIVE (SBTi) IN DENMARK A PROGRESS REPORT IN THE LEAD-UP TO COP28*.

United Nations' High-Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities. (2023). *Integrity Matters: Net Zero Commitments by Businesses, Financial Institutions, Cities and Regions*.

Velux Group. (2024a). *Sustainability Report 2023*.

Velux Group. (2024b). *Annual Report 2023*.

Vestas Wind Systems. (2024a). *Annual Report 2023*.

Vestas Wind Systems. (2024b). *Sustainability Report 2023*.

WRI, & WBCSD. (2004). *The Greenhouse Gas Protocol. A Corporate Accounting and Reporting Standard*.

Zomer, T., McAloone, T. C., & Pigosso, D. C. A. (2022). To What Extent Is Circular Product Design Supporting Carbon Reduction Strategies? An Analysis of Nordic Manufacturing Firms within the Science-Based Targets Initiative. *Proceedings of the Design Society*, *2*, 1189–1198. doi: 10.1017/pds.2022.121