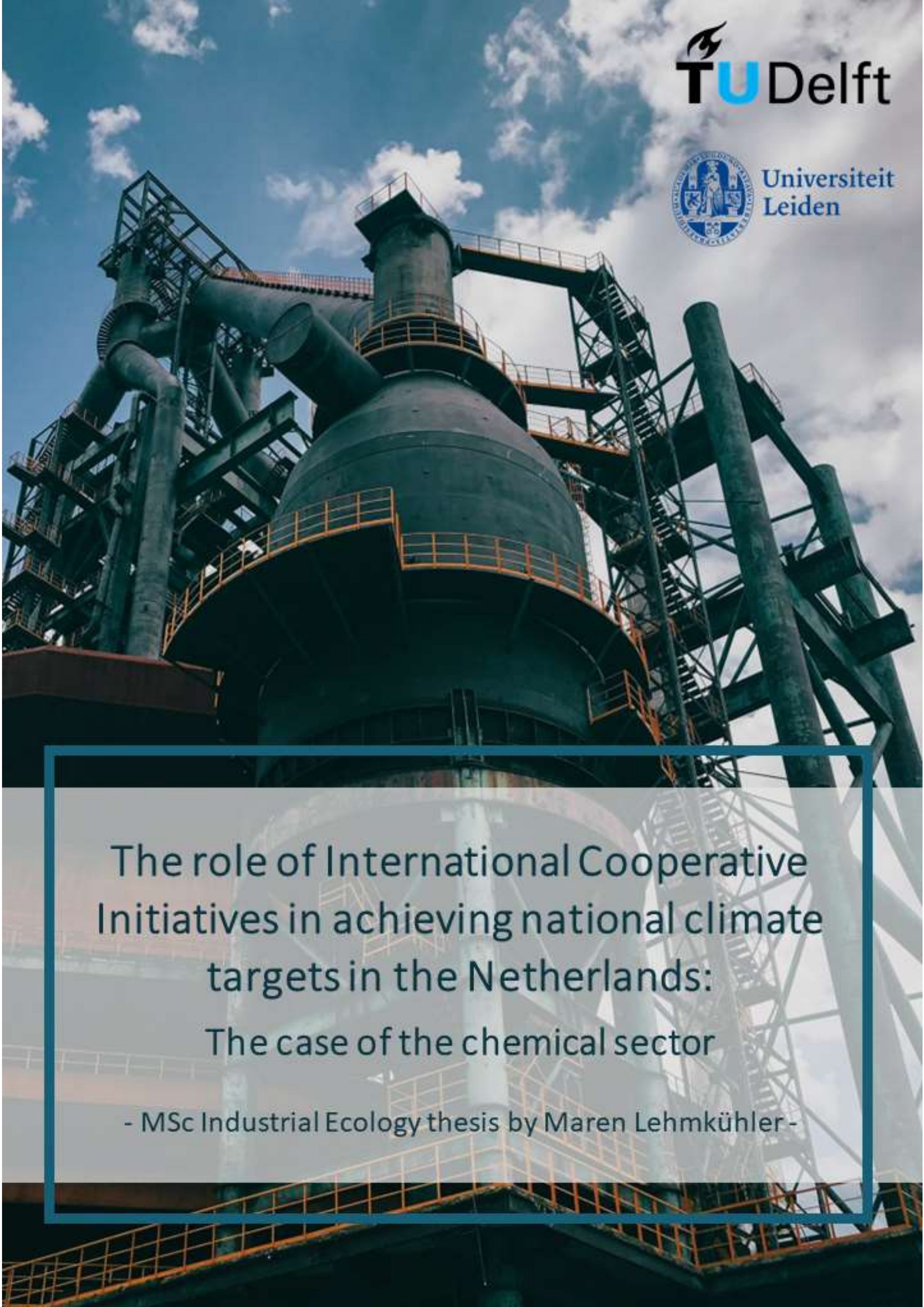

The role of International Cooperative Initiatives in achieving national climate targets in the Netherlands:

The case of the chemical sector

- MSc Industrial Ecology thesis by Maren Lehmkühler -

The role of International Cooperative Initiatives in achieving national climate targets in the Netherlands: The case of the chemical sector

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Maren Lehmkühler
Berlin, December 19, 2023

Acronyms

ACA – Absolute Contraction Approach

AIM – *Activiteitenbesluit* (Activities Decree) Internet Module

BA1.5 – Business Ambition for 1.5°C initiative

CA100+ - Climate Action 100+

CAA – Climate Ambition Alliance

CCPI - Climate Change Performance Index

CCPO - Climate Change Policy Objective

CCS – Carbon Capture and Storage

CCU – Carbon Capture and Utilization

CDP – Carbon Disclosure Project

CNN – Climate Neutral Now initiative

CO_2eq – Carbon Dioxide Equivalents

CSS - Chemicals Strategy for Sustainability

GHG – Greenhouse Gas

EED – European Energy Efficiency Directive

EPI – Environmental Performance Index

EU ETS – European Union Emissions Trading System

GWP100 – Global Warming Potential over 100 years

H/S/C - Heat, Steam, and Cooling

ICI – International Cooperative Initiative

IEA – International Energy Agency

InEnA – International Environmental Agreement

INGO – International Non-Governmental Organization

IPCC – Intergovernmental Panel on Climate Change

IUCN - International Union for Conservation of Nature

KEV – *Klimaat- en Energieverkenning* (Climate and Energy Outlook)

NDC – Nationally Determined Contribution

NECP – National Energy and Climate Plan

NAZCA - Non-state Actor Zone for Climate Action

NEa – *Nederlandse Emissieautoriteit* (Dutch Emissions Authority)

NSA – Non-state and Subnational Actor

OBM - *Omgevingsvergunning Beperkte Milieutoets* (environmental permit limited environmental assessment)

OECD - Organization for Economic Cooperation and Development

PBL - Planbureau voor de Leefomgeving (Netherlands Environmental Assessment Agency)

RCECP - Responsible Corporate Engagement in Climate Policy

R&D – Research and Development

RD&D – Research, Development, and Demonstration

RtZ – Race to Zero campaign

SBI – *Standaard Bedrijfsindeling* (Netherlands Standard Industrial Classification of Economic Activities)

SBT – Science-Based Target

SBTi – Science-Based Targets initiative

SDA - Sectoral Decarbonization Approach

SDE++ – *Stimulering Duurzame Energieproductie en klimaattransitie* (Sustainable Energy Production and Climate Transition Scheme)

SDG – Sustainable Development Goal

TKI - Top Consortia for Knowledge and Innovation

UN - United Nations

UNFCCC – United Nations Framework Convention on Climate Change

VNCI - Association of the Dutch Chemical Industry

Wm – *Wet milieubeheer* (Environmental Management Act)

WRI – World Resources Institute

WWF – World Wide Fund for Nature

Executive Summary

Introduction

Climate change is a pressing global issue that affects us all. Despite countries committing to ambitious targets in the 2015 Paris Agreement, there is a collective shortfall in meeting these goals. The Netherlands, with 60% of its landmass below sea level, has a particular interest in averting the severe impacts of climate change. In the global decarbonization endeavor, businesses have a particularly important role to play when it comes to collective climate action and the mitigation of Greenhouse Gas (GHG) emissions as they are responsible for the majority of global emissions. One industry stands out as the largest industrial energy consumer: The global chemical sector. While the chemical sector not only has substantial energy requirements owing to its highly energy-intensive operations, it is also heavily dependent on fossil fuels as feedstock for producing chemical end-products.

Amidst the challenges countries face in meeting their climate goals, the role that Non-state and Subnational Actors (NSAs), such as cities, regions, or businesses, play in transnational climate governance has gained prominence. Research indicates that NSA climate action complements national climate policy, aiding in achieving countries' decarbonization targets, driving more ambitious policies, and narrowing the emissions gap. Furthermore, in the past years, many International Cooperative Initiatives (ICIs) have emerged to support NSAs in their climate mitigation efforts. However, the impact of these initiatives, and the question of whether they aid in accelerating the global low-carbon transition or merely serve as a greenwashing tool, distracting from the implementation of further climate regulations and policies, has not been extensively explored in the academic literature so far.

Given the susceptibility of the Netherlands to the impacts of climate change and the significant climate footprint of the chemical sector, this study will delve into this subject within the context of both the Netherlands and the chemical industry. The primary aim therefore is to address the following research question:

"What effect do International Cooperative Initiatives have on the climate achievements of the chemical sector in the Netherlands and how does that influence national targets and policies?"

Methodology

To address this question, we employed a multifaceted methodology. Initially, we determined a company sample and identified various ICIs for examination. The selected company sample comprises 50 entities within the chemical (including petrochemical) sector, chosen based on the highest revenue generated in the Netherlands within this industry. The companies in the sample belong to the sub-sectors petroleum processing, chemicals, rubber plastics, and pharmaceuticals, aligned with codes 19 to 22, respectively, of the Dutch Standard Industrial Classification of Economic Activities. Additionally, the chosen ICIs for analysis encompass Business Ambition for 1.5°C, Climate Ambition Alliance, Climate Neutral Now, Science-Based Targets initiative, RE100, Climate Action 100+, and Responsible Corporate Engagement in Climate Policy. These ICIs were selected based on both their substantial participant numbers and their specific focus areas, which pertain to either corporate GHG emission reduction or climate policy.

The subsequent step in our methodology involved evaluating the performance of these 50 chemical sector companies over five years, spanning from 2018 to 2022. This assessment took into account factors such as the companies' headquarters' locations and their levels of participation in ICIs. The primary focus of this analysis centered on the five companies responsible for the largest share of GHG emissions within the company sample. Additionally, we conducted a detailed examination of companies affiliated with the Science-Based Targets initiative (SBTi), utilizing a logical framework that assesses ambition, robustness, implementation, and substantive progress. Due to limitations and data challenges related to intensity targets and reporting of scope 3 emissions, our analysis concentrated on companies with absolute scope 1+2 targets. Beyond illuminating the impact of company participation in ICIs on the companies themselves and their GHG emissions, our objective was to assess its effects on Dutch national targets and policies. To achieve this, we explored the relationship between NSAs and state-level climate action in the Netherlands through correlation analysis, building on prior cross-national research in this domain. Finally, we synthesized these results to gain a comprehensive understanding of the influence ICIs wield on climate action at both the economic and government levels.

Results

Before delving into the results of this research, we want to highlight that although our company sample is drawn from the top 50 chemical companies operating in the Netherlands, and our analysis explores the interaction between NSA and state-level climate action within a Dutch context, the evaluation of the impact and climate mitigation progress of entities in the chemical industry relates to the global level.

The first analysis of this research, assessing the relationship between corporate GHG emissions and levels of ICI participation revealed a significant growth in participation over time, with 86% of companies in the entire sample engaging in either one or two ICIs by 2023. Subdividing the sample based on headquarters' locations highlighted that, in proportion to their sample size, Dutch companies participated in more ICIs than their EU and global counterparts. However, an analysis of GHG emission trends over time unveiled a contrasting picture – while emissions decreased by about -11% for the entire company sample, emissions from Dutch-headquartered companies increased by approximately 12% between 2018 and 2022. This lack of correlation between the extent of ICI participation and success in mitigating GHG emissions suggested that there must be other, more prominent factors affecting the emission trajectories of companies.

In fact, in our detailed analysis of the five highest emitters, accounting for nearly half of the entire sample's emissions, we identified several pivotal factors that significantly impacted companies' GHG emission levels. These factors encompass economic elements like acquisitions or divestments of entities or assets, along with fluctuations in production volumes. Additionally, undertaking new ventures, such as hydrogen production, which generates substantial scope 1 emissions, has a profound impact on corporate emissions. External factors, such as pandemics or geopolitical events, also play a crucial role. A prime illustration is the repercussions of the Russia-Ukraine war, which commenced in February 2022. The resulting natural gas shortage led to a surge in natural gas prices, prompting numerous refineries to transition from natural gas to oil, which emits more GHGs per unit of fossil fuel combusted.

After having derived these preliminary insights, we delved deeper into assessing the mitigation progress of chemical sector companies, we focused on those entities having joined the SBTi. Initial analysis revealed a seemingly contrasting trend, with non-SBTi members reducing their emissions by approximately -18%, while SBTi members with approved targets increased theirs by almost 26%. However, as will be demonstrated later on, the predominant responsibility for this trend lies with the two companies in the SBTi with the highest GHG emissions. Furthermore, a supplementary analysis, which considers the base years of set targets, indicates that companies with a more extended history of participation in the SBTi exhibit more significant success in reducing their emissions, underscoring the initiative's effectiveness over time in assisting companies in their climate action pursuits.

To further delve into the climate mitigation progress of SBTi-participating businesses, we applied a comprehensive framework analyzing progress on ambition, robustness, implementation, and substantive progress for chemical sector companies within the SBTi that had set absolute scope 1+2 targets. Results underscored that, while these companies set ambitious targets, they lacked robust third-party verification, with most companies merely achieving "limited assurance" levels. Furthermore, the examination of ambition level distribution indicated that, although a majority of companies established highly ambitious targets, the weighted ambitions (adjusted for company size or emissions) reflected less ambitious levels. This discrepancy arose from the comparatively less ambitious targets set by the largest emitters, emphasizing their substantial importance in terms of impact.

Further examination of progress on implementation, particularly in analyzing companies' energy consumption from various sources, unveiled that overall consumption had increased by approximately 26% between 2018 and 2022, depicting the sector's growth in these years. This increase, even if half of the companies in the sample achieved reductions in energy consumption, is largely attributed to the two largest consumers, Air Liquide and Linde, who both increased their energy consumption in the studied five-year period. Furthermore, the consumption of renewable sources had only seen a marginal increase of 4%, rising from 10% to 14%. While some companies demonstrated commendable efforts in transitioning to more renewable energy, departing from fossil fuels, others, specifically, three firms, did not exhibit the same effort, even decreasing the proportion of renewables consumed during the studied timeframe.

Notably, when scrutinizing substantive progress, we found that a considerable majority of companies in the sample, precisely two-thirds, achieved a reduction in their emissions. However, when comparing the emission levels in 2022 to the companies' respective targets, discouraging findings emerged, indicating that the proportion of companies on track with their targets is gradually decreasing, with only one-third of businesses still on track. Comparing the GHG emission levels with the combined ambition of companies unveiled that the actual combined scope 1+2 emissions had surpassed the targeted level in 2022. However, this trend was primarily attributed to one company, Air Liquide, the largest emitter in the sample, which increased its emissions by 41% between 2018 and 2022, emphasizing the significance of major emitters in corporate climate action. As revealed in our analysis, the notable increase in emissions can be primarily attributed to Air Liquide's initiation of new activities, specifically the production of hydrogen, a process emitting substantial GHG emissions.

In the final phase of this research, we aimed to evaluate the relationship between NSA and state-level climate action, examining their reciprocal effects. To gain insight into state-level climate action, we first explored climate targets and policies in the Netherlands. While the Dutch government committed to a 55% reduction in GHG emissions by 2030 (compared to 1990 levels) and carbon neutrality by mid-century, the industry faces more ambitious targets, particularly a 59% reduction by 2030. Besides existing environmental and energy-related regulations for the industrial - which includes the chemical - sector, various strategies and roadmaps have been established to support these sectors in their decarbonization endeavors. While the Netherlands has implemented a wide array of strong climate policies such as carbon pricing, voluntary agreements, and deployment subsidies, favoring and supporting sustainable and low-carbon practices, the chemical sector is falling behind on its climate goals. To attain the nation's ambitious climate objectives, increased voluntary climate action by NSAs occurring more swiftly is imperative.

Building upon these insights, we delved into the relationship between NSA and state-level climate action. Consistent with prior studies on the topic, correlations emerged, particularly between the level of climate policy in the Netherlands and the level of NSA participation in ICIs. The division of the sample into companies headquartered in the Netherlands and those elsewhere did not yield significant additional insights. While our analysis tested for correlation, it is essential to note that correlation does not imply causation. Moreover, we want to alert the reader to the possibility that the correlation we identified may be a consequence of variables growing over time rather than representing a genuine correlation. However, prior empirical research conducted on this topic on a cross-national level has demonstrated both a correlation and a causal relationship between these two groups of actors engaged in climate action. They mutually reinforce each other, acting as complements. This holds particularly true for countries with high civil liberties, such as the Netherlands. Our findings align with the results of this empirical study, identifying the most robust correlation between the ambition of national state-level policies and NSA participation in ICIs, suggesting that the correlations we observed are most likely not purely the result of analyzing variables over time. As a result, we want to underscore the bidirectional influence of both actors.

To synthesize the findings from our analyses, it can be affirmed that, while a direct relationship between a company's degree of involvement in various ICIs and its success in mitigating corporate emissions is not evident, other factors - such as economic or geopolitical considerations - significantly impact businesses' GHG emissions. Nonetheless, an increase in NSA participation in ICIs contributes to heightened societal awareness regarding corporate climate action. This, in turn, amplifies the influence of investors, consumers, or the general public, putting pressure on companies to adhere to their climate targets. Furthermore, the bidirectional relationship between NSA and national state-level climate actions indicates that increased ICI involvement stimulates more ambitious policies, and vice versa, mutually reinforcing their positive effects on collective global climate action.

Implications & policy recommendations

The comprehensive analyses conducted throughout this research have yielded valuable insights, leading to several implications. Firstly, we advocate for an elevated level of standardization in corporate emissions reporting, emphasizing the need for collaborative efforts among initiatives to implement uniform and transparent methods, as well as reporting standards. Additionally, we recommend standardizing the scope 2 accounting method to facilitate more meaningful cross-company comparisons. Moreover, we propose that the CDP undertakes validation tests for the responses companies submit in their CDP questionnaires. This step will help uncover data errors, enhancing the reliability of CDP data and instilling greater confidence in its accuracy and usability.

Additionally, to intensify the pressure on companies, we recommend that the SBTi not only publicly discloses companies' set targets but also their progress toward these targets. While target data is accessible in the SBTi, information on GHG levels requires extraction from annual sustainability reports, or other sources, involving making own calculations, which is time-consuming and necessitates a certain level of expertise in the topic. Enhancing accessibility for the broader public could be achieved by including progress reports alongside the targets themselves. Furthermore, we advocate for the implementation of separate scope 1 and 2 targets within the SBTi. This approach would facilitate more meaningful insights, in particular for the chemical sector. Specifically, observing the trajectory of scope 1 emissions would provide valuable insights into a chemical sector company's commitment to circularity, showcasing a shift from fossil to more sustainable renewable feedstocks.

In addition to broader implications, we also put forth several policy recommendations. Firstly, as our endeavor to estimate corporate country-level emissions by using a revenue proxy did not lead to satisfactory results, we propose that corporate emission reporting should extend beyond the global level to include additional reporting at the national level. This step would empower the public to discern companies genuinely committed to climate mitigation from those contributing to carbon leakage (when a company outsources its energy-intensive processes to countries with less stringent climate policies). Public awareness would facilitate informed choices by consumers and investors, increasing pressure on companies to mitigate their GHG emissions.

Secondly, recognizing the limited free access to CDP questionnaires, we call for greater accessibility for individuals. We recommend collaborations between governments and organizations like the CDP to ensure universal access. We propose maintaining existing fee structures for investors, academic institutions, and financially capable entities while enabling free access for individuals through daily quotas. The associated costs could be covered by government funds.

Given the relative significance of large emitters highlighted in this study, we recommend a targeted focus on these companies. We therefore support the Netherlands' initiative to develop tailor-made agreements with the 20 largest emitters, and, in case this initiative proves effective in the future, propose extending this approach to other nations. Furthermore, we suggest providing additional funding support for companies in their decarbonization efforts, proportionate to their sizes, ensuring fairness in distributing the funds.

As a final policy recommendation, considering the reinforcing and bidirectional influence between NSAs and state actors, we propose an increase in public-private collaboration - besides the aforementioned support schemes for large emitters - particularly with companies demonstrating success in climate mitigation. This collaboration would enable state agencies to learn from the best practices of these “climate champion companies” and formulate climate policies accordingly. Simultaneously, collaborating companies could garner positive publicity, capturing the attention of climate-conscious consumers and investors, thereby fostering growth and market share.

This collaborative effort could, in turn, serve as a motivator for those businesses less successful in mitigating their GHG emissions to raise their climate action ambitions and proactively implement them.

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1. Introduction

The global challenge of climate change presents an urgent problem requiring collective action from all around the world. Despite the critical need for swift and substantial climate action to mitigate GHG emissions, the world is falling short of the targets set by the 2015 Paris Agreement. Instead of dropping, global emissions have further increased in the past years, from 47 *Gt* of carbon dioxide equivalents (CO_2eq) in 2015 (US EPA, 2023) to about 54 $Gt\ CO_2eq$ in 2022 (Crippa et al., 2023). While this trend continues, countries are moving further away from their climate goals, contributing to a growing emissions gap.

The Netherlands in particular faces a heightened interest in climate mitigation due to its vulnerability to severe flood risks resulting from a significant portion of its landmass, namely 60%, located below sea level. Consequently, the country establishes ambitious climate targets and policies to avoid catastrophic climate change. However, given the strong Dutch economy, a substantial portion of the country's emissions arise from industrial production, with the chemical sector playing a crucial role. This sector, contributing approximately 40% of the country's industrial emissions (CE Delft, 2019), holds economic importance, representing about 6% of the national GDP (Hoffmann, 2023).

On a global scale, the chemical sector is a major contributor to energy consumption and GHG emissions. According to the International Energy Agency, the IEA (2022), the chemical sector, being the largest global industrial energy consumer while also being the industry subsector with the third-highest direct CO_2 emissions due to using fossil fuels as feedstock, is not on track on its climate goals. To effectively mitigate its climate emissions, the sector needs do decrease its CO_2 emissions by -18% between 2022 and 2030.

Recognizing the failure of countries to achieve their climate goals, there is an increasing acknowledgment of the role of NSAs, such as companies, cities, and regions. In recent years, numerous ICIs have emerged to support NSAs in transitioning to a carbon-neutral world. But what is their potential for mitigating emissions in the Dutch chemical sector? And what bi-directional relationship exists between NSAs participating in ICIs and the establishment of national targets and polices in the Netherlands? This research aims to answer these questions, providing a clear picture about the status quo of climate change mitigation as a result of ICI participation in the Dutch chemical sector, and the effects this has on national climate targets and policies.

To provide a foundation for understanding this research focus, this chapter addresses the observed knowledge gap that motivated the study, outlines the research strategy, discusses the societal relevance of the topic, and identifies the link to Industrial Ecology. Therefore, this chapter unfolds as follows: section 1.1 delves into the identified knowledge gap that sparked our interest and motivated our exploration of the topic. Section 1.2 discusses the societal relevance and the connection to the field of Industrial Ecology, while sections 1.3 and 1.4 present the main research questions along with their underlying sub-questions and the research strategy, respectively. Finally, section 1.5 offers the reader a comprehensive reading guide.

1.1 Knowledge gap

Due to the complexity and the iterative nature of the topic of NSA climate action, as well as the lack of transparency in the data, authors in the academic literature have called for further research into this field, such as Bjørn et al. (2022), pointing out a need for "systematic assessments of the effectiveness of initiatives". Moreover, particularly the voluntary nature of ICIs poses challenges in evaluating their impact on corporate climate change mitigation (Widerberg & Pattberg, 2015). At the same time, both mandatory as well as voluntary reporting schemes for companies lack consistencies (Busch et al., 2020), adding onto the difficulties conducting such assessments. While both companies as well as ICIs publish reports describing ambitions and potential impacts, too little information is provided to put this data into context and make meaningful comparisons and evaluations. These informational barriers are hindering the advancement of academic research on the progression within ICIs (Hale et al., 2020), which - in a topic this important - delays the opportunity to generate valuable insights.

Moreover, there is an observable gap in the scientific literature regarding the relationship between NSAs participating ICIs and national climate targets and policies. On top of that, evaluations of whether company targets are behind or beyond the levels of pre-existing national commitments and whether initiatives on a voluntary basis displace or discourage direct government climate action are lacking (Giesekam et al., 2021). While prior research has explored this topic on a cross-national level (Andonova et al., 2017), and examined how and to which extent national governments include the contributions of NSAs into their global climate commitments (Hsu et al., 2019), country-level research is scarce. In particular, no research specifically focused on this topic in a Dutch national and chemical sector context has - to our knowledge - been conducted yet.

To summarize, a noticeable gap exists in academic literature regarding the advancement of NSAs within ICIs encompassing their ambition levels, effectiveness in GHG emission mitigation, and the strategies employed by companies to attain their objectives. Additionally, we lack knowledge about how participation in different ICIs affects national state-level climate action and how this, in turn, affects participation in ICIs, in the context of the Dutch chemical sector.

1.2 Societal relevance

Climate change poses a global wicked problem impacting not only future generations but also present marginalized communities currently facing the immediate consequences of shifting climate patterns leading to natural catastrophes. These communities lack the resources to protect themselves and adapt to these changes which, considering that climate change stems from the flourishing economies of affluent, industrialized nations, is inherently unfair. Mitigating the worst effects of climate change concerns all of us, but major corporations, contributing a significant portion to global GHG emissions, hold a distinctive role in this collective effort.

Therefore, companies adopting targets that are aligned with mitigation pathways outlined in the ambitious Paris Agreement can help to not only lower overall emissions of the corporate world but also be a main driver for climate policy (Walenta, 2019). ICIs aspire to assist companies in this undertaking, striving to accelerate the global pace of climate action to secure a sustainable and livable future for each and everyone on this planet.

This research could therefore have a significant impact on ICIs as well as corporate entities in their endeavor to mitigate their corporate emissions as it aims to better understand the potential effects that participating in ICIs can yield - in both a company level-context as well as in its effects on national climate targets ad policies in the Netherlands. Our findings could provide guidance for ICIs to help push national climate target-setting further and, as a result, contribute to the advancement of Dutch climate targets and policies. By illuminating the current regime and its potential to further positive climate action, our research could help shape a more sustainable future.

Furthermore, considering the existing gap in the literature, our investigation into the role ICIs play in shaping both corporate climate mitigation as well as national targets and policies, is a valuable contribution to both academic and societal work.

1.2.1 Link to Industrial Ecology

Given that Industrial Ecology focuses on a systemic approach to global sustainability challenges, this research aligns seamlessly with the principles of this field. The reasons for this are manifold: Firstly, as ICIs are concerned with global climate mitigation, it draws upon the scientific knowledge relevant to climate change and Industrial Ecology research. Moreover, the increasing participation of NSAs in climate action and transnational climate governance can drive climate targets, policies, as well as a societal shift as more people get to know of ICIs and what companies do to mitigate their GHG emissions. As a result of this increased knowledge, investors, consumers, as well as society as a whole can put pressure on companies to have their climate targets aligned with pathways laid out in the Paris Agreement for avoiding the worst effects of climate change. This, in turn, could result in increased ambitions in national climate targets and improved climate policies.

The interplay of the economy, society, and political landscapes underscores the systemic nature of this topic. Dynamics within these distinct areas can and will causally impact one another. The interconnectedness of actors as well as the interdisciplinarity of this topic therefore aligns with the fundamental principles of the field of Industrial Ecology, seeking to observe sustainability problems from a multidisciplinary system dynamics perspective.

1.3 Research questions

This research holds two primary objectives. Firstly, it aims to evaluate the climate mitigation progress of Dutch chemical sector companies participating in ICIs. Secondly, it seeks to assess the relationship between NSA climate action and the climate action of the government of the Netherlands, represented by its level of ambition regarding climate targets and policies. Therefore, the main research question of this study is as follows:

"What effect do International Cooperative Initiatives have on the climate achievements of the chemical sector in the Netherlands and how does that influence national targets and policies?"

The question specifically focuses on understanding how participating in ICIs affects the climate-related goals and actions of chemical companies operating in the Netherlands. Moreover, researching the role it plays for both general and chemical sector-specific Dutch national climate targets and policies is a valuable contribution to understanding the leverage of the chemical sector's action on the Dutch government's climate action agenda.

The rationale behind directing attention towards the chemical sector stems from its profound significance in bolstering the Dutch economy, alongside its immense potential for substantial GHG emission reduction, thus presenting a viable avenue for climate mitigation in the Netherlands. In the pursuit of evaluating and addressing the main research question, it has been divided into the following sub-questions:

SQ1: "What type of climate action programs can the chemical sector engage in, in the Netherlands?"

The objective of this sub-question is to explore the wide range of potential climate actions carried out by chemical companies operating in the Netherlands. We will delve into the topic of climate change in a Dutch context, discussing national GHG emissions from different industries and providing rationale for focusing on the chemical sector. Moreover, we will shed light on the chemical industry in the Netherlands, including relevant subsectors and chemical industry clusters. We will then introduce several ICIs that are pertinent to the Netherlands, narrowing down our selection to those specifically relevant to this research based on criteria such as high levels of participation and a focus on either climate mitigation or engagement in climate policy. While this sub-question aims to provide the reader with an overview of relevant ICIs, the final selection of ICIs under study will be made in Chapter 4.

SQ2: "What are the climate achievements of chemical industry companies that have joined International Cooperative Initiatives?"

After having made our selection of the ICIs relevant to this research, we will delve into examining the extent of the selected firms' climate action involvement in said initiatives. Besides looking into the evolution of NSA participation in ICIs on a general level for the entire company sample, we will subdivide the sample to evaluate participation rates on a Dutch national, EU, and global level, comparing where most participation occurs relative to the sample size. On top of that, this sub-question seeks to analyze how GHG emissions of the company sample have evolved over time and if there is an observable relationship between successful corporate climate mitigation and the number of ICIs joined per company. Lastly, this sub-question will analyze these emission trends on a company-level, with a focus on the five largest emitters. By delving into these aspects, a more comprehensive understanding of the landscape of ICI participation and GHG emissions of chemical sector companies in the Netherlands will be obtained.

SQ3: "What climate mitigation progress has been achieved so far by companies in the chemical sector that participate in the Science-Based Targets initiative?"

For diving deeper into the topic of NSA climate action and ICI participation, we will apply the framework by Hale et al. (2020) assessing the progress, implementation, and impact of NSA climate action to the companies in our sample having joined the SBTi. By evaluating the progress on ambition, robustness, implementation, and substantive - as well as causal - impact, this sub-question therefore seeks to obtain a better understanding of the advancement of our company sample within each type of progress. By evaluating each type of progress separately, we are able to understand where progress is being made and where it is still lacking.

SQ4: "What are the current Dutch national climate targets and which climate policies are relevant for the chemical industry in the Netherlands?"

Upon acquiring a profound comprehension of the Dutch chemical sector, the pertinent ICIs - with a specific focus on the SBTi - and the impacts on the climate actions of private sector chemical enterprises resulting from participation in these initiatives, our focus will shift towards delving into the national climate change agenda of the Netherlands. To achieve this, an extensive exploration will be conducted on the evolution of climate targets and the implementation of climate policies introduced over the past years. To encompass both the sector-specific and national dimensions, this analysis will be conducted at both levels. Moreover, regulations for the chemicals sector are discussed to provide a better picture of what the Dutch government is doing to limit the negative environmental and climate impacts of large industrial companies. Lastly, addressing this sub-question will involve assessing the mitigation progress achieved by the industrial and chemical sector in the Netherlands to date. Additionally, it will entail comparing the level of ambition of national climate policies with those of other nations, providing context to illustrate the current position of the Netherlands in its efforts toward national climate action.

SQ5: "How does the participation of chemical sector companies in International Cooperative Initiatives affect national targets and policies in the Netherlands, and vice versa?"

In order to address the last part of analysis central to this research, hence the effect of NSA climate action on the climate targets and policies established by the Dutch government, and vice versa, this final sub-question delves into this topic by basing its analysis on research by Andonova et al. (2017), which explored the question of whether NSA climate action and national policy are substitutes or complements.

1.4 Research strategy

As mentioned previously in section 1.3, this research holds two primary objectives: evaluating the climate mitigation progress of chemical sector companies participating in ICIs and assessing the relationship between NSA and state-level climate action. To achieve these objectives and answer the aforementioned research question (and sub-questions), quantitative methods will be employed, leveraging data from various sources.

The research objectives encompass a series of crucial steps aimed at deepening our insights into the chemical sector's global economic significance and the challenges inherent to addressing its emissions. Additionally, the research seeks to delve into the theoretical foundations of transnational climate governance and scrutinize how companies actively participate in climate action.

Another pivotal aspect involves gaining insights into corporate emission quantification, control, and management methods and mechanisms. This encompasses an exploration of various methods employed by different ICIs, with a specific emphasis on the SBTi and its methodology. Moreover, it involves an evaluation of the relationship between a company's participation in ICIs and its GHG emissions.

Furthermore, this research aims to assess companies engaged in the SBTi by scrutinizing their level of ambition, the substantive progress they have achieved, and a critical evaluation of the strategies implemented (in the context of energy consumption) to meet their targets. This evaluation also extends to the robustness of practices, providing a comprehensive picture of the effectiveness of the companies' efforts.

In the final phase, the research shifts focus to the political landscape in the Netherlands within the context of climate change. This involves exploring national climate targets and policies, with a specific emphasis on those relevant to the chemical sector. Additionally, the study investigates the bi-directional relationship between NSA and national state-level climate action, especially within the Netherlands.

This study will center its attention on a sample of 50 chemical and petrochemical companies of the subsectors petroleum processing as well as chemicals, rubber plastics, and pharmaceuticals, engaged in (petro-)chemical manufacturing activities in the Netherlands. The primary focus is on assessing climate action progress within the SBTi framework. The time frame under study spans five years, from 2018-2022, allowing us to incorporate the most recent development in the data. Further details regarding the specific choices made for conducting this research will be comprehensively discussed in Chapter 4.

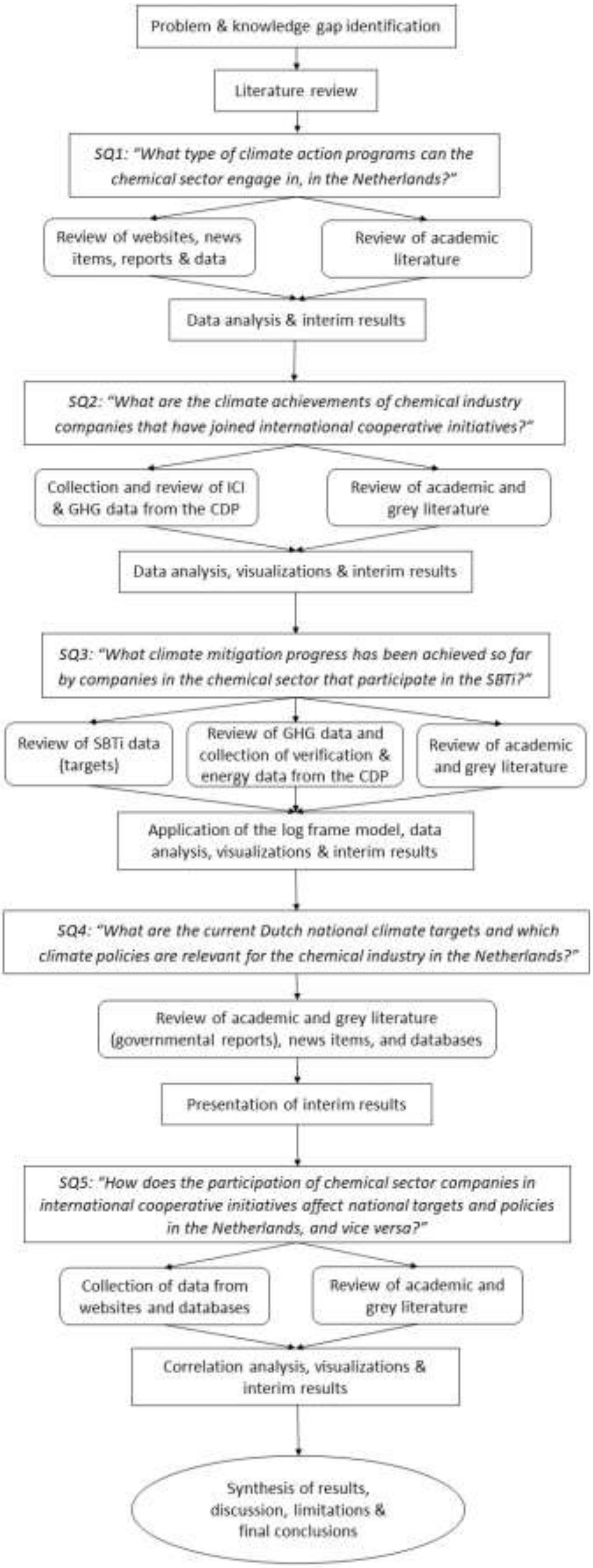


Figure 1.1: Research flow diagram.

1.5 Reading guide

This thesis is structured as follows:

Chapter 2 presents the literature review, offering insights into the emergence of NSAs, examining company-level climate action, and tracing the historical evolution of transnational climate governance, including orchestration. On top of that, this chapter also discusses the role of the private sector in advancing national climate action.

Chapter 3 on the other hand is providing an overview of the chemical industry in the Netherlands, covering its significance to the Dutch economy and national GHG emissions, the various sub-sectors it comprises, and the relevant chemical clusters in the country. Furthermore, this chapter investigates the ICIs relevant to the Dutch chemical sector and conducts an initial analysis of initiatives deemed suitable for this research.

Chapter 4 elaborates on the methodology inherent to this research. This encompasses the selection of the company sample under study and the ICIs under analysis. The general methodology that is common industry practice nowadays for quantifying company-level GHG emissions, is outlined. This chapter also delves into the methodology inherent to the SBTi. Furthermore, it discusses the two studies employed for firstly measuring the companies' progress within the SBTi and secondly, to evaluate the relationship between NSA and national state-level climate action. The chapter concludes with a comprehensive explanation of the data collection process for each analysis.

Moving to Chapter 5, which presents the results of the first analysis of this research, examining levels of ICI participation per company as well as those of corporate GHG emissions. Furthermore, an analysis of a potential relationship between these two variables is conducted. This chapter also dives deeper into the development of company-level emissions over a period of five years, with a specific focus on the five largest emitters in the company sample.

In Chapter 6, the assessment of companies' mitigation progress within the SBTi takes center stage. This involves a detailed analysis of four types of progress, namely, ambition, robustness, implementation, and, lastly, substantive impact. The chapter concludes with an ex-post analysis of these four progress types, exploring the causal impact of chemical sector companies participating in the SBTi.

Chapter 7 on the other hand presents Dutch national climate targets, policies, and regulations for the chemical sector. Moreover, it highlights the mitigation progress made by the Netherlands to date, while comparing the level of ambition of its national climate policies with that of other nations.

Chapter 8 is dedicated to evaluating the relationship between NSA and national state-level climate action. It discusses the crucial variables for conducting the correlation analysis, and presents results on two levels: Firstly, ICI participation of the overall company sample and, secondly, ICI participation of those companies headquartered in the Netherlands.

Chapter 9 offers a comprehensive discussion of this research, including a thorough elaboration on the difficulties associated with estimating country-level corporate emissions using a proxy. Moreover, the chapter showcases the contributions made to the academic literature, while discussing the limitations of both the methodology as well as the results.

Finally, Chapter 10 presents the overall conclusions by addressing and answering the main research question and each of the sub-questions, providing a synthesis of the results of the different analyses. Furthermore, it discusses implications, makes policy recommendations, as well as recommendations for future research.

2. Literature review

2.1 The emergence of NSA climate action

Climate action has become a more and more important topic worldwide. To limit global warming to below 1.5°C above preindustrial levels, climate governance efforts have become increasingly complex. Since climate change is a global problem, the involvement of intergovernmental organizations like the United Nations (UN) as well as actions from national governments and NSAs are needed. In the realm of climate change, the UN established the Intergovernmental Panel of Climate Change (IPCC) in 1988. Moreover, in 1992, it created a framework convention, the UNFCCC (United Nations Framework Convention on Climate Change), which went into force in 1994, and, since then, the UN has primarily operated through it and the subsequent regulations developed within the institutional structure established by this treaty. Furthermore, in the year 2005, the Kyoto Protocol came into force, putting in action the objectives of the UNFCC by requiring industrialized nations and transitioning economies to adhere to specific GHG emission reduction targets. The UNFCCC solely calls upon these countries to implement mitigation policies and measures and periodically report their progress. Important elements of the Kyoto Protocol include shifting from a focus on regulatory instruments to market-based solutions and implementing flexible market mechanisms such as international emissions trading. At present, the Kyoto Protocol boasts 192 signatory parties (UNFCCC, n.d.).

Even though an international body like the UN and a framework convention such as UFCCC are crucially important when addressing global challenges like climate change, it has been argued that "the proliferation of negotiation and cooperation venues alone will not help solve the climate challenge" (Bausch & Mehling, 2012). Moreover, various initiatives can individually hold significant relevance and ideally work in harmony with one another, but no single platform can offer a universal solution to the mitigation challenge.

Therefore, it is not surprising that during the 2014 Lima Climate Change Conference (COP20) as well as the UN Climate Summit (UNCS) in New York 2014, the role of NSAs started to receive increasing attention. In the time leading to the 2015 UN Climate Change Conference (COP21) in Paris, over 50 initiatives were launched during the UNCS with the aim of engaging NSAs, and the subsequent "Lima-Paris-Action-Agenda" mobilized a further 70 initiatives, involving more than 10,000 actors by the time of the COP21 (Chan et al., 2018). These efforts show that NSAs such as regions, cities, investors, companies, or organizations have an important role to play when it comes to both mitigating and adapting to climate change. While scholars argue that the UNFCCC should continue to play a central role in international climate mitigation (Moncel & Van Asselt, 2012), and countries should keep on pursuing their Nationally Determined Contributions (NDCs), which are their national climate action plans, NSAs have been declared to hold the capacity to "catalyze and significantly enhance" national endeavors to mitigate GHG emissions and enhance resilience to climate risks (Hsu et al., 2015).

To emphasize this importance and to represent a symbolic progression towards recognizing NSAs within the UNFCCC, the Lima Conference introduced the Non-state Actor Zone for Climate Action (NAZCA), a novel platform under the UNFCCC formally acknowledging climate mitigation and adaptation initiatives beyond national commitments.

2.2 Company-level climate action

Before analyzing climate action programs and initiatives in the Netherlands and diving deeper into the topic of climate governance, however, one needs to understand that at its very core, NSA climate action can be approached through two distinct methods: top-down and bottom-up. These approaches vary in terms of where decision-making authority resides within an organization or society. When considering these approaches in the context of companies, specifically the direction of influence and action between governments and firms, they can be understood as follows:

Top-down climate action, within the government-to-firm context, entails governments at various levels (local, regional, national, or international) establishing regulations and policies that directly impact companies. These regulations encompass emissions reduction targets, market-based mechanisms such as carbon pricing, and environmental standards, which firms are obligated to adhere to (Monast, 2017). Moreover, economic incentives play a pivotal role. Governments offer financial incentives to encourage sustainable practices among firms, such as tax credits, renewable energy project subsidies, and grants for environmentally friendly initiatives. Governments can also fund research and development efforts in clean technologies and sustainable practices, thereby providing companies with opportunities to adopt innovative solutions.

Another mechanism involves mandatory environmental reporting by firms. Governments may require companies to disclose their environmental performance, carbon emissions, and sustainability efforts. This reporting helps assess compliance and monitor progress towards climate goals. However, for corporate environmental reporting to be an effective communication tool, regulating authorities need to enforce mandatory reporting while providing guidance for companies (Bubna-Litic, 2007). Furthermore, governments can establish carbon markets and cap-and-trade systems that place restrictions on carbon emissions, compelling companies to purchase emissions allowances and create economic incentives for emission reductions.

In the chemical sector of the Netherlands, top-down climate action is robust, with the Dutch government implementing climate targets for the industrial sector that are even more ambitious than the country's overall national targets. Simultaneously, regulations, policies and economic incentives favor sustainable practices to encourage firms to invest in climate mitigation and sustainable practices. Specific targets, regulations, and policies for the Dutch chemical sector are detailed in Chapter 7.

On the other hand, in a bottom-up approach, firms voluntarily take actions to reduce their carbon footprint, including setting emissions reduction targets, implementing sustainable supply chain practices, and investing in renewable energy. Companies may also engage in advocacy efforts to influence government policies. This can involve lobbying for pro-environmental regulations, supporting renewable energy incentives, and advocating for climate-friendly policies at different governmental levels. Moreover, companies signal their commitment to climate action through environmental reporting and transparency (Arena et al., 2014). Some companies voluntarily disclose environmental data, carbon emissions, and sustainability efforts to the public, fostering awareness and showcasing their commitment to corporate climate mitigation to investors and customers. Furthermore, due to this observed increase in willingness of companies to take voluntary climate action, recent years have shown the emergence of ICIs. These initiatives aid NSAs in their climate action endeavors, such as helping companies to set emission reduction targets that are aligned with the science behind the Paris Agreement's 1.5°C goal. Sabel and Victor (2015) describe how climate policy approaches rooted in bottom-up methods can be effective but necessitate institutions – such as the UNFCCC - that encourage collaborative exploration and the expansion of solutions amid uncertainties.

Another facet of bottom-up climate action is regional collaborations or cooperation within industries, for example among large emitters (Rayner, 2010), as firms within the same sector may work together to establish industry-specific sustainability standards and best practices, influencing government policies collectively. Furthermore, sustainable procurement, particularly relevant to a company's supply chain emissions (scope 3), is gaining prominence in recent years (Walker et al., 2012). Firms can stimulate demand for sustainable products and services by favoring suppliers and partners that adhere to environmental standards, potentially influencing government regulations concerning green procurement.

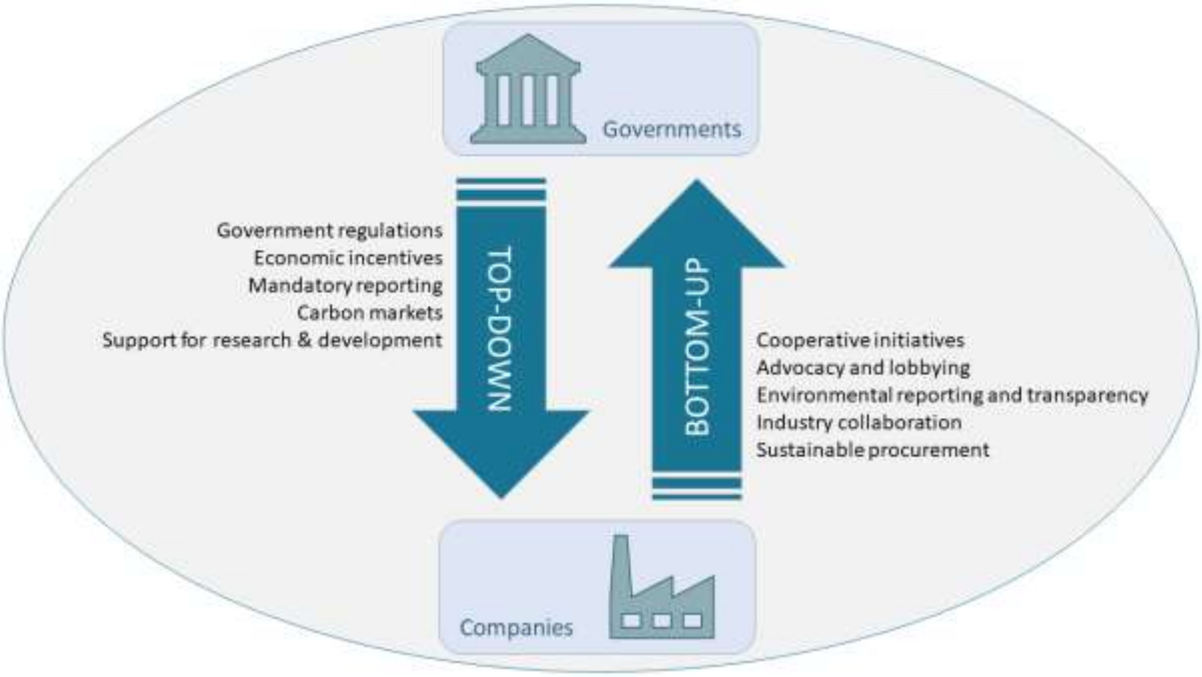


Figure 2.1: Top-down vs. bottom-up climate actions in a government-firm context.

2.3 Transnational climate governance

With the proliferation of bottom-up approaches, the landscape of climate change governance has witnessed a notable transformation toward a more transnational orientation. Presently, climate change governance transcends the confines of national borders, with an increasing engagement of NSAs voluntarily participating in climate action to complement national strategies. One such bottom-up approach with the aim of mobilizing initiatives and NSAs in the context of the UNFCCC for climate change mitigation and adaptation is the Global Climate Action Agenda. The benefits of these bottom-up approaches within the climate regime, leading to a shift towards a more transnational form of climate governance, have previously been described by Stewart et al. (2013), who assert that such strategies not only yield short-term emission reductions but also establish connections between bottom-up initiatives and the UNFCCC system through GHG monitoring and reporting systems.

The commitments of NSAs towards climate mitigation have also been explored by scholars. In research by Wouters (2013) that aimed at testing the emission reduction potential of ten of the 21 initiatives of the “Wedging the gap” approach described below by Blok et al. (2012), a significant portion of the 25 randomly chosen member companies within the “Top 1000 companies” category have voluntarily embraced targets for reducing emissions. This demonstrates that companies' voluntary commitment to climate action has been in existence for more than a decade already, and over this time, it has continued to grow in significance.

Not only in climate change mitigation but also in adaptation, a shift is evident towards a more transnational approach that involves the active participation of NSAs. While adaptation concerns were initially seen as a national and local matter, nowadays, international organizations such as the UNFCCC play a significant role in transnational adaptation governance. We are witnessing the emergence of a "fourth era" of adaptation that operates on an increasingly global and transnational scale, with NSAs playing an integral role in this transformative process (Dzebo & Stripple, 2015).

In practice, both top-down and bottom-up approaches can complement each other, resulting in an effective interpretation of nation’s climate mitigation obligations (Mayer, 2019). Government policies establish a regulatory framework and incentives for companies to take action, while firms actively participate in shaping those policies through voluntary efforts, advocacy, and industry leadership. Consequently, this can circumvent political obstacles and a lack of leadership within national governments, thus driving progress in mitigation efforts and fostering networks of trust. In turn, this can contribute to reshaping political and economic conditions through collaboration between governments and NSAs, making an effective international climate treaty more achievable (Stewart et al., 2013).

This linkage between top-down and bottom-up approaches has also been described by Blok et al. (2012), who recognized that, in order to limit global warming to 2°C above pre-industrial levels, a top-down strategy alone was ineffective. Instead, he proposed a bottom-up or hybrid approach to be preferred in order to “wedge the emissions gap” and, as a result, presented 21 coherent major initiatives with substantial GHG emission reduction potential.

While the distinction between top-down and bottom-up approaches is crucial within the realm of global climate governance, a more nuanced spectrum of solutions to collective action challenges should be embraced through orchestration. Orchestration is a strategy wherein international organizations (such as the UNFCCC) and states enlist intermediaries, for instance NSAs or ICIs, to guide targets in the pursuit of essential collective objectives (Bäckstrand & Kuyper, 2017).

The reason for the need to orchestrate is that, as a result of the explosion of transnational institutions and initiatives, an increasingly complex, decentralized, and polycentric transnational regime complex for climate change has developed (Abbott, 2012). Complex due to the sheer number of members participating. Decentralized, because the majority of organizations have been established by specific groups of actors from the ground up and pursue their distinct objectives with minimal or no central coordination. And polycentric because tasks like implementing regulations and financing public resources are divided among numerous organizations with varying memberships and operating scopes. Therefore, in this complex, decentralized, and polycentric transnational regime, international organizations like the UNFCCC should assume the role of an orchestrator.

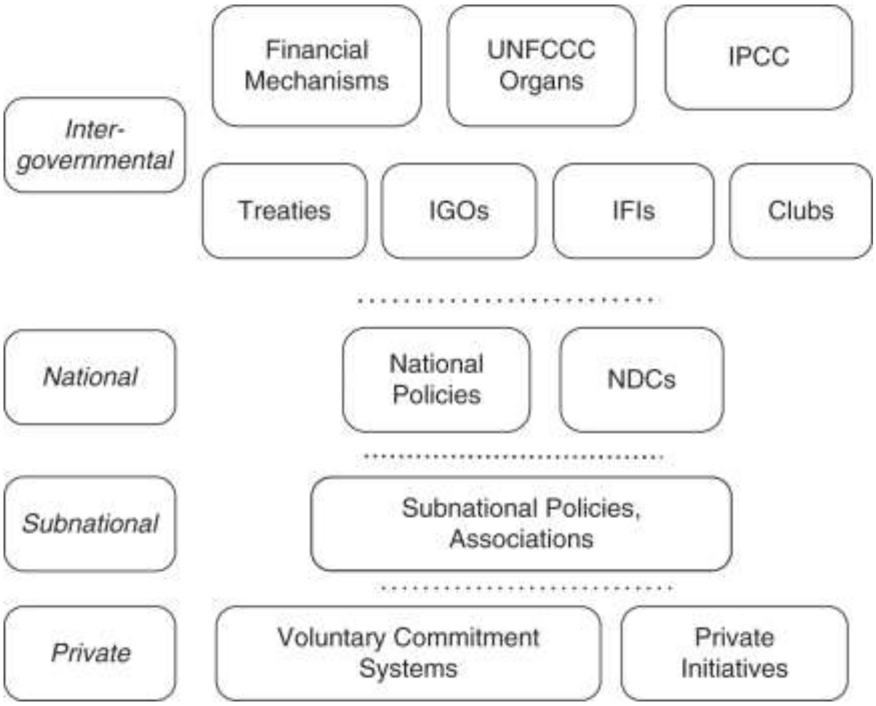


Figure 2.2: The polycentric governance complex for climate change (Abbott, 2018).

Orchestration, involving an alignment between the orchestrator entities and the intermediaries has the potential to leverage additional contributions by establishing catalytic connections and facilitating the proliferation of actions. While most orchestration initiatives have historically centered on international climate negotiations, with the UNFCCC, as a result of the Paris Agreement, being consolidated as the primary coordinator of NSAs and ICIs (Bäckstrand & Kuyper, 2017), Chan et al. (2018) argue for extending orchestration efforts to regional and national levels. This can result in valuable effects in supporting the fulfillment of national commitments and igniting greater ambition. Moreover, the function of an orchestrator should involve facilitating the exchange of information, establishment of standards, and oversight of transnational endeavors, with a concentration on fostering these practices (Hale & Roger, 2013).

In the context of a complex landscape with multiple orchestrators, enhancing catalytic linkages can sometimes be achieved through better coordination. Although a natural inclination might be to prioritize scaling up actions due to the immense transformation required, it is essential for orchestrators to resist an exclusive focus on scale, but they should also promote experimental and small-scale initiatives (Chan et al., 2018). This need for experimentation has already been expressed by Abbott (2017). He argues that collaborative initiatives and other governance bodies concerned with voluntary climate commitments should act as orchestrators promoting well-planned, controlled policy experiments that adhere to scientific norms. Moreover, in case such formal policy experiments are not possible, voluntary commitments should be regarded as informal experiments, coordinating them to stimulate innovation, comparability, analysis, and systematic learning.

2.4 The role of the private sector in advancing national climate action

There are various ways in which the private sector's climate action can impact national climate targets and policies such as setting emissions reduction targets, investing in clean technologies, engaging in advocacy and supply chain management as well as joining programs and initiatives. Moreover, due to its independence from the government, the private sector has a certain level of freedom when engaging in these endeavors, allowing for experimentation to identify best practices when it comes to GHG emission reduction. The UNEP (2018) described the number of NSA participants in mitigation efforts to be rapidly increasing and states that these actors have a significant potential for emission reduction. ICIs in particular can help bridge the emissions gap, yet their current contribution is limited compared to countries' pledges.

As mentioned above, the private sector can play a critical role in shaping climate policy and advancing toward more ambitious climate targets through its actions and advocacy. According to Vandenbergh and Gilligan (2017), the combination of voluntary initiatives driven by corporations, NGOs, and individuals, along with well-designed private initiatives and innovative technologies, presents a promising approach to addressing climate challenges, even in the absence of the government's coercive resources and power. Unlike public governance, which tends to be rigid, bureaucratic, and slow in implementation, often relying on command-and-control regulations that restrict business and consumer activities, private governance offers greater economic and political feasibility. It fosters environmental innovation, enables fast and flexible decision-making, and can effectively leverage the international trade system to exert pressure for climate mitigation across borders, where national governments may have limited regulatory reach over economic actors.

Moreover, NSA climate action, in particular, NSA participation in ICIs, acts as a complement to national targets and policies introduced by national governments (Widerberg & Pattberg, 2015), while a bidirectional influence exists between NSAs and state-level actors. As showed by Andonova et al. (2017), while ambitious national targets and policies Introduced by governments increase the level of NSA participation in ICIs, at the same time, this increased NSA climate actions by NSAs leads to further ambitiousness of national targets and policies, highlighting the complementary nature of NSA and state-level climate action. This interdependence has also been described by the UNEP (2018), stating that NSA climate action goes beyond emissions reduction, fostering confidence in climate policy, advocating for ambitious goals, and sharing knowledge. Effective non-state climate actions require common principles, clear targets, monitoring, and government support.

Therefore, the private sector has a particularly unique role in pushing towards more ambitious climate targets and policies.

3. The chemical industry and climate action in the Netherlands

This chapter will revolve around the exploration of how the Dutch chemical sector, in particular, can take climate action and which are the available ICIs for collaboration. This endeavor is geared towards addressing the following research question:

SQ1: "What type of climate action programs can the chemical sector engage in, in the Netherlands?"

By addressing this question, the chapter seeks to clarify the topic of Dutch private sector climate action and provide rationale for the specific selection of ICIs under study, which will be conducted in Chapter 4. This chapter is structured as follows:

Section 3.1 aims to provide background information on the topic of climate change in a Dutch context, while diving deeper into levels of national GHG emissions. Section 3.2 delves into the intricacies of the chemical industry in the Netherlands, examining its significance to the Dutch economy, delineating its subsectors both broadly and within the confines of this study, and exploring the various industry clusters within the country. Having acquired insights into the chemical industry, the focus shifts to climate action that chemical companies in the Netherlands can undertake. Section 3.3 investigates the extent of ICI participation in the Netherlands, outlining the status quo and the ICIs that Dutch companies have joined. Building on these ICIs, section 3.4 selects a subset for detailed discussion, assessing their relevance for the Dutch chemical sector and this research. Ultimately, section 3.5 concludes the chapter by summarizing crucial points.

3.1 The Netherlands in the face of climate change

The impacts of climate change are starting to become a reality for many people all around the globe. With the increasing intensity and frequency of natural catastrophes and the heightened social awareness of the issue, it is no wonder that both the public as well as the private sector are starting to take climate action. GHG emission reductions are needed - and they are needed now.

Some countries in particular are highly threatened by the effects of global warming and the resulting sea level rise stemming from melting polar ice caps and glaciers. One such country is the Netherlands as its areas situated below sea level constitute 60% of the country's territory, and these flood-prone regions generate 70% of the gross national product (Kabat et al., 2005). Therefore, avoiding catastrophic climate change is immensely relevant to Dutch society and economy, and GHG emission reductions are the focus of both the public as well as the private sector.

In the public sector, the intention to reduce GHG emissions can be felt for instance by introducing more climate policies, raising taxes, and imposing new regulations. In the private sector, on the other hand, businesses have a unique role to play in responding to climate change as they are responsible for a significant portion of global emissions and are well-positioned to drive innovation and develop solutions that can help reduce emissions and mitigate the impacts of climate change. Often, companies take on a proactive role in this by innovating, setting internal emission targets, and reducing company GHG emissions.

In order to speed up this process and support businesses in their environmental target setting, many ICIs aimed at helping businesses in their endeavor of reducing their GHG emissions have been established. For companies, joining such initiatives and committing to their sustainability targets can not only provide a good brand reputation for both consumers and investors but also anticipate future, more stringent climate policy, putting them in a competitive advantage. Moreover, many firms also conceive and acknowledge the risks that they face from climate change in the future and hence join climate action initiatives. As mentioned above, due to sea level rise-induced flooding risks, Dutch businesses, in particular, have a major motivation to push toward a low-carbon economy. To signal this, participation in ICIs is becoming more and more common.

3.1.1 GHG emissions in the Dutch private sector

As previously mentioned, the private sector plays a unique role in advancing national climate action. Therefore, for the purpose of this research, we assume that voluntary corporate climate action in the private sector drives more ambitious climate targets and policies introduced by the Dutch government. For this reason, we will examine the impact of corporate climate action happening exclusively in the private sector on national targets and policies introduced by the government.

The Netherlands, home to the sixth largest economy in the European Union, serves a critical role as a transportation hub for Europe, with a consistent trade surplus, secure industrial relations, and low unemployment rates. The country's industry is primarily centered around food processing, chemical production, petroleum refining, and the manufacturing of electrical machinery (Forbes, 2018).

According to the National Inventory Report 2022 submitted by the Netherlands to the UNFCCC, the energy sector is responsible for the highest GHG emissions in the Netherlands. Specifically, in 2020, the energy sector accounted for 80.3% of the country's total GHG emissions, followed by the industrial processes and product use sector at 5.5%, agriculture at 10.5%, waste at 1.6%, and the land-use, land-use change, and forestry sector at 2.1% (RIVM, 2022).

However, the Dutch energy sector is not a purely private sector. Specifically, it is a mix of public and private entities, with a liberalized market allowing private companies to generate, trade, and supply energy. Nevertheless, the government plays a crucial role through relatively intense regulation, including measures like structural requirements, contractual limitations, information disclosure rules, price oversight, and market monitoring (Mulder & Willems, 2019). Additionally, the government invests in renewable energy and owns companies such as *Energie Beheer Nederland (EBN),* a public company that manages the Dutch state's interests in oil and gas exploration and production. The transmission and distribution of energy are regulated by the independent government agency, Authority for Consumers and Markets *(Autoriteit Consument & Markt, ACM),* to ensure fair pricing. Overall, the government's influence on the energy sector in the Netherlands remains significant, despite it being largely composed of private companies.

Therefore, as the aim of this research is to find out about the private sector's influence on national climate targets and policies, we will not focus our attention on the energy sector in the Netherlands even if it contributes to the largest share of the country's' GHG emissions. Rather, we will look at purely private sectors. More specifically, energy-intensive industries as these make up for a large portion of the Netherlands' energy consumption and hence have a large potential to set ambitious emissions targets and achieve significant reductions.

According to the Climate and Energy Outlook 2022 *(Klimaat- en Energieverkenning, KEV)* report published by the Netherlands Environmental Assessment Agency *(Planbureau voor de Leefomgeving, PBL),* the industrial sector is the most energy-intensive sector in the Netherlands. As defined in the report, the industrial sector includes the food and beverage industry, the basic metal industry, the chemical industry, the paper and cardboard industry, the building materials industry, other industries, construction, refineries, coking plants, extraction, transportation and distribution of energy, waste management (including waste incinerators and landfills), and water utilities (PBL, 2022). In 2021, the Dutch industrial sector was responsible for approximately one-third of the country's total final energy consumption (CBS, 2022).

The energy-intensive industries in the Netherlands are primarily located in the Rotterdam harbor area, which is one of the largest petrochemical hubs in the world. Within the industrial sector, the most energy-intensive subsectors are the chemical industry, refineries, and steel production. Moreover, industrial GHG emissions are dominated by a limited number of companies: the 20 companies with the largest emissions contribute to more than 80 percent of the total emissions (PBL, 2022).

When examining the CO_2 emissions from the industrial sector, it becomes apparent that over 40% of these emissions stem from the chemical industry, which produces goods through chemical reactions involving raw materials. Examples of such products include plastics and fertilizers. Alongside the chemical industry, the petroleum industry, including the petrochemical sector, is also a notable contributor, accounting for over 20% of the CO_2 emissions generated by the Dutch industrial sector (CE Delft, 2019).

Based on this knowledge, we decided to focus our research on private-sector chemical companies in the Netherlands.

3.2 The Dutch chemical industry

The chemical sector is a vital one for global production due to its interconnectedness with other industries such as our energy system, including fossil fuels and renewables, transportation, pharmaceuticals, buildings, mining, agriculture, and manufacturing. According to the American Chemistry Council (2019), products from the chemical industry can be found in about 96% of all manufactured goods.

Also in the Netherlands, the chemical sector holds significant economic importance, with a turnover of €71 billion as of 2019 (CEFIC, 2023b), providing 13% added value to the industry while producing about 18% of the total Dutch export of goods (VNCI, n.d.). As a result, the country ranks as the fourth-largest chemical producer in Europe and the tenth largest globally. The chemical industry, being the second-largest industry in the Netherlands, creates employment opportunities for 45,000 individuals across more than 380 companies (CEFIC, 2023b). Remarkably, when excluding the food, beverages, and tobacco industry, the chemical industry stands as the largest business sector in the Netherlands (VNCI, n.d.). Moreover, according to Hoffmann (2023), sales of chemical products contribute six percent to the national GDP, with €60 billion out of €1 trillion. Additionally, the Dutch chemicals industry accounts for two percent of global production.

3.2.1 Sub-sectors within the chemical industry

According to Borschiver et al. (2005), the chemical industry is characterized by its complexity and strong interconnections with other sectors of the economy. As a result, the definition of sub-sectors within the chemical industry relies on the specific classification system employed. There are several classification systems used to categorize the sub-sectors within the chemical industry. Some commonly used ones include the Global Industry Classification Standard (GICS), the International Standard Industrial Classification of All Economic Activities (ISIC) as well as the European Classification of Economic Activities (NACE), among others.

However, since we are focusing specifically on the Dutch chemical sector, the most suitable classification system to consider is the Netherlands Standard Industrial Classification of Economic Activities, or the *Standaard Bedrijfsindeling (SBI).* The SBI classification system provides detailed codes and categories specific to various industries in the Netherlands, including the chemical sector. Within the SBI, the chemical industry is primarily represented by point (SBI code) 20 *"Vervaardiging van chemische producten"* (manufacturing of chemical products), encompassing various sub-categories that cover different aspects of chemical production.

Depending on different sources, the chemical industry furthermore involves more or less of the SBI codes 19, 21, and 22, with their respective sub-divisions. For example, the Dutch government established 10 *"Topsectoren"* (Top Sectors) - one of them being Chemistry NL - representing areas where industry and research centers in the Netherlands demonstrate global excellence through collaboration of different governmental and non-governmental stakeholders (RVO, 2022a).

According to the latest official monitoring report of these Top Sectors, the Chemistry NL Top Sector comprises three subsectors:

- **Petroleum Processing**
  SBI 19 *"Vervaardiging van cokesovenproducten en aardolieverwerking"*, manufacturing of coke oven products and petroleum processing, includes all activities related to refining and processing petroleum.

- **Chemical Industry**
  SBI 20 *"Vervaardiging van chemische producten",* munfacturing of chemical products, encompasses a wide range of activities, including the production of industrial gases, chemicals, detergents, synthetic fibers, and dyes.

- **Rubber Plastics Industry**
  SBI 22 *"Vervaardiging van producten van rubber en kunststof"*, manufacturing of rubber and plastic products, encompasses the manufacturing of rubber, plastics, as well as products like tires, pipes, packaging materials, and construction materials.

It is important to note that the pharmaceutical industry is excluded from the Chemistry NL Top Sector definition to prevent overlap with the Life Sciences & Health Top Sector (CBS, 2018). However, since the pharmaceutical industry (SBI 21 *"Vervaardiging van farmaceutische grondstoffen en producten"*, manufacturing of pharmaceutical raw materials and products) is clearly a chemical industry, we include it in our definition of subsectors. Hence, for the purpose of this study the chemical industry refers to those sectors relating to the SBI codes 19, 20, 21, and 22.

All of these SBI codes comprise of more detailed sub-categories, which themselves often entail further sub-divisions of sectors and end-products. The full table displaying all sub-divisions of SBI classifications for codes 19, 20, 21, and 22 can be found in Appendix A.

3.2.2 Chemical industry clusters in the Netherlands

The chemical industry in the Netherlands thrives due to a favorable business climate, supported by the presence of essential preconditions. The country benefits from the availability of crucial raw materials, which can be conveniently accessed either through the port of Rotterdam or via pipelines. Furthermore, there are direct connections between the major chemical centers in the Netherlands and those in Belgium, Germany, and Northern France, facilitating efficient trade and collaboration. The Netherlands is home to five prominent chemical clusters:

1. Rotterdam-Moerdijk
2. Chemelot
3. Delfzijl (Noord-Nederland)
4. Zeeland (West-Brabant)
5. Rotterdam-Rijnmond (Noordzeekanaalgebied)

These clusters serve as hubs of chemical activity and innovation, hosting numerous companies operating in the sector. Additionally, Rotterdam, Zeeland, and Chemelot are part of the ARRRA (Antwerp-Rotterdam-Rhine-Ruhr-Area) cluster, a collaborative initiative between the chemical industries of the Netherlands, Antwerp (Belgium), and the Rhine-Ruhr area (Germany). This strategic alliance further enhances the industry's regional cooperation and competitive advantage and - with its integrated pipeline connections - is responsible for about 40% of the EU's petrochemical production (Port of Rotterdam, n.d.).

Figure 3.1: The five chemical industry clusters of the Netherlands.

Apart from the existing five physical industry clusters, the Dutch government has established what is referred to as the "Sixth Cluster" to ensure connectivity and collaboration among chemical companies in the country. The Sixth Cluster brings together companies from nine different sectors, including the chemical sector. Within the chemical industry, this collaborative initiative represents relatively smaller chemical companies focusing on specialty chemicals and new, innovative start-ups that are geographically dispersed across the Netherlands. (VNCI, n.d.).

Due to the Dutch chemical sector's diversity and complexity, it includes a variety of different companies, ranging from large multinational corporations to smaller specialized companies. Notable key players in the industry include firms such as Shell, DSM or AkzoNobel. In addition to the major companies in the Dutch chemical sector, several important organizations such as the Association of the Dutch Chemical Industry (VNCI), exist that play a significant role in the industry.

3.3 ICI participation of companies in the Netherlands

When exploring the landscape of NSAs and ICIs in the Netherlands, according to the NAZCA webpage, as of October 2023, 32,517 actors are involved in climate actions, of which 368 are located in the Netherlands. Of these 368 NSAs, 232 are companies, engaging in themes such as land use, ocean and coastal zones, water, human settlements, transport, energy, and industry. Furthermore, 181 firms in the Netherlands are participating in ICIs, and many have made commitments to topics such as emission reductions, energy efficiency, or renewable energy (UNFCCC, 2023b).

Figure 3.2 below depicts the commitments to emission reductions by companies in the Netherlands. It is crucial to emphasize that the timeframes for short, medium, and long-term commitments are established by the individual stakeholders, namely, the companies involved. Moreover, in order to establish credibility and foster trust, the UNFCCC monitors and reports on advancements made in voluntary commitments, which relates to the “progress reported” in Figure 3.2. An understanding of the progress of NSAs towards their climate commitments is facilitated by utilizing a progress framework collaboratively developed with Camda, a community consisting of data and analytical experts. This framework integrates metrics that cover the ambition, robustness, and delivery/impact of climate actions undertaken by NSAs (UNFCCC, 2022b).

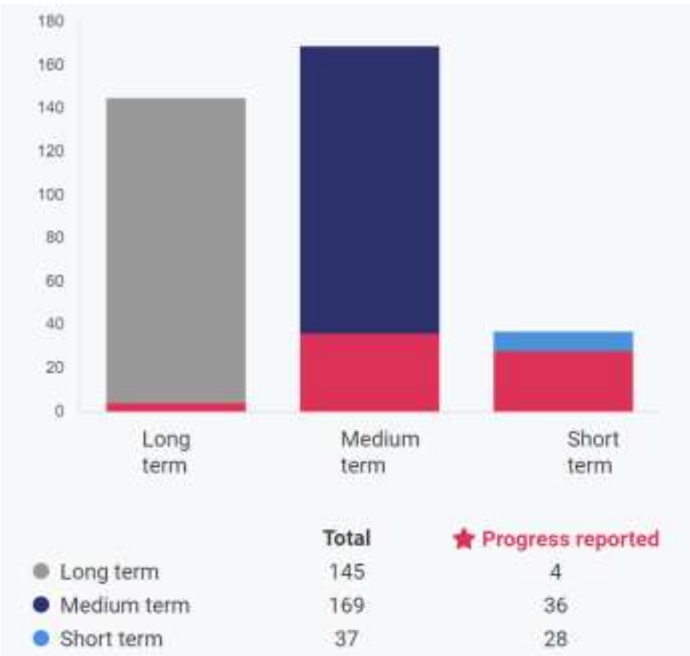


Figure 3.2: Commitments by companies in the Netherlands to emission reduction target term by % (UNFCCC, 2023b).

An evaluation of the GHG emission reduction potentials of NSAs as conducted by Kuramochi et al. (2020), revealed that the complete execution of individual commitments by NSAs within the ten high-emitting economies (one of them being the EU) under study could potentially lead to a further reduction in projected GHG emissions by -3.8% to -5.5% in 2030, in comparison to scenario forecasts based on current national policies. Furthermore, when considered at the national level, the full implementation of these individual commitments has the potential to enable both the European Union and Japan to surpass their NDCs.

As climate action gains momentum among NSAs, including those in the chemical sector and its sub-industries, companies are voluntarily making commitments to address climate change and actively participating in ICIs. This growing trend can be observed not only by tracking the increasing membership in prominent ICIs but also by the academic community's examination of company objectives and strategies for mitigating climate change. In a recent study conducted by Booth et al. (2023), the authors shed light on the fact that 19 out of the 20 largest pharmaceutical companies have made commitments to reduce GHG emissions. Their approaches to establishing climate targets and reporting emissions vary.

The chemical industry has a history of engaging in voluntary initiatives. One of the most prominent initiatives, known as "Responsible Care," was initiated by the Chemistry Industry Association Canada as far back as 1985. It advocates for the enhancement of health, safety, and environmental performance within chemical companies. Today, nearly all major chemical firms are active participants in this initiative, underscoring the significance of voluntary actions undertaken by NSAs. Although "Responsible Care" primarily focuses on issues other than climate mitigation and falls outside the scope of this research, its importance within the chemical sector warrants acknowledgment.

Appendices B and C show tables depicting overviews of cooperative initiatives in which the Netherlands is engaged in (23 cooperative initiatives in total), as well as those with participants located in the Netherlands (58 in total), respectively. Since our analysis is focused on the topic of climate action effectiveness and mitigation potential of businesses in particular, Appendix C depicts only those cooperative initiatives filtered for the actor type “Companies”, which sum up to 33 out of the 58.

3.4 Analysis of ICIs applicable to this research

Out of these 33 cooperative initiatives introduced in Appendix C, the following eight initiatives have been selected to be presented and discussed for their relevance to the Dutch chemical sector. While this section aims to provide a general overview of ICIs that Dutch chemical sector companies can engage in, scrutinizing these initiatives as well as making the final selection of ICIs that will be subject to this research, will occur in section 4.2.

1. Business Ambition for 1.5°C
2. Climate Ambition Alliance
3. Climate Ambition Alliance: Race to Zero
4. Climate Neutral Now
5. Science-Based Targets initiative
6. RE100
7. Climate Action 100+
8. Responsible Corporate Engagement in Climate Policy

This initial selection is based on both the high number of participants, increasing the chances of also finding high participation among the company sample under study, as well as the fact that all initiatives focus either on climate mitigation or climate policy.

1. Business Ambition for 1.5°C

The Business Ambition for 1.5°C (BA1.5) campaign empowers companies to establish robust, Science-Based Targets (SBTs) and reduce emissions in line with the urgency and scale prescribed by climate science. This initiative garners support from an unprecedented global coalition consisting of UN agencies, business associations, and industry leaders. It provides a clear framework for businesses to establish themselves as credible climate leaders and incorporates a range of activities, such as high-level events, technical webinars, communication, and corporate engagement endeavors. The lead organizations behind the BA1.5 are the SBTi, the UN Global Compact, and the We Mean Business coalition.

The campaign has grown to become the largest and fastest-expanding consortium of companies committed to taking urgent action for a 1.5°C future. Since its launch in 2019, hundreds of companies from various sectors and regions, boasting a collective market capitalization exceeding $13 trillion, have joined the campaign, and pledged to pursue credible climate targets. Companies aligned with the BA1.5 initiative undergo an independent validation of their targets by the SBTi and become integral to the UN Climate Champions Race to Zero coalition. To participate in the campaign, companies can submit a signed commitment letter aligning with BA1.5. All targets submitted by these companies will undergo validation by SBTi, in adherence to their criteria and the specific expectations of the campaign commitment. Failure to submit targets for validation will result in removal from the initiative.

As of now, the BA1.5 initiative spans 65 countries and includes 1,588 companies covering at least 45 industry sectors, along with 93 investors hailing from 26 countries (UNFCCC, 2023a). It is important to note that the BA1.5 concluded in 2021 and has since merged into the Forward Faster Campaign, which was launched during the UN High-Level Political Forum in mid-July 2023 (UN Global Compact, 2023).

2. Climate Ambition Alliance

The Climate Ambition Alliance (CAA), launched in 2019, unites countries, businesses, investors, cities, and regions in a collective effort to achieve net-zero CO_2 emissions by 2050. Country engagement in the CAA is spearheaded by the governments of Chile and the United Kingdom, with the support of the UNFCCC. Mobilization of non-government actors is led by the High-Level Climate Champions for Climate Action, namely Nigel Topping and Gonzalo Muñoz, as part of the "Race to Zero" campaign (refer to the subsequent section for more information), which is, next to the "Net Zero 2050", one of the two to the CAA inherited campaigns. Under the Paris Agreement, it is incumbent upon Parties to communicate long-term strategies aimed at achieving low GHG emissions by mid-century. The primary objective of this coalition is to advocate for net-zero CO_2 emissions in alignment with the latest scientific knowledge. Achieving this significant shift toward net-zero CO_2 emissions necessitates the active involvement of stakeholders from all segments of society, which is why this alliance includes regions, cities, businesses, and investors alongside countries. They are all aligned in pursuit of this common goal, recognizing the manifold benefits of transitioning to a low-carbon future.

Within the framework of the CAA, there has been notable growth in both Parties and non-party stakeholders as members. As of 2021, there were 137 Parties out of the total 191 signatories to the Paris Agreement who are part of the CAA. Moreover, the initiative operates in 178 countries, with participation from 8,238 companies spanning at least 46 industry sectors, 579 investors located in 49 countries, and 1,281 organizations situated in 84 countries. Additionally, 51 regions, 1,136 cities, and 136 countries are actively engaged in this initiative (UNFCCC, 2023a).

3. Climate Ambition Alliance: Race to Zero

Race to Zero (RtZ), inherited to the CAA and introduced in 2020, is an UN-backed global campaign that mobilizes NSAs - including corporations, municipalities, regions, financial institutions, educational establishments, and healthcare facilities - to take decisive and immediate steps to halve global emissions by 2030. The objective is to create a healthier, more equitable world that is carbon-neutral within the prescribed timeframe. All participants in this initiative share a common overarching goal: to swiftly and equitably reduce emissions across all scopes, in accordance with the Paris Agreement, and adhere to transparent action plans with robust near-term targets. As previously mentioned, overseen by the UNFCCC and championed by the governments of Chile and the UK, as well as the High-Level Champions for Climate Action, Nigel Topping and Gonzalo Muñoz, Race to Zero rallies actors beyond national governments to join the CAA. Its counterpart campaign, Race to Resilience, was launched during the 2021 Climate Adaptation Summit. This UN-endorsed global campaign seeks to catalyze a significant increase in global commitment to climate resilience, with a focus on prioritizing people and nature to foster a resilient world where we not only endure climate shocks and strains but also thrive despite them.

The RtZ campaign unites various leading networks and initiatives within the climate action community, all of which are motivating their members to meet the RtZ minimum criteria. The membership of the RtZ initiative has witnessed remarkable growth, now exceeding 11,000 members, with numbers of member participation that align with those of the CAA for the categories of companies, investors, organizations, regions, and cities. Furthermore, the RtZ initiative has successfully drawn in financial institutions managing more than $88 trillion in assets under management, as well as healthcare institutions, despite operating during a global pandemic (UNFCCC, 2023a).

4. Climate Neutral Now

Climate Neutral Now (CNN) was initiated and is overseen by the UN Climate Change in 2015, with the aim of urging all segments of society to take action towards achieving a climate-neutral (net-zero) world by mid-century, as laid out in the Paris Agreement established in the same year. CNN promotes immediate action through a three-step approach: measuring, reducing, and optionally contributing to carbon reduction efforts via certified carbon credits in carbon markets. The first two steps are mandatory, while the third is encouraged. Committing to these steps encourages behavioral changes within companies and organizations, which, in turn, catalyze changes in their respective industries and networks. Participants are obligated to annually report their actions, with their progress compared to set milestones, resulting in an "achievement badge" that communicates their level of ambition and accomplishment. All reported information is made public. Participation in the CNN initiative is open to all types of organizations and companies worldwide. The process involves submitting a signed pledge committing to measuring and reducing GHG emissions, with the option to contribute, followed by a one-year period to report on their actions. Participants failing to report for two consecutive years are excluded. In CNN, each participant sets their own goals and ambitions, and their individual progress is reported and assessed annually. There is no collective goal reported by the initiative as a whole.

In recent years, the growing awareness of the need for immediate climate action has led to a steady increase in CNN participants. As of now, the initiative operates in 67 countries, with 523 companies spanning at least 42 sectors, 8 investors in 7 countries, 143 organizations in 37 countries, and 3 cities participating (UNFCCC, 2023a). While CNN remains operational, the UN secretariat is gradually phasing it down. The recommendations from the Secretary General's High-Level Expert Group on Net-Zero Emissions Commitments of non-state entities have indicated that CNN is not in alignment with net-zero recommendations. Pledges were accepted until July 31, 2023, but 2023 marks the final year of monitoring under CNN. Reports on emissions for 2023 or earlier years will be accepted until June 30, 2024. After this deadline, no further reports will be considered. Visual assets displaying participation in the initiative can be used until December 31, 2024 (UNFCCC, 2022a).

5. **Science-Based Targets initiative**

The SBTi is a collaboration between the UN Global Compact, the World Resources Institute (WRI), the World Wide Fund for Nature (WWF), the We Mean Business coalition and the Carbon Disclosure Project (CDP). The SBTi, which was launched in 2015, works to encourage businesses to set and implement SBTs to reduce their GHGs. Targets are classified as "science-based" when they align with the current climate science consensus on what is required to achieve the Paris Agreement's objectives of restraining global warming to no more than 1.5°C above pre-industrial levels.

The SBTi acknowledges the pivotal role played by the private sector in curbing GHG emissions and advocates for the integration of SBTs into sustainability management. The initiative invites companies of all sectors and sizes to participate and pledge their commitment to establishing SBTs. It acknowledges the distinct characteristics of various business areas, which is why it is developing industry-specific pathways. Additionally, the SBTi is particularly interested in welcoming companies operating within high-emitting sectors, as they hold a pivotal role in driving the shift toward a zero-carbon economy.

Establishing a SBT involves a five-step process as depicted in Figure 3.3 below.

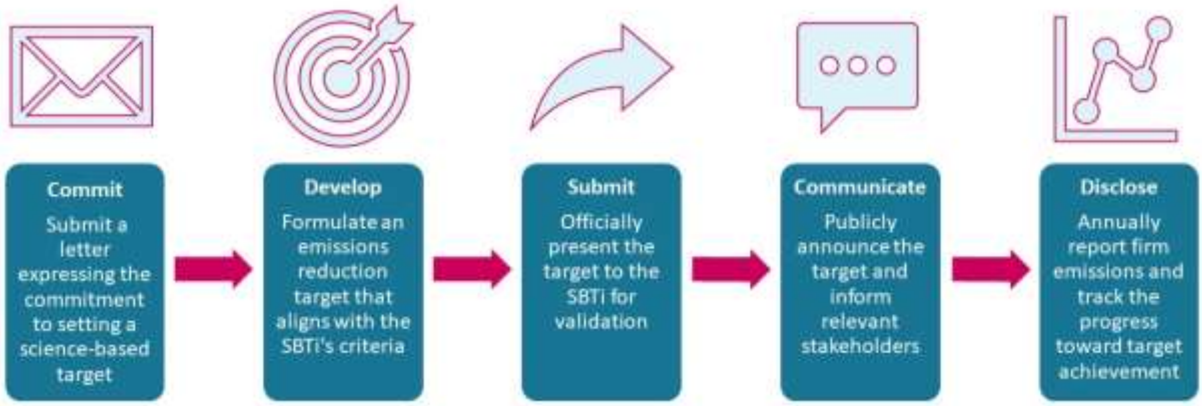


Figure 3.3: The five-step target-setting process of the SBTi. Adapted from (SBTi, n.d.-b).

The SBTi emphasizes that the adoption of SBTs is a prudent business decision and involves strategic decisions such as deciding which base year to set for targets. It fosters resilience against regulatory changes, enhances investor confidence, stimulates innovation and competitiveness, saves costs, and future-proofs growth. Furthermore, it conveys a tangible commitment to sustainability, which resonates with increasingly eco-conscious consumers. Companies undergoing the target validation process benefit from in-depth feedback and assistance from SBTi's technical experts. Businesses that endorse the SBTi commitment letter gain immediate recognition as "Committed" on the SBTi's website, as well as on the CDP, UN Global Compact, and We Mean Business websites.

The initiative has seen a rapid increase in the number of members joining in recent years. Currently, as of November 2023, 6,561 companies are participating in the SBTi, of which 3,898 have set SBTs, and 2,590 have made net-zero commitments. At present, the SBTi does not evaluate targets for cities, local governments, public sector entities, educational institutions, or nonprofit organizations. However, cities can express their interest in establishing targets through the SBT Network (SBTi, 2023).

The SBTi Monitoring Report 2022 highlights that European companies lead with 55% of approved targets and commitments, followed by Asian and North American firms at 20% and 18%, respectively. Latin American, Australian, and African businesses contribute 8%. The top five industries with most SBTs set are the services, manufacturing, infrastructure, materials, and the food, beverage, and agriculture industries with 1320, 856, 349, 346, and 343 and approved targets and commitments, respectively (SBTi, 2022b). Notably, the SBTi has witnessed a significant increase in companies' coverage of scope 1+2 GHG emissions over the past four years, as depicted in Figure 3.4 below.

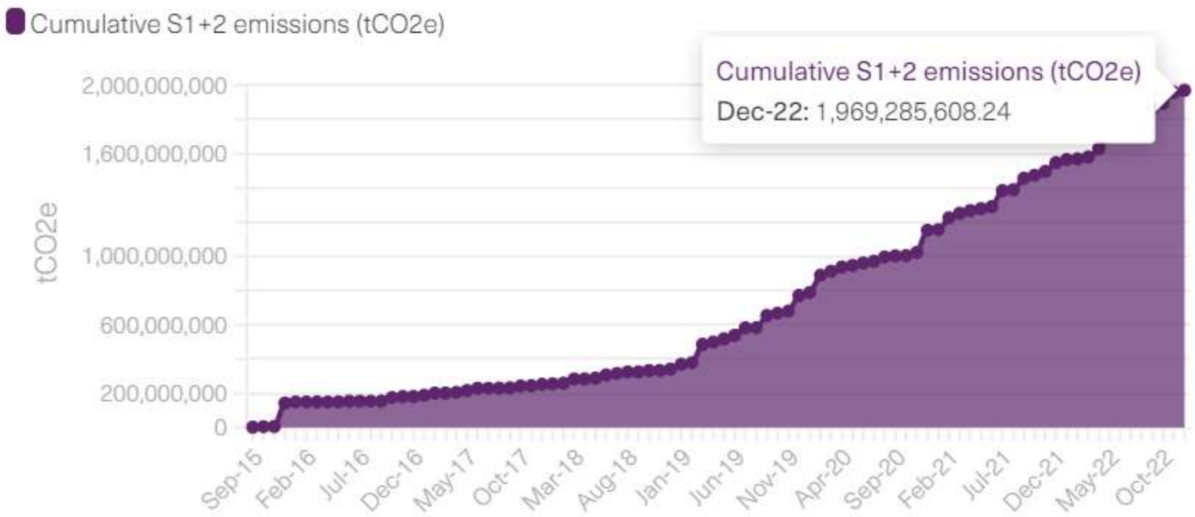


Figure 3.4: SBTi companies' scope 1+2 emissions coverage ($MtCO_2e$) over time as of December 31 2022 (SBTi, 2022b).

6. RE100

Launched in 2014, the RE100 stands as a global initiative uniting influential businesses dedicated to achieving 100% renewable electricity. Established in partnership with the CDP and led by the Climate Group, the RE100's mission is to expedite the transition to widespread adoption of zero-carbon grids while actively promoting the business case for renewables, collaborating to address barriers, and championing transparent reporting mechanisms. Furthermore, it offers members various opportunities for sharing knowledge and profiling, actively influencing EU policy to facilitate companies' access to renewable energy in Europe.

Members are urged to annually report their electricity and renewable electricity usage to the CDP, while the RE100 Annual Report monitors and communicates progress towards RE100 goals. It is important to note that the RE100 does not specifically track the carbon savings of companies working towards 100% renewable power; instead, it focuses on data related to electricity consumption and the utilization of renewables, highlighting various options and their locations. Additionally, RE100 emphasizes the financial investments its members make in renewable power and climate change initiatives plus showcasing the savings achieved by businesses through renewable energy (UNEP, 2022). The RE100 has grown from 13 companies in 2014 to 424 members as of November 2023. According to a news item of the RE100 from the 7th of November 2023, recent commitments by companies surpass 500 *TWh* per year for achieving 100% renewable electricity by 2050. To put this number into context, this exceeds the annual electricity consumption of France (RE100, 2023b).

7. Climate Action 100+

Climate Action 100+ (CA100+), spearheaded by the five investor networks Asia Investor Group on Climate Change (AIGCC), Ceres, the Investor Group on Climate Change (IGCC), the Institutional Investors Group on Climate Change (IIGCC), and the Principles for Responsible Investment (PRI), stands as the largest investor engagement initiative globally on climate change. With over 700 investors responsible for more than $68 trillion in assets under management, this initiative engages with over 160 of the world's major corporate GHG emitters pivotal to the net-zero transition. Signatories play a crucial role in driving engagement, developing company-specific strategies, and focusing on high-level requests to enhance climate change governance, reduce GHG emissions, and fortify climate-related financial disclosures. The initiative emphasizes increased business alignment with a net-zero emissions future and progress towards the CA100+ Net-Zero Company Benchmark indicators.

CA100+ welcomes asset owners, asset managers, and engagement service providers that officially represent assets and typically engage with companies. Prospective signatories must also be members of one of the coordinating investor networks (i.e., AIGCC, Ceres, IGCC, IIGCC, or PRI) and be capable of participating in engagements with focus companies. Notably, 69% of the assessed companies have declared an ambition to achieve net-zero by 2050 or sooner, 90% have board-level oversight on climate change, yet only a third link executive pay directly to emission reduction targets. Furthermore, while 89% of companies commit to aligning their disclosures with the Task Force for Climate-related Financial Disclosures (TCFD) recommendations, so far only 17% have robust decarbonization strategies. Additionally, merely 5% of companies explicitly commit to aligning their capital expenditure plans with long-term GHG reduction targets, and only 17% have medium-term targets aligned with the IEA’s 1.5°C scenario covering all material emissions (UNFCCC, 2023a).

8. Responsible Corporate Engagement in Climate Policy

Guided by the Caring for Climate organization in collaboration with WRI, CDP, WWF, Ceres, and The Climate Group, the Responsible Corporate Engagement in Climate Policy (RCECP) initiative encourages companies to assume a leadership role and commit to engaging responsibly in climate policy. This involves ensuring that companies' involvement in climate policy is comprehensive, aligned, and transparent by urging them to adhere to a set of best practice steps. Core elements such as legitimacy, opportunity, consistency, accountability, and transparency serve as the framework for businesses to bridge the gap between their sustainability commitments and corporate policy positions.

Companies pledging to engage responsibly commit to establishing internal audit processes for all activities influencing climate policy, promoting consistency in these activities, and communicating on policy positions, actions, and outcomes. In the short term, the initiative aims to expand the number of companies committing to responsible engagement and educate them about available resources and tools. In the long term, it strives to align with other commitments in the We Mean Business framework, offering businesses a clear pathway to alter their behavior in addressing climate change and leveraging business action to achieve the decarbonization goal set by the Paris Agreement.

Since 2015, the initiative has continued to educate, track, and invite company participation. In 2018, 129 companies had joined, and the initiative regularly conducts webinars, events, and outreach with individual companies, industry groups, and other stakeholders (UNEP, 2023).

3.5 Summarizing climate action in the Netherlands

The goal of this chapter was to address the question:

SQ1: "What type of climate action programs can the chemical sector engage in, in the Netherlands?"

The objective was to present a synopsis of the Dutch chemical sector and relevant ICIs. Additionally, this chapter sought to establish the theoretical foundation for understanding the importance of mitigating GHG emissions for the Netherlands and the chemical sector. Information and data were primarily gathered through the examination of various websites, news sources, databases, and both academic and grey literature, including reports from key organizations in climate change governance.

The chemical sector plays a central role in global production, tightly intertwined with energy, transportation, and pharmaceuticals. Particularly noteworthy is its substantial economic impact in the Netherlands, ranking fourth in Europe and tenth globally. The chemical sector contributes significantly to industry value and Dutch exports, providing employment to over 45,000 individuals. Major chemical clusters in the Netherlands, like Rotterdam-Moerdijk and Chemelot, foster innovation and collaboration, accounting for 40% of EU petrochemical production. The "Sixth Cluster" focuses on specialty chemicals and innovation among smaller dispersed companies. In this study, the chemical industry is defined to encompass sub-sectors specified by SBI codes 19, 20, 21, and 22, covering petroleum processing, the chemical industry, the rubber plastics industry, and the pharmaceutical industry, respectively.

In the Netherlands, 368 NSAs engage in climate actions, with 232 of them being companies. These companies actively participate in initiatives, committing to emission reductions, energy efficiency, and renewable energy. Notably, companies in the chemical sector voluntarily commit to climate action and engage in initiatives, contributing to global efforts.

Eight initiatives were scrutinized from a roster of 33 cooperative initiatives pertinent to companies in the Netherlands. This initial selection was based on their relevance to the research and their applicability to the Dutch chemical sector. The criteria for inclusion involved a high number of participants, thereby increasing the likelihood of finding substantial participation within the company sample under examination. Furthermore, all the initiatives analyzed in this section exclusively focus on either climate mitigation or climate policy. These eight initiatives are as follows: Business Ambition for 1.5°C, Climate Ambition Alliance, Climate Ambition Alliance: Race to Zero, Climate Neutral Now, SBTi, RE100, Climate Action 100+, and Responsible Corporate Engagement in Climate Policy. While this chapter aimed to explore these ICIs, the final selection of ICIs to be studied in this research, will be made in the subsequent Chapter 4.

4. Methodology

This chapter outlines the methodology employed for the various analyses conducted in this research. A general overview of this methodology can be found in Figure 4.1 below.

Section 4.1 elucidates the process of selecting the company sample, followed by section 4.2, which covers the selection of ICIs. In section 4.3, the general methodology for quantifying company-level GHG emissions according to the GHG Protocol is discussed. Section 4.4 delves into the methodology of the SBTi, while section 4.5 encompasses the methodology for evaluating the achievements of chemical sector companies participating in ICIs, divided into two parts: firstly, the assessment of progress for companies in our sample that joined the SBTi, utilizing the log frame model by Hale et al. (2020); secondly, the methodology employed to evaluate the impact of ICI participation on national climate targets and policies (and vice versa) in the Netherlands which is based on a study by Andonova et al. (2017). Lastly, section 4.6 details how and from which sources data was collected.

Please note that Figure 4.1 below illustrates the "data gathering" step occurring before the three assessments conducted. However, in this chapter, we will only delve into data gathering after discussing the methodology of the three analyses employed. The rationale behind this order is that, although, naturally, we collected the data before conducting our assessments, we introduce specific variables and considerations in the subsections related to the different analyses. Therefore, placing the data gathering section after the sections explaining the assessments conducted, aims to facilitate the reader's understanding of specific analysis-related data and variables.

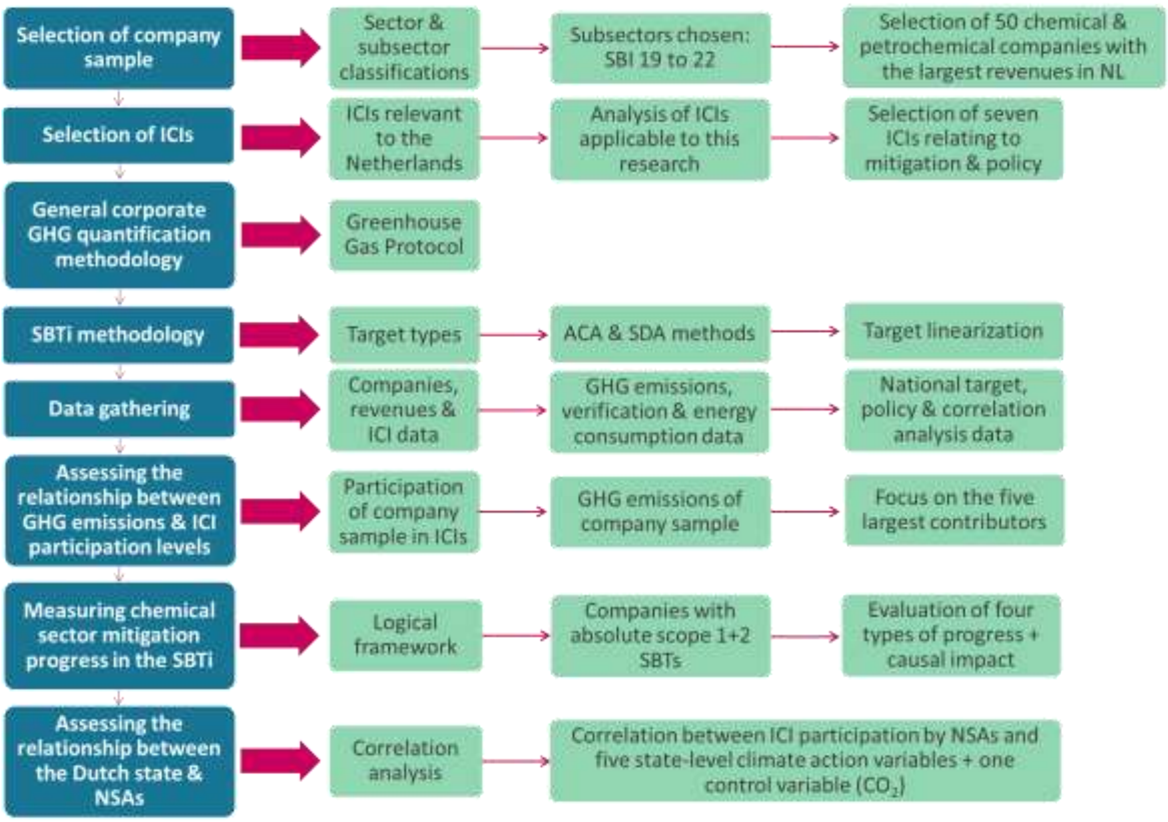


Figure 4.1: Overview of the methodological steps employed to conduct this research.

4.1 Selection of the company sample

Regarding the selection of the target population, our focus will be directed towards key players within the Dutch chemical and petrochemical sector, more precisely, those operating within the subsectors of SBIs 19-22 as elaborated in section 3.2.1. For the remainder of this research, when talking about “chemical companies” or the “chemical industry”, we encompass all businesses and sub-sectors falling under the definition of SBIs 19 to 22 in these terms.

According to the NFIA (2023), the Netherlands is attracting 19 of the world's top 25 major chemical companies, highlighting the sector’s importance to the country once more. To ensure an appropriate sample, the selection process is based on the relevance of private-sector chemical firms in terms of revenues. Initially, our goal was to select those chemical enterprises with the highest GHG emissions in the Netherlands. However, in the end, we opted to sample 50 chemical firms based on their highest revenues (further details provided below), including both firms headquartered and operating in the Netherlands, as well as firms headquartered elsewhere but operating within the country. The reason for sampling 50 companies is that firstly, a sample of 50 is large enough to generalize insights to a larger population, while still being small enough to conduct company-level analysis.

Furthermore, our specific focus will be on companies that are either solely dedicated to the chemical industry or have distinct operations within the Dutch private chemical sector. Generally, a chemical company is defined as a type of industrial enterprise that specializes in the production, development, and distribution of chemicals. This includes companies involved in various aspects of the chemical industry, including the manufacturing of chemical substances, such as organic and inorganic compounds, specialty chemicals, petrochemicals, polymers, and pharmaceuticals. Moreover, chemical companies may also engage in research and development (R&D) activities to innovate and improve chemical processes, as well as provide services related to chemical analysis, testing, and consulting.

However, for the purpose of sampling from the overall population of firms, our analysis will exclusively focus on physical products within the chemical sector, therefore chemical manufacturing enterprises, excluding services from consideration. As a result, our sample will not include logistics-related aspects such as wholesale and trade intermediaries, as well as companies specializing solely in the transport and storage of chemicals, R&D or other aforementioned service-based business models.

By narrowing our focus to firms involved in the manufacturing of chemical substances, we aim to compare them based on their similarities in business practices and supply chains. This approach will allow for a more meaningful and relevant comparison among chemical manufacturers within the industry.

Nevertheless, along the company sampling process, two major problems were discovered:

1. Most companies report their GHG emissions on a global level, and country specific GHG emission data cannot be obtained.
2. Many chemical production sites in the Netherlands are branches or subsidiaries of larger, multinational corporations and, in most cases, do not report their emission separately.

To address the first problem, we chose to sample the top 50 companies within the SBI codes 19-22 based on their highest revenues in the Netherlands instead of their GHG emissions. Additionally, given the unavailability of specific GHG emission data for chemical manufacturing sites and subsidiaries in the Netherlands, we opted to analyze the parent companies for our selected sample instead as more data was available for these firms. Details of this process are elaborated throughout section 4.6.

4.2 Selection of ICIs

After the initial presentation of the eight initiatives relevant to Dutch chemical companies in section 3.4, we analyzed their suitability to our research. The following key insights emerged from this analysis:

- Several initiatives exhibit overlap or thematic alignment.
- The SBTi and the RE100 stand out as the two initiatives with frameworks robust enough for effectively evaluating company progress.
- The CAA and RtZ share common members, with the CAA acting as the overarching initiative that encompasses both the RtZ and Net Zero 2050 campaigns.
- CNN is slated for discontinuation due to misalignment with net-zero recommendations.
- BA.5 only operated from 2019 to 2021.
- RE100 focuses on renewable electricity consumption rather than tracking carbon savings.
- CA100+ is an investor-driven initiative that selects focus companies instead of relying on voluntary business participation.
- RCECP has fewer members compared to the other initiatives, but it is uniquely relevant for the Dutch chemical industry, focusing on climate policy.

Given these insights, the decision has been made to center our analysis on the SBTi and the targets it sets for measuring company progress and evaluating NSA climate action. This decision has been made given the robustness of the SBTi framework. While the RE100's framework is also robust, our focus is on climate mitigation and overall decarbonization rather than specific elements such as renewable electricity. Nonetheless, we will also examine participation in the remaining initiatives to investigate whether a higher number of joined initiatives correlates with greater success in emissions reduction efforts. Consequently, alongside the SBTi, the following ICI selection has been made:

In the context of the CAA and the RtZ, our analysis will specifically focus on the RtZ campaign. This decision is driven by the fact that the CAA serves as the overarching initiative housing two campaigns, and only the RtZ campaign aligns with Dutch interests as outlined by the UNFCCC (2023b). Moreover, we will analyze participation in the BA1.5 initiative to evaluate its impact on company climate action throughout its operational years, spanning from 2019 to 2021. Additionally, we will assess corporate involvement in the RE100 and the RCECP to gauge companies' dedication to renewable electricity and engagement in climate policy, respectively. On top of that, we will observe participation in the CA100+ to assess the focus companies chosen by investors and evaluate if any additional observable progress in mitigation efforts can be identified. The CNN will be excluded from our analysis due to its misalignment with net-zero recommendations and planned discontinuation by 2024.

Lastly, it's worth noting that the data on GHG emissions reported by the companies within our sample will be sourced from the CDP (see section 4.6.2). Since this data will be an integral part of our analysis and a company's voluntary participation in emission disclosure is a strong indicator of its dedication to achieving net-zero emissions, we will also incorporate firms' involvement in the CDP into our analysis.

Originally established as the "Carbon Disclosure Project", the CDP is a nonprofit organization dedicated to operating the global disclosure system for investors, companies, cities, states, and regions, facilitating the management of their environmental impacts. The global economy regards the CDP as the benchmark for environmental reporting, offering the most comprehensive and extensive dataset on corporate and municipal sustainability actions. The CDP began its journey in 2000 by urging companies to reveal their climate-related impact, being the pioneering platform at that time that harnessed investor influence to encourage corporate disclosure regarding environmental impacts. Over time, its environmental disclosure scope has evolved to encompass deforestation and water security, and, in 2021, the organization adopted a new strategy expanding its horizons to encompass all planetary boundaries. This extended ambition includes a focus on biodiversity, plastic usage, oceans, and an understanding of the intricate interplay of natural and Earth's systems.

The CDP collects environmental data by distributing questionnaires to participants, which can include companies and cities. These participants have the option to decide whether they wish to complete and return the questionnaire. Following the receipt of completed questionnaires, the CDP assesses the responses and assigns a score on a scale from A to F. It is important to note that an F score is assigned when a participant chooses not to respond, and this score is not necessarily reflective of the actual environmental performance of that participant. With the world's most extensive and comprehensive repository of data on environmental actions, the CDP's insights empower investors, companies, cities, as well as national and regional governments to make informed decisions today for a sustainable economy that serves both people and the planet in the long term.

The demand for environmental information about companies from investors and purchasers becomes evident when reviewing data released by the CDP. At present, the CDP has received requests from 746 investors with assets totaling over $136 trillion, asking companies to disclose information on climate change, water security, and forests. Furthermore, more than 330 major buyers, wielding a collective purchasing power of about $6 trillion, have requested their suppliers to disclose data through the CDP. Moreover, the CDP's reporting currently encompasses over 23,000 companies, representing approximately two-thirds of global market capitalization, reporting on climate change, water security, and forests. Additionally, more than 1,100 cities, states, and regions have disclosed environmental data through the CDP (CDP, 2023).

Therefore, the CDP will be included in the analysis, leading us to a total sample of seven ICIs under study as depicted in Figure 4.2 below.

Figure 4.2: Selected ICIs under study.

4.3 General methodology for quantifying company GHG emissions

The international community has long recognized the imperative need to curtail emissions to forestall further global warming, and businesses play a crucial role in this endeavor. For being able to formulate a corporate climate action strategy, however, companies must quantify their GHG emissions and gain a precise understanding of diverse emission sources first. While this is a difficult task for companies of all sizes, it is essential when aiming to mitigate a company's climate impact by establishing and attaining GHG reduction targets. Initiated with the aforementioned Kyoto Protocol in 1997, nations reached a historic accord, establishing binding targets and measures to combat climate change. This landmark agreement laid the foundation for the development of the GHG Protocol, an essential framework for global climate mitigation.

Introduced one year after the Kyoto Protocol, in 1998, and developed in collaboration between the WRI and the World Business Council for Sustainable Development, the GHG Protocol establishes a standardized framework for the assessment and control of GHG emissions stemming from both private and public sector activities. To support the quantification of GHG emissions, the GHG Protocol has formulated accounting standards, tools, and training resources. Additionally, it furnishes companies with guidelines and stipulations to facilitate the creation of an emissions inventory, encompassing the calculation of their corporate carbon footprint, which represents the total amount of a company's GHG emissions from all its activities.

Before diving deeper into the framework of the GHG Protocol however, we firstly need to understand how different GHGs are measured and expressed. To facilitate the comparison of GHG emissions across various companies, it is imperative that they are measured in the same unit. Distinct GHGs, such as methane or nitrous oxides, exhibit different levels of global warming potential which is gauged over a 100-year timeframe, commonly denoted as *GWP100*. Carbon dioxide is assigned a *GWP100* value of 1, serving as the baseline, against which other GHGs are assessed. For instance, methane has a *GWP100* of approximately 28, while nitrous oxide carries a *GWP100* of 273, meaning that these GHGs are 28 and 273 times as potent as CO_2, respectively. Given that carbon dioxide acts as the benchmark in these computations, GHGs are typically expressed in CO_2eq (Climate Partner, n.d.).

Now that we have gained an understanding of how GHGs are measured and expressed in the same unit, we will explore how companies classify their corporate GHG emissions According to the GHG Protocol, this classification occurs in three scopes: scope 1, scope 2, and scope 3.

- **Scope 1 – direct emissions**
  Scope 1 emissions consist of direct emissions originating from sources owned or under the control of a company. This encompasses on-site energy usage like natural gas and fuel, emissions from the company's fleet vehicles (such as cars, vans, trucks, helicopters, and so on) or emissions stemming from combustion taking place in boilers and furnaces that are owned or controlled by an enterprise. Furthermore, emissions from refrigerants leaking from cooling systems count towards scope 1. Process emissions released during industrial processes and on-site manufacturing, such as – in our case particularly relevant – chemicals or factory fumes are also part of scope 1 emissions.

- **Scope 2 – indirect emissions**
  Scope 2 emissions, on the other hand, involve indirect emissions resulting from purchased or acquired energy, such as electricity, steam, heat, or cooling. Opposed to scope 1, scope 2 emissions are generated off-site from the generation of energy which is then consumed by the reporting company. For instance, electricity acquired from a utility company is considered scope 2 emissions as it is generated externally. It is important to note that if a reporting company generates its own energy on-site from owned or controlled sources, the related emissions fall under the category of direct scope 1 emissions. This differentiation is also applicable to entities such as electricity utilities or suppliers that operate their energy generation facilities, with the emissions being categorized as scope 1.

  Establishing the methodology for attributing emissions to electricity consumption is crucial in determining scope 2 emissions. There are two main accounting methods for allocating scope 2 GHG emissions from electricity generation to end consumers on a specific grid, achieved by applying emission factors to each unit of energy consumption. These two methods are the location-based approach, which relies on emission factors derived from the average GHG emissions generated by the energy grid in a facility's specific location, and, secondly, the market-based approach, where emission factors are derived from the energy mix associated with each market instrument used for energy procurement (Sotos, 2015).

- **Scope 3 – indirect value chain emissions (upstream and downstream)**
  Finally, scope 3 emissions account for all indirect emissions occurring in a reporting company's value chain, therefore from assets not owned or controlled by the reporting company but indirectly impacted within its value chain. Despite being beyond the reporting company's control and therefore being particularly difficult to measure and manage, scope 3 emissions often constitute a substantial portion of an enterprise's GHG emissions inventory.

  The GHG Protocol classifies scope 3 emissions based on the financial transactions of a company, dividing them into upstream and downstream emissions and categorizing them into 15 groups depicted in Figure 4.3. Upstream emissions pertain to indirect GHG emissions within a company's value chain associated with purchased or acquired goods (physical products) and services (non-physical products), extending from cradle to gate. One example of upstream emissions are the GHG emissions relating to the transportation of purchased raw materials (as well as the emissions related to the raw materials themselves). Downstream emissions on the other hand include the indirect GHG emissions within a company's value chain linked to goods and services that have been sold. The GHGs are emitted after exiting the company's ownership or control. One example of this is the combustion of fuel in a passenger vehicle.

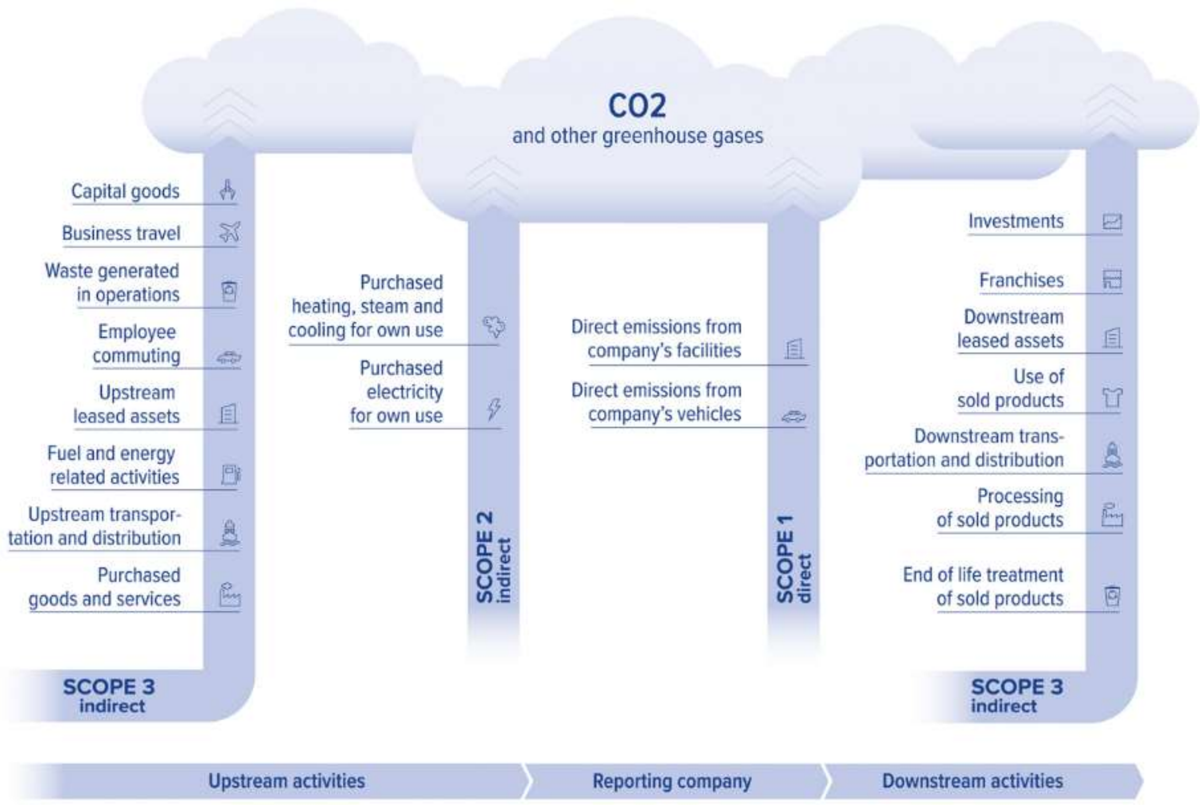


Figure 4.3: Scope 1,2, and 3 emissions according to the GHG Protocol (Climate Partner, n.d.).

To summarize, the GHG Protocol is the main framework for measuring and controlling company GHG emissions, classifying emissions into scope 1,2, and 3. Scope 1 concerns only those emissions occurring from activities directly connected to a company's activities (therefore on-site emissions or from owned or controlled sources). Indirect emissions on the other hand, characterized by the GHG Protocol as "a consequence of the activities from the reporting company but occur at sources owned or controlled by another company" (GHG Protocol, 2022), refer to scope 2 and scope 3 emissions. Specifically, scope 2 includes only the indirect emissions linked to the generation of purchased or acquired energy, while scope 3 emissions relate to those GHGs occurring along the value chain, both upstream and downstream of an enterprise's operations.

For the course of this research, we will use the GHG emission classifications presented by the GHG Protocol.

4.4 SBTi Methodology

Given our decision to concentrate the analysis on the SBTi for assessing company mitigation progress, as elaborated in section 4.2, a concise overview of the SBTi's methodology will be provided.

Regarding the target-setting process, generally, an SBT consists of five key elements: the base year, the target year, the base years' emissions (expressed per scope), the emission scope or scopes covered, and a targeted reduction value, expressed as a percentage (compared to the base year).

Moreover, the SBTi divides between absolute and intensity targets that companies can set for scopes 1,2, and 3. While absolute targets refer to the overall reduction of company emissions per scope, irrespective of company growth or contraction, intensity targets focus on reducing emissions relative to a specific metric, such as unit of production. Intensity targets offer the advantage of allowing companies to demonstrate their progress in climate mitigation through reductions in intensity, even if the company experiences growth. This is beneficial because, when focusing solely on absolute emissions, it might seem like companies did not make progress in their mitigation endeavors. However, a drawback of intensity targets when it comes to the assessment of company progress is the challenge of making comparisons among companies, especially if these companies operate in different sectors and set reduction targets based on different goods manufactured. This challenge has also been described by Giesekam et al. (2021), arguing that intensity targets involve collecting additional data, adding complexity to the evaluation process as this not only demands individual, company-specific metrics but also entails extensive searching and verification of the indicator.

On top of absolute and intensity targets, companies can set net-zero, as well as renewable electricity targets. Moreover, as of this year, 2023, enterprises can set supplier engagement (scope 3) targets, showcasing their commitment to engaging stakeholders along the supply chain to join them on their decarbonization journey. Companies designated as "committed" on the other hand, lack validated SBTs at present. In case these companies do not manage to submit their targets to the SBTi for validation within a period of two years, the company's status on the SBTi's website is changed to '"commitment removed". Besides offering the possibility of setting SBTs via its initiative, the SBTi also provides sector guidance for the following sectors: aluminum, apparel and footwear, aviation, buildings, cement, chemicals, financial institutions, forest, land and agriculture, information and communication technology, maritime, oil and gas, power, steel, and, lastly, transport (SBTi, n.d.-b).

Recognizing the significance of the global chemical sector, the SBTi is actively engaged in developing sector-specific guidance. The initiative has initiated the Chemical Sector Development Project, aimed at creating tailored guidance and Sectoral Decarbonization Approach (SDA) methods (more information in the subsequent section) specifically customized for chemical companies to establish ambitious decarbonization targets. Furthermore, the SBTi has - together with an expert advisory group consisting of major global chemical enterprises - released a Chemical Sector Status Report, offering an updated assessment of the climate impacts of the chemical industry. In this report, the initiative outlines its strategy for addressing the unique challenges within this critical industry.

4.4.1 The two methods for setting science-based targets

As already mentioned before, the SBTi helps companies to set SBTs that align with the global climate goals formulated in the Paris Agreement. This target-setting process occurs in five steps (refer to section 3.4). Currently, the SBTi utilizes two open-source and freely accessible methods for assessing corporate emission reduction targets:

- The Absolute Contraction Approach (ACA)
- The Sectoral Decarbonization Approach (SDA)

While the ACA offers a standardized method ensuring companies achieve absolute emissions reductions aligned with global decarbonization pathways, the SDA serves as an alternative approach.

The ACA method, being the most straightforward, mandates each company to reduce its emissions at the same annual rate globally required for meeting a specified temperature goal. This aligns with the Grandfathering allocation principle, where past emissions are integrated into future emission allowances and are hence "grandfathered". The ACA method is available in three versions, corresponding to different emission pathways outlined by the IPCC and associated with distinct temperature goal classifications (2°C, well-below 2°C, and 1.5°C) (Bjørn et al., 2021). According to the SBTi (n.d.-a), the ACA is the preferred choice for the majority of companies setting SBTs, with two-thirds of the targets approved by the SBTi in 2020 using this method to limit global warming to 1.5°C.

In contrast, the SDA method envisions that all companies within an industry will move towards a shared emission intensity by 2050 (Bjørn et al., 2021). The SDA allows for the derivation of carbon-intensity metrics and targets based on global mitigation pathways, specifically for high-carbon activities like electricity generation, aviation, road transportation, or basic material production. Unlike other methods, the SDA calculates targets for scope 1 and scope 2 emissions differently. For companies categorized as "heterogeneous", hence those producing diverse outputs, the SDA method simplifies by relying on the straightforward emission grandfathering of absolute sectoral emissions. For the SDA method, there are two versions aligned with distinct sectoral emission pathways, both developed by the IEA and consistent with the target classifications of 2°C and well-below 2°C (Bjørn et al., 2021). Even though most companies opt for the ACA, the SDA's sector-specific metrics accommodate variations in decarbonization pace among different sectors and economic activities, reflecting the diverse rates of decarbonization in Paris-aligned pathways. For instance, power generation may decarbonize more rapidly, while activities like aviation and cement production may follow a slower decarbonization pace than the global average. The SBTi is currently working on creating additional 1.5°C sectoral pathways. This process incorporates recent scenarios published by both the IPCC (AR6 report) and the IEA (SBTi, n.d.-a).

In its initial years, the SBTi permitted alternative methods involving economic metrics like value-added and GDP contribution for allocating the global carbon budget. However, as the initiative progressed and evaluated targets employing these economic allocation and intensity methods, it became evident that they could result in substantial absolute increases in emissions, particularly for rapidly expanding companies. Consequently, such methods were deemed inconsistent with the initiative's objectives, and currently, only the ACA and SDA are in use.

In a study by Bjørn et al. (2021), these SBT methods were applied to eight archetypical companies and corresponding emission imbalances. As depicted in Figure 4.4, implementing the ACA method yields a linear emission pathway, consistent for all eight archetypical companies from the baseline year to the target year. In contrast, the application of the SDA results in sigmoid-shaped SBT pathways that exhibit greater divergence. This divergence is attributed to sectoral differentiation and variations in baseline emissions intensities and projected growth rates.

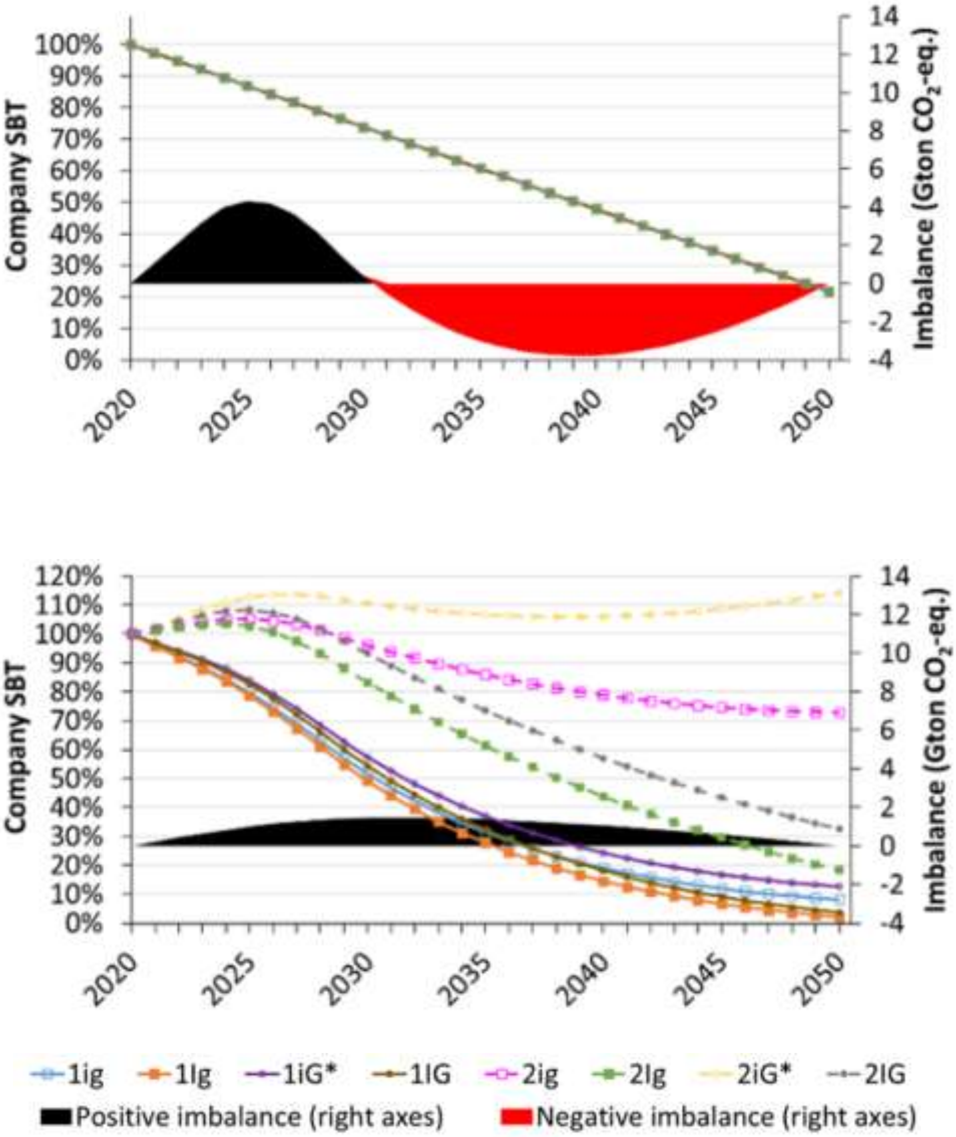


Figure 4.4: Implementing the ACA (upper figure) and the SDA (lower figure) methods on the eight archetypical companies (referring to 1ig, 1Ig, 1iG, 1IG, 2ig, 2Ig, 2iG*, and 2IG depicted in the legend) and the associated emission imbalances. Company emissions pathways and global emission imbalances are presented, with SBTs indexed to 2020 on the left axes, and emission imbalances depicted on the right axes (Bjørn et al., 2021).*

Throughout this research, we will operate under the assumption that all absolute targets set by companies follow a linear trajectory. This assumption is necessitated by the absence of detailed methodologies provided by the SBTi for target-setting among its members (Bjørn et al., 2021). Assuming linearity in targets becomes crucial for facilitating meaningful comparisons across diverse companies within our sample. Without assuming linearity, even comparing different targets set by the same company would pose considerable complexity.

Moreover, in cases where companies set overlapping targets for the same scope, we applied linear interpolation to combine these two targets. For example, one of our sampled companies, Saint-Gobain, a French materials company, has set two overlapping scope 1+2 targets: Firstly, a -33% and secondly, a -90% targeted reduction between the years 2017 and 2030, as well as 2017 and 2050, respectively. The calculation employed to determine the (linear) percentage reduction required post-2030 to achieve an overall reduction of -90% by 2050 (compared to the base year 2017) after reducing scope 1+2 emissions in the first 13 years (2017-2030) at -33% was as follows:

$$x\% = 1 - \frac{100\% - 90\%}{100\% - 33\%} = 85\%$$

These 85% were then applied for the period after 2030, hence Saint-Gobain is targeting to reduce its emissions by -85% past 2030. The same calculation was utilized for other companies that had overlapping absolute scope 1+2 targets.

4.5 Methodology for measuring the achievements of chemical sector companies joining ICIs

For testing the effect of ICI participation on both company-level climate mitigation achievements as well as on national targets and policies in the Netherlands, we will utilize a deductive approach.

Before applying the deductive approach, however, we will conduct an initial exploration of the data collected, aiming to investigate the engagement patterns of chemical sector companies in our sample with the seven ICIs under scrutiny: SBTi, CDP, RE100, CA100+, BA1.5, RtZ, and the RCECP. Additionally, we will evaluate the evolution of GHG emissions of the entire company sample *(n=50)* to date and assess if and how participation in ICIs influences the effectiveness of company-level climate mitigation efforts. While we initially investigate this topic by examining the entire company sample to uncover any discernible trends, our attention will subsequently pivot to the five companies accountable for emitting the most GHG emissions. This shift is prompted by their comparatively larger significance in terms of climate impact.

After this initial exploration, we will dive deeper into the topic by applying the aforementioned deductive research approach, which will be based on two studies from the academic literature.

Firstly, for analyzing overall GHG emission reductions, we will use the logical framework developed by Hale et al. (2020) for assessing progress, implementation, and impact of NSA climate action, hereafter abbreviated as the "log frame model", and apply it to the context of the SBTi. Secondly, to assess the impact on national targets and policies, our analysis draws from the work of Andonova et al. (2017). Their research delves into the intricate interplay between national policies and transnational climate governance, exploring whether these elements act as substitutes or complements. Subsequent sections will elaborate on these studies and elucidate the methodology employed in our analyses.

4.5.1 The logical framework for assessing the chemical sector progress in the SBTi

Introduced by Hale et al. in 2020, the log frame model is a conceptual framework aimed at measuring progress, implementation, and impact of NSA climate action. It serves as a template for researchers and practitioners and can be applied to a wide array of ICIs targeting mitigation, adaptation, and other spheres of NSA climate action. The log frame model depicts the influence of climate action through a causal chain originating from the targets set by actors. These targets, whether quantitative or qualitative, are measured against pertinent baselines and benchmarks. The framework further extends to the inputs provided by the actors, the outputs generated, and the direct and indirect outcomes and impacts influenced by these outputs.

According to Hale et al. (2020), in order to measure any progress or impact, we need a baseline, such as the current level of GHG emissions, as well as a benchmark to make meaningful comparisons. Salient benchmarks in climate mitigation are aligned with the objectives of the Paris Agreement and hence in line with 1.5°C or 2°C pathways, or with those of Sustainable Development Goals (SDGs) or net-zero emissions. The progression along the log frame model is represented by overall causal progress, but progress can also be observed for each step of the causal chain, as depicted in Figure 4.5 below. Here, it is important to note that while causal progress is depicted from "left to right", in reality, it is rather occurring in a non-linear fashion with each element of the chain able to affect another.

Progress on ambition therefore depends on the ambitiousness of the commitments and targets that actors set, while robustness refers to the capacity and resources of NSAs to achieve those targets. Progress on implementation pertains to the tangible outcomes, signifying the means - such as activities and products - that actors employ to attain their specified targets. Assessing progress at each of these stages offers valuable insights into whether a specific climate action is advancing through the sequence of causal progression, indicating its likelihood of achieving the targets set by NSAs.

Ambition, robustness, and implementation serve as crucial prerequisites for achieving substantive progress, which involves the culmination of the causal chain, namely, outcomes and impacts. It is essential to note that outcomes can be either direct (e.g., a decrease in a company's GHG emissions) or indirect (e.g., the adoption of similar targets by other companies in the sector). Impact, on the other hand, refers to the changes in targeted behaviors, as well as social, economic, and environmental indicators. Subsequently, the overall causal progress is an ex-post evaluation of the effectiveness and efficiency of assessed NSA climate action across all the previously evaluated progress stages, namely, ambition, robustness, implementation, and substantive progress. Effectiveness can be defined by the magnitude of the outcomes and impacts compared to the benchmark, along with the speed at which it leads to scalability. Efficiency, on the other hand, can be conceptualized as the effectiveness relative to the inputs allocated, such as the funds invested, in specific NSA climate action.

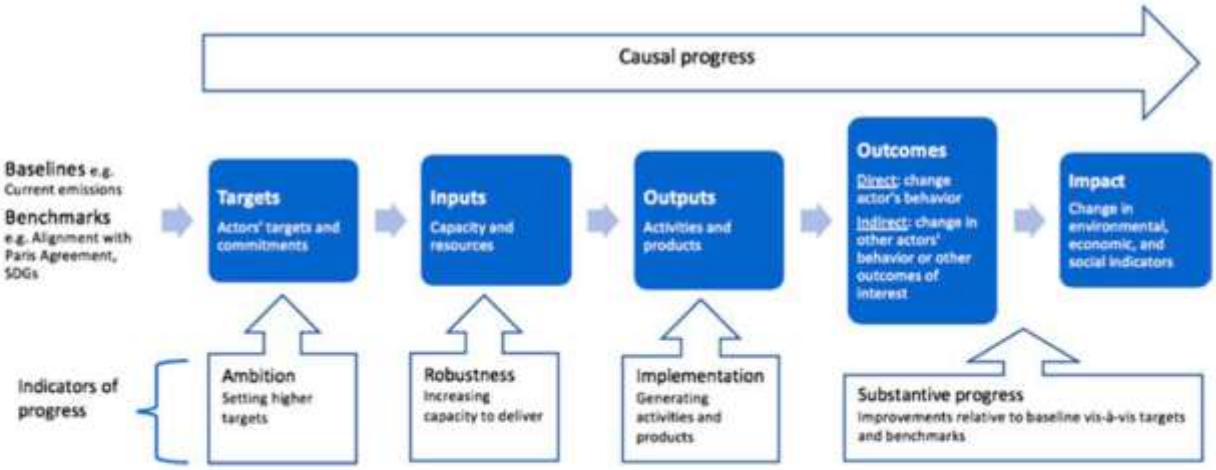


Figure 4.5: Log frame model for measuring progress, implementation, and impact of climate action (Hale et al., 2020).

As mentioned earlier, the log frame model is versatile and can encompass various climate actions, including both mitigation and adaptation. To exemplify its practical use, Hale et al. (2020) specifically apply the log frame model to these subsets of climate action. Since our focus is on measuring the mitigation progress, i.e., GHG emission reductions, of chemical sector companies within the SBTi, we will adopt the author's recommendations for tracking progress and impact related to GHG reductions.

However, due to limitations in data availability and accessibility, which will be thoroughly discussed in section 4.6, we will only be able to get a limited picture of chemical sector company climate action in the SBTi, and the log frame model by Hale et al. (2020) had to be modified to account for this.

A major modification of the log frame model is that we can only apply it in its entirety to those companies in our sample that have established absolute scope 1+2 SBTs. This focus on absolute targets stems from the challenges associated with intensity targets, as discussed in section 4.4, making comparisons among companies difficult. However, since the five companies having set intensity targets, namely, Cargill, Corbion, DSM, Henkel and Oriflame, have also set absolute targets, they are still included in the analysis. Another reason for excluding intensity targets from the analysis is that we were only able to linearize absolute targets. Additionally, reasons for excluding scope 3 targets refer to the intricacies involved in measuring and controlling scope 3 emissions as these processes pose challenges for many companies. Although, by our last year of analysis, 2022, most companies provide a scope 3 emission figure, there is considerable variation in the covered categories (out of the 15 scope 3 up- and downstream emission categories outlined by the GHG Protocol). This variation exists not only temporally, with companies gradually expanding their scope 3 measurement approaches over time, but also among different companies. While some entities measure and report only a few categories, others cover all 15.

Furthermore, engagement, renewable electricity, as well as net-zero targets are excluded. One company, Takeda, has set a supplier engagement (scope 3) target, another one, Saint-Gobain, has set an overall scope 1+2+3 net-zero target and lasty, Henkel, has set a renewable electricity target. Each of these three targets corresponds to a temperature alignment of 1.5°C. On top of that, the absolute target by FUJIFILM had to be excluded as well since it was a combined scope 1+2+3 (well-below 2°C) target. Consequently, while for one type of progress, namely robustness, we can evaluate companies with both absolute and intensity targets, for all other types of progress, the application of the entire log frame model will be limited to absolute scope 1+2 targets, especially when having to linearize, like it is done for the combined ambition of targets.

An overview of the benchmarks and baselines, key indicators, as well as monitoring periods for assessing each type of progress in the causal chain of the log frame model is depicted in Table 4.1 below, while the subsequent sections elaborate on these.

Table 4.1: Tracking progress and impact for GHG reductions of chemicals sector companies in the SBTi.

TYPE OF PROGRESS	BENCHMARKS AND BASELINES	KEY INDICATORS	MONITORING PERIOD
AMBITION	Extended company targets (absolute scope 1+2 targets)	SBTi absolute targets (scope 1+2) within 1.5°C or 2°C trends	2015-2030
	SSP1-19 Energy and Industrial Processes Scenario		
	SSP1-26 Energy and Industrial Processes Scenario		
	IEA Net Zero by 2050 Pathway for the chemical sector		
ROBUSTNESS	Third-party verification	Verified companies	2018-2022
		Type of verification	
		Assurance standards used	
		Proportion of emissions verified	
IMPLEMENTATION	Energy use	Decrease in fossil fuels	2018-2022
		Increase in renewable energy	
	Energy use of the Chemical and petrochemical sector in the Netherlands and the EU		
	Global industry energy use		
SUBSTANTIVE	**Direct**	**Direct**	2018-2022
	○ GHG baselines	○ GHG mitigation so far	
	○ GHG targets		
	Indirect	**Indirect**	
	○ Ambitiousness of targets	○ Company temperature alignment	SBT target year
	○ Effect of NSA climate action on national targets and policies in the Netherlands (and vice versa)	○ Progression of national target, policies, and NSA climate action in the Netherlands	2009-2022
CAUSAL	Effectiveness of setting SBTs	All of the above	Ex-post evaluation

Ambition

To measure the progress on ambition, as a baseline, we will take the reduction targets that companies have set and extend them. To do so, we are assuming that GHG emissions remained constant before the baseline year as well as after the target year. Moreover, as mentioned in section 4.4, we are assuming an ACA method, hence linear GHG reduction targets.

The combined ambition of these targets will then be compared against three scenarios. As mentioned before, for climate action targeted at mitigation, Hale et al. (2020) recommend using benchmarks that align with the goals of the Paris Agreement, SDGs, or net-zero pathways. Therefore, for comparing the combined ambition of the companies that have set absolute scope 1+2 targets, we will use scenarios from both the most recent report by the IPCC, the 6th assessment report (AR6), as well as from the Net Zero by 2050 Pathway by the IEA. The IPCC's AR6 presents the following five shared socioeconomic pathways (SSPs). These are also depicted in Figure 4.6 below.

- **SSP1-1.9:** Very ambitious, zero emissions by 2050, scenario to comply with the 1.5°C objective of the Paris Agreement
- **SSP1-2.6:** Sustainable development scenario, zero emissions after 2050 and 1.8°C global warming by 2100
- **SSP2-4.5:** Middle of the road scenario, 2.7°C global warming by 2100
- **SSP3-7.0:** Regional rivalry scenario, 3.6°C global warming by 2100
- **SSP5-8.5:** Fossil fuel-driven development scenario, 4.4°C global warming by 2100

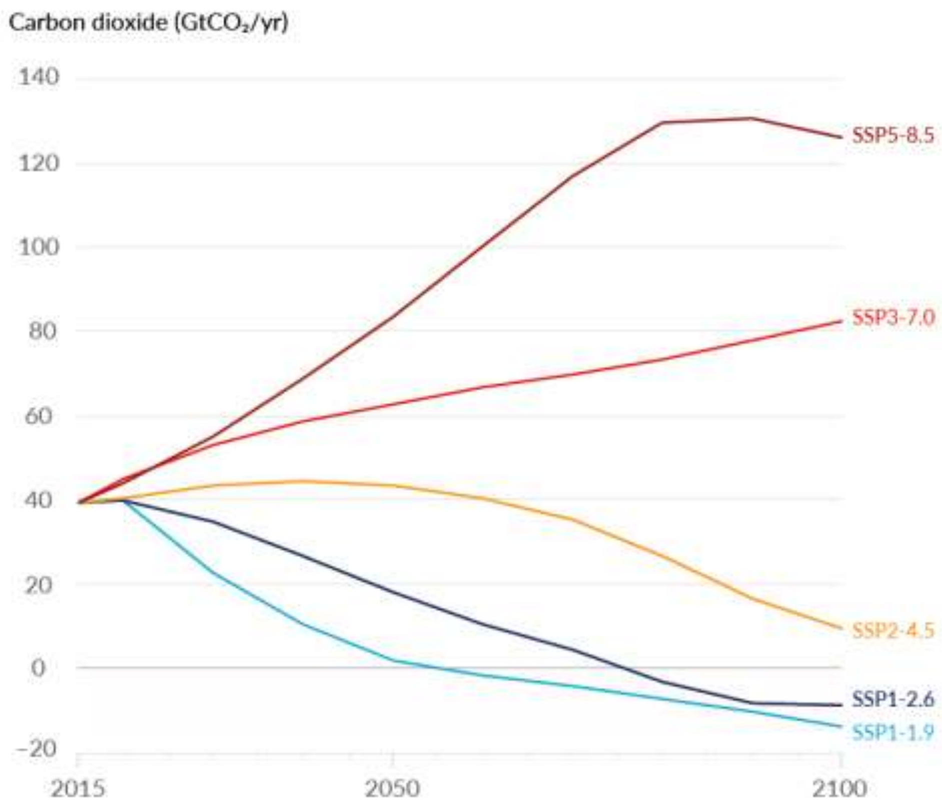


Figure 4.6: Future annual emissions of CO_2 across five illustrative scenarios (IPCC, 2021).

Of these five SSPs, SSP1-1.9 and SSP1-2.6 were chosen, hereinafter referred to as SSP1-19 and SSP1-26, respectively. To account for the chemical sector, we will look at those two SSPs specifically for energy and industrial processes of OECD90+EU countries. Next to these two scenarios by the IPCC, we will also compare the combined ambition of absolute scope 1+2 targets against the Net Zero by 2050 Pathway for the global chemical sector by the IEA (IEA, 2021). All three scenarios chosen are depicted in Appendix D.

Even though these scenarios are based on the most recent climate science, they are not without limitations. The following scenario issues have been identified: Firstly, all three scenarios express emissions reductions solely in terms of CO_2 per year, excluding the other five Kyoto gases *(GWP100),* whereas the absolute scope 1+2 targets in our analysis are expressed in CO_2eq. While CO_2eq data was available for global SSP1-19 and SSP1-26 scenarios, it was not available for the OECD90+EU country-specific or for Industrial and Energy Process scenarios. However, as we have seen a consistent decline in fluorinated gas and nitrous oxide use since 1990 (CEFIC, 2023a), CO_2 currently represents the most significant GHG for the chemical sector, mitigating the impact of this unit discrepancy. Nevertheless, in order to offset the remaining effects of these unit variations, we will present the targeted emission reduction trajectories as a percentage relative to the levels of this year, 2023. Additionally, it is crucial to note that the Industrial and Energy Process scenarios encompass not only chemical manufacturing but also the power sector, buildings, transportation, and byproduct emissions. Despite this broader coverage, it serves as the best proxy available for both SSP1-19 and SSP1-26.

The IEA scenario faces the same limitation as the two SSPs from the IPCC relating to the different unit, focusing solely on CO_2 emissions, but – as mentioned before - given that the chemical industry predominantly emits CO_2, this limitation is considered acceptable.

As mentioned before, key indicators are those SBTi absolute targets for scope 1+2 reductions for 1.5°C, well below 2°C and 2°C trends. The monitoring period is occurring between 2015 and 2030 since the earliest base year that companies have set was 2015 and most targets ended in 2030. Within the analysis of progress on ambition, we will also test for effects of headquarters' locations as well as the numbers of ICIs that companies in our sample have participated in.

Robustness

To evaluate robustness, one can take a look into how a company plans to achieve its climate targets. This can relate to internal company structures such as if there is a dedicated sustainability department, ambassadors, focus groups, or other committed staff within the company. Moreover, this can relate to (financial) resources allocated to mitigation, internal incentives created as well as both short- and long-term sustainability plans and to what level those are elaborated. However, as all these metrics are rather difficult to assess, especially when aiming to make comparisons among companies, we will look at third-party verification instead as this is a reliable and measurable robustness benchmark.

The key indicators used for assessing third-party verification are manifold: First, the verified companies themselves. Here, we will not only assess those companies that have set absolute scope 1+2 targets but also those with intensity targets. However, as mentioned before, those companies with intensity targets have also set absolute targets, therefore, they would have been included in the analysis in any case. Nevertheless, two other companies that were excluded from the analysis on ambition progress due to their combined scope 1+2+3 targets, namely FUJIFILM and Henkel, were included in the robustness check to get a better picture of the overall external assurance of companies in the SBTi.

Second, the type or level of verification. Since third-party verification data will almost exclusively be obtained from CDP questionnaires, the type of verification is ranked according to the different classifications of the CDP for the level of external assurance obtained: none, limited, moderate, reasonable, and high. Even though the CDP does not differentiate between limited and reasonable assurance within its scoring methodology (CDP, n.d.), we report these two types of verification separately.

Third, the assurance standards used. To ensure the broad comparability of third-party verification activities conducted by companies, the CDP mandates that the verification aligns with recognized standards that must adhere to six criteria established by the CDP (see Figure 4.7 below). Any third-party verification standard mentioned in a company's submission to the CDP is evaluated against these criteria for approval. The CDP has compiled a list of standards deemed suitable for CDP reporting and another list of standards considered inappropriate. This list can be found in Appendix E. Moreover, CDP-accredited companies providing verification solutions include APEX, LRQA, LUCIDEON, Toitū Envirocare, JMACC, TÜV Süd, JQA and KERAMIDA (CDP, n.d.).

Figure 4.7: The six criteria of the CDP for third-party verification standards. Adapted from the CDP (n.d.).

Lastly, the proportion of emissions verified will be assessed, reported separately for scopes 1,2, and 3. To earn CDP Leadership points for the scope 1+2 verification in 2023, full verification of 100% of emissions within each scope 1 and scope 2 is required. For Leadership points related to scope 3 in 2023, a minimum of 70% of scope 3 emissions within the reporting boundary must be verified.

The monitoring period relates to the time frame under study, hence the five-year period from 2018 to 2030.

Implementation

Assessing implementation, therefore, evaluating the successful delivery of outputs compared to planned ones, can help to determine if companies are taking the necessary steps for mitigating their GHG emissions. Given the pronounced energy intensity and substantial scope 1 and 2 emissions of chemical companies, our assessment of implementation progress will center on energy metrics.

Utilizing the energy consumption of the examined companies that have established absolute scope 1+2 SBTs as a baseline, we will focus on two primary indicators: firstly, scrutinizing the reduction in fossil fuel consumption, and secondly, examining the augmentation in renewable energy utilization. Specifically, we will assess the following five metrics for the 5-year time period between 2018 and 2022:

1. Consumption of fuel from renewable sources (*MWh*)
2. Consumption of fuel from non-renewable sources (*MWh*)
3. Consumption of self-generated non-fuel from renewable sources (*MWh*)
4. Consumption of purchased electricity, heat, steam, and cooling (H/S/C) from renewable sources (*MWh*)
5. Consumption of purchased electricity and H/S/C from non-renewable sources (*MWh*)

Please note that, for the analysis of the company sample using the five energy metrics detailed above, Akzo Nobel and Teva Pharmaceutical Industries were excluded as Akzo Nobel only began reporting to the CDP in 2023 (disclosing data from 2022), and Teva Pharmaceutical Industries' CDP response of 2020 (2019 data) is not publicly accessible. Data from Akzo Nobel's 2021 annual report and Teva's 2019 ESG (Environmental, Social & Governance) report lacked sufficient detail for meaningful comparison with other data. However, even though both companies could not be included in the specific analysis using the five indictors, they were still included in the assessment of overall ratio of renewable vs. non-renewable energy consumption, as this data was obtainable from their reports.

Benchmarks, on the other hand, aim to contextualize these metrics by comparing the energy consumption of our company sample to the Dutch and EU27 chemical and petrochemical (including refineries) sectors, as well as global industry sector energy data. Data for the Netherlands and the EU were obtained from Eurostat (2022a, 2022b), while global industry sector data was sourced from the IEA (2023b). As the last available data for all benchmarks was in 2021, the data of our company sample can only be compared up to 2021.

For the Dutch chemical and petrochemical sector, the energy sources between 2018 and 2021, including solid fossil fuels, manufactured gases, peat and peat products, oil shale and oil sands, and nuclear heat, all recorded zero values (Eurostat, 2022b) and were consequently omitted from the graph. Additionally, the share of renewables, biofuels, and non-renewable waste was negligible and hence also excluded from the graph (Figure 4.8).

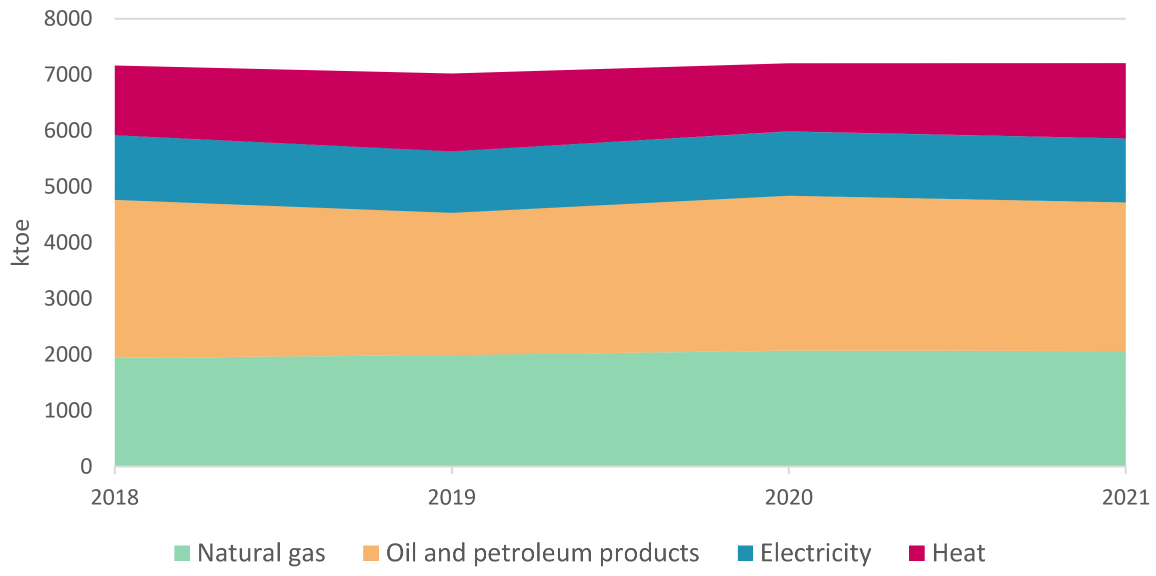


Figure 4.8: Final energy consumption between 2018 and 2021 of the chemical and petrochemical sectors in the Netherlands, by energy source (ktoe). According to data from Eurostat (2022b).

For the EU27 data spanning from 2018 to 2021, values for oil shale and oil sands, nuclear heat, manufactured gases, peat and peat products, renewables and biofuels, and non-renewable waste were all zero or exceptionally small (Eurostat, 2022a). Consequently, these were excluded from the graph (Figure 4.9).

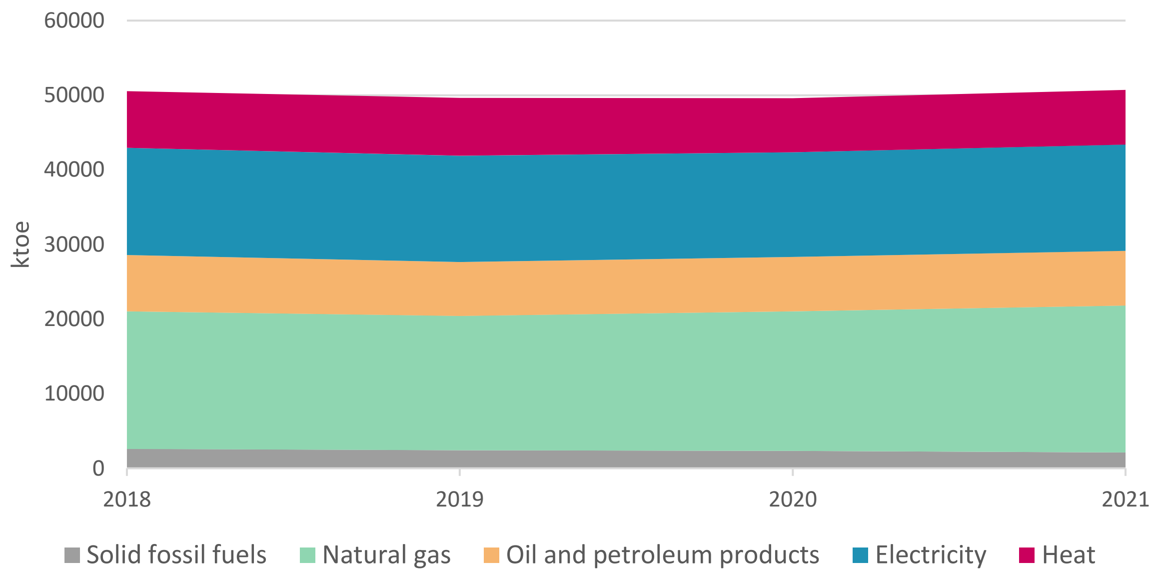


Figure 4.9: Final energy consumption between 2018 and 2021 of the chemical and petrochemical sectors in the EU27, by energy source (ktoe). According to data from Eurostat (2022a).

Finally, in the global industry sector's energy usage data from 2018 to 2021, nuclear energy remained zero throughout the entire timeframe, and the values for crude, NGL (Natural Gas Liquids), and feedstocks were relatively small (IEA, 2023b). Therefore, these elements were excluded from the graph, as illustrated in Figure 4.10. Nevertheless, it is important to note here that nuclear energy is currently only used to produce electricity. Therefore, even though nuclear energy is not part of the final energy use, it is likely that some portion of the electricity consumption reported stems from nuclear sources. However, since the electricity data used is merely reported as one single figure by the IEA, we do not know whether the electricity is coming from renewable, non-renewable, or nuclear sources. This consideration should be kept in mind when comparing our results to the benchmark.

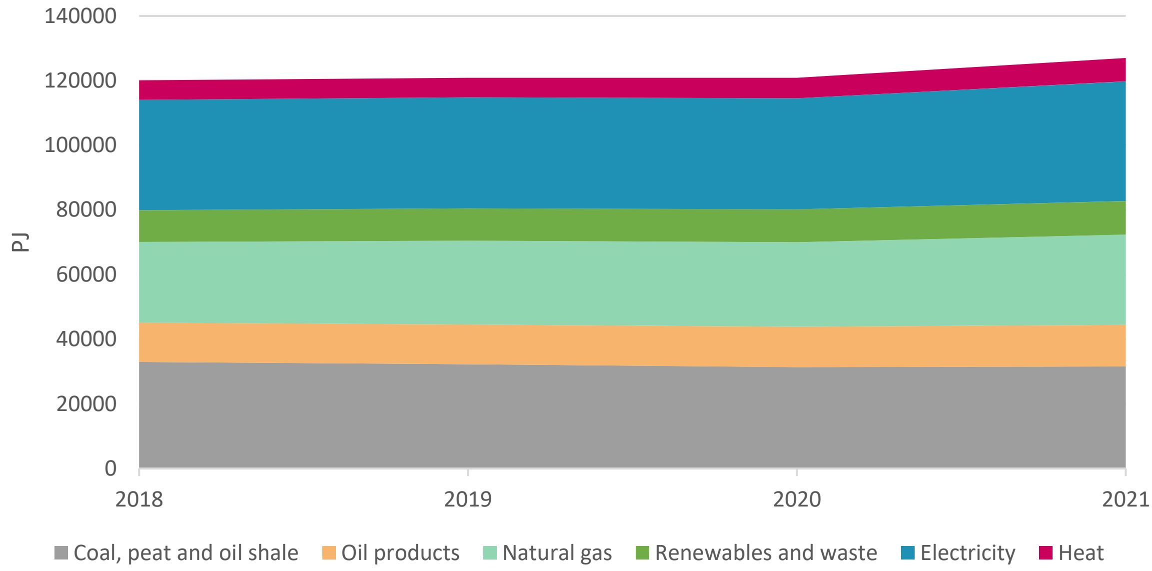


Figure 4.10: Final energy consumption between 2018 and 2021 of the global industry sector, by energy source (PJ). According to data from the IEA (2023b).

For a more meaningful comparison with the five key indicators mentioned earlier, the energy use data from the three benchmarks was categorized into three groups: renewables and biofuels, non-renewables, and electricity. Furthermore, these categories were presented as proportions of the total energy consumption for each benchmark. This approach allows for a more relevant comparison with the proportions of different energy types in our company sample, considering the differences in spatial scales and units between the benchmarks themselves and our sample's data.

Substantive progress

Finally, substantive progress will be most directly measured against the GHG reduction targets analyzed in the ambitions section. In this context, the GHG emissions in the base year serve as our baseline, while the GHG reduction targets (ambition) act as our benchmark. The key indicator for measuring this is the actual change in GHG emissions since the baseline year, with emissions being held constant before the base year. Conducting this comparison of actual GHG emissions over the years against emission targets will enable us to assess whether the companies in the sample, having set absolute scope 1+2 targets, are achieving their climate objectives. The monitoring period occurs from 2018 to 2022, our time frame under study.

Moreover, to examine the impact of a company's headquarters location on its climate achievements, we will also conduct an analysis to determine if there are any specific countries where companies appear to be more successful in meeting their climate targets than others by looking at which of those companies are on track vs. not on track on their targets . Moreover, a similar analysis will be conducted testing for any potential effects of different levels of ICI participation as well as variation in subsectors.

Furthermore, besides measuring the direct substantive progress, we will also take a look at the indirect substantive progress. Here, we will look at two things, namely, the ambitiousness of targets and the effect that NSA climate action has on national targets and policies in the Netherlands.

According to Hale et al. (2020), analyzing the ambition of targets is a crucial step in assessing substantive progress. Companies that are not on track to achieve their very ambitious targets may make a more meaningful contribution to NSA climate action than those perfectly on track with less ambitious climate goals. These actors might want to set higher targets in the future. To evaluate this, we will examine the temperature alignment of company targets (1°C, well-below 2°C, or 2°C) to gauge their level of ambition.

The second analysis of indirect substantive progress examines the impact of NSA climate action on national climate action (such as targets and policies) in the Netherlands, and vice versa. This analysis, distinct from the log frame model and absolute scope 1+2 SBTs, focuses on the participation of the entire company sample *(n=50)* in the seven ICIs under study from 2009, when the first companies in the sample joined ICIs, until 2022. This separation is necessary to evaluate Dutch climate targets, policies, and other indicators of national climate action by testing the effect of NSA climate action on Dutch actors. Restricting the analysis to absolute scope 1+2 SBTs of companies headquartered in the Netherlands would limit the sample significantly, leading to inconclusive results. Although this analysis is separate from the log frame model and will be discussed in the subsequent section 4.5.2, it is mentioned here to highlight the relationship between the analyses and both national as well as NSA climate action.

Causal progress

Finally, the causal progress assessment will comprehensively evaluate the effectiveness of the sampled companies within the SBTi. This ex-post analysis will synthesize insights from various progress types discussed earlier, providing a conclusive evaluation of the causal progress of climate action undertaken by chemical sector companies participating in the SBTi.

To assess efficiency, a facet typically encompassed in the evaluation of causal impact as per Hale et al. (2020), we would ideally compare the effectiveness derived from setting SBTs - indicative of overall mitigation success - in relation to the inputs invested by a company. These inputs might encompass financial resources allocated to corporate climate action or personnel dedicated to formulating the company's decarbonization strategy. However, given that evaluating efficiency necessitates a focused, company-level analysis for eac company in the sample, this lies beyond the current scope of our research and, therefore, will not be assessed in this study.

4.5.2 The effect of ICI participation on national climate targets and policies

Our examination of the interconnectedness between national state and NSA climate action will follow a deductive approach, drawing insights from a study by Andonova et al. (2017) that delves into the dynamic relationship between national policies and transnational governance. This study, notable for measuring cross-national participation in ICIs across jurisdictions, posits that robust national policies positively influence the engagement of sub- and non-state entities in transnational governance. Furthermore, the study suggests that the effects of micro-level incentives and transnational pressures on participation in transnational governance are contingent on domestic institutions. Based on these premises, the authors formulated the following five hypotheses:

1. *"H1: The greater the wealth of a society, the more non-state and sub-state actors participate in transnational climate governance.*

2. *H2: The more environmental INGOs operate in a country, the more non-state and sub-state actors participate in transnational climate governance.*

3. *H3: The more a country depends upon foreign markets that themselves exhibit high levels of participation in transnational governance schemes, the more non-state and substate actors in that country participate in transnational climate governance.*

4. *H4: When domestic political institutions give sub- and nonstate actors greater agency to engage in governance activities, societal and diffusion mechanisms more effectively increase participation in transnational climate governance.*

5. *H5: When governments hold pro-climate policy goals, more sub-/non-state actors will participate in transnational climate governance. Further, this effect will be particularly important for determining participation when political institutions are relatively closed."*

   (Andonova et al., 2017)

The authors proceeded to formulate an empirical model with the primary dependent variable being the cross-national indicator of NSA participation in transnational climate governance, specifically, participation in ICIs. Additionally, alternative versions of this dependent variable were created by excluding the two largest ICIs and by segmenting the baseline model into states with high civil liberties and those with low civil liberties, using the Freedom House measure of civil liberties. This segmentation aimed to assess the impact of civil liberties on cross-national climate governance participation.

The authors employed a set of primary explanatory variables, including national climate policy scores and instances of participation in International Non-Governmental Organizations (INGOs). They also incorporated alternative measures and variables for robustness checks to assess the resilience of their results based on the main explanatory variables. Furthermore, in their regression analyses, Andonova et al. (2017) included the natural log of CO_2 emissions as a control variable to adjust for inherent country characteristics affecting potential participants in transnational climate governance. Countries with higher CO_2 emissions are expected to engage in more transnational initiatives, reflecting their role as primary targets of influence from public policies and transnational schemes.

The study's findings revealed a bi-directional causal relationship between national policies and transnational governance, indicating mutual influence. Ambitious policies were identified as positively impacting the participation of NSAs in transnational governance. Conversely, the climate action initiatives of NSAs could also influence national policies. In countries with high civil liberties, where societal and diffusion mechanisms are more likely to be at play, certain explanatory variables such as GDP per capita and ISO 14001 certifications, a widely adopted international standard for environmental management systems, exhibited a notable impact on national policies. Additionally, other factors like the extent of actor integration into supply chains, involvement in INGO networks, individual possession of material resources, and associated values were found to contribute to the dynamics of national policies. The robustness checks, using alternative variables, further confirmed the results.

Given our focus on the Netherlands in our analysis, replicating the empirical study was not feasible, as it primarily examined cross-national NSA climate governance. The study employed measures related to the relationship between two nations, such as trade variables, accounting for the level of trade between states A and B. However, we can leverage the insights from the study, particularly its indication of a bi-directional causal relationship between state and NSA climate action, to inform our analysis.

Furthermore, the study's hypothesis with the highest relevance to our research question is H5, which highlights the importance of specific variables, especially in countries with high civil liberties. As stated by Andonova et al. (2017), these variables include the Environmental Performance Index (EPI) Climate Change Policy Objective (CCPO) indicator (refer to section 7.4 for explanation), ratifications of international environmental agreements (InEnAs), GDP per capita, the number of ISO 14001 certifications, and participation in INGO networks in a given country.

As the Netherlands consistently maintains high civil liberties throughout our analysis period, between 2009 and 2022 (Freedom House, 2023), we will focus on these five identified variables. Moreover, we will also employ the CO_2 control variable. These variables essentially constitute the main set of explanatory variables utilized by Andonova et al. (2017), with one exception: the trade variable. In our analysis, we opted not to include the trade variable as it pertains to cross-country trade flows, which are irrelevant to our focus on the Netherlands. Given that our analysis solely centers on a domestic context without cross-national comparisons, the trade flow variable becomes redundant. Furthermore, the limited importance of the trade variable for countries with high civil liberties renders its exclusion less consequential.

Based on these considerations, we perform a correlation analysis to examine the association between the participation of chemical companies in our sample in the seven studied ICIs and each of the previously discussed variables:

- EPI CCPO
- InEnA ratifications,
- Participation in INGO networks
- GDP per capita,
- ISO 14001 certifications, and
- CO_2.

As we are not making cross-national comparisons, our correlation analysis is conducted over time, specifically between 2009 and 2022. We perform the analysis on two levels: first, considering the overall ICI participation of the entire company sample, and second, focusing only on companies headquartered in the Netherlands to assess the impact on the aforementioned variables. This approach helps evaluate whether the engagement of Dutch chemical companies in transnational climate change governance has a greater effect on national state climate action compared to the overall global ICI participation of the chemical sector.

4.6 Data gathering

As mentioned before, this research adopts a deductive approach, deriving conclusions from established premises and propositions, specifically drawing on studies by Hale et al. (2020) and Andonova et al. (2017) that analyze the progress of NSA climate action and its impact on national targets and policies, respectively. Since we aim to examine the influence of climate action in the private chemical sector on Dutch national targets and policies, the research design incorporates both descriptive and correlational elements to comprehensively understand the current state and impact of various initiatives on chemical companies and the climate mitigation actions of the Dutch government.

To effectively address the research question and sub-questions, a multifaceted approach, analyzing predominantly quantitative data, will be employed. The comprehensive assessment begins with an extensive desk research phase, involving a thorough review of textual and numerical data sources, including academic literature, government reports, CDP disclosures, reports from various ICIs and companies, online sources, and other relevant datasets. The use of models and graphs, created using Excel and Python, facilitates data analysis, shedding light on various aspects such as Dutch national targets, policies, and emission data, as well as climate targets, GHG emission levels of chemical sector companies in our sample, ICI initiatives, energy consumption, verification metrics, and more. Specifics regarding data collection and sources for each type of data or analysis conducted are discussed in the subsequent sections.

4.6.1 Data gathering for companies, revenues, and ICI participation

To acquire the necessary data for the company sampling process, we sought insights into the organizational structure of the parent companies under examination, including all their locations and subsidiaries engaged in chemical manufacturing activities in the Netherlands. The data required included revenue information for both the parent company and its Dutch locations and subsidiaries. This was done to gain an understanding of what the total revenues of each of the 50 parent companies' chemical manufacturing operations in the Netherlands are.

To account for those Dutch chemical and petrochemical manufacturing sites with the largest revenues, we initiated the company data collection process by obtaining data on the largest revenues of chemical and petrochemical manufacturing sites, along with their relevant sub-sectors, in the Netherlands from *Dun & Bradstreet*, a US-based company offering global commercial data, analytics, and business insights. After compiling a list of companies with the highest revenues, we conducted web searches to identify the parent companies and their respective headquarters. Subsequently, we extended our dataset by researching additional subsidiaries operating under the parent companies, using *Dun & Bradstreet* to include revenue and sub-sector data for all chemical manufacturing locations in the Netherlands.

To investigate the participation of companies in our sample in ICIs, we conducted a comprehensive review of the respective ICI webpages, the UN Environmental Program's climate initiatives website, and the UNFCCC's Global Climate Action platform, with a specific focus on NAZCA Actor tracking. Our analysis considered companies that joined these initiatives in or before 2023.

For the SBTi and the application of the log frame model, we examined participation from our sample that joined the SBTi in or before 2023, with a target base year in or before 2021. This criterion applied to 30 out of the 50 companies in our sample (members with targets and/or commitments). However, in our analysis, we excluded members without approved targets, hence "committed" status.

4.6.2 Data gathering for GHG emissions, verification, and energy consumption

Due to the unavailability of country-level corporate emissions described in section 4.1, the GHG emission data gathered and used throughout this research relate to global corporate emissions. These were primarily sourced from CDP questionnaires for all 50 companies throughout the 5-year period between 2018 and 2022. In cases where the data was unavailable on the CDP platform, we gathered information from the companies' annual (sustainability) reports. This occurred when companies either did not receive a CDP questionnaire, chose not to respond, declined to do so, or kept the questionnaire private on the CDP's website. In cases where companies commenced reporting to the CDP after 2018, our ability to include their emission data depended on whether acceptable-level data were available in their annual (sustainability) reports for the years preceding their CDP participation. Subsequently, we utilized the available data for the years leading up to the company's enrollment in the CDP and incorporated CDP data from the initiation year of their participation onward. Appendix F depicts for which companies and in which years, CDP data was obtainable.

Moreover, although we collected data for scopes 1, 2, and 3, the majority of our analyses concentrated on scopes 1 and 2. This decision was made due to inconsistencies in scope 3 reporting not only across years but also among different companies in the sample. On top of that, in case both market-based and location-based scope 2 figures were reported by a company, we used the numbers relating to the market-based accounting method as this accounting method seemed to be more prominent among the sampled companies, therefore allowing for better comparison. Furthermore, we sourced information on the selected scope 2 accounting method for SBTs from the CDP, as the SBTi does not include this information in its target database.

In addition to acquiring scope 1, 2, and 3 emissions data, the information needed for the robustness analysis (see section 4.5.1) was sourced through the CDP. Within the "verification" section of the CDP questionnaire, companies detail the level or type of assurance, the applicable standard, and the proportion of emissions verified for each of the three scopes. This data was extracted and utilized in our robustness analysis. However, for two companies within the study sample, namely Akzo Nobel and Teva Pharmaceutical Industries, this information was not available for the entire 5-year study period.

Firstly, Akzo Nobel only commenced reporting its 2022 data to the CDP (2023 questionnaire). Nonetheless, external assurance was conducted by an independent auditor (PWC) for the years between 2018 and 2021, with details on the level of assurance, verification standard employed, and the proportion of emissions verified being documented in the company's annual reports. Secondly, Teva Pharmaceutical Industries did submit a 2020 CDP response (representing data from 2019), but this data was not publicly accessible on the CDP website. However, the missing data in this instance could be obtained from the company's 2019 sustainability report.

Similar to the robustness analysis of the log frame model, we utilized data from the CDP for the analysis of progress on implementation. A specific section within the CDP questionnaire provides information on the company's energy consumption from various sources. This data was employed to evaluate progress on implementation. Contrary to the robustness analysis, the absence of certain years in the CDP reporting for Akzo Nobel and Teva Pharmaceutical Industries posed a challenge in the implementation analysis. As detailed information on energy consumption by different sources was not available on the companies' websites or in their annual (sustainability) reports, both companies had to be excluded from the company sample in some of the analyses conducted to assess progress on implementation.

As discussed in section 4.5.1, modifications to the log frame model were necessary to address limitations related to data availability and accessibility. The data obtained solely from company reports and the CDP offered a limited perspective on company climate action, lacking insights into specific internal processes. Recognizing the black-box nature of the analysis, we endeavored to minimize the impact of this issue by – as mentioned before - adjusting the log frame model.

4.6.3 Companies excluded from the sample

Some companies, despite contributing significantly to revenues in the Dutch chemical and petrochemical sector, were omitted from our sample for two primary reasons. Firstly, exclusion occurred when a company's activities did not align with our definition of chemical manufacturing; certain firms listed in *Dun & Bradstreet* as chemical manufacturers were identified as service-oriented or logistics-focused entities, such as those specializing in chemical blending.

The second instance of exclusion arose when companies failed to disclose GHG emission data transparently. This lack of transparency included scenarios where only percentage GHG reductions were provided without corresponding numerical data or when no comprehensive CDP or sustainability report data was accessible for the entire 5-year study period. Each time a company was excluded, we initiated the aforementioned sampling process anew, selecting the chemical manufacturer with the next-highest revenue from *Dun & Bradstreet* data, identifying its parent company, additional locations, subsidiaries, and so forth. Refer to Appendix G for an overview of the excluded companies and the reasons for their exclusion.

4.6.4 Data on national targets, policies, and the related analysis

The data collection for the analysis exploring the relationship between ICI participation and Dutch national climate targets and policies (see section 4.5.2) unfolded as follows: The examination of national climate targets, policies, and regulations applicable to the chemical sector in the Netherlands involved reviewing governmental reports such as the Climate Agreement, Dutch Ministry websites, and reports by organizations like the Organization for Economic Cooperation and Development (OECD). The investigation considered the latest commitments, targets, regulations, and policies to understand changes over recent years and assess whether these changes result from more ambitious climate actions by NSAs.

The correlation analysis, building upon Andonova et al.'s (2017) study, incorporates various variables, as detailed in section 4.5.2. While the ICI participation data was already obtained at the climate mitigation analysis stage, other data needed for the Dutch national-level correlation analysis was collected from diverse sources. The EPI CCPO and civil liberty level data were sourced from the EPI and Freedom House websites, respectively. GDP per capita data came from the Eurostat database, while national-level CO_2 emission data was obtained from Statista. Data on ratified InEnAs were gathered from the International Environmental Agreements Database Project, a project by the University of Oregon. Information on participation in INGO networks was extracted from the International Union for Conservation of Nature (IUCN) website, recognized by Andonova et al. (2017) as a reliable proxy for transnational advocacy activity. Lastly, ISO 14001 certification data was sourced from the ISO certification survey dataset, available on the official ISO website.

5. The relationship between corporate GHG emissions and ICI participation

This chapter explores the patterns of chemical sector companies in our sample engaging with any of the seven ICIs under investigation, namely, the SBTi, CDP, RE100, CA100+, BA1.5, RtZ, and, finally, the RCECP. Additionally, we will assess the evolution of GHG emissions of the companies in our sample so far and whether participation in ICIs influences the efficacy of company-level climate mitigation efforts. Moreover, we will direct our focus to the five companies contributing most to the GHG emissions of the company sample. This chapter therefore aims to answer the following question:

SQ2: "What are the climate achievements of chemical industry companies that have joined International Cooperative Initiatives?"

Section 5.1 delves into overall ICI participation, categorizing the company sample into those headquartered in the Netherlands, those in the EU (excluding the Netherlands), and those based outside the EU. Section 5.2 subsequently analyzes the GHG emissions of the company sample over time, while section 5.3 explores trends in the development of company-level scope 1 and 2 emissions with a particular focus on the five companies exhibiting the highest emissions. Section 5.4 subsequently investigates the impact of ICI participation on mitigation success, maintaining the same segmentation of the sample applied in section 5.1. Finally, section 5.5 provides a concise summary of the findings.

5.1 Company sample participation in ICIs

After examining the company sample for participation in various ICIs, it is evident that 86% of the companies joined either one or two initiatives. Two firms, namely Kuwait Petroleum Corporation and Tronox, did not participate in any ICIs, while the maximum number of ICIs a company joined was five (refer to Figure 5.1 below). Companies having joined five ICIs are Akzo Nobel, Corbion, DSM, Givaudan, International Flavors & Fragrances IFF, and, lastly, Saint-Gobain. The detailed table listing all ICIs for each company is available in Appendix H.

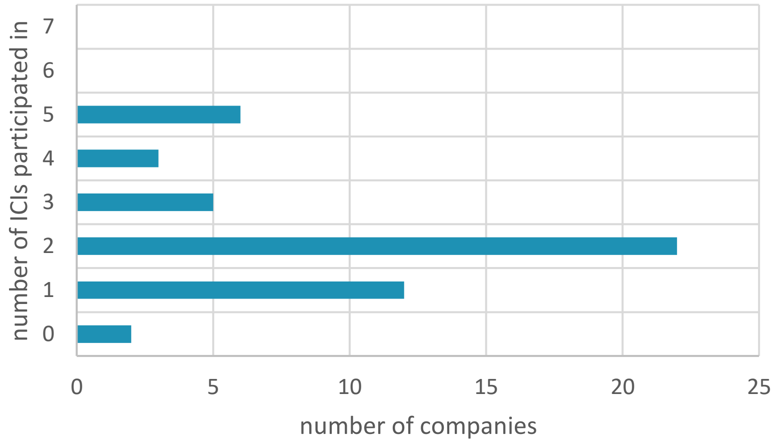


Figure 5.1: Overall ICI participation of company sample. According to data from ICI websites.

Certain companies in our sample operate in the petrochemical sector, placing them in the oil and gas sector. These companies include BP, ExxonMobil, Kuwait Petroleum Corporation, Neste, Shell, TotalEnergies, and Valvoline. Here, it is essential to highlight that their possibilities for ICI participation are limited because some of the ICIs do not accept involvement from oil and gas businesses.

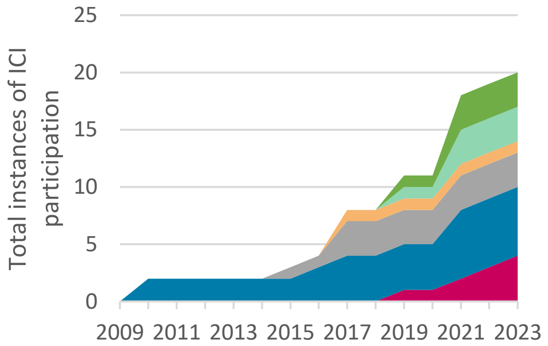
The SBTi is the first one of the sampled ICIs that excludes participation from fossil fuel companies. The SBTi is currently developing its methodology for the oil and gas sector. Although it had previously accepted commitments from companies undergoing sector development, including oil and gas, the validation of fossil fuel sector targets and commitments from these companies are now temporarily paused. There are, however, exceptions to this. Companies eligible to join the SBTi include those deriving less than 50% of revenue from the sale, transmission, and distribution of fossil fuels, or providing equipment or services to fossil fuel companies. Additionally, companies with less than 5% revenue from fossil fuel assets, electric utilities mining coal for their own power generation, and subsidiaries of fossil fuel companies (considered non-fossil fuel entities) can join the SBTi (SBTi, 2022a).

Furthermore, since the BA1.5 is a campaign under the SBTi, is also restricting participation for fossil fuel companies.

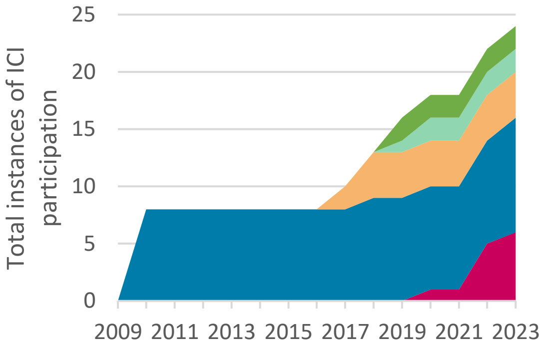
The third ICI that prohibits participation from fossil fuel companies is RE100. Its membership criteria explicitly state that, along with airlines, munitions, gambling, and tobacco companies, entities exclusively in the fossil fuel sector will not be considered for RE100 membership. Moreover, companies increasing their holdings in fossil fuel assets and financial institutions investing in fossil fuel-related companies or projects are also excluded from the initiative (RE100, 2023a). This underscores RE100's commitment to not accept any entities within its ranks that might, directly or indirectly, undermine its mission.

On the contrary, the CDP, CA100+, RCECP, and the RtZ campaign permit the inclusion of companies from the fossil fuel sector. However, it is crucial to note that, while non-fossil-fuel companies in our sample have the potential to participate in all seven of our sampled ICIs, fossil-fuel companies are restricted to a maximum participation of four.

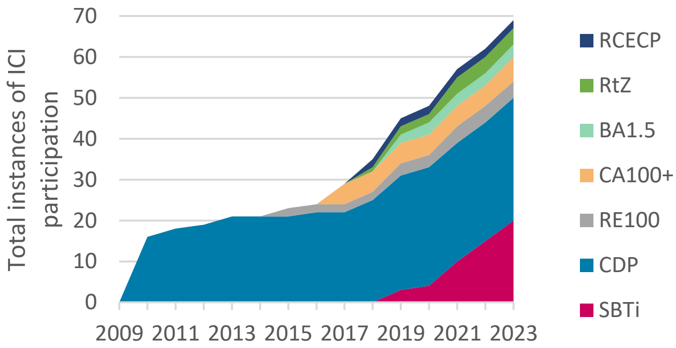
Moreover, when examining ICI participation trends over time (Figure 5.2), a consistent pattern emerges across all three subgroups within our overall company sample: those headquartered in the Netherlands *(n=6),* those based in the EU (excluding the Netherlands) *(n=10),* and those headquartered outside the EU (excluding both the Netherlands and the EU) *(n=34).* In total, by 2023, there were 113 instances of ICI participation across the entire company sample of 50 companies. Furthermore, to gain a better understanding of participation levels per ICI, we have plotted this on an additional graph, which is depicted in Appendix I.



(a) Companies headquartered in the Netherlands



(b) Companies headquartered in the EU (except the Netherlands)



(c) Companies headquartered globally (except the EU)

Figure 5.2: ICI participation of the company sample, by company headquarter location.

As seen in the figures above, ICI participation shows a steady increase over time, with a notable acceleration and a wider array of ICIs joined in recent years. Notably, in the Netherlands subgroup, there is a conspicuous absence of participation in the RCECP. Similarly, the EU subgroup demonstrates no involvement in both the RE100 and the RCECP. It is crucial to clarify, however, that these observations may not necessarily indicate a lack of climate engagement or renewable energy initiatives among companies in the EU but could be attributed to the larger sample size of the global subgroup, enhancing the likelihood of broader participation in various ICIs.

However, when examining the proportions of companies in the split samples and the overall instances of ICI participation in 2023, it becomes evident that companies headquartered in the Netherlands exhibit higher participation rates relative to their sample size compared to their EU and global counterparts, as depicted in Table 5.1. This suggests that Dutch companies are actively demonstrating their commitment to climate mitigation. The exploration of whether this proportionally higher commitment among Dutch companies translates to greater success in the sector's decarbonization efforts will be investigated in the following section.

Table 5.1: Comparison of proportions of companies in the sample and ICI participation of the three split samples.

HEADQUARTER LOCATION	RATIO OF THE NUMBER OF COMPANIES TO THE TOTAL COMPANY SAMPLE	RATIO OF ICI PARTICIPATION INSTANCES TO THE ICI PARTICIPATION INSTANCES OF THE ENTIRE COMPANY SAMPLE
NL	12%	18%
EU	20%	21%
GLOBAL	68%	61%
TOTAL	100%	100%

5.2 GHG emissions of the company sample over time

When analyzing Figure 5.3, which illustrates the evolution of emissions from 2018 to 2022, it is evident that the overall scope 1 and 2 emissions of the entire company sample have decreased over time, declining from approximately 660 *Mt* CO_2eq to about 590 *Mt* CO_2eq*.* It is also apparent that scope 1 emissions constitute a larger portion than scope 2 emissions. This is attributed to the fact, as mentioned earlier, that the chemical (and petrochemical) sector utilizes fossil fuels as feedstocks in the production of chemical and petrochemical products, which account for scope 1 emissions.

Additionally, as can be seen in Appendix J, scope 3 emissions constitute the largest portion of total emissions. However, it is notable that scope 3 emissions appear to have increased significantly, more than doubling between 2018 and 2023. As previously mentioned, this increase is influenced by the variation in reported scope 3 coverage among companies and over time, underscoring the decision to exclude scope 3 emissions from the main analysis to prevent potential distortion of results.

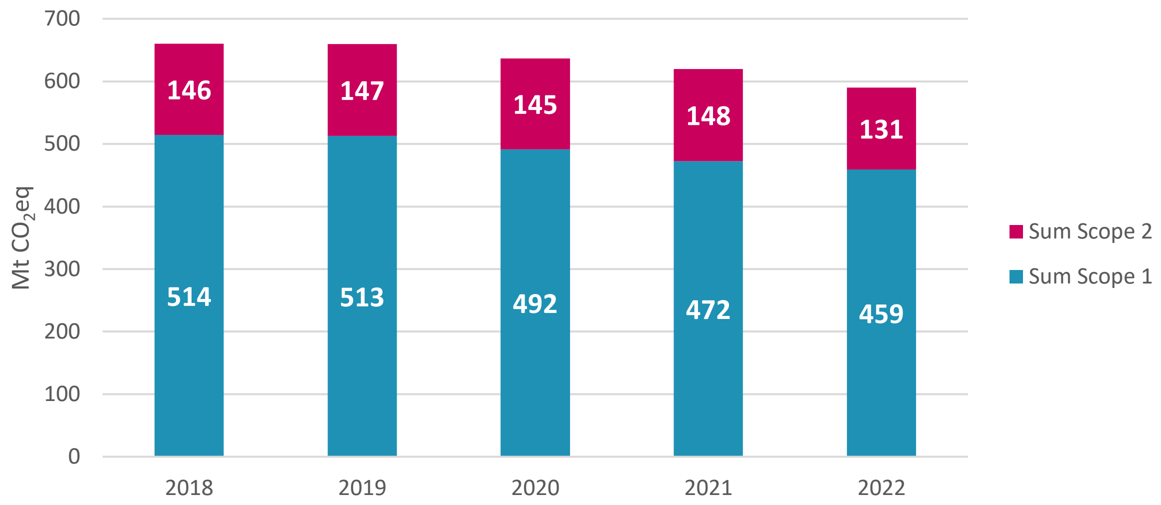


Figure 5.3: Development of total worldwide scope 1 and 2 emissions of the entire company sample between 2018 and 2023.

While Figure 5.3 illustrates the decline in scope 1 and 2 emissions for the entire company sample from 2018 to 2022, we conducted further analysis by examining the evolution of emissions using the split samples outlined in section 5.1. This exploration aimed to determine whether the higher proportional participation in ICIs by chemical sector companies headquartered in the Netherlands correlates with proportionally greater success in mitigating scope 1+2 emissions. The outcomes of this analysis are presented in Table 5.2 below.

Table 5.2: Evolution of scope 1 and 2 emissions between 2018 and 2022 of the three split samples and the overall company sample.

HEADQUARTER LOCATION	SCOPE 1+2 (MT CO_2EQ) IN 2018	SCOPE 1+2 (MT CO_2EQ) IN 2019	SCOPE 1+2 (MT CO_2EQ) IN 2020	SCOPE 1+2 (MT CO_2EQ) IN 2021	SCOPE 1+2 (MT CO_2EQ) IN 2022	PERCENTAGE CHANGE FROM 2018 TO 2019
NL	34,6	34,0	41,9	41,8	38,8	12%
EU	142,4	154,6	151,8	153,8	156,2	10%
GLOBAL	483,4	471,1	442,9	424,3	394,8	-18%
ENTIRE SAMPLE	660,3	659,7	636,6	619,9	589,8	-11%

Surprisingly, our assumption was contradicted by the findings. Scope 1 and 2 emissions increased for both Dutch- and EU-headquartered companies. This suggests that a higher level of ICI participation does not necessarily translate to greater success in companies' mitigation endeavors. Nevertheless, scrutinizing the surge in scope 1+2 emissions from companies headquartered in the Netherlands, it becomes apparent that this spike is attributed to the chemical company LyondellBasell. Upon further investigation, it was revealed that in 2020, LyondellBasell acquired a plastics recycling company based in Belgium (LyondellBasell, 2020), elucidating the substantial increase in emissions for that specific year.

5.3 Company-level GHG emission trends and largest emitters

In addition to examining the GHG emission trends of the entire company sample, as well as the three split samples analyzing differences when it comes to companies' headquarter locations, it is crucial to emphasize the significance of companies that contribute the most to the total emissions. The emissions changes of these major emitters have a substantial impact on the overall scope 1 and 2 emissions. Specifically, the top five emitters - ExxonMobil, Shell, SABIC, TotalEnergies, and Air Liquide (in descending order) - account for nearly half (49.4%) of total scope 1+2 emissions of the entire company sample.

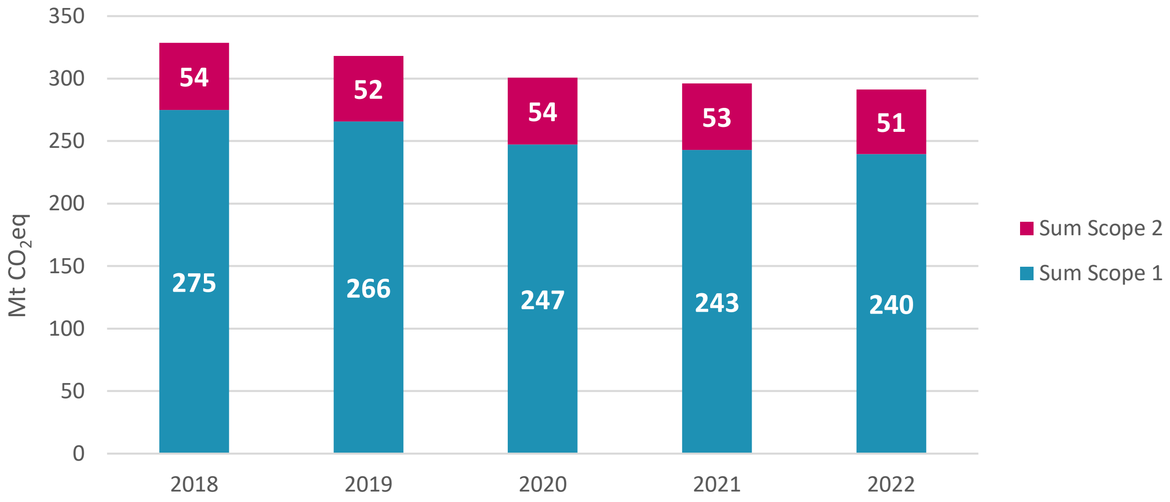


Figure 5.4: Scope 1+2 emissions between 2018 and 2022 of the five largest emitters.

As illustrated in Figure 5.4, the cumulative scope 1 and 2 emissions from the top five emitters witnessed a decline from 329 *Mt CO_2eq* in 2018 to 291 *Mt CO_2eq* in 2022. This indicates a reduction of approximately -12%, slightly exceeding the overall -11% decrease observed for the entire company sample during the same period. Furthermore, Appendix K depicts the evolution of scope 1 and 2 emissions of the three largest emitters for each company separately.

As can be seen in Appendix K, among these five companies, all managed to decrease the sum of their scope 1 and 2 emissions between 2018 and 2022, except for the French industrial gases manufacturer, Air Liquide. While the overall emissions for the other four firms decreased during this period, there are noticeable variations between the years. Specifically, after following a downward trajectory in the initial years under study, there is a slight increase observed towards the end of the five-year timeframe, especially from 2021 to 2022. The only company among the five largest emitters that consistently reduced both scope 1 and 2 emissions throughout these five years is the energy and petrochemical multinational company Shell, the second-largest contributor in our sample. The subsequent paragraphs will delve into the reasons why the other four major emitters did not achieve the same success as Shell, providing insights into the observed trends.

We will commence this in-depth examination of companies by focusing on the other two energy and petrochemical multinationals in the sub-sample of the five companies with the largest GHG emissions, namely, ExxonMobil and TotalEnergies, representing the first- and fourth-largest emitters in our sample, respectively. ExxonMobil reported a slight increase in scope 1 emissions (1 *Mt* CO_2eq) between 2020 and 2021, maintaining the same level the following year (while scope 2 emissions continued to decrease). In contrast, TotalEnergies exhibited a more substantial increase of 4 *Mt* CO_2eq in scope 1 emissions between 2021 and 2022, with scope 2 emissions remaining constant. This occurred after a previous downward trajectory for both scope 1 and 2 emissions in the preceding years.

The observed increase between 2021 and 2022 can be attributed to the impact of the Russia-Ukraine war, which commenced on February 24, 2022. As Russia curtailed natural gas pipeline flows in response to imposed sanctions by the West, Europe experienced an energy supply shortage, leading to a substantial surge in natural gas prices. Industries, including refineries within the petrochemical sector, responded by shifting to alternative fossil fuels, primarily oil (Sharafedin, 2022). This gas-to-oil switch elucidates the spike in scope 1 emissions, given that oil has a significantly higher emissions factor (more CO_2 is released per unit of fossil fuel combusted) compared to natural gas (Juhrich, 2016).

An illustrative case highlighting these effects is evident in the example of TotalEnergies. The company discusses the Russia-Ukraine war extensively throughout its 2023 sustainability report. Through this report, we can discern that the increase in scope 1+2 emissions between 2021 and 2022 is directly linked to the gas-to-oil switch previously mentioned as TotalEnergies provides emission breakdowns based on continents where the emissions occurred. Interestingly, while emissions from operations remained relatively constant on all other continents, the surge in scope 1+2 emissions between 2021 and 2022 is solely attributed to operations in Europe (TotalEnergies, 2023). This corroborates our hypothesis that the emissions increase during this period can be ascribed to the company's shift from gas to oil for operating their refineries in response to the Russia-Ukraine war.

In addition to the widespread gas-to-oil switch adopted by many petrochemical firms operating refineries in Europe, acquisitions of new companies can also impact emission levels. Notable acquisitions by the five largest emitters in our sample took place between 2018 and 2022. ExxonMobil acquired MPM Lubricants in 2018, while TotalEnergies purchased Bluecharge, Singapore’s largest electric vehicle charging network, in 2021, along with the East African Crude Oil Pipeline in 2022. SABIC acquired Black Diamond Structures, a developer and manufacturer of innovative nanomaterial products, in 2019. Lastly, Shell led in acquisitions between the beginning of 2018 and the end of 2022, completing a total of nine, followed by Air Liquide, which acquired four companies during that time (Crunchbase, 2023).

These acquisitions have the potential to significantly increase a company’s emissions, as they now encompass the emissions of additional entities. However, as exemplified by Shell, a higher number of acquisitions does not necessarily translate to higher emissions. Shell stands out as the company that has undertaken the most acquisitions while simultaneously achieving a consistent decrease in emissions. One plausible explanation for this trend could be that when a parent company strategically divests some subsidiaries while acquiring new businesses, the potential emission impacts from the acquisition of new entities may be counterbalanced. Besides the acquisition or divestment of firms, company emissions may also rise due to overall company growth, characterized by increasing revenues or assets.

For example, while ExxonMobil reports a -4% and a -3.3% decrease in scope 1+2 emission intensities from 2020-2021 and 2021-2022, respectively (ExxonMobil, 2023), we also observe substantive respective revenue growths of 57% and 45% in those years (MacroTrends, 2023a). Therefore, we assume that the progress in reducing carbon intensities is partly offset by the company’s growth. Nevertheless, as ExxonMobil only experienced a slight increase in their scope 1 emissions between 2020 and 2021, the company managed to substantially decrease their scope 2 emissions in the year after, indicating that overall, the company is back on a downward trajectory.

The rationale concerning company growth is furthermore applicable to SABIC, the third-largest contributor in our sample, operating in the (petro-)chemicals and metals sector. As outlined in their 2022 sustainability report, the 3.2% increase in scope 1 emissions aligns proportionally with a 3.9% rise in production experienced by the company in 2022 compared to 2021. Additionally, the company attributes the slight decline in scope 2 emissions (-1.1%) to ongoing global grid emission factor updates and the implementation of significant Power Purchase Agreements (offtake agreements for power) in Europe. These agreements have led to an augmentation of the company's dedicated renewable power, directly contributing to the reduction of its scope 2 emissions (SABIC, 2023).

The last company under scrutiny in this analysis is Air Liquide, an industrial gases producer, representing the fifth-largest contributor. The company experienced a slight uptick in scope 1 emissions, rising from 15.5 $Mt\ CO_2eq$ in 2021 to 16.3 $Mt\ CO_2eq$ in 2022. This increase is primarily attributed to the integration of the TotalEnergies hydrogen production unit in Gonfreville, France, effective from June 15, 2022, and heightened utilization of cogeneration units due to prevailing energy conditions. Notably, Air Liquide has been actively investing in the hydrogen sector as part of its decarbonization strategy, contributing to the development of a low-carbon society. However, the production of hydrogen from fossil fuels through steam reforming of natural gas results in significant GHG emissions, particularly in the form of scope 1 emissions (Suleman et al., 2016). According to Air Liquide (2022), cogeneration units and hydrogen production capacity collectively contribute to over 80% of the Group's direct emissions in Europe and the Americas.

On the other hand, scope 2 emissions are associated with installed capacity across different regions and the local power generation mix. The prevalence of coal-based power generation in Asia and South Africa elucidates the substantial role of these geographical areas, constituting more than 70% of the company's scope 2 emissions. According to Air Liquide, the 2 $Mt\ CO_2eq$ increase in scope 2 emissions between 2021 and 2022 is linked to the inclusion of new assets in the reporting scope, particularly those associated with the acquisition of the Sasol Air Separation Units in South Africa on June 24, 2021, impacting the entire reporting year 2022 (Air Liquide, 2022).

Examining the 2018 and 2019 emissions reported by the company in its 2022 sustainability report reveals a notable disparity between the levels of scope 1 and 2 emission data obtained from the CDP questionnaires. While scope 1 emissions align more or less with the CDP questionnaire data, scope 2 emissions are substantially higher, particularly around 5 $Mt\ CO_2eq$ in both years. Initial consideration suggested that this discrepancy might be due to different scope 2 accounting methods (market- vs. location-based). Indeed, a closer examination revealed that, while in 2018, Air Liquide reported the same number for scope 2 market-based and location-based figures (which is highly unlikely to be accurate), in 2019, they reported a location-based figure in the CDP questionnaires. Conversely, in their sustainability report, they reported a market-based figure, potentially explaining the misalignment of the numbers.

For the subsequent years (2020-2022), scope 1 and 2 emission figures from Air Liquide's sustainability report and its response to the CDP align. However, the company restated its emissions for the years 2020 to 2022, as can be seen in Table 5.3 on the next page.

Table 5.3: Scope 1 and 2 emissions reported in Air Liquide's sustainability report (Air Liquide, 2022).

Scopes 1 and 2

	2018	2019	2020	2021	2022
Scope 1: total direct greenhouse gas emissions (GHG) (in thousands of tonnes of CO_2-eq.)[a]	16,082	16,239	15,345	15,536	16,273*
Scope 2: total indirect GHG (in thousands of tonnes of CO_2-eq.)[b]	16,976	16,927	17,184	20,829	23,033*
Total emissions as reported (in thousands of tonnes of CO_2-eq.)	33,058	33,166	32,529	36,364	39,306[c]*
Total restated emissions (in thousands of tonnes of CO_2-eq.)[d]	–	–	39,564	40,085	39,464

(a) (b) and (c) Actual Group emissions taking into account significant perimeter changes (up and down) having an impact on CO_2 emissions during the year as of their effective date.
(a) Reporting taking into account a minimum of 95% of the Group's emissions. The methodology and reporting of excluded sources are subject to a continuous improvement process.
(b) Total of indirect GHG emissions generated by the production of electricity and steam purchased outside the Group. Emissions are reported using the "market-based" methodology.
(c) Corresponding emissions using "location-based" methodology are 38,330 kt CO_2-eq.
(d) Emissions are reported using the "market-based" methodology,restated, from 2020 and each subsequent year, to include the emissions of the assets for the full year, taking into account (upwards and downwards) changes in scope having a significant impact on CO_2 emissions.
* Indicator verified by the independent verifier.

As can be seen, Air Liquide is reporting their total restated combined scope 1+2 emissions to be about 7 *Mt CO_2eq* higher in 2020, now indicating that the company experienced an emissions decrease of about -0.3% from 2020 to 2022. As can be seen in footnote *(d)* of the table, Air Liquide explains the restating of emissiony by taking into account upwards and downwards chnages in scopes.

While this explanation seems theoretically plausible, three aspects cast doubt. Firstly, the company is merely restating its total scope 1+2 emissions figure, not providing separate reporting for each scope as done for the original emission figure reported. Consequently, it becomes challenging to identify and trace the changes in scopes, hampering a clear understanding of alterations. Secondly, although scope 1 and 2 emissions for 2022 are marked as verified by an independent party, the restated emissions lack such verification, prompting inquiries into why the company, having enlisted an independent third-party verifier already, did not seek verification for the restated figures. Anticipating section 6.2.2 at this point, it is noteworthy that Air Liquide did indeed receive third-party verification in 2020. While the level of this verification merely achieved "limited assurance", the fact that the restated figure is about 22% higher than the original figure, which has in fact been verified, does not seem very plausible.

Lastly, it is intriguing that Air Liquide initiated restating its emission figures in 2020, coinciding with the year it uses as the base for internal company targets. The substantial increase in their restated 2020 emissions figure allowed them to report a reduction since then, in contrast to the considerable increases we uncovered. While no definite conclusions can be drawn about these issues and we do not want to accuse Air Liquide of anything, we still want to underscore our skepticism surrounding these developments.

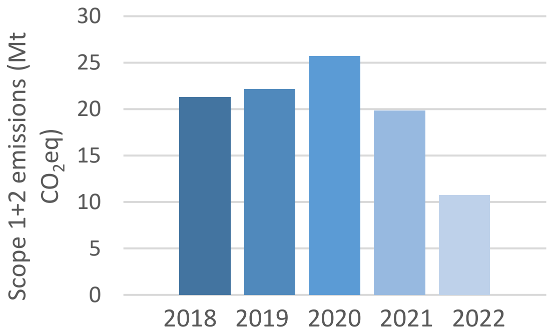
Besides focusing on the five largest emitters in our company sample and assessing their scope 1 and 2 emission trajectories separately, we furthermore explored the evolution of the combined scope 1+2 emissions of the remaining 45 firms in our sample between 2018 and 2022. The accompanying graphs, arranged based on the companies with the highest contributions (as of 2022) to the overall scope 1+2 emissions of the entire company sample (except the five largest emitters) in descending order, are provided in Appendix L.

While analyzing the trajectory of company-level GHG emissions of the remaining 45 companies in the sample, notable increases were observed for specific companies like the Dutch fertilizer producer OCI N.V., the Irish industrial gas manufacturer Linde, and the US-American corporation International Flavors & Fragrances IFF. These substantial surges in scope 1 and 2 emissions might be the result of acquisitions of other companies or the addition of new assets as a result of revenue and hence company growth. Another reason might be that companies have embarked on new activities such as making hydrogen, like it was the case for Air Liquide.

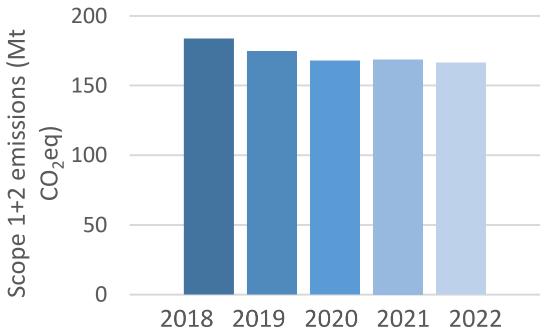
In such instances, it becomes especially pertinent to focus on carbon intensities rather than absolute emission figures while, at the same time, keeping in mind the aforementioned economic and geopolitical factors to draw meaningful conclusions about the companies' commitment to and success in their climate action endeavors.

5.4 Levels of ICI participation and company-level climate mitigation

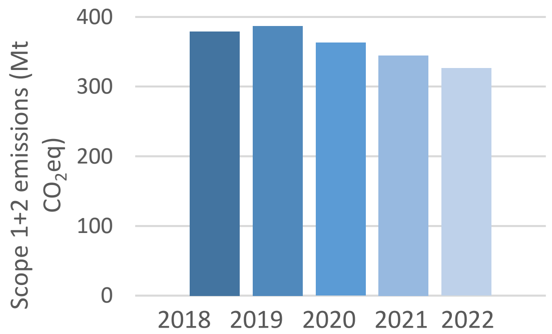
Due to the rather surprising results obtained in the analysis in section 5.2, we decided to further assess the relationship between ICI participation levels of companies and the development of corporate GHG emissions over time. To do so, we analyzed ICI participation of the entire company sample, looking at the evolution of scope 1+2 emissions of sampled companies having joined zero, one, two, three, four, or five ICIs. The results are depicted in Figure 5.5 below and on the next page.



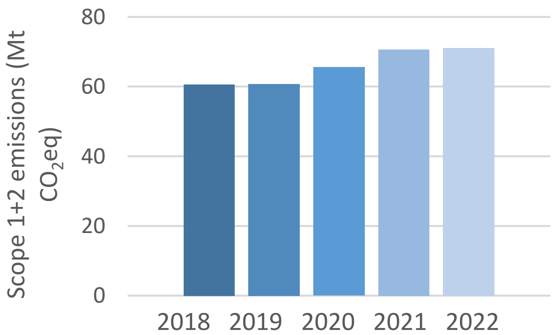
(a) Company participation in 0 ICIs (n=2)



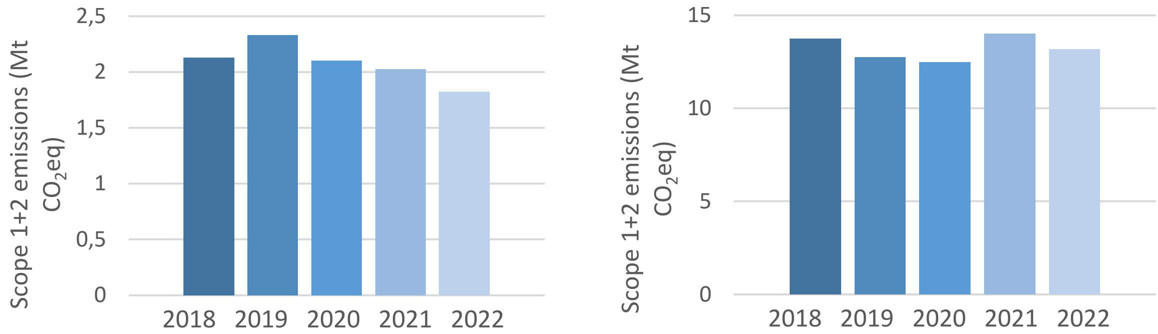
(b) Company participation in 1 ICI (n=12)



(c) Company participation in 2 ICIs (n=22)



(d) Company participation in 3 ICIs (n=5)



(e) Company participation in 4 ICI (n=3)

(f) Company participation in 5 ICIs (n=6)

Figure 5.5: Evolution of scope 1+2 emissions of the company sample, by number of ICIs participated in.

The results affirm our earlier findings when segmenting the sample by headquarters: A greater number of ICI participation does not necessarily correspond to more successful corporate mitigation efforts. Nonetheless, it's crucial to consider that factors like company expansion or acquisitions of new businesses as well as geopolitical events could be driving GHG emission increases, rather than indicating unsuccessful corporate climate action.

Furthermore, we would like to advise the reader to carefully consider the number of companies engaging in a specific number of ICIs. These variations in sample sizes introduce a degree of variability that affects the generalizability of the results. This is especially pertinent for the sub-samples with very small sizes, in particular the sub-sample for the participation in zero *(n=2)* ICIs. Consequently, we are not able to make any statements or draw conclusions from data of merely two companies.

Furthermore, it is plausible that heightened ICI participation might be a response to conceal decarbonization challenges, signaling a commitment to climate action despite unfavorable emission trends. This could be driven by a desire to maintain a positive image for investors and customers. Another possible explanation is that companies, having experienced internal mitigation setbacks, join more ICIs in recognition of the need for external support. A detailed company-level analysis for each company would be required to ascertain the precise reasons behind these trends, examining past climate action efforts, internal structures, and other factors. However, such an analysis is beyond the scope of this research.

5.5 Summary of results

This chapter aimed to explore the topic of ICI participation of chemical sector companies in the Netherlands and how this relates to the industry's climate mitigation efforts by answering the question:

SQ2: "What are the climate achievements of chemical industry companies that have joined International Cooperative Initiatives?"

As we showed, the involvement of companies in ICIs has significantly increased over time, with approximately 86% of the sample participating in one or two ICIs by 2023. Although some companies, particularly those in the petrochemical and fossil fuel sectors, face limitations in specific initiatives such as RE100, BA1.5, and SBTi, the overall trend indicates a growing commitment to climate action.

Upon dividing the company sample into three subgroups based on headquarters location (Netherlands, EU excluding the Netherlands, and rest of the world excluding the EU), it became evident that Dutch companies, proportionally, exhibit a higher level of ICI participation. This suggests a potentially elevated commitment to corporate climate action among Dutch firms.

However, an unexpected finding emerged when analyzing the actual trends in scope 1+2 emissions for companies within the three split samples. Despite an overall -11% decrease in emissions for the entire company sample between 2018 and 2022, emissions from Dutch companies increased during this period. Subsequent analysis exploring the impact of ICI participation on emission trends affirmed these results, indicating that a higher number of ICIs joined does not necessarily translate to greater success in companies' climate action endeavors. It suggests that increased ICI participation might be a response to prior internal mitigation challenges or a strategy to enhance brand reputation. However, further, detailed company-level analysis is essential to uncover the specific reasons behind these trends and understand the nuances of the relationship between ICI participation and GHG emission outcomes.

Additionally, a closer examination at the company level identified that five major emitters - ExxonMobil, Shell, SABIC, TotalEnergies, and Air Liquide - account for approximately 50% of scope 1+2 emissions for the entire company sample. The cumulative emissions of these companies decreased by about -12% between 2018 and 2022. While Shell was the only company achieving constant scope 1 and 2 emission reductions, the other companies showed more fluctuations in their emission trajectories. Particularly, an increase between 2021 and 2022 has been observed which we found to be the result of the Russia-Ukraine war, leading to spiraling natural gas prices, making oil refineries switch from gas to oil. This effect was mirrored in particular in the emissions development of the energy companies ExxonMobil and TotalEnergies. Moreover, the analysis revealed that these GHG emission flucatuations may – besides being the result of geopolitical events – also be attributed to acquisitions or divestments of other companies or assets or to embarking on novel activities such as making hydrogen.

Also when assessing the combined scope 1+2 emission development of the 45 other companies in the sample, some entities experienced notable emission increases during the 5-year time frame under study. Reasons for this may also relate to the factors discussed in the context of the five largest emitters. Furthermore, focusing on carbon intensities rather than absolute emissions becomes particularly relevant to making statements about the climate mitigation success of firms.

In conclusion, while ICI participation is becoming more and more widespread, indicating a general commitment to climate goals, the relationship between ICI participation and successful climate mitigation is complex and influenced by a variety of factors such as company-specific economic factors as well as geopolitical ones. Proportional commitments by Dutch companies suggest a dedication to climate action, however, but further in-depth investigations are necessary to understand the dynamics influencing emission trends and the effectiveness of mitigation efforts. Nevertheless, while levels of ICI participation do not indicate a company's mitigation success, increased participation rates lead to ICIs gaining more prominence, resulting in increased awareness of corporate climate action among different stakeholders such as investors and the broad public. This, in turn, increases the pressure on firms to take their climate commitments more serious.

6. Evaluating the achievements of chemical sector companies in the SBTi

This chapter aims to dive deeper into the topic of NSA climate action by scrutinizing the progress, implementation, and impact of chemical sector companies having joined the SBTi. We therefore seek to answer the following research question:

SQ3: "What climate mitigation progress has been achieved so far by companies in the chemical sector that participate in the Science-Based Targets initiative?"

As delineated in section 4.5.1, we will employ the log frame model by Hale et al. (2020), a framework designed for assessing the advancement of NSA climate action within four domains of progress: ambition, robustness, implementation, and substantive progress. Consistent with earlier analyses, our focus will center on scopes 1 and 2, given the constraints in data availability regarding scope 3, a topic addressed at various junctures throughout this research. Additionally, owing to discrepancies in the definition of intensity metrics among the various companies in the sample, we will concentrate on absolute targets within the SBTi.

The chapter is structured as follows: In the initial section, section 6.1, we delve into the overall target setting of chemical sector companies in the SBTi. Subsequently, in section 6.2, we evaluate members with absolute scope 1+2 targets based on four types of progress, namely, ambition, robustness, implementation, and substantive progress. Moving forward, section 6.3 provides an assessment of the overall causal progress, incorporating an ex-post analysis of the previously examined four types of progress. This is undertaken to comprehend the collective impact of chemical sector companies with absolute scope 1+2 SBTs. Finally, section 6.4 brings the chapter to a close by summarizing key points and presenting conclusions.

6.1 Chemical sector companies in the SBTi

A preliminary assessment of the climate achievements of chemical sector companies participating in the SBTi, considering all types of targets, yielded unexpected findings. As we have seen, the overall scope 1+2 emissions for the entire company sample decreased by approximately -11% from 2018 to 2022. However, when focusing on companies with approved SBTi targets, constituting 23 out of the 50 companies in our sample, there is an observed increase in emissions of about 26%, in contrast to a decrease of approximately -18% for non-SBTi members *(n=20)* and around -6% for those companies having merely made commitments within the SBTi but do not have approved targets yet *(n=7).* The detailed calculations for these figures can be found in Appendix M. Figure 6.1 below illustrates the cumulative change in scope 1+2 emissions for SBTi members (companies with approved targets). Despite a slight decrease between 2021 and 2022, the overall trend shows an upward trajectory.

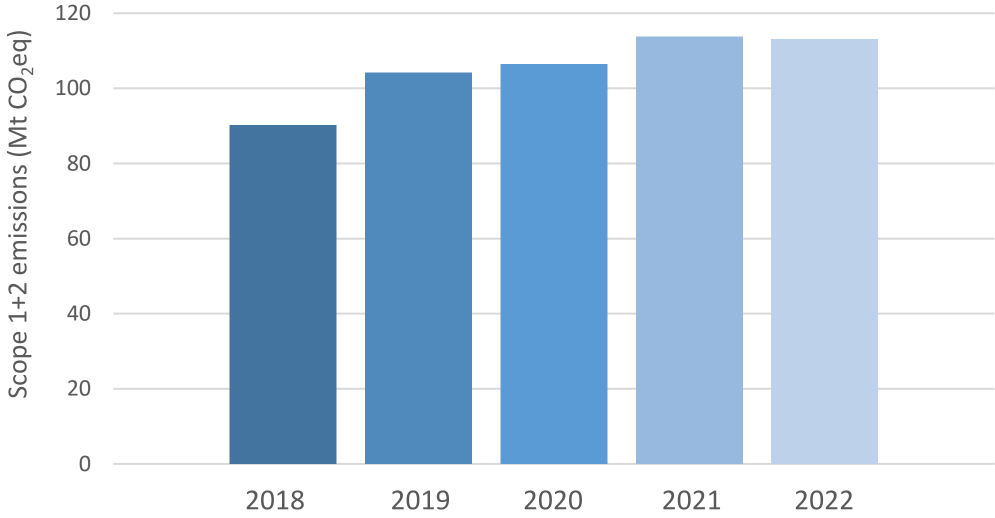


Figure 6.1: Evolution of combined scope 1+2 emissions of all companies with approved SBTi targets.

While Figure 6.1 illustrates the overall evolution of scope 1+2 emissions for all companies with SBTs, regardless of their respective base years, Appendix N provides plots making differentiations based on the base year of targets. If companies have established multiple targets at different points in time, for the purpose of distinguishing company progress by starting year, we will consider the earliest starting year (base year) of the first target set by a particular firm. It is important to note that the graphs for companies that initiated their targets in the years 2013, 2018, and 2020 are not included. This omission is due to the fact that, in each of these years, only one company from our sample - namely FUJIFILM, Teijin, and Akzo Nobel, respectively - set an SBT. The evolution of combined scope 1+2 emissions for these companies has already been depicted in the company-level plots, available in Appendix L.

As evident from the plots in Appendix N, we note scope 1+2 emission reductions across all company sub-samples that initiated targets in 2020 or earlier. Only those companies that set their SBT base year in 2021, therefore, joined the initiative at a later point in time, exhibit an increase in emissions. This suggests that companies with longer-standing participation in the SBTi demonstrate more substantial success in mitigating their emissions, indicating the effectiveness of the initiative over time in supporting companies in their climate action endeavors.

Given the constraints of applying the log frame model by Hale et al. (2020) in its entirety exclusively to companies with absolute scope 1+2 targets, encompassing 23 targets set by 21 companies (Saint-Gobain and Takeda having established both short-term and long-term scope 1+2 targets), we cannot assess all companies affiliated with the SBTi. However, recognizing that the overall climate action progress of chemical sector companies in the SBTi appears to be lacking thus far serves as an intriguing foundation for subsequent analyses.

Figure 6.2 below offers a comprehensive overview of the various targets and commitments established by companies in our sample within the SBTi, presented in absolute numbers. Out of the absolute targets, three pertain to long-term goals (with target years set for either 2040 or 2050), whereas 37 are associated with near-term targets (with target years in 2025, 2030, or 2035). Most companies, about 80%, are using the market-based scope 2 reporting method for tracking progress (refer to section 4.3 for detailed information). Moreover, it is important to note that all absolute targets for both scope 1 and scope 2 were combined, meaning that the target baseline encompasses the sum of both scopes, and the targeted emissions in the target years are also articulated as the sum of scopes 1+2.

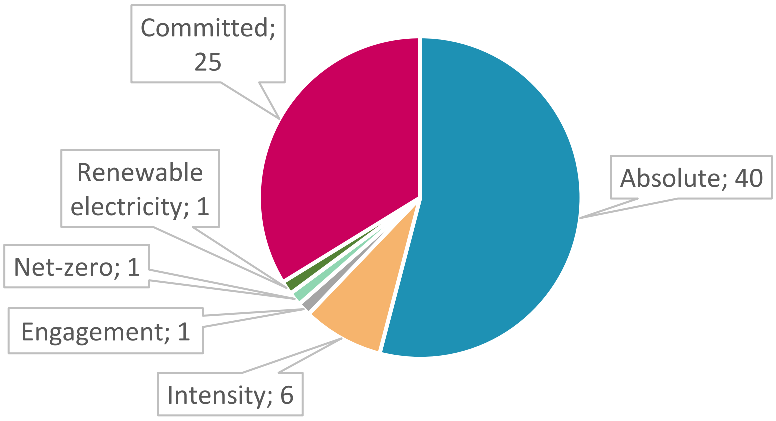


Figure 6.2: Overview of all target types and commitments of our company sample in the SBTi. According to data from the SBTi.

Additionally, Table 6.1 provides further insights into the scopes covered and the temperatures to which the targets are aligned, encompassing both absolute and intensity targets.

Table 6.1: Temperature alignment and scopes covered of absolute and intensity SBTs set by companies in our sample.

		Absolute target			Intensity target		
Targets & commitments	**n**	**Scope 1+2**	**Scope 1+2+3**	**Scope 3**	**Scope 1+2**	**Scope 1+2+3**	**Scope 3**
1.5°C	41	19	-	14	1	-	4
Well-below 2°C	6	3	1	2	-	-	-
2°C	2	1	-	-	-	-	1
Committed	25	NA	NA	NA	NA	NA	NA
Grand Total	**74**	**23**	**1**	**16**	**1**	**0**	**5**

6.2 Achievements of chemical sector companies with absolute scope 1+2 targets

This section presents the outcomes of the log frame analysis for chemical sector companies in our sample that have established absolute scope 1+2 targets. The results are categorized into distinct sub-sections, each focusing on a type of progress: the ambition of targets, the robustness of disclosure practices, changes implemented in energy metrics to achieve targets, and the substantive impact that the companies' actions had on their respective scope 1+2 emissions.

All figures in the ensuing sub-sections illustrate the number of companies *(n)* with active targets in each year. This provides insight into the target coverage for each specific year within the studied time frame for each type of progress.

6.2.1 Ambition

Figure 6.3 below illustrates the collective ambitions of all 21 companies with established absolute scope 1+2 targets, compared against three scenarios: SSP1-19 and SSP1-26 scenario ranges for OECD90+EU countries in Industrial and Energy Processes, and the IEA Net Zero by 2050 Pathway for the global chemical sector. Due to the scenario issues we encountered relating to the different units (extended targets in *Mt* CO_2*eq* and scenarios in *Mt* CO_2), we opted to present the combined targets and scenarios as a percentage relative to the emission level of the current year, 2023. This approach facilitated a comparison of the targets against the scenarios while mitigating challenges arising from different units. Moreover, the collective ambitions are weighted by the size of companies or, more specifically, their volume of GHG emissions. This allows us to derive more meaningful insights in term of measuring the impact of the combined ambitions of companies with absolute scope 1+2 SBTs.

As evident, the combined ambitions align closely with the SSP1-19 (1.5°C) and SSP1-26 (1.8°C) scenarios, consistent with the SBTi target classifications of these companies, which have primarily established absolute scope 1+2 targets in line with a 1.5°C pathway (with only three targets aligning with a well-below 2°C and one target aligning with a 2°C pathway). In absolute numbers, scope 1+2 emissions for all 21 companies are targeted to decrease by approximately -27%, reducing from around 118 *Mt* CO_2*eq* in 2015 to about 86 *Mt* CO_2*eq* in 2030.

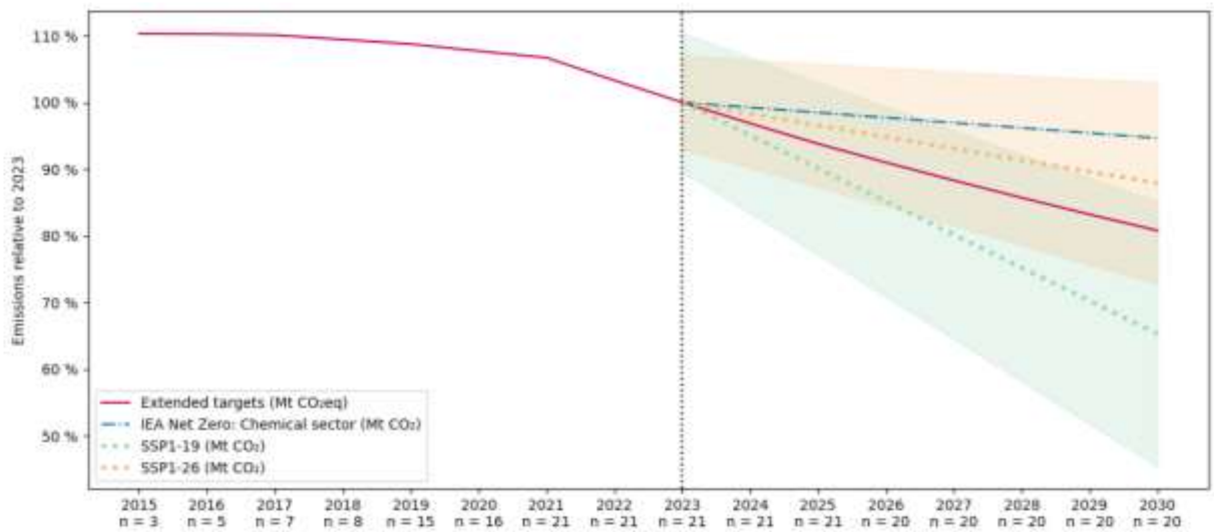


Figure 6.3: Overall combined ambitions (weighted by emission levels) of 21 companies with absolute scope 1+2 targets compared against scenarios from the IPCC (2021) and the IEA (2021).

Subsequently, to examine potential differences in headquarter locations and, in particular, to see if Dutch companies set more ambitious targets than their EU-based or global competitors, we subdivided the sample into the headquarter split samples initially used before. Therefore, we divided the overall sample *(n=21)* into companies headquartered in the Netherlands *(n=3),* those headquartered in the EU (excluding the Netherlands) (*n=4*), and those headquartered elsewhere (non-EU) *(n=14).* The outcomes for these three analyses are collectively illustrated in Figure 6.4 below.

Observing the results, it seems like chemical sector companies headquartered in the Netherlands are establishing more ambitious targets, aligning with the SSP1-19 scenario and consequently, a 1.5°C pathway. In comparison, EU-based firms exhibit ambition levels spanning between the SSP1-19 and SSP1-26 scenarios, similar to the combined ambition of the overall company sample with absolute scope 1+2 targets. However, caution should be exercised, as the Dutch and EU company samples consists of only three and four companies, respectively, representing sample sizes too small to make any definitive statements.

Finally, the split sample of companies with headquarters outside the EU, while still within the SSP1-19 and SSP1-26 scenario ranges, has set the least ambitious targets. Nevertheless, it is important to note that this split sample is also significantly larger than the other two sub-sample groups, enhancing its generalizability to the ambitions of companies headquartered outside the EU.

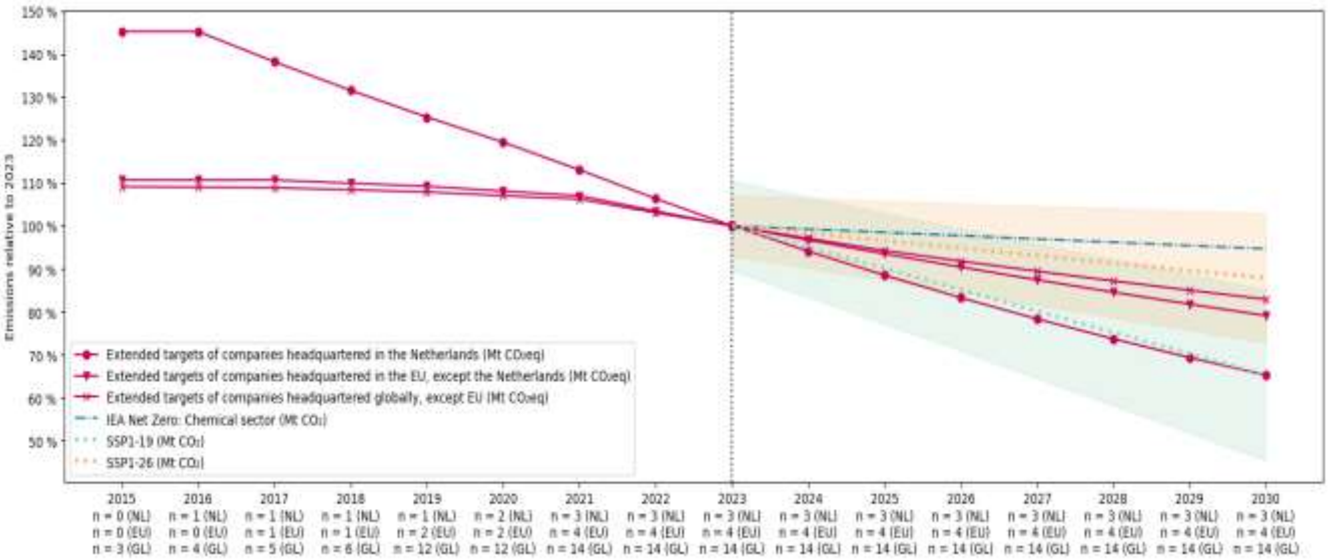


Figure 6.4: Combined ambitions (weighted by emission levels) of split-sample companies headquartered in the Netherlands, the EU (excl. NL), and globally (excl. EU) with absolute scope 1+2 targets compared against scenarios from the IPCC (2021) and the IEA (2021).

Additionally, we conducted further analysis to assess if there is a discernible difference in the collective ambition of absolute scope 1+2 targets among companies that have joined two, three, four, or five ICIs (including the SBTi). The results of this analysis are discussed below and graphically presented in the four plots showcased in Appendix O. As there is only one company in the SBTi - Roche Holding - that has joined only one ICI, namely, the SBTi, and Roche Holding has not yet obtained approved targets, maintaining the "committed" status, no analysis has been conducted, and consequently, no plot is depicted for the ambition of SBTi companies with absolute scope 1+2 targets that have joined only one ICI.

The outcomes of this additional analysis reveal that, across all sub-samples, ambition levels fall within the range of the SSP1-19 (1.5°C) and SSP1-26 (1.8°C) scenarios. Furthermore, the findings suggest that the highest ambition levels were observed in companies that joined four ICIs *(n=1),* aligning with a 1.5°C pathway, followed by those companies that joined five ICIs *(n=6).* The third most ambitious combined targets were established by businesses that participated in three ICIs *(n=3),* while the least ambitious targets were associated with companies involved in two ICIs *(n=11).* However, also here, it is crucial to exercise caution in interpreting these results due to the varying sizes of sub-samples, which affects the reliability of statements about the results and their generalizability to other companies that have joined a certain number of ICIs.

Overall, due to the exceptionally small size of certain sub-samples, with some comprising only a single company, it is not possible to draw reliable conclusions. Instead, we can only offer suggestions that hint at the potential for higher ambitions among Dutch-headquartered companies. The same holds true for the analysis testing for levels of participation in ICIs and target ambitions. Although it appears that companies with more instances of ICI participation tend to set more ambitious targets, the limited sample sizes prevent us from making anything beyond suggestive observations.

Lastly, to delve deeper into the data beyond examining the average ambition levels of the entire company sample and checking for effects of headquarter locations and levels of ICI participation, we opted to analyze the reduction trajectories of individual companies. Table 6.2 below illustrates the distribution of these trajectories by organizing the results into percentage ranges, along with the number and names of companies falling into each range. These percentage ranges reflect the targeted emissions level in 2030 relative to those of this year, 2023. A comprehensive table depicting the percentage levels in 2030 for each company can be found in Appendix P.

Table 6.2: Distribution of GHG emission reduction trajectories. Ranges of ambition levels in 2030, relative to 2023 and (number of) companies with absolute scope 1+2 SBTs falling into each range.

Range in 2030, relative to 2023	**Number of companies**	**Companies**
50-60%	3	Avery Dennison, Givaudan, International Flavors & Fragrances IFF
60-70%	13	Astellas Pharma, DSM, Oriflame, PPG Industries, Arkema, LANXESS, Takeda Pharmaceutical Company, Teva Pharmaceutical Industries, Merck & Co. Inc., Gilead Sciences, Synthomer, Akzo Nobel, Corbion
70-80%	0	-
80-90%	4	Saint-Gobain, Air Liquide, Linde, Teijin
90-100%	1	Cargill

As indicated in Table 6.2, three noteworthy companies, namely Avery Dennison, Givaudan, and International Flavors & Fragrances IFF, have set the most ambitious targets, falling within the 50-60% range relative to 2023. These ambitions align with the lower boundary of the SSP1-19, representing the 1.5°C scenario outlined by the IPCC. Likewise, companies falling within the 60-70% range align with this pathway, positioning themselves within the middle of the SSP1-19 scenario range. Moving to the 80-90% range, these companies fall between the SSP1-19 and the SSP1-26 (1.8°C) scenarios. Meanwhile, Cargill, the company with the least ambitious target located in the 90-100% range, aligns between the SSP1-26 scenario and the IEA Net Zero by 2050 Pathway for the global chemical sector.

As depicted in Figure 6.3, when combined, the overall weighted ambition levels reach approximately 81% relative to the level of 2023. However, an examination of Table 6.2 reveals that the majority of company targets fall within the 60-70% range. This disparity underscores the relative significance of company sizes and their respective emission levels. Notably, companies such as Air Liquide and Linde, each contributing 35% of the total emissions within the company sample (firms with absolute scope 1+2 SBTs), emphasize the impact of company (and GHG emission) sizes on the overall outcomes. This reinforces our decision to portray weighted ambition levels rather than an average figure, acknowledging the substantial influence of company sizes on our results.

6.2.2 Robustness

The results assessing the progress on the robustness of companies that have established absolute scope 1+2 targets, examining the level of third-party verification for scope 1 and scope 2 separately over the 5-year period under study, are illustrated in Figure 6.5. Despite observing slight increases in verification coverage and enhancements in assurance levels for both scopes, it is noteworthy that the assurance levels remain inadequate, with no company attaining high assurance levels.

The most substantial level of assurance, termed "reasonable" assurance, has been reached by four companies. Cargill achieved this level in 2018 for scopes 1 and 2, as well as in 2019 for scope 1, while DSM obtained it from 2018 to 2022 for all scopes (except scope 3 in 2018). International Flavors & Fragrances IFF attained reasonable assurance in 2022 for scopes 1 and 2, and Linde secured it in 2022 for scopes 1 and 2 as well.

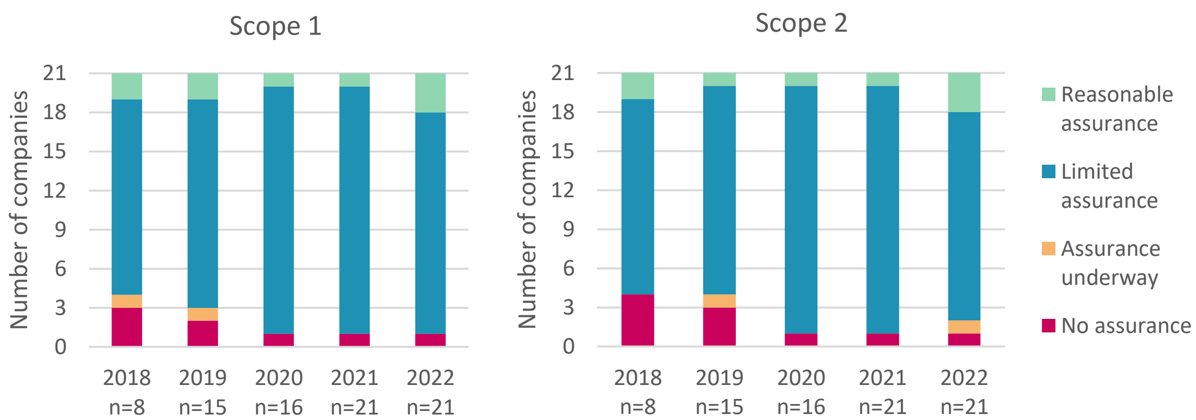


Figure 6.5: Level of third-party verification for scope 1 and 2 of all 21 companies with absolute scope 1+2 targets.

In addition to the results for the scope 1 and 2 robustness checks for companies with absolute scope 1+2 targets *(n=21),* we conducted an extended analysis on overall robustness, encompassing all absolute targets, including scope 3. This increased our sample size by one company, the Japanese firm FUJIFILM, resulting in a total of 22 companies. The rationale behind this extended analysis is to explore third-party verification trends for scope 3 emissions, despite excluding scope 3 figures from the analyses. This investigation aims to assess if there is an observable trend indicating increasing verification of scope 3 emissions, potentially enhancing the reliability of scope 3 quantifications in the future. Charts depicting the results of this analysis can be found in Appendix Q. Notably, FUJIFILM is the only company that achieved the level of "high assurance" for scopes 1 and 2 in 2018 and from 2020 to 2022, as well as for scope 3 between 2020 and 2022, indicating the company's potential role as a trailblazer for other firms seeking to improve their control and management practices for all three emission scopes.

Additionally, we conducted further analyses to examine the evolution of relevant assurance standards and the coverage of verified emissions over time. Several insights emerged: Firstly, assurance standards have become more standardized over time. In 2018, there was a higher variation in standards in use, while in 2022, fewer different standards were employed (Figure 6.6). Secondly, the analysis reveals that over time, an increasing number of companies have their emissions verified by third parties. Moreover, the predominant standard is the ISEA3000, the International Standard on Assurance Engagements 3000. Please note that even though verification standards for scope 3 in 2018 were provided in the CDP questionnaires, there was no data on the level of assurance and the proportion of emissions verified.

Figure 6.6: Relevant verification standards of 22 companies with absolute scopes 1,2, and 3 targets. Standards used over time for scopes 1,2, and 3.

Finally, we examined the evolution of the percentage of emissions verified over the years, from 2018 to 2022. This analysis indicates that, over time, emission assurance has become more sophisticated, encompassing a higher percentage of emissions verified for all scopes (Table 6.3 and Figure 6.7). This analysis has also been extended to the company sample that has set absolute scope 1, 2, and 3 targets *(n=22)* in order to assess scope 3 assurance coverage as well.

Table 6.3: Scope 1,2, and 3 emissions verified over time of 22 companies with absolute scopes 1,2, and 3 targets.

	SCOPE 1	SCOPE 2	SCOPE 3	AVERAGE
2018	93%	95%	-	94%
2019	96%	99%	92%	96%
2020	99%	99%	97%	98%
2021	100%	100%	95%	98%
2022	100%	100%	98%	99%

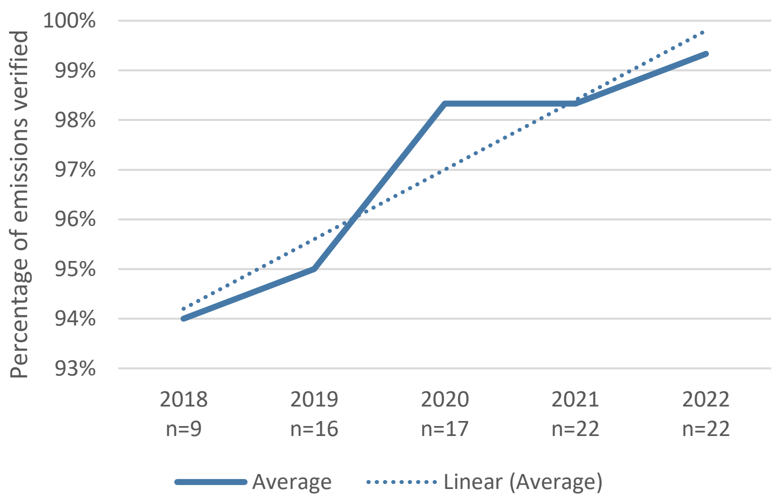


Figure 6.7: Average of scope 1,2, and 3 emissions verified over time of 22 companies with absolute scopes 1,2, and 3 targets.

Please note that for all analyses in the robustness checks, we decided not to conduct split-sample assessments, neither for the different headquarters locations nor for the number of ICIs that companies participated in. The reason for that is that we obtained similar results for all companies of the sample, and additional analyses would not have provided further insights.

The only insight that stood out is the high level of assurance of FUJIFILM, a Japan-based company. This observation could imply that Japanese companies potentially excel and attain a higher level of performance in terms of third-party verification. Yet, a closer look at other companies headquartered in Japan with absolute SBTs, such as Astellas Pharma, Teijin, and Takeda Pharmaceutical Company, reveals that these companies have also merely achieved the level of "limited assurance". Therefore, it is evident that FUJIFILM's exceptional performance in third-party verification is most likely not attributed to the company's headquarter location.

Moreover, as reasonable assurance was achieved by Cargill, DSM, International Flavors & Fragrances IFF, as well as Linde, companies headquartered in the US, the Netherlands, the US, and Ireland, respectively, the relatively equal distribution of reasonable assurance across these diverse headquarters locations suggests that assurance levels are not tied to a company's headquarter location.

6.2.3 Implementation

The assessment of implementation progress involved scrutinizing the energy consumption of companies with absolute scope 1+2 SBTs, utilizing five specific indicators outlined in section 4.5.1. It is worth noting that Akzo Nobel and Teva Pharmaceutical Industries were excluded from the primary analysis due to a lack of granular data; however, their implementation progress will be addressed in a separate analysis in this section. Figure 6.8 below illustrates the average consumption of the company sample *(n=19)* categorized by different energy sources. While the graph displays four indicators, the fifth - self-generated non-fuel renewable energy - has been omitted due to its limited representation. A more granular company-level representation of different energy sources consumed in 2022 for all companies, including Azo Nobel and Teva *(n=21),* is depicted in Appendix R.

Figure 6.8 also reveals a notable surge in electricity consumption, especially from non-renewable sources, in 2020. Upon individual company-level analysis, this spike was attributed primarily to the activities of one company, the US-based commodities firm Cargill. We hypothesize that the increase in Cargill's electricity consumption in 2020 resulted from heightened commodities production activities in response to the COVID-19 pandemic. However, this spike may also be the result of a mathematical error (a comma set in the wrong place), highlighting data issues when it comes to self-reported data obtained from the CDP questionnaires.

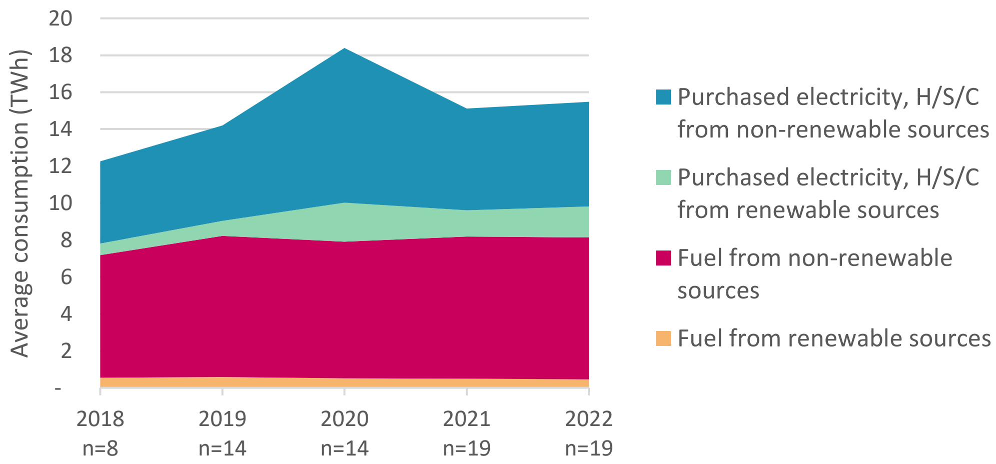


Figure 6.8: Average consumption of different energy sources of 19 companies present in the Netherlands with absolute scope 1+2 targets.

Another noteworthy observation is the overall growth in average energy consumption over the years, increasing about 26%, from roughly 25 *TWh* to around 31 *TWh*, indicating the expansion of the chemical sector, which is expected to persist as global industries heavily depend on products from this sector.

The fluctuations in energy consumption per company from 2018 to 2022 are visually represented in the graph found in Appendix S. Simultaneously, Table 6.4 below summarizes the insights obtained by categorizing companies into ranges based on their changes in total energy (inclusive of renewable and non-renewable fuels and electricity) consumption, offering a comprehensive view of the evolving energy consumption within the company sample.

Observably, about half of the companies witnessed an increase in their energy consumption between 2018 and 2022. Notably, two companies, Linde and International Flavors & Fragrances IFF, stand out with substantial increases, registering a growth of 137% and a remarkable 798%, respectively. In contrast, Akzo Nobel achieved the most significant reduction in energy consumption, decreasing it by -53% between 2018 and 2022. Even though half of the companies in the sample decreased their energy consumption, as the two largest consumers, namely, Air Liquide and Linde, increased theirs during the five-year period, the overall observed trend was an increase by the aforementioned 26%, once more highlighting the importance of large emitters.

Table 6.4: Distribution of changes in energy consumption between 2018 and 2022 and (number of) companies with absolute scope 1+2 SBTs falling into each range.

Change in energy consumption between 2018 and 2022	Number of companies	Companies
0% to 25%	2	DSM, LANXESS
25% to 50%	5	Arkema, Corbion, Gilead Sciences, Givaudan, Air Liquide
50% to 100%	2	Synthomer, Takeda Pharmaceutical Company
> 100%	2	International Flavors & Fragrances IFF, Linde
-1% to -25%	6	Astellas Pharma, Avery Dennison, Merck & Co. Inc., PPG Industries, Cargill, Saint-Gobain
-25% to -50%	3	Oriflame, Teijin, Teva Pharmaceutical Industries
< -50%	1	Akzo Nobel

Besides the overall growth in average energy consumption over the years, we observe an upward trend in renewable energy consumption, primarily driven by an increase in purchased electricity and H/S/C from renewable sources. Furthermore, the consumption of fuel from renewable sources has declined over time. Notably, the consumption of self-generated non-fuel renewable energy experienced a significant drop in 2019, followed by a gradual increase, and a substantial surge from 2021 to 2022.

To facilitate comparisons between the energy consumptions of the company sample under study and the benchmarks outlined in section 4.5.1, we adopted a refined categorization approach, organizing all data (previously expressed via five energy metrics) into three main categories:

1. Renewables and biofuels
2. Non-renewables
3. Electricity and H/S/C

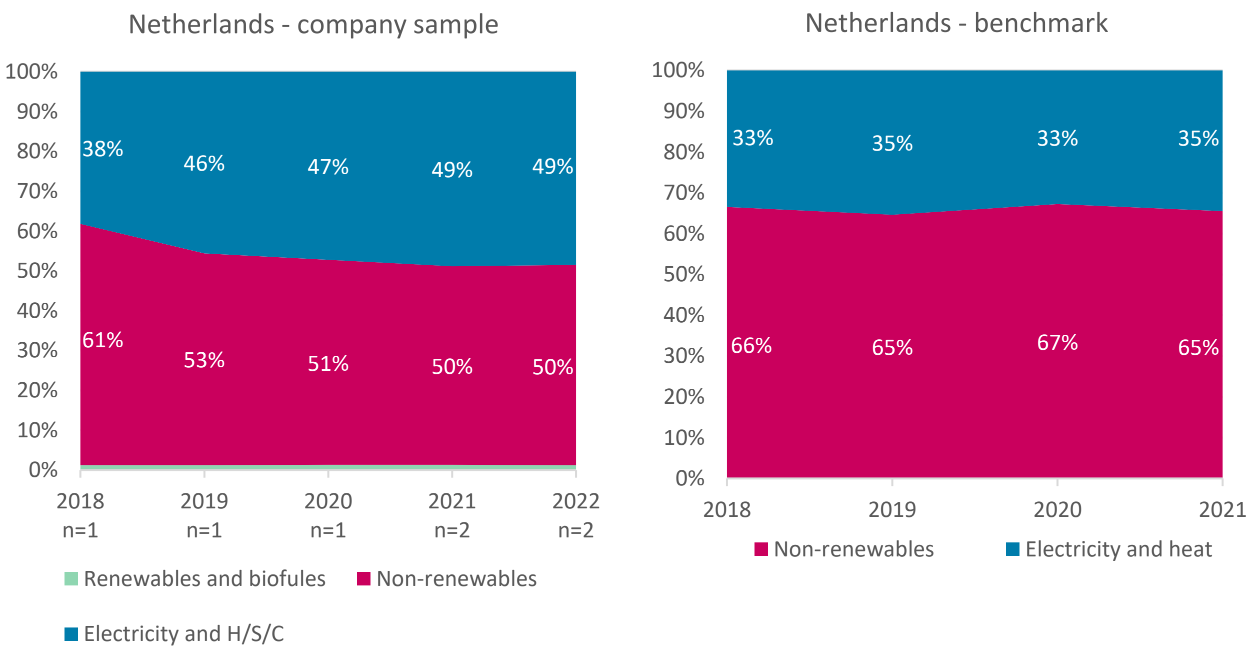
Although this consolidation removes the distinction between purchased electricity and H/S/C in renewable vs. non-renewable sources, we aligned our reporting with the Eurostat and IEA benchmarks, where electricity is presented as a single figure without differentiation between renewable and non-renewable sources.

This adjustment enabled a comparative analysis of the proportions of different energy sources consumed relative to the overall consumption. The comparisons were conducted across distinct split-samples based on headquarters location. However, these split-samples differ slightly from those used in previous analyses as certain countries could not be excluded from our benchmarks.

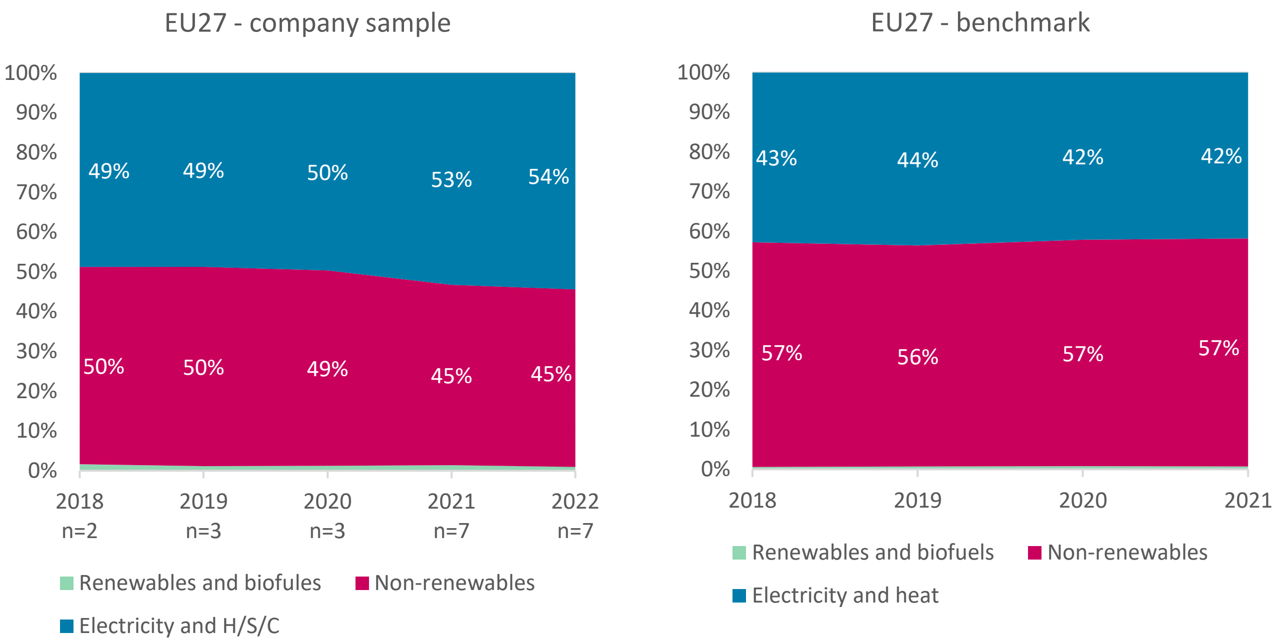
Specifically, we compared companies in our sample headquartered in the Netherlands to the Chemical and Petrochemical Industry in the Netherlands benchmark. Additionally, we compared EU companies (including the Netherlands) in our sample to the Chemical and Petrochemical Industry in the EU27 benchmark. Lastly, we compared our overall sample to the Global Industry Sector benchmark. Also in this analysis, Akzo Nobel and Teva Pharmaceutical Industries were excluded since electricity consumption was unknown. The results of this comparative analysis are illustrated in Figure 6.9.

The comparison reveals that companies within the Netherlands and EU split samples generally exhibit slightly higher consumption of renewables and biofuels in contrast to their respective benchmarks. Conversely, at the global level, there is a lower utilization of renewables and biofuels compared to the benchmark. It is crucial to keep in mind, however, that the benchmarks for the Netherlands and the EU pertain to the chemical and petrochemical industry, while the global benchmark encompasses the overall industrial sector. This might distort the results and explain why we observe different trends for the Netherlands and EU vs. the global benchmark.

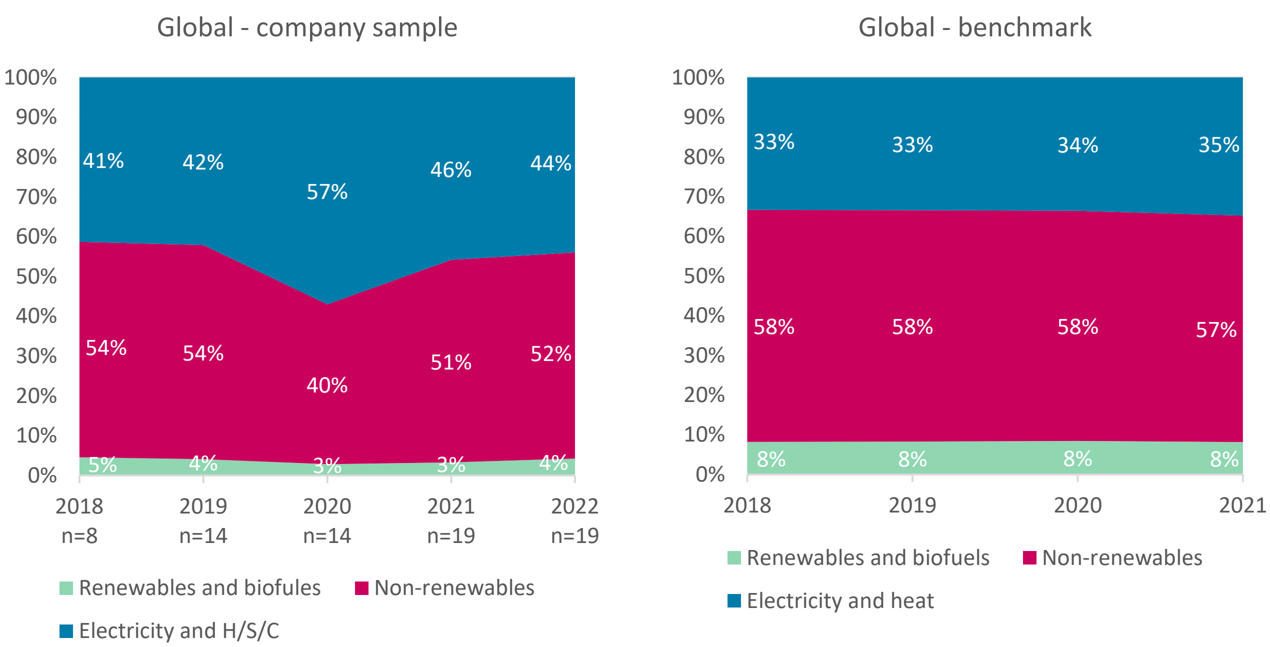
Across all split samples, electricity consumption surpasses the respective benchmarks. Furthermore, although there is no discernible trend indicating an increase in renewables and biofuel consumption over the years, there is a noticeable upward trajectory in electricity consumption. This suggests a global shift toward electrification of vehicles and machinery, steering away from the combustion of fossil fuels. Notably, in all split samples and benchmarks, electricity consumption has risen when comparing levels from 2018 to 2022.



(a) Energy consumption by source over time of companies with absolute scope 1+2 targets headquartered in the Netherlands (n=2) compared to the Chemical and Petrochemical Industry in the Netherlands benchmark. In the company sample, renewables and biofuels remained at 1%, and in the benchmark at 0%, over the entire time.



(b) Energy consumption by source over time of companies with absolute scope 1+2 targets headquartered in the EU27 (n=7) compared to the Chemical and Petrochemical Industry in the EU27 benchmark. In the company sample, renewables and biofuels 2% in 2018, then decreased and remained at 1% until 2022, in the benchmark it remained at 1% (2018-2021).



(c) Energy consumption by source over time of all companies with absolute scope 1+2 targets (n=19) compared to the Global Industry Sector benchmark.

Figure 6.9: Comparisons of implementation progress for companies with presence in the Netherlands having set absolute scope 1+2 targets, sub-samples divided by headquarter locations compared to respective benchmarks from Eurostat (2022a, 2022b) and the IEA (2023b).

Finally, we undertook a comprehensive company-level analysis by examining the proportion of renewables consumed by each company between 2018 and 2022 relative to their overall energy consumption. Figure 6.10 depicted below illustrates the share of renewables, including biofuels, self-generated non-fuel renewable energy, and electricity and H/S/C from renewable sources, for each company in 2018, as well as the percentage changes in renewable energy consumption from 2018 to 2022. As mentioned before, both Akzo Nobel and Teva Pharmaceutical Industries are encompassed in this analysis.

Notably, companies like Corbion, Takeda, and Gilead Sciences demonstrated substantial increases in the share of renewable energy, achieving a remarkable 23%, 19%, and 17% growth, respectively. Conversely, Air Liquide, International Flavors & Fragrances IFF, and Arkema experienced reductions in their shares of renewables consumed, with decreases of -4%, -2%, and -1%, respectively.

Moreover, overall renewable energy consumption (biofuels, self-generated non-fuel renewable energy, and electricity and H/S/C from renewable sources) of the entire company sample including Akzo Nobel and Teva Pharmaceutical Industries *(n=21)* increased by 4% between 2018 and 2022, from 10% to 14%.

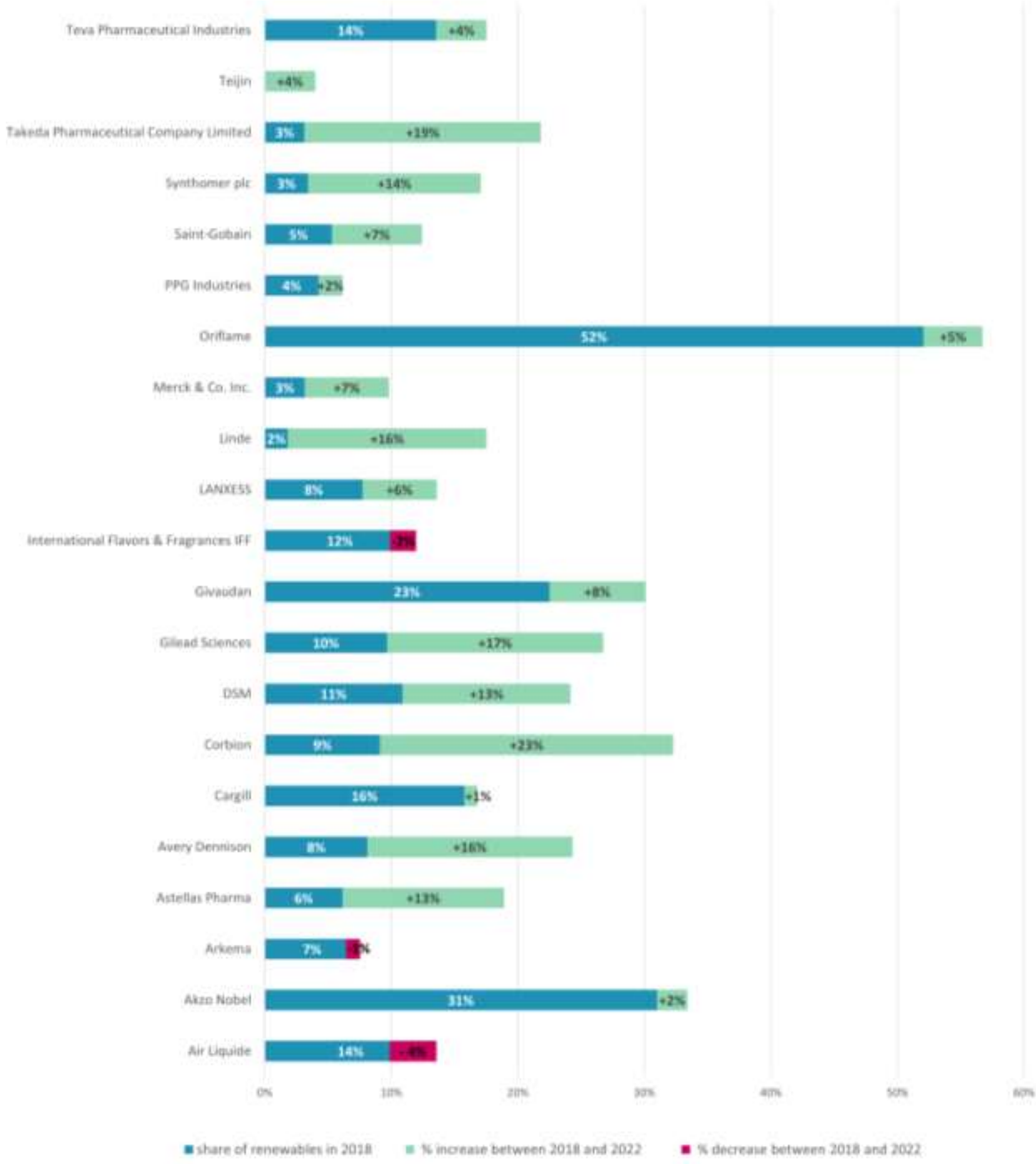


Figure 6.10: Share of renewable energy (both fuels and electricity) in 2018 of companies with absolute scope 1+2 targets (n=21) relative to their overall energy consumption and changes from 2018 to 2022.

6.2.4 Substantive progress

The final category of progress, namely substantive progress, promises to enhance our comprehension of the outcomes stemming from involvement in the SBTi, encompassing both direct and indirect impacts.

Direct

Direct substantive progress evaluates the success of mitigation efforts by chemical companies in our sample that have set absolute scope 1+2 SBTs, comparing their achievements to the collective ambitions outlined in section 6.2.1. As depicted in Figure 6.11 below, in 2018, the combined scope 1+2 emissions of these companies were significantly lower, specifically, approximately 29 *Mt* CO_2*eq*, than their combined emission targets in that year. However, in the years following 2018, the chemical sector experienced a substantive increase in emissions rather than the anticipated decrease. Overall, the total scope 1+2 emissions from the 21 companies with absolute scope 1+2 targets set rose by about 26% between 2018 and 2022, climbing from around 88 *Mt* CO_2*eq* to approximately 112 *Mt* CO_2*eq,* surpassing the targeted emissions level between 2021 and 2022.

In contrast, the targeted emissions from the collective ambitions of these companies were expected to decrease by -6% from 2018 to 2022, from about 117 *Mt* CO_2*eq* to around 111 *Mt* CO_2*eq*. Despite the substantial overall emissions growth, there is a slight reduction in emissions (-0.5 *Mt* CO_2*eq*) observable between 2021 to 2022, attributed to a decrease in scope 2 emissions by 0.8 *Mt* CO_2*eq,* while scope 1 emissions continued to rise. Refer to Appendix T for the corresponding data table providing further insights.

Here, we would like to again emphasize the methodology concerning ambition progress outlined in section 4.5.1. The approach we utilized extended company targets, maintaining constant emission levels in the years before the target started (base year) and ended (target year). Consequently, even if companies had not established or initiated their targets by 2018, their projected emission levels are considered in this analysis through the extension method.

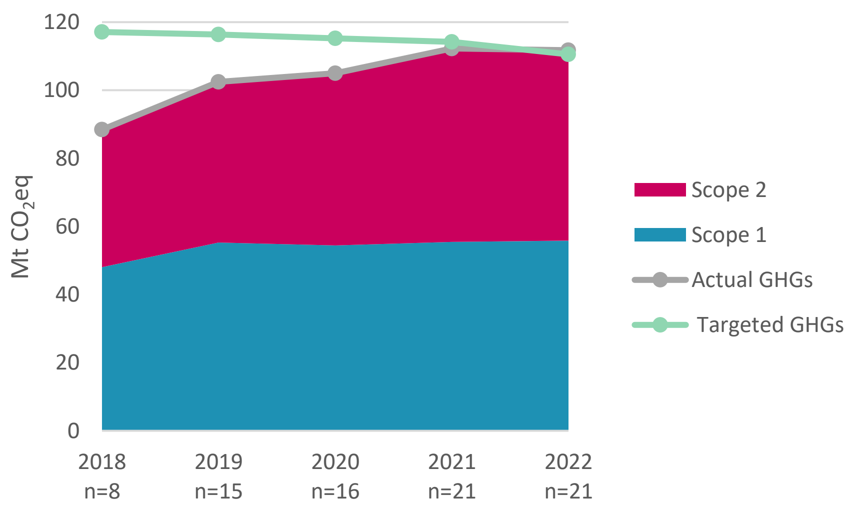


Figure 6.11: Targeted vs. actual scope 1 and 2 emissions of the companies with absolute scope 1+2 targets.

Upon examining the reported GHG emission results of companies, it swiftly became evident that four firms within the overall sample *(n=21)* accounted for approximately 88% of the total scope 1+2 emissions in 2022. These key emitters, listed in descending order based on their scope 1+2 emissions' magnitude, are Air Liquide, Linde, Cargill, and Saint-Gobain. To delve into the dynamics of emission fluctuations over the 2018-2022 period and discern the role of these major emitters in the substantial emission increase, we calculated the percentage changes in scope 1+2 emissions for all companies. This analysis aims to shed light on how emissions evolved over time and specifically how the aforementioned four prominent emitters performed.

The outcomes of this analysis for each of the companies with absolute scope 1+2 SBTs are illustrated in Appendix U. Additionally, Table 6.5 below shows the distribution of these results, categorizing the results into ranges, indicating how many companies, and which ones, have experienced scope 1+2 emission increases or decreases within specific percentage ranges.

Table 6.5: Distribution of changes in energy consumption between 2018 and 2022 and (number of) companies with absolute scope 1+2 SBTs falling into each range.

CHANGE IN SCOPE 1+2 EMISSIONS BETWEEN 2018 AND 2022	NUMBER OF COMPANIES	COMPANIES
0% TO 25%	3	Gilead Sciences, Givaudan, Synthomer
25% TO 50%	2	Air Liquide, Takeda Pharmaceutical Company
50% TO 100%	1	Linde
> 100%	1	International Flavors & Fragrances IFF
-1% TO -25%	8	Cargill, Corbion, DSM, LANXESS, Merck & Co. Inc., PPG Industries, Saint-Gobain, Teijin
-25% TO -50%	5	Akzo Nobel, Arkema, Astellas Pharma, Oriflame, Teva Pharmaceutical Industries
< -50%	1	Avery Dennison

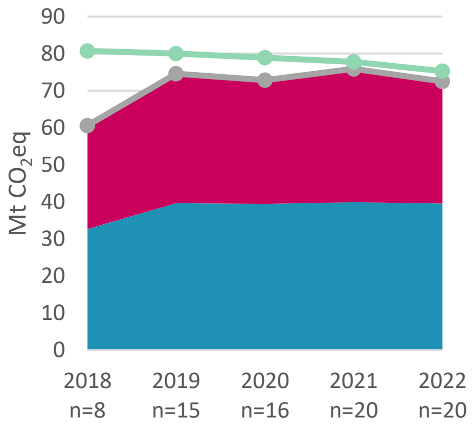
As anticipated, calculating the scope 1+2 emission changes between 2018 and 2022 yielded valuable insights into companies' performance in mitigating their GHG emissions. Notably, a considerable majority of companies in the sample, precisely two-thirds, achieved a reduction in their emissions. The "champions" in this were the companies Avery Dennison, Oriflame, and Teva Pharmaceutical Industries, decreasing their scope 1+2 emissions by -56%, -43%, and -41%, respectively.

On the other hand, when looking at the percentage changes in scope 1+2 emissions between 2018 and 2022 of the four previously mentioned largest emitters, we observed the following:

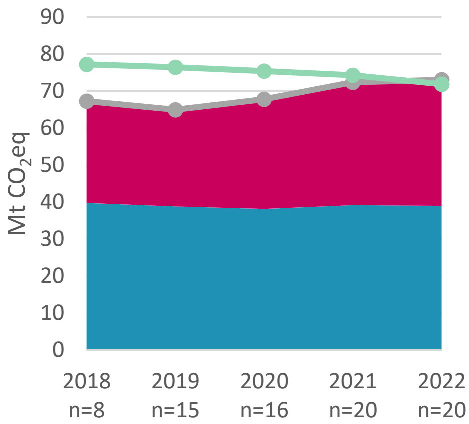
- Air Liquide: emission increase of 41%
- Linde: emission increase of 83%
- Cargill: emission decrease of -15%
- Saint-Gobain: emission decrease of -16%

Moreover, we noted a significant surge in emissions from International Flavors & Fragrances IFF, with an astonishing increase of 750%. This notable spike has already been observed when analyzing changes in company-level energy consumption between 2018 and 2022 (refer to section 6.2.3) and is primarily attributed to the tremendous growth the company experienced in recent years, more than tripling its revenues from 2018 to 2022 (MacroTrends, 2023b). Despite the magnitude of this 750% increase in emissions, it is noteworthy that IFF constitutes only approximately 1.6% of the total sample's emissions (as of 2022), rendering it less influential in shaping the overall emission trend.

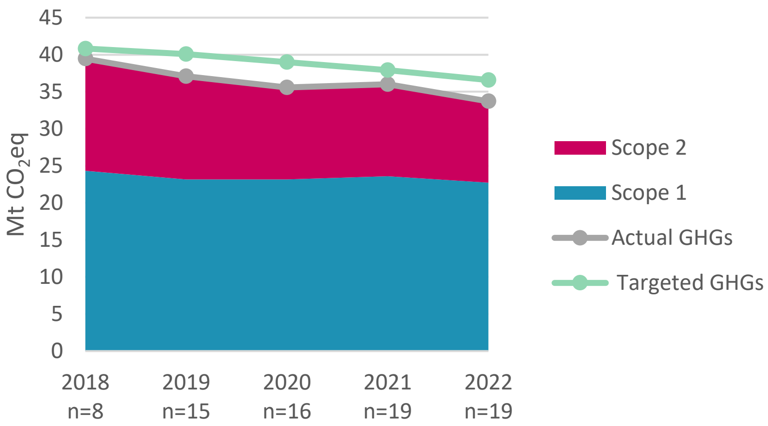
Regrettably, as we have seen, the two companies responsible for the most substantial share of emissions within the company sample, namely, Air Liquide and Linde, witnessed a considerable uptick in their emissions. In 2022, each of these companies individually contributed to 35% of the total scope 1+2 emissions, collectively constituting over two-thirds of the total emissions. To assess their impact on the results, we decided to refine the analysis by conducting three additional examinations: the first excluded Air Liquide from the analysis, the second excluded Linde, and the third excluded both companies from the sample. The outcomes of these analyses are illustrated in Figure 6.12.



(a) Company sample excluding Air Liquide (n=20)



(b) Company sample excluding Linde (n=20)



(c) Company sample excluding Air Liquide and Linde (n=19)

Figure 6.12: Additional analyses of targeted vs. actual scope 1 and 2 emissions of the company sample excluding Air Liquide, Linde, and both companies.

As evident from these three additional analyses, excluding both companies from the sample would align the companies that have established absolute scope 1+2 targets on a trajectory toward reducing their emissions. Furthermore, even if only Air Liquide were excluded from the sample, the companies would still be on course, despite a notable 83% increase in Linde's emissions from 2018 to 2022. These findings underscore that, notably, Air Liquide plays a pivotal role in surpassing the targeted emissions in 2022 outlined in the combined ambitions of the company sample under scrutiny. This emphasizes the critical impact of companies contributing the most to the overall emissions of the sample.

Figure 6.13 below illustrates the companies in the sample that were on track versus those not on track with their absolute scope 1+2 targets by the year 2022. Please note that, while not all companies had set already targets in the first years of the studied timeframe, we are comparing the emissions of companies to the extended targets, allowing us to make comparisons for all 21 companies in each of the five years. Notably, there is an observable increase in the number of companies on track from 2018 to 2019, which is explained by many companies having set targets in 2019; however, in the subsequent years, this figure gradually declined, suggesting that companies fail to meet their targets already after a short period of time after target-setting. Appendix V provides a detailed breakdown of this analysis for each company, indicating their on-track or not-on-track status for each year within the 5-year period under study.

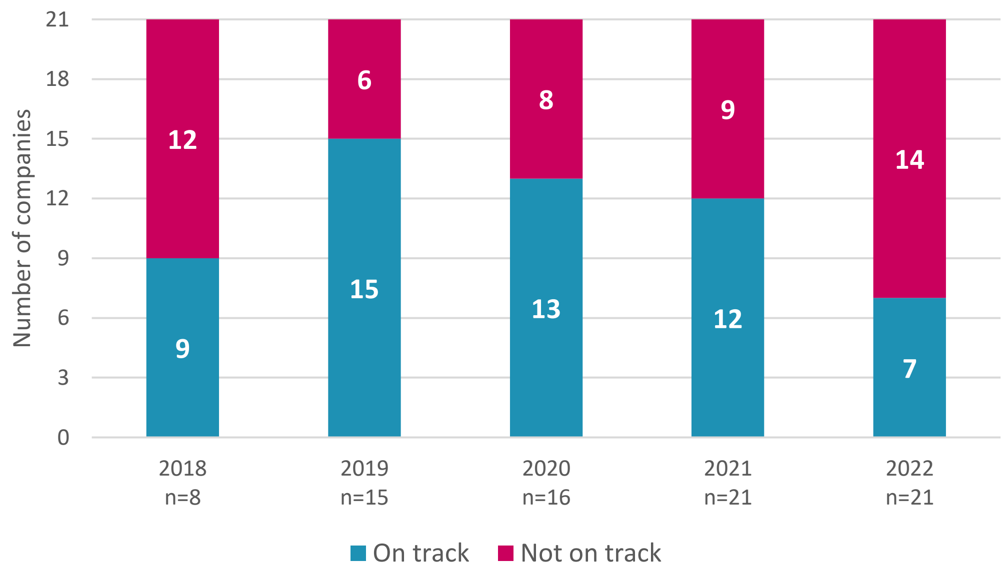


Figure 6.13: Companies with absolute scope 1+2 SBTs Companies whose emissions are above or below the extended target.

Furthermore, we conducted an assessment to discern any potential relationships between companies being on track and their headquarters' location, the number of ICIs they participated in, and their respective subsector. It is worth noting that, given that some companies had multiple locations or subsidiaries within the Netherlands, and for some, their subsectors varied, we opted for the subsector that contributed the largest portion to the respective parent company's overall revenue.

The outcomes of this analysis however did not reveal any significant relationships between a company's success in achieving its targets and factors such as its headquarters' location, the number of ICIs participated in, or its respective subsector. While Israel and France appeared to be promising headquarters locations, and "Basic Chemical Manufacturing" and "Soap, Cleaning Compound, and Toilet Preparation Manufacturing" seemed to yield more favorable results in terms of target achievement, it is essential to note that the sample size is relatively small, making it challenging to draw definitive conclusions. Therefore, we recommend replicating this analysis with a larger sample size to derive more conclusive and robust findings. The graphical representations of this analysis can be found in Appendix W.

Indirect

To evaluate indirect substantive progress, we begin by examining the ambition level of the set targets. As discussed in section 6.2.1, the majority of targets are notably ambitious and align with a 1.5°C pathway, accounting for 17 out of 21 targets. Among the companies successfully on track with their absolute scope 1+2 targets in 2022, namely, Arkema, Astellas Pharma, Corbion, Oriflame, Saint-Gobain, and Teva Pharmaceutical Industries, six are aligned with a 1.5°C pathway. The seventh company, Cargill, although on track, has set a target that is less ambitious, aligning with a 2°C pathway. We recommend revisiting Cargill's target and enhancing its ambition.

Of the remaining 14 companies not on track with their targets, three are aligned with a well-below 2°C pathway, and the rest align with a 1.5°C pathway.

The final analysis for assessing the indirect impact of companies setting absolute scope 1+2 targets involves examining the influence on national targets and policies. As mentioned before, this analysis is distinct from the log frame model and will be expounded upon later in this research, in Chapter 8. However, it is crucial to emphasize that the correlation between NSA and national climate action is an indirect consequence of companies participating in transnational climate governance, such as joining ICIs and setting SBTs.

6.3 Causal impact

Examining the causal impact of companies within the chemical sector having set absolute scope 1+2 SBTs allows for a comprehensive evaluation, synthesizing insights from previous sections on the four different types of progress. This assessment enables us to scrutinize the effectiveness of companies' mitigation efforts in the SBTi.

While companies are setting rather ambitious targets, predominantly aligning with a 1.5°C pathway, there is a noticeable absence of robust practices, with the majority achieving only limited assurance. Delving into implementation, chemical companies with absolute scope 1+2 SBTs, when compared to their respective benchmarks, demonstrate slightly superior performance compared to their counterparts in the same sector. Despite the overall sum of scope 1+2 emissions surpassing the targeted level in 2022, it is crucial to note that this discrepancy is primarily attributed to Air Liquide.

Other companies in the sample performed much better, maintaining emissions below the targeted level in 2022.

However, assessing which companies are on track with their targets reveals a declining trend since 2019. Only one-third of the companies in the sample *(n=21)* remained on track with their targets in 2022. This indicates that companies need to intensify efforts to realign with their targets.

Certain companies in the sample demonstrate commendable progress in their climate action endeavors, excelling in both implementation and substantive progress. The top performers, notably Avery Dennison, a US-based packaging materials manufacturer, and Oriflame, a Swiss cosmetics producer, showcase significant impact. In contrast, large emitters with a history of poor performance, such as Air Liquide and Linde, could benefit from studying these exemplary companies and adopting their best practices to enhance the overall causal impact of the company sample under study in the upcoming years.

Overall, while we see varying degrees of climate mitigation effectiveness of companies with absolutes scope 1+2 SBTs, we cannot make any statements about the efficiency. To do so, we would have to analyze the means (such as human or financial resources invested) for achieving a certain level of emission reductions. Doing so involves diving deep into individual company data, which is beyond the scope of this research.

6.4 Summary

This chapter aimed to address the research question:

SQ3: "What climate mitigation progress has been achieved so far by companies in the chemical sector that participate in the Science-Based Targets initiative?"

To address this inquiry, we employed the log frame model developed by Hale et al. (2020), which assesses the progress, implementation, and impact of NSA climate action on companies within our sample who have joined the SBTi. Within this framework, we evaluated four types of progress: ambition, robustness, implementation, and substantive progress. Our primary focus in this assessment is on scope 1 and 2 emissions due to data constraints related to scope 3 emissions.

Following an initial analysis to determine the achievements of SBTi members (companies with both targets and commitments), we uncovered a noteworthy trend. While non-SBTi members in our company sample *(n=20)* reduced their scope 1+2 emissions by approximately -18% between 2018 and 2022, SBTi members with approved targets *(n=23)* experienced an increase of about 26% in emissions during the same period. However, as we have demonstrated and will further explain in a subsequent paragraph of this summary, this significant increase is primarily attributed to two firms. Companies having made commitments within the SBTi *(n=7)* reduced their emissions by around -6% during this timeframe. Checking for differentiations in base years furthermore revealed that, while the company sub-samples that had joined the SBTi years ago managed to successfully mitigate their emissions between 2018 and 2022, the company sub-sample with the base year in 2021 reported an emissions increase. This points to the effectiveness of the SBTi over time in supporting company in reducing their emissions.

These discoveries served as a compelling foundation for further analyses, including the application of the log frame model by Hale et al. (2020). Overall, companies in the SBTi have established 40 absolute, six intensity, one renewable electricity, one net-zero, and one engagement target. Additionally, 25 companies hold a "committed" status and hence do not have approved targets yet.

Examining the ambitions of companies with absolute scope 1+2 targets revealed an alignment with the IPCC's SSP1-19 and SSP1-26 scenarios, signifying adherence to a 1.5°C pathway. Notably, a targeted decrease of around -27% in combined scope 1+2 emissions between 2015 and 2030 is envisioned. Moreover, companies headquartered in the Netherlands suggested to exhibit more ambitious targets than their EU and non-EU counterparts. Additionally, companies participating in more ICIs seem to set more ambitious targets. Nevertheless, caution is warranted in generalizing these results and we refrain from making any definitive conclusions due to the extraordinarily small sizes of some of the split samples. Overall, the impact of the weighted (by amount of GHG emissions) combined ambitions is lower than if the targets would have simply been averaged as large emitters have set less ambitious targets than most of the other companies in the sample.

The second type of progress assessed, robustness, highlighted a prevailing lack of third-party emission verification, with most companies achieving only "limited assurance" status. Some companies demonstrated improvements in this aspect, reaching "reasonable assurance" levels, such as Cargill, DSM, IFF, and Linde. Furthermore, FUJIFILM achieved levels of "high assurance." The robustness analysis also revealed that over time, the use of different verification standards has become more standardized, and an upward trend in the proportion of emissions verified for all three emission scopes has been observed.

Moving on to the assessment of progress in implementation, it was observed that the overall energy consumption of companies with absolute scope 1+2 SBTs increased by approximately 26% between 2018 and 2022, underscoring the importance of the chemical sector and its interconnectedness with other global industries, as the chemical sector is expected to grow further in the coming years. The results also highlighted a substantial surge in electricity consumption in 2020, attributed to commodities company Cargill, and assumed to likely be a result of the COVID-19 pandemic. Compared to their respective benchmarks, companies in our sample headquartered in the Netherlands and the EU outperformed, utilizing more renewables and biofuels, as well as electricity, than the average in their respective locations within the chemical and petrochemical sector. In global terms, looking at the global industry benchmark, our overall company sample with scope 1+2 SBTs *(n=21),* despite using more electricity, exhibited lower consumption of renewables and biofuels. Overall, these companies increased their renewable energy consumption by 4%, from 10% to 14% between 2018 and 2022.

The last type of progress assessed, substantive progress, offered a comprehensive understanding of the outcomes of companies in the SBTi, examining impacts both directly and indirectly. Direct substantive progress evaluated the success of mitigation efforts by companies with absolute scope 1+2 targets by comparing their actual emission levels to the ambition levels examined in the first progress analysis on ambition. The analysis revealed that while the targeted emissions were expected to decrease by about -6% between 2018 and 2022, the actual scope 1+2 emissions increased by a significant 26%, surpassing the targeted emissions levels in 2022. However, a company-level analysis uncovered that this trend is primarily attributed to the two largest emitters, Air Liquide and Linde, each responsible for 35% of the emissions in the total sample. Further analysis revealed that, in particular, Air Liquide is responsible for surpassing the combined emission targets of the company sample. If this firm were to be excluded from the sample, the combined scope 1+2 emissions would still be below the targeted levels in 2022, emphasizing the critical role of this enterprise.

We also conducted an analysis to determine whether companies were on track with their absolute scope 1+2 targets in 2022. While there was initially an increase in companies on track from 2018 to 2019, subsequent years witnessed a decline, with only a third of companies remaining on track by 2022. The number of companies on track gradually decreased over time.

Finally, to assess the indirect impact of companies setting SBTs, we first looked at the ambitiousness of targets. Most companies that were on track (six out of seven) set absolute scope 1+2 targets aligning with a 1.5°C pathway. The last company on track, Cargill, set the least ambitious target, aligning merely with a 2°C pathway. Despite Cargill being on track, the low ambition level of its target suggests that some other companies not on track but with more ambitious targets overall might have more success in their decarbonization endeavors and, therefore, more substantive impact than Cargill being on track with a weak target. We recommend the company to increase its target to align with a well-below 2°C or 1.5°C pathway. As a second indirect impact, we also want to highlight the influence that NSA climate action can have on national targets and policies, and vice versa. Although indirect impact is worth noting in the context of substantive progress, the analysis of this relationship will occur in Chapter 8.

In conclusion, we acknowledge the climate achievements of some companies in the SBTi, while others are not demonstrating the level of commitment needed to meet the goals established in the 2015 Paris Agreement. Therefore, we emphasize the need for continuous efforts and transparency in climate action. A particular focus and potential support should be employed for those companies contributing the most to global emissions to successfully mitigate the chemical sector's emissions.

Finally, it's essential to mention that, despite conducting various split-sample analyses to investigate the impact of factors such as headquarter locations, the number of ICIs in which a company participated, and subsectors, our results lack the certainty needed for broad generalization to a larger population. The findings were somewhat ambiguous, and to validate these assumptions, we strongly advocate for the replication of our analyses using a more extensive company sample. In general, we recommend further research to gain a more profound understanding of observed trends, especially at the company level. This would enable a comprehensive assessment not only of the effectiveness but also the efficiency of companies' climate action endeavors.

7. National climate targets and policies in the Netherlands

This chapter will center on the commitment that the Netherlands government has undertaken concerning climate mitigation. It will delve into the climate targets, policies, and regulations, addressing both the overarching national context and, more specifically, those pertinent to the industrial or chemical sector. Consequently, it aims to respond to the following research question:

SQ4: "What are the current Dutch national climate targets and which climate policies are relevant for the private chemical industry?"

Section 7.1 initiates the discussion by exploring Dutch national and industry-specific targets, presenting insights into the progressive evolution of the Netherlands' commitment to ambitious climate goals. It also outlines various plans formulated by the Dutch government to realize these objectives. Moving to section 7.2 delves into the policies and strategies implemented at both the European and Dutch national levels to facilitate the chemical sector's transition toward a low-carbon paradigm. Section 7.3, on the other hand, aims at evaluating the climate progress of the chemical sector within the framework of existing targets and policies to date, while section 7.4 includes a brief policy assessment by comparing the Dutch climate policies with the rigor and ambition observed in climate policies of other nations. Finally, section 7.5 concludes the chapter by summarizing key points, and offering overall conclusions.

7.1 Dutch national and industry-specific targets

The Dutch government aims to address climate change by implementing measures to decrease the Netherlands' GHG emissions significantly. In the Climate Act on May 28, 2019, the government of the Netherlands established a GHG emission reduction target of 49% reduction by 2030, measured against the emission levels recorded in 1990. Additionally, their long-term objective was to achieve a remarkable 95% overall emission reduction as well as carbon neutrality in the electricity sector by 2050 (Government of the Netherlands, 2019).

However, in 2020, the European Commission introduced a novel, more ambitious proposal that the Netherlands adopted, aiming to reduce GHG emissions by a minimum of 55% by 2030 and achieve climate neutrality by 2050. This proposal fulfills their commitment under the European Green Deal, presenting a thorough and responsible plan to elevate the European Union's targets. Moreover, it aligns with the goals of the Paris Agreement, striving to limit global temperature rise to below 2°C and endeavoring to keep it within 1.5°C (European Commission, 2020).

To attain these ambitious goals, the Dutch government has developed the following:

- The Climate Plan,
- The National Energy and Climate Plan (NECP), and
- The National Climate Agreement.

The aforementioned Climate Act plays, besides specifying the country's GHG emission reduction goals, a crucial role in providing individuals and companies in the Netherlands with a clear roadmap for achieving climate goals. It obligates the government to craft a comprehensive Climate Plan *(Klimaatplan 2021-2030),* outlining targeted measures to accomplish the specified objectives. Meanwhile, the National Climate Agreement, established in June 2019, outlines the policies and strategies required to reach these climate objectives, and represents a collaborative effort with various sectors, including electricity, industry, built environment, traffic and transport, and agriculture, to actively pursue carbon reduction targets.

Central to the agreement is the principle of ensuring that reducing GHG emissions is not only achievable but also financially feasible for everyone. The government is committed to implementing a cost-efficient transition that minimizes the financial impact on households and equitably distributes the financial burden among citizens and businesses. Therefore, the additional costs associated with the Climate Agreement for the Netherlands are expected to be below 0.5% of GDP by 2030, a level considered manageable for society. The Dutch government emphasizes strategic planning until 2050, introducing measures gradually to avoid hasty decisions and prioritizing cost-effective and sustainable approaches.

Moreover, the Climate Agreement serves as a pivotal component, not only within the Climate Plan but also in the NECP, which the Dutch government submitted to the European Commission at the end of 2019. This integrated approach demonstrates the country's commitment to tackling climate change on both national and international levels (Ministerie van Economische Zaken, Landbouw en Innovatie, 2020). On top of that, in the coalition agreement of the current cabinet of the Netherlands, which formed at the beginning of 2022 (Rutte IV cabinet), the policy for the 2030 goal aims at an even higher GHG reduction of 60% to ensure the target of 55% will be met. Adding onto that, an 80% reduction is targeted for 2040 and GHG neutrality by 2050 (Government of the Netherlands, 2022). An overview of all the important milestones in this endeavor can be seen in Figure 7.1.

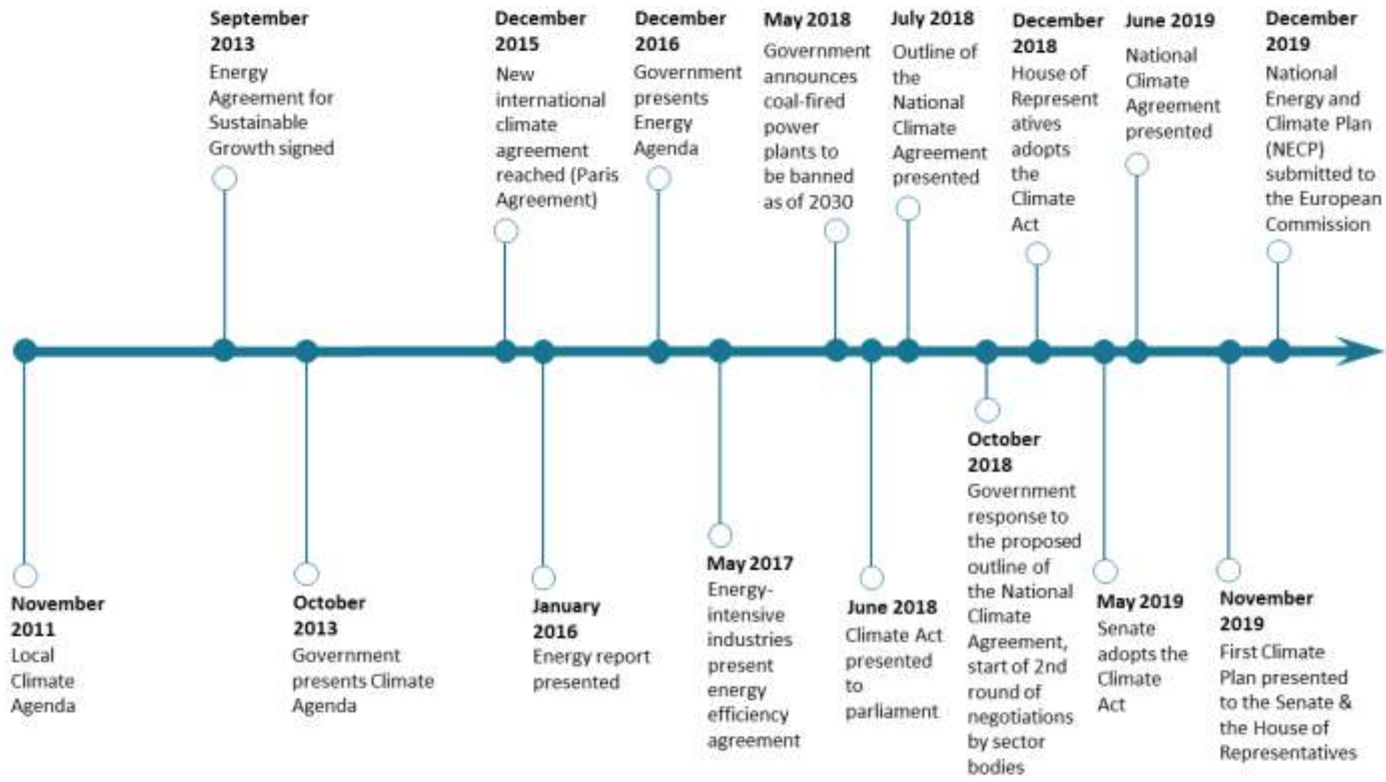


Figure 7.1: Timeline of milestones towards the climate agreement. Adapted from Ministerie van Economische Zaken, Landbouw en Innovatie (2020).

To ensure the achievement of the national climate targets, the Climate Act establishes governance tailored to safeguarding these objectives, with ultimate responsibility resting on the Minister of Economic Affairs and Climate Policy. The Climate Act outlines the following elements:

- **The Climate Plan**
  As mentioned before, this document encompasses the essential elements of government policy to be implemented over the next decade. It can be amended in 2021 and will undergo revision and readoption at least once every five years.

- **The Climate and Energy Outlook *(KEV)***
  The PBL publishes the KEV, which provides a forecast of GHG emissions in 2030. It considers the current state of climate and energy management in the country, along with anticipated future developments. The KEV's reference scenario is updated annually, and the projected emissions by 2030, as well as the 55% reduction target, may change each year due to existing and proposed policies (including those based on the Climate Agreement) and shifts in the national and international environment. The KEV is released annually since 2019.

- **Climate Memorandum *(Klimaatnota)***
  The *Klimaatnota* contains a Government Appraisal of the targets and includes additional policy intentions aimed at attaining these objectives. The first *Klimaatnota* was published in 2020 and is released annually thereafter (Government of the Netherlands, 2019).

Besides the overall national climate targets, the Dutch government has also put forward sector-specific commitments for the following five sectors: The built environment, mobility, industry, agriculture and land use, as well as electricity.

Within this sector division, the chemical industry is classified under the broader industry category. The established objective for the industry, aiming to curtail GHG emissions, is notably ambitious and substantial. The target is a 59% reduction by 2030 compared to 1990 levels, which translates to 14.3 *Mt* CO_2*eq* in additional reductions needed on top of existing policies. While this poses a significant challenge for the industry, the ambition appears justified considering the achievements in GHG emission reductions thus far. In 1990, industry emissions stood at 86.7 *Mt* CO_2*eq*, decreasing to 55.1 *Mt* CO_2*eq* by 2015. To meet the new target, the industry must further cut emissions by 19.4 *Mt* CO_2*eq*, factoring in both ongoing policy efforts (currently totaling 5.1 *Mt* CO_2*eq*) and the additional target of a 14.3 *Mt* CO_2*eq* reduction. This decarbonization pathway for the industrial sector is depicted in Figure 7.2 below. It is noteworthy that this industry target holds significance not only in absolute terms but also stands out in comparison to targets set for other sectors. Additionally, the industry's ambitious target is grounded in its capacity to achieve GHG emission reductions at a relatively modest cost compared to other sectors (Government of the Netherlands, 2019).

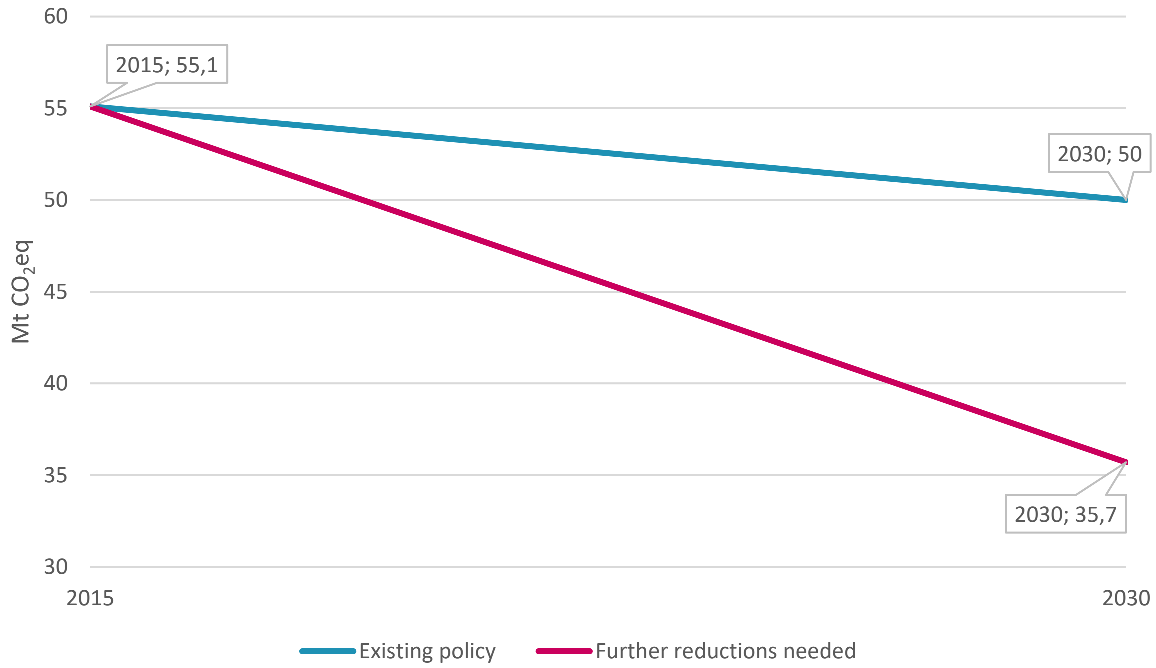


Figure 7.2: Decarbonization pathways for the Dutch industrial sector. Graph depicts existing policies as well as further reductions needed to achieve the targeted 59% reduction by 2030. According to the Government of the Netherlands (2019).

7.2 Strategies and policies for the Dutch chemical sector

To achieve its ambitious targets and to regulate emissions to air, water, and soil, the government of the Netherlands has implemented a wide array of regulations for the industrial and the chemical sector. These are outlined in Appendix X.

Turning our attention to strategies and policies for the chemical sector in the Netherlands, according to the RVO (2022b), there are four main areas of focus for energy reduction in the Dutch industrial sector: process efficiency, heat use, electrification, and the circular use of raw materials. These areas have been identified by the *Sector Industrietafel*, a board set up by the industry sector alongside other organizations to ensure that the 2030 climate goals are being met. Within these areas, GHG emission reductions in the industrial sector are aimed to be achieved by the following strategies depicted in Figure 7.3.

Figure 7.3: Strategies for GHG mitigation in the Dutch industrial sector as proposed by the Sector Industrietafel. According to RVO (2022b).

The EU has established various strategies that are relevant to the Dutch chemical sector. Among these are the Industrial Strategy, the Plastics Strategy, the Circular Economy Action Plan, the Zero Pollution Action Plan, and lastly, the Chemicals Strategy for Sustainability (CSS), which will be discussed in more detail in the following paragraphs.

On October 14, 2020, the European Commission released the CSS as part of the EU's broader commitment to achieving zero pollution, a central element of the European Green Deal. The primary objective of the CSS is to enhance protection for both citizens and the environment while fostering innovation in the realm of safe and sustainable chemicals. The strategy delineates more than 80 actions and establishes a tentative schedule for their execution. The European Commission offers periodic progress updates on the status of action implementation through a tracking table, which can be found on its website. The CSS entails several key actions, including:

- Prohibiting the use of the most harmful chemicals in consumer products, permitting their utilization only when absolutely necessary,
- Taking into account the combined effects of chemicals when assessing their risks,
- Gradually phasing out the use of per- and polyfluoroalkyl substances within the EU, except when their use is deemed essential,
- Encouraging increased investment and innovative capacity in the production and utilization of chemicals designed for safety and sustainability, encompassing their entire life cycle,
- Promoting the EU's self-sufficiency in the supply of critical chemicals while emphasizing sustainability,
- Establishing a streamlined "one substance one assessment" process for evaluating the risks and hazards associated with chemicals, and
- Assuming a leading global role by advocating for and upholding high standards, while refraining from exporting chemicals that have been banned within the EU (European Commission, 2023a).

While the CSS may appear ambitious and comprehensive in theory, and some scholars such as Barile et al. (2021) and Herzler (2022) have acknowledged its aim to increase regulation in response to threats to human health and the environment, it has also faced criticism from academia. Academics have recognized the importance of considering the combined exposure to various chemicals and the need to deepen scientific knowledge in this area as well as emphasize the goal of enhancing consumer protection (Barile et al., 2021; Bridges et al., 2023; Herzler et al., 2022; Scholz et al., 2022). Moreover, all authors agree that chemicals can have broad impacts on health and ecosystems but that there is room for improvement for the CSS in data collection and the streamlining of bureaucratic procedures for faster regulation publication.

Adding onto the regulatory perspective, Barile et al. (2021) and Herzler et al. (2022) mention that the CSS aims to expedite regulatory decisions, however, Scholz et al. (2022) and Bridges et al. (2023) criticize this approach, stating that it lacks scientific justification and does not address pressing sustainability concerns. Moreover, Scholz et al. (2022) and Bridges et al. (2023) express support for the CSS if combined with other initiatives to reduce hazardous chemical pollution, as well as emphasizing the need for innovative evaluation methodologies. Overall, Barile et al. (2021) and Herzler et al. (2022) generally discuss the EU CSS positively, highlighting the improvement in public health through chemical regulations, whereas Scholz et al. (2022) and Bridges et al. (2023) criticize the CSS for focusing primarily on individual industrial chemicals and not adequately considering factors like exposure levels and sustainability issues.

In addition to the European Union's CSS, in the year 2018, the VNCI has crafted decarbonization strategies for the Netherland's chemical industry in its "Roadmap for the Dutch Chemical Industry towards 2050." The objective outlined in this roadmap is an 80 to 95 percent reduction by 2050, as illustrated in Figure 7.4 below. This roadmap establishes that, through innovation, the Dutch chemical industry can feasibly attain the required emission reductions while sustaining a yearly added value growth of 1 percent. The various options explored within the roadmap encompass alternative feedstocks such as biomass, electrification utilizing renewable power, as well as the implementation of carbon cycle closure methods including plastic recycling and Carbon Capture and Utilization (CCU), along with Carbon Capture and Storage (CCS). However, substantial investments are required to finance these innovations. Furthermore, the VNCI advocates for an active involvement of the Dutch government to encourage the adoption of abatement options that may not yet be economically viable (VNCI, 2018).

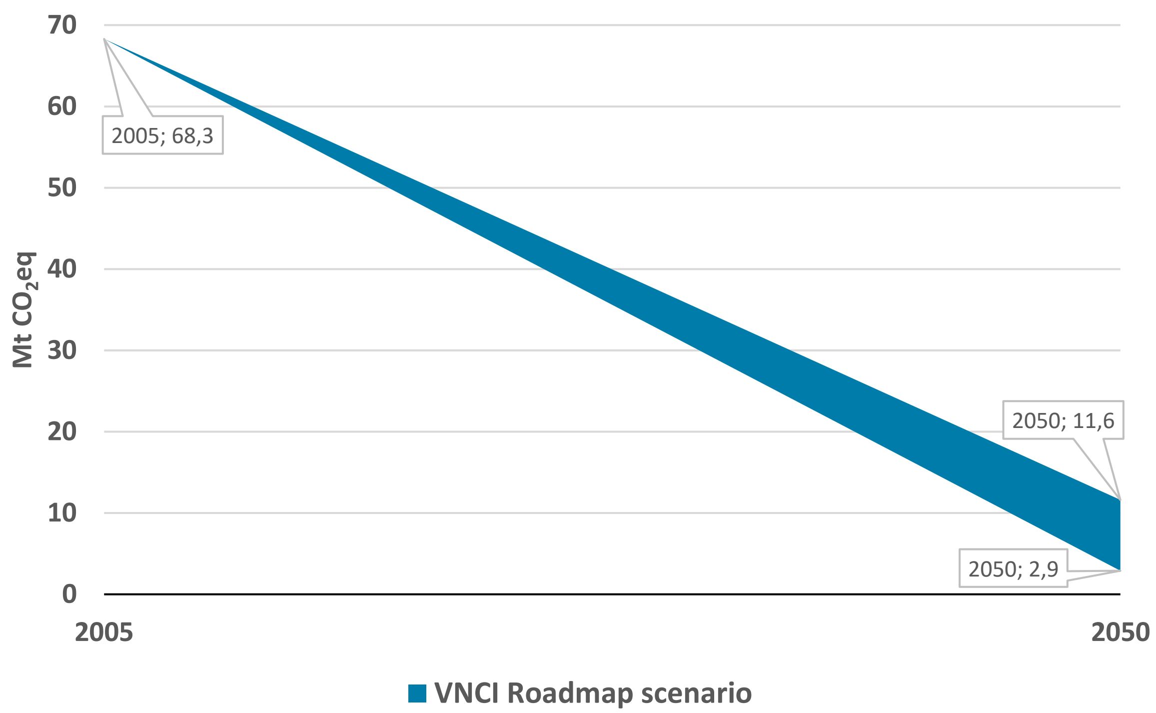


Figure 7.4: VNCI decarbonization roadmap scenario for the Dutch chemical sector. Graph depicts the range between an 80% (upper bound) and a 95% (lower bound) reduction by 2050 (compared to 1990 levels). According to (VNCI, 2018).

To achieve such ambitious decarbonization objectives, the Dutch government has enacted a range of policies, which will be elaborated upon in the subsequent paragraphs.

To begin with, under the aforementioned NECP, policies are categorized into the five dimensions outlined in Figure 7.5 below. Moreover, the NECP outlines different policy measures for the different sectors of electricity, industry, mobility, built-up environment, and agriculture and land use (Ministerie van Economische Zaken en Klimaat, 2019). Given our focus on the chemical industry, we will exclusively address the policy measures applicable to the industrial sector.

Figure 7.5: The five policy dimensions as described in the NECP. According to Ministerie van Economische Zaken en Klimaat (2019).

Furthermore, according to the Climate plan, the energy-intensive industry, under which the chemical sector falls, is largely covered by the EU ETS (Ministerie van Economische Zaken en Klimaat, 2020). However, the following supplementary national policy measures are employed for the industrial sector:

- **Amendment of the Environmental Management Act (*Wm*)**
  The *Wm* is undergoing revisions. As mentioned before, the updated Act will require companies to implement energy-saving measures with a payback period of five years or less. These amendments align with the government's integrated climate approach, emphasizing both energy efficiency measures and the promotion of sustainable energy generation.

- **National CO_2 tax since 2021**
  Since 2021, a national CO_2 tax has been implemented to ensure the further reductions of 14.3 Mt in emissions needed (on top of existing policies) compared to the base path by 2030. This tax is an objective measure set by the government, based on verifiable criteria, closely aligning with the EU ETS benchmarks already applied by the Dutch Emissions Authorit (*Nederlandse Emissieautoriteit, NEa).* To successfully align with these benchmarks, the government of the Netherlands requests objective and verifiable assessments from the PBL to determine the required level of the CO_2 tax, within predefined conditions. It is important to note that the purpose of this tax is not revenue generation but rather to incentivize companies to make investments within the Netherlands. In the event that the tax does generate revenue, the funds will be directed towards greening the industrial sector through a backstop mechanism.

- **Subsidy for *CO_2*-reducing measures**
  The implementation of CO_2 reduction measures is facilitated through the Sustainable Energy Production and Climate Transition Scheme (*Stimulering Duurzame Energieproductie en klimaattransitie, SDE++)* program, which will be discussed at a later point in this section. To ensure that CCS does not overshadow techniques vital for the long-term transition, CCS subsidies within *SDE++* are restricted to situations where there are no cost-effective alternatives in techniques, processes, and sectors. Additionally, there is a cap on the subsidy for industrial CCS at 7.2 $Mt\ CO_2$. Starting from 2035, new *SDE++* decisions for new CCS applications (excluding negative emissions) will not be issued. Furthermore, the share of companies contributing to renewable energy storage has increased from half to two-thirds since 2020. This adjustment applies to major consumers, including those in the industrial sector.

Besides these additional for the Dutch industrial sector relevant policies, there is an upcoming hydrogen program in the works. Moreover, the Integrated Knowledge and Innovation Agenda, which has been formulated within the framework of the Climate Agreement, includes the following programs relevant to the industrial sector:

- Closing material cycles
- Establishing a climate-neutral industrial heating system
- Electrification and substantial process innovations

Through innovation, demonstrations, and pilot projects, these programs aim to advance the development and cost-efficiency of technologies that reduce CO_2 emissions (Ministerie van Economische Zaken en Klimaat, 2020).

The current policy package for the Dutch industrial sector has also been described and analyzed by the OECD, identifying various policies or measures based on an internal inventory list by the Netherlands Enterprise Agency, the RVO. The 47 policy instruments of the current national policy package with specific relevance for the decarbonization of the Dutch industrial sector are structured into seven areas depicted in Table 7.1. The following paragraphs will briefly discuss the instrument type and delve into certain policy instruments; however, a detailed examination of all policy instruments is beyond the scope of this research.

Table 7.1: Relevant policy instruments by type for the decarbonization of the Dutch industrial sector (OECD, 2021).

INSTRUMENT TYPE	POLICY INSTRUMENTS
Electricity and carbon pricing instruments	Taxes on energy use
	Energy surcharge *(Opslag Duurzame Energie [ODE])*
	EU ETS (including indirect cost compensation)
	National carbon levy
Voluntary Agreements	Multi-year agreements on energy efficiency (*Meerjarenafspraken energie-efficiëntie* [MJA-3/ MEE] (ended 2020)
	Front runner programs/regional industry cluster programs
R&D / Demonstration support - generic	European programs: H2020, EU SME Instrument, European Innovation Council (EIC), ERANET
	Domestic: National Science Agenda, TO2
	Tax incentives: WBSO & Innovation box
	Nationaal Groeifonds
	SMEs: Innovation vouchers, DVI, SBIR
	Guarantees: SME credit guarantee scheme (BMKB), Growth facility
	Top Consortia for Knowledge and Innovation (TKI)
	Top Sectors: *Topsectorenaanpak*, PPS/TKI, Knowledge and Innovation Covenant (KIC), MOP, SME Innovation Support Top Sectors (MIT), Dutch Research Council (NOW)-KIC
R&D / Demonstration support - specific	European: NER300/Innovation Fund, InnovFin EDP, SET Plan
	Top Sectors: GoChem, TSE-R
	Integrated Knowledge & Innovation Agenda Climate
	Mission-driven research, development and innovation (MOOI)
	Multi-year Mission Driven Innovation Programs (MMIPs)
	Demonstration Energy and Climate Innovation (DEI, DEI+, DEI+ CE, HER+)
	Invest NL
Deployment / Adoption subsidies	Stimulation of sustainable energy production and climate transition (SDE++)
	Energy investment allowance (EIA)
	Accelerated climate investment in industry (VEKI)
	MIA (*Milieu-InvesteringsAftrek* – environmental investment deduction) and Arbitrary depreciation of environmental investments (VAMIL)
	Investment Subsidy Sustainable Energy (ISDE)
	Green project scheme
	EU LIFE program
	Small-scale investment allowance (KIA)
Command and control	Environmental Management Act: Obligation for investment in energy savings
Infrastructure programs	European Structural and Investment Funds (ESIF): European and regional development fund (ERDF)
	Porthos and Athos CO_2 network
	North Sea Wind Power Hub
	Taskforce Infrastructure Climate Agreement Industry (TIKI)
	Multi-year Program Infrastructure Energy and Climate (MIEK)
	National Program Regional Energy Strategy (RES)

Electricity and carbon pricing instruments

Carbon pricing stands as an effective and efficient means of curbing carbon emissions. Depending on its structure, it incentivizes low-carbon investments, heightens costs for carbon-intensive activities, and encourages cleaner energy utilization. This strategy is pivotal for transitioning to a low-carbon economy and fostering innovation in low-carbon technologies. Simultaneously, the design of electricity taxes plays a critical role in their efficacy for decarbonization. While such taxes raise the cost of using electricity, their impact on promoting a greener electricity mix hinges on their differentiation between energy sources. In the Netherlands, the government employs diverse policy tools related to carbon emissions and electricity usage, including specific energy taxes for the industrial sector based on fuel type, electricity taxes, a sustainable energy surcharge, and participation in the EU ETS. While some measures effectively price carbon, others, like electricity taxes and surcharges, impact electricity costs without considering fuel type or carbon content. Additionally, a 21% VAT rate applies to energy product purchases, including excise taxes and EU ETS allowances. Recent climate agreements have introduced a national carbon levy for industry and modified the energy surcharge for natural gas and electricity.

- **Energy tax**
  In the Netherlands, energy taxation is governed by the EU Energy Tax Directive (2003/96/EC), which establishes minimum taxation rates for energy products across EU member states. A tax of €0.4755 per *GJ* is levied on coal and coke products intended for heating. Additionally, an extra energy tax is imposed on industrial consumption of natural gas and electricity, and this tax rate varies based on consumption using a four-tier system. The Netherlands employs a regressive rate structure for natural gas and electricity taxes, resulting in varying tax rates for Dutch consumers based on their energy consumption levels. This means that energy-intensive users benefit from lower tax rates compared to users with lower energy consumption. Moreover, there are various exemptions and refund schemes for the energy tax depending on factors such as a company's operations and its commitment to decarbonization through energy efficiency improvements.

- **Energy surcharge *(Opslag Duurzame Energie, ODE)***
  The ODE, which was introduced on January 1, 2013, and expanded through the Climate Agreement, serves as an incentive for shifting from fossil fuels to sustainable energy sources. It operates as an additional charge on both natural gas and electricity, distinct from the energy tax explained beforehand. The *ODE* follows a similar structure to the energy tax, with rates that vary based on consumption levels, decreasing as energy usage decreases. Moreover, the same exemptions apply. The primary purpose of the *ODE* is to provide funding for renewable energy projects under the *SDE++,* a subsidy scheme for companies or organizations in different sectors (including the industrial sector) that are either producing renewable energy themselves or applying techniques for the reduction of CO_2. In 2023, the available budget for the *SDE++* is €8 billion (RVO, 2023c).

- **EU ETS**
  Dutch industrial emissions from major companies like Shell and Yara fall under the jurisdiction of the EU ETS, initiated in 2005, utilizing a cap-and-trade approach for carbon regulation. This system sets a cap on total allowable carbon emissions, gradually decreasing over time, encouraging emission reductions. Companies within the EU ETS provide tradable emission permits through auctions or secondary trading. Presently, around 430 Dutch companies participate, and the emission allowance price is €84.16 per ton of CO_2 (as of 04.09.2023), according to Ember (2023). In Phase 4 (2021-30) of the EU ETS, the number of allowances decreases by 2.2% annually. Installations obtain allowances through free allocation, auctions, or the secondary market, with flexibility to save or trade unused allowances. The allocation method varies across sectors, with industries susceptible to carbon leakage receiving free allowances to uphold competitiveness. In the Dutch industrial sector, including the entire refinery sector and chemicals subsector, these allowances were 96% and 73% of their total verified emissions in 2019, respectively. The NEa supervises the EU ETS in the Netherlands. Emissions must be reported by March's end, with allowances surrendered by April's end. The NEa ensures compliance and takes enforcement action as needed.

- **National carbon levy for industry**
  In addition to the energy tax, *ODE,* and EU ETS, the Dutch government introduced a targeted carbon pricing mechanism for the industrial sector, effective since 2021. This national carbon levy aims to achieve a carbon emission reduction of 14.3 *Mt* within the Dutch industrial sector, corresponding to the additional reductions required to meet the ambitious 59% industry target. Complementing the EU ETS, the national carbon levy establishes a minimum domestic price per ton of CO_2 for EU ETS emissions, ensuring a fixed price trajectory until 2030. Starting at €30 per ton in 2021, the levy will incrementally rise to €125 per ton by 2030, with an annual increase of €10.56 per ton. Its purpose is to mitigate the risk of EU ETS prices falling to levels discouraging investment in low-carbon assets. Businesses must report emissions and levy-free base calculations to the NEa, responsible for implementing the carbon levy. The mechanism also sets a minimum carbon price for electricity production within the EU ETS. If the EU ETS price drops below this minimum level, the Dutch national levy becomes applicable.

Voluntary agreements

Voluntary agreements serve as vital indicators of a firm's dedication to decarbonizing its operations. In the Netherlands, notable voluntary agreements include those within the Top sector program, research networks, and energy efficiency agreements MJA-3 and MEE.

The Dutch government introduced Top Sectors to enhance collaboration among businesses, the government, and universities. Businesses in the Top Sectors access various financial and non-financial benefits, such as tax incentives, funding options, guarantees, and advisory services. Each Top Sector establishes TKIs, where corporations and research institutions collaborate on research agendas and objectives and generate additional funding for research through the facilitation of sharing knowledge, risks, and investments, and can leverage public-private partnership allowances. Industry clusters, alongside Top Sectors, play a pivotal role in fostering knowledge-sharing and strengthening research networks. Moreover, MJA-3 and MEE, the major long-term energy efficiency agreements in the Netherlands, concluded in 2020 due to the shift away from voluntary commitments under the ambitious Climate Agreement (OECD, 2021). While both agreements were not mutually exclusive, MEE primarily targeted larger EU ETS companies.

Research, development, and demonstration

As highlighted earlier, R&D and demonstration (RD&D) of technologies play a crucial role in the transition to a carbon-neutral future, as industry-wide decarbonization requires innovative approaches and technologies to enhance processes and reduce emissions. Table 7.1 showcased a wide array of generic and specific policy instruments for RD&D support from both the EU and the Netherlands. Some of these instruments specifically target research institutes, SMEs, or other organizations, while others are applicable to large industrial firms. Given the multitude of RD&D programs, specific policy instruments will not be discussed here as this falls beyond the scope of this study.

However, to get an understanding of the importance of RD&D and how budget is spent, we will examine the Dutch government's total energy technology RD&D spending. In 2021, the public budget for energy RD&D totaled €443.2 million, marking a 38.2% increase from the previous year. Figure 7.6 illustrates the budget breakdown. For the industry, the Dutch government allocated €79 million, distributing 67.5%, 21.7%, 1.5%, and 9.3% to industrial techniques and processes, industrial equipment and systems, other industry, and unallocated industry, respectively (IEA, 2023a).

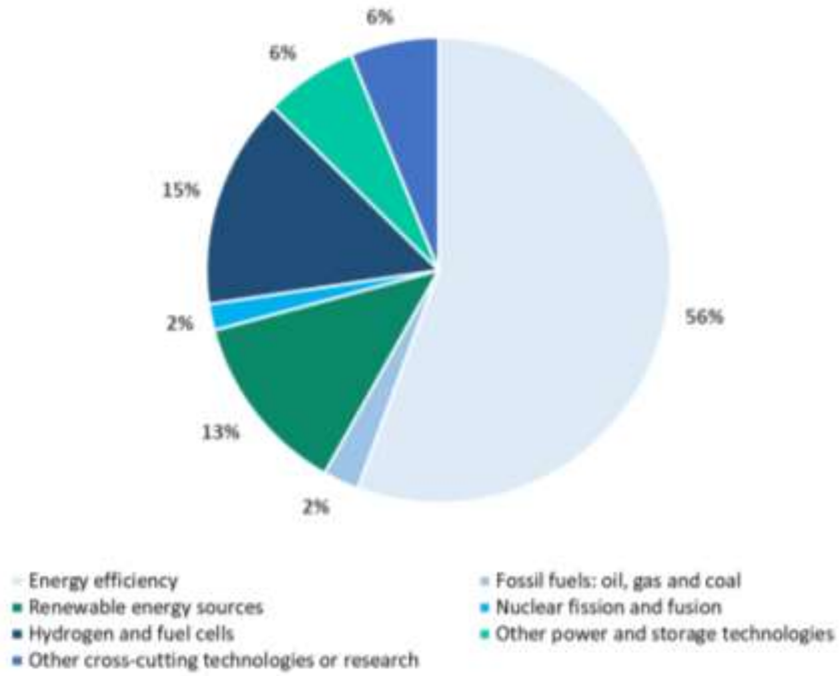


Figure 7.6: General Dutch national energy technology RD&D budget breakdown for 2021. According to data from the IEA (2023a).

Deployment

Once a technology is sufficiently developed and ready for widespread use, the government intervenes to promote technology adoption in the industrial sector to leverage benefits like learning-by-doing and network effects. Besides supporting the decarbonization of the Dutch industrial sector, this speeding up of the technology deployment will generate a competitive advantage for Dutch firms through state-of-the-art technology. Policy instruments in the deployment type can be divided into specific and generic instruments.

- **Specific or targeted deployment instruments**

  The first specific policy instrument for industrial technology deployment is the *SDE++* scheme, briefly discussed in the context of *ODE* revenues, which support the program. The *SDE++* is a subsidy scheme for businesses investing in decarbonization (scope 1 emission reductions) and renewable energy production. Since 2020, eligible projects cover renewable electricity, gas, heat, CHP (Combined Heat and Power), low-carbon heat, low-carbon production, carbon capture, utilization and sequestration, and lastly, hydrogen. As of 2021, the scope expanded to include bio-based production and plastics recycling. Relevant to diverse sectors, including industry, firms can seek subsidies based on avoided CO_2 emissions, capped at €300 per ton. However, *SDE++* applications may require feasibility studies and permits, posing potential challenges for companies in terms of time and cost. While most *SDE++* projects align with EU ETS participating installations, PBL is developing a correction factor to ensure fairness for non-participants in revenue calculations.

  In addition to the *SDE++* scheme, the Energy Investment Allowance (EIA), in place since 1997, is a significant deployment policy instrument. The EIA, a tax allowance for energy-saving investments, is particularly applicable to the industrial sector. Qualifying investments must be on the RVO's energy list, primarily related to industrial processes and applications. Other essential instruments include the VEKI (accelerated climate investment in industry, *Versnelde Klimaatinvesteringen Industrie)* grant, exclusively available to industrial firms, facilitating the adoption of proven carbon-reducing technologies with a payback period exceeding five years. It focuses on energy efficiency, waste recycling, local infrastructure, and other CO_2 reduction measures.

  Furthermore, the *MIA* (Environmental Investment Deduction, *Milieu-InvesteringsAftrek*) and *VAMIL* (Arbitrary Depreciation of Environmental Investments, *Willekeurige afschrijving milieu-investeringen)* schemes are tax incentives for eco-friendly investments by Dutch companies, excluding those related to energy conservation or renewable energy covered by *SDE++* and EIA. *MIA* deducts a portion of eco-friendly investment expenses from taxable income, while *VAMIL* allows one-time accelerated depreciation. Companies often combine both, aligning with RVO's environmental list *(Milieulijst)* covering technologies for industrial processes, subject to annual updates reflecting evolving technology options.

- **Generic/less relevant instruments**

  While not explicitly aimed at industrial decarbonization, other pre-existing tools could potentially have a limited influence on the adoption of low-carbon technologies. These include policy instruments such as the small-scale tax allowance *(KIA, Kleinschaligheids Investerings Aftrek),* a general investment tax incentive program for SMEs, or the green project scheme (*Groenprojecten regeling*), a subsidized bank loan program designed to fund projects related to environmental sustainability, the circular economy, and sustainable construction and only addressing the financing part of the investment. Other generic policy instruments are the *ISDE* (*Investering sSubsidie Duurzame Energie*), a grant accessible to companies and entrepreneurs to support the acquisition and setup of heat pumps or solar water heaters, as well as the LIFE program, which is the EU's financial tool for environmental and climate initiatives. The purpose of the LIFE program is to back innovative projects aligned with European policies on nature, the environment, and climate. The LIFE program is structured into two sub-programs, one dedicated to the environment (constituting 75% of the budget) and the other to climate action (comprising 25% of the budget).

Command-and-control instruments

As extensively detailed in Appendix X, numerous command-and-control instruments govern the environmental practices of the Dutch industrial sector, with the *Wm* standing as the primary environmental legislation in the Netherlands. Within the *Wm* framework, the *Activiteitenbesluit* outlines rules and regulations for various industrial companies, encompassing requirements like the energy-saving obligation. Contrastingly, the Netherlands presently does not enforce any product standards specifically pertaining to carbon emissions.

Infrastructure programs

Infrastructure programs are pivotal in driving industrial sector decarbonization by improving infrastructure and fostering collaboration. These programs operate at both the European and national levels.

At the European level, three key programs are the European Commission's Connecting Europe Facility (CEF), the North Sea Wind Power Hub, and the European Regional Development Fund (ERDF). The CEF allocated €102 million to the Porthos project, establishing an open-access CO_2 transport network connecting major ports like Rotterdam and Antwerp to an offshore storage site in the North Sea. The Athos project, part of this initiative, plans to store captured CO_2 in depleted offshore fields. The North Sea Wind Power Hub focuses on a Hub-and-Spoke system for enhanced wind power accessibility. The ERDF on the other hand, supports economic and social cohesion in the EU, aiding innovation, the digital agenda, SMEs, and the development of a low-carbon economy.

At the national level, three programs contribute to industrial sector decarbonization. The Taskforce Infrastructure Climate Agreement Industry (TIKI) guides the establishment of necessary infrastructure for the sector's transition. The Multi-year Program Infrastructure Energy and Climate (MIEK) facilitates collaborative agreements to develop a comprehensive primary energy infrastructure. Lastly, the National Program Regional Energy Strategy (RES) outlines a regional approach to achieve local energy objectives, fostering collaboration among stakeholders for the integration of renewable energy generation and related infrastructure.

Green procurement programs

The Dutch government has embraced a system of Sustainable Public Procurement, which mandates considering environmental and social impacts in procurement programs. The government applies environmental criteria when purchasing products, such as requiring energy-efficient computers and reusable building materials for road construction projects with the aim of leading by example and stimulating the market for sustainable products.

Moreover, for socially responsible public procurement, the *MVI (Maatschappelijk Verantwoord Inkopen)* criteria tool provides guidelines. Governmental organizations can decide the level of their ambitions and whether they want to set basic, significant, or ambitious goals. In the Dutch green procurement program, environmental effects throughout a product's lifecycle are calculated by a software tool. These effects are then condensed into an environmental cost indicator, allowing procurers to compare bids based on their environmental costs after establishing a maximum threshold for this indicator.

Green procurement is further integrated into the CO_2 Performance Ladder, an instrument aiding public and private organizations in reducing carbon emissions through certification. This ladder consists of five tiers for construction works and materials procurement and is certified by a third party. Organizations with a Ladder certificate can gain an advantage in tender submissions, making this instrument both a CO_2 management system and a procurement tool.

7.3 Chemical and industrial sector mitigation progress so far

After a comprehensive discussion of the climate targets, regulations, and policies applicable to the Dutch chemical sector, this section will assess the sector's progress toward achieving the ambitious climate goals set by the Dutch government.

Firstly, it should be noted that, while the targets set in the Climate Act are not legally binding, companies are actively pursuing the ambitious objective of a 59% reduction, equating to an absolute GHG emission reduction of 19.4 *Mt* CO_2eq by 2030 (relative to 1990 levels). As noted earlier in section 7.1, the Dutch industrial sector has already achieved a substantial reduction of 31.6 *Mt* CO_2eq between 1990 and 2015, indicating a promising trajectory toward meeting the additional reductions required to attain its goal.

According to the Climate Memorandum *(Klimaatnota 2022),* the Netherlands, opting for a faster pace in its mitigation endeavor, requires more significant reductions from its industry compared to the EU ETS standards. To meet ambitious national targets, the government is developing tailor-made agreements with the 20 largest emitters, building upon regional sustainability plans. The goal of this customized approach is to assist these companies, grounded in shared commitments, in attaining extra and expedited CO_2 reductions before 2030, ensuring a sustainable future in the Netherlands (Adriaansens, 2022). The six industrial clusters are actively translating these plans into concrete actions, defining sustainable energy needs through front-runner programs and Cluster Energy Strategies. Prioritization and phasing will be outlined in the Industry Implementation Program. Additionally, industries are seeking subsidies for specific sustainability projects while collaborating with science and Top Sectors on RD&D of new energy carriers and circular production techniques, crucial for achieving climate-neutral and circular production post-2030 (Ministerie van Economische Zaken en Klimaat, 2022).

The industry sector's residual task for emissions is indicated at 34.4 *Mt* CO_2eq, potentially increasing with tailor-made agreements. The estimated range, inclusive of the agenda policy, falls between 28-43 *Mt* CO_2eq, fitting within this span. Proposed measures encompass a CO_2 minimum price for industry, subsidies for sustainable energy infrastructure and renewable energy carriers, customization agreements, deployment of green hydrogen from Europe, and adjustments in the *SDE++* scheme. The CO_2 minimum price is expected to have no impact due to its lower value than the anticipated EU ETS price. Subsidies for customization and green hydrogen are viewed as most effective and also fiscal greening measures and policies for circular material use, are on the agenda. Commitments to biogas and biofuel production with CCS could result in several megatons of emission reductions. The national CO_2 levy for industry ensures emission reduction for medium-sized industrial companies. Of the indicative 5.9 *Mt* CO_2eq per year additional reduction in 2030, 4 *Mt* CO_2eq per year is anticipated through the CO_2 tax, and the remaining 1.9 *Mt* CO_2eq reduction requires a package of measures (Ministerie van Economische Zaken en Klimaat, 2022).

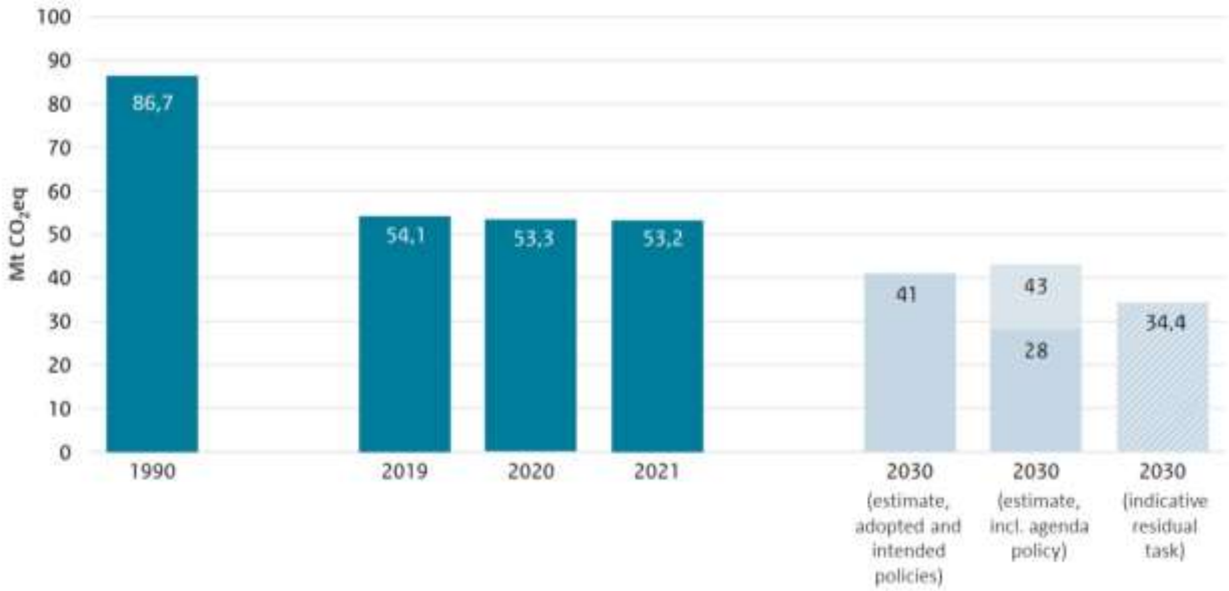


Figure 7.7: Past and planned development of emissions in the industry sector. Adapted from Ministerie van Economische Zaken en Klimaat (2022).

As previously mentioned, the government supports companies in making their operations sustainable through subsidies for sustainability and innovation, ensuring the availability of renewable energy and the required infrastructure. Industry's emission reduction plans theoretically have the potential for about 20 *Mt CO_2eq* reduction, meeting the 2030 target. Plans for an additional 11 *Mt CO_2eq* reduction in the supply chain (scope 3 emissions) are subject to preconditions. Most plans focus on CCS, process efficiency, residual heat, electrification, and green hydrogen. Innovation routes mainly invest in circularity, process improvement/energy savings, hydrogen, biomass as a raw material, CCU, and electrification. Timely expansion of infrastructure for electricity, hydrogen, and heat is crucial for sustainable industry development, requiring both immediate action and a long-term view to effectively integrate different energy carriers (Ministerie van Economische Zaken en Klimaat, 2022). The anticipated reduction of scope 1 GHG emissions from planned projects is illustrated in Figure 7.8.

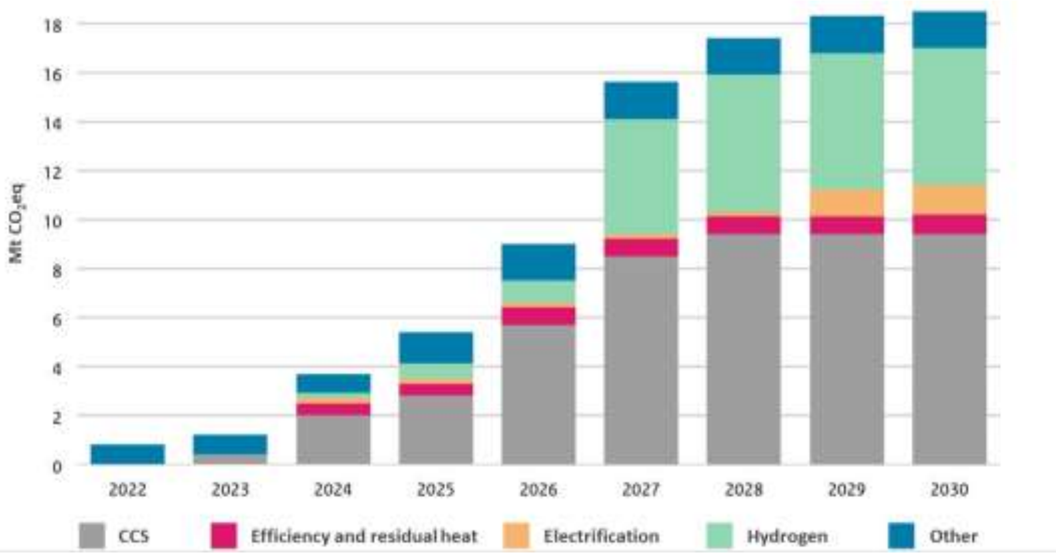


Figure 7.8: Expected emission reductions from planned projects (scope 1) by year of implementation and technology option. Adapted from Ministerie van Economische Zaken en Klimaat (2022).

Upon closer examination of the events in recent years, it appears that both the industry sector as well as the chemical sector itself are indeed making progress towards achieving their climate goals. Between 2015 and 2022, we observe marginal reduction in GHG emissions. However, in 2022, both energy consumption and GHG emissions experienced a significant decline, dropping from 54 *Mt* CO_2eq in 2021 to 49.8 *Mt* CO_2eq in 2022. As we can see in Figure 7.9, when compared to the Dutch emission reduction pathway for industry (section 7.1), the actual GHG emissions of the Dutch industrial sector fell below the current policy scenario for the first time in 2022. Yet, in order to attain the nation's ambitious climate objectives, further and more rapid emission reductions are imperative.

This major emission drop from 2021 to 2022 in the Dutch industrial sector has also been reported by various sources. According to the Klimaatweb (2023), in 2022, the CO_2 emissions of the 330 companies under the EU ETS in the Netherlands, which are responsible for about half of the country's CO_2 emissions, saw a decrease of -7.6% compared to 2021. In comparison to pre-pandemic levels in 2019, it is nearly a -20% drop.

Similarly, when focusing specifically on the chemical sector, we observe the same trend, with major GHG emitters such as Chemelot, Dow Chemical, or Yara recording significant drops in GHG emissions. Nevertheless, this decrease is most likely attributed to reduced industrial production a consequence of elevated natural gas prices (given that chemical companies heavily rely on natural gas in their manufacturing processes) as a result of the Russia-Ukraine war, rather than explicit sustainability initiatives. This casts uncertainty regarding its impact on the 2030 climate goals and raises questions about future emission trends, prompting considerations about the industry's capacity to align with the Netherlands' ambitious climate objectives (Klimaatweb, 2023).

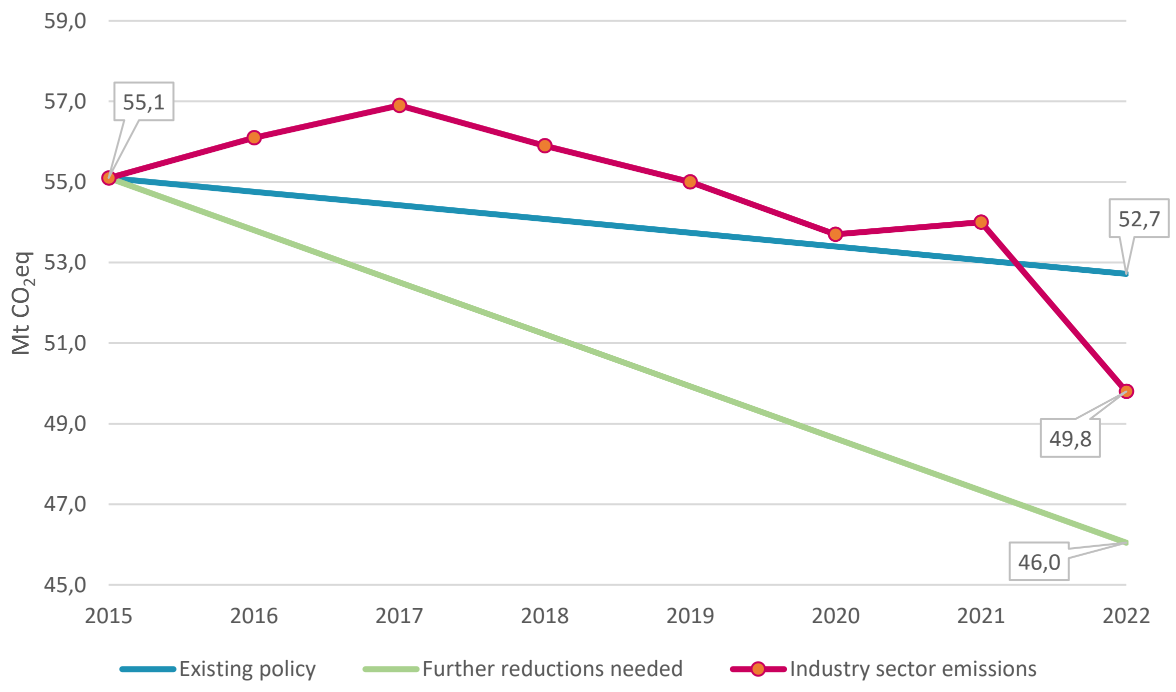


Figure 7.9: The Dutch decarbonization pathway for industry (existing policy and further reductions needed) in comparison to actual GHG emissions of the industrial sector (2015-2022). According to pathway data from the Government of the Netherlands (2019) and emission data from Rijksoverheid (2023).

As previously mentioned, and according to Minister Rob Jetten, “The Netherlands has been struggling to achieve its climate goals for years.” (Ministerie van Economische Zaken en Klimaat, 2023). The significant decline in GHG emissions from 2021 to 2022 is more attributable to the elevated energy prices resulting from the Russia-Ukraine conflict than to the success of robust and stringent climate policies.

Therefore, it is not surprising that in April this year, 2023, the Dutch government announced a commitment to invest €28 billion on emission-reduction measures in the upcoming years to ensure the achievement of its from 49% to 55% increased 2030 climate objectives. The over 120 distinct measures that will be implemented range from an increased CO_2 tax for industrial companies to subsidies for home insulation, solar panels, or second-hand electric vehicles. The government also aims to transform the energy sector to be carbon-neutral by 2035 as well as having mandated that energy-intensive industrial companies must achieve carbon neutrality by 2040. To attain this objective, these companies are required to scale up their adoption of hydrogen in production processes and enhance the demand for recycled inputs, including their use in the production of plastics (Euronews Green, 2023).

7.4 Dutch climate policies in comparison to other nations

After having evaluated the progress that the Netherlands has made so far in its national climate action endeavors, we will now contextualize the climate targets and policies of the Netherlands by comparing them to other countries' climate action progress and policy agendas. To do so, we will be making use of the EPI, as well as the CCPO.

The 2022 EPI presents an information-rich sustainability assessment translating advanced scientific discoveries into actionable policy insights. By making use of 40 performance indicators measuring how close countries are to meeting globally established sustainability targets for specific environmental issues, the EPI evaluates 180 countries based on their national endeavors to safeguard environmental health, boost ecosystem vitality, and address climate change. Countries with high scores demonstrate sustained and ongoing commitments to implementing policies that safeguard environmental health, uphold biodiversity and habitat preservation, conserve natural resources, and decouple GHG emissions from economic expansion. EPI scores are generally correlated with a country's wealth (Figure 7.10), although there are instances where certain countries surpass their economic counterparts, while others fall behind (Wolf et al., 2022). In the 2022 rankings, the Netherlands made the 11th place with an EPI of 62.6 (with 100 being the maximum achievable score) and a 10-year positive change of 5.9 points.

The top ten countries with the highest EPI scores (ranging from 62.8 to 77.9) are, in descending order, Denmark, the United Kingdom, Finland, Malta, Sweden, Luxembourg, Slovenia, Austria, Switzerland, and Iceland.

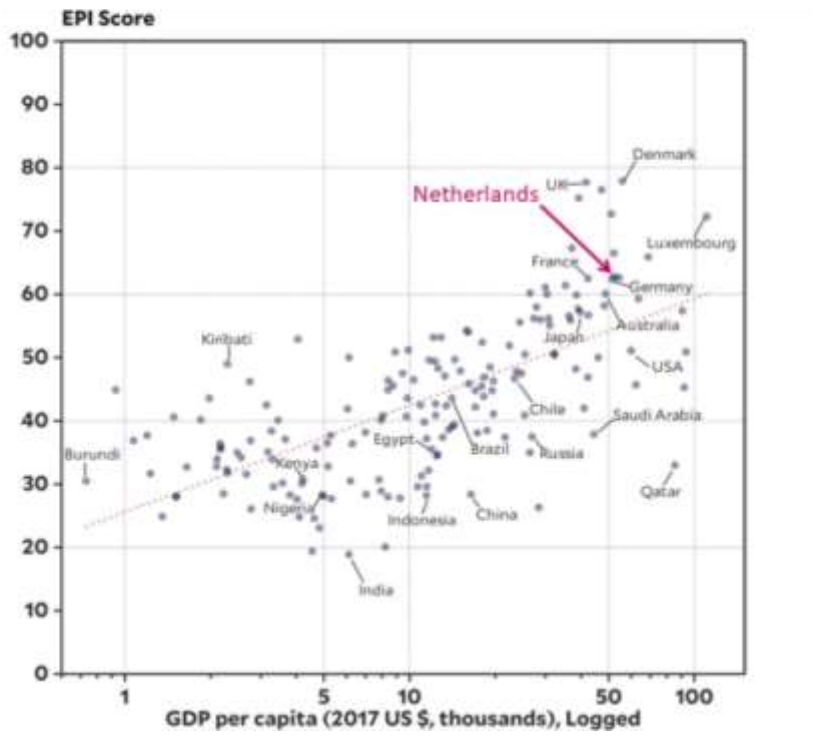


Figure 7.10: Correlation between GDP per capita and the EPI Score (Wolf et al., 2022).

In addition to comparing the overall EPI of the Netherlands with other nations, we will also assess the country's climate policies in particular.

Being one of the 40 aforementioned indicators of the EPI, the CCPO depicts the level of ambitiousness of climate policies of different states. This indicator, which the EPI introduced in 2022, is made up purely of one single issue category, Climate Change Mitigation, and comprises 38% of the total EPI score. As of 2022, the Netherlands achieved rank 32, with a score of 54.5 (out of 100) and a 10-year positive change of 10.6 points. Current frontrunners in climate change policy are Denmark and the United Kingdom (score > 90) as well as Finland and Malta (score > 80), as can be seen in Figure 7.11. Although being ranked 32nd does not necessarily portray the country's susceptibility to climate change risks in the best light, it is crucial to underscore that this position still places it within the top 20% globally.

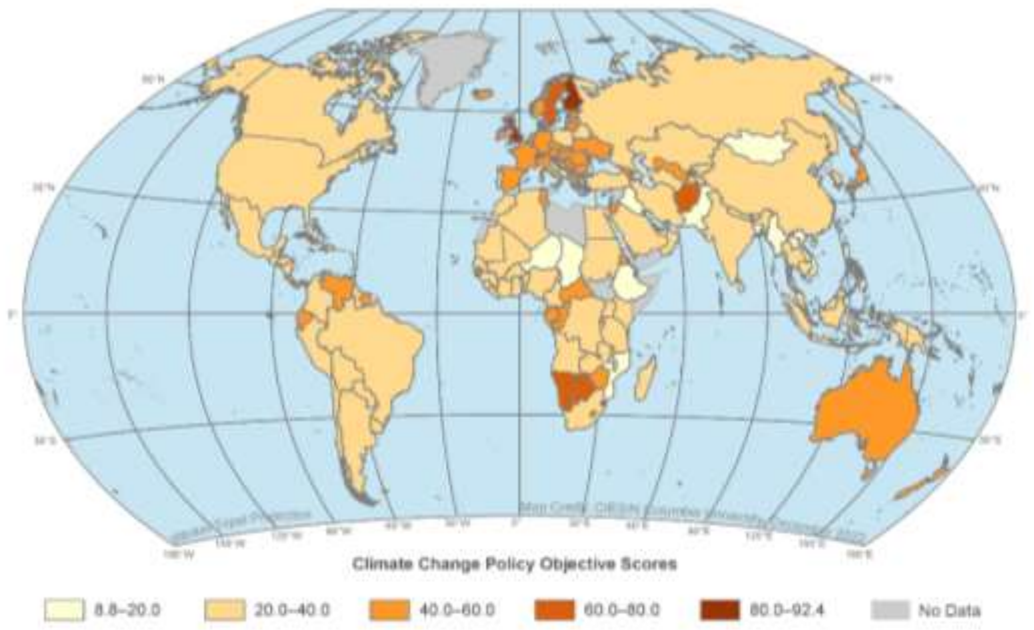


Figure 7.11: 2022 EPI: Climate Change Policy Objective (SEDAC, 2023).

While the EPI CCPO facilitates cross-national comparisons of the ambitiousness of climate policies, it is important to note that the EPI is an aggregate indicator composed of several individual indicators based on an underlying model. Aggregate indicators can be subject to several limitations such as weighting issues, lacks in data availability and quality, a limited scope, or the simplification of complex issues. Moreover, scholars argue that although such indexes serve as valuable tools for ranking countries based on specific characteristics, criticisms have emerged regarding their limited relevance and responsiveness to environmental changes, thereby diminishing their overall utility and significance (Oţoiu & Grădinaru, 2018).

Additionally, an evaluation of the 2022 EPI by the Joint Research Centre of the European Commission revealed the need for revisions to enhance statistical robustness in the lower-level correlation structure and ensure stability in country ranks. Caution is warranted when interpreting EPI rankings due to their susceptibility to changes in methodology as well as the EPI combining three policy objectives into a single score using a weighted arithmetic mean, which may for full compensability between policy objectives. These weights assigned to indicators and policy objectives impact country rankings. Within the EPI CCPO, most indicators exhibit strong positive correlations with their aggregates. However, some indicators show weak correlations, and one correlates negatively with all others, potentially limiting the discriminative capacity of aggregates (Smallenbroek et al., 2023).

Despite its imperfections, the EPI, developed over two decades with continual refinements, introduces a pioneering composite measure to the global environmental policy arena. Acknowledging the challenges of using an aggregate indicator, we have opted to employ it in our analysis for Chapter 8, but readers are cautioned to consider the aforementioned limitations relating to the nature of the EPI (CCPO) of being an aggregate indicator.

An alternative index for measuring a country's climate change (policy) performance is the Climate Change Performance Index (CCPI). Comprising four indicators (with respective sub-indicators) - GHG Emission (40%), Renewable Energy (20%), Energy Use (20%), and Climate Policy (20%) - the CCPI ranks the Netherlands 8th in 2024, a notable improvement from rank 13 in 2023. Unlike the EPI CCPO, the CCPI positions Dutch policy to be one of the leading nations globally, namely, in 4th place, highlighting a "well-developed climate policy system focusing on a circular economy, offshore wind, and solar energy" (Schmitz, 2023). However, similar to the EPI (CCPO), the CCPI is an aggregate indicator, necessitating awareness of the limitations mentioned above.

The disparities in rankings between the EPI (CCPO) and the CCPI underscore the challenges with aggregate indicators, revealing significant differences based on the underlying methodology, indicators used, assigned weighting, and measurement of categories. Nevertheless, the Netherlands' ranking among the top-20% countries in the EPI CCPO, coupled with its 4th position in the climate policy indicator of the CCPI, aligns with academic literature assessing recent climate policy initiatives in the Netherlands. This literature showcases the country's robust pursuit of policies for both mitigation and adaptation (Kirabaeva et al., 2023), supporting the conclusion that Dutch climate policies favor a low-carbon transition of the economy.

7.5 Summarizing the current targets, policies, and progress on climate goals so far

This chapter aimed to answer the research question:

SQ4: "What are the current Dutch national climate targets and which climate policies are relevant for the private chemical industry?"

The goal was to present a comprehensive overview of climate targets and policies pertinent to the Dutch chemical sector to provide a foundational understanding of the topic for the analysis conducted in the subsequent chapter. Information was primarily derived from grey literature such as government reports, supplemented by the examination of databases, news articles, and academic literature.

The Dutch government is committed to a 55% reduction in GHG emissions by 2030, while striving for carbon neutrality by 2050, aligned with the European Green Deal and the Paris Agreement. To ensure the realization of the 55% goal, an even more ambitious reduction of 60% is being pursued. The chemical industry faces a demanding objective of a 59% reduction by 2030, necessitating an additional 14.3 *Mt* CO_2eq reduction beyond the expected 5.1 *Mt* CO_2eq reduction from existing policies.

As the chemical industry is responsible for a wide array of environmental emissions to air, water, and soil, there are many rules and regulations pertaining to it, both at the EU and national levels. Different regulations apply to companies based on size and emissions, while, at the same time, stringent chemical safety regulations are enforced. Given this regulatory landscape, government support is essential for a fair transition to an environmentally friendly and low-carbon chemical sector that is still able to be competitive on the global market. The sector benefits from an array of EU and Dutch national strategies and policy tools, spanning electricity and carbon pricing, voluntary agreements, RD&D support, deployment subsidies, command-and-control measures, and infrastructure programs. These instruments collectively aim to streamline industry-wide decarbonization efforts.

While the industry sector's emission reduction plans have potential, challenges persist, and timely infrastructure expansion is crucial. While a substantial emissions drop occurred between 2021 and 2022, however most likely driven by energy price dynamics, robust climate policies are essential for sustained progress. The government's €28 billion commitment to investing in emission-reduction measures underscores a dedication to intensified climate efforts, encompassing measures like increased CO_2 taxes and industrial carbon neutrality mandates.

In comparison to other countries, the Netherlands ranks 11th in the 2022 EPI, which evaluates countries based on sustainability indicators. Furthermore, in the EPI CCPO, a subset of the EPI aimed at assessing a nation's climate policies, the Netherlands holds the 32nd position. Looking at a different indicator, the CCPI, the country ranks 8th and 4th in the overall CCPI, as well as the climate change policy sub-indicator, respectively. As both the EPI (CCPO) as well as the CCPI are aggregate indicators however, we want to caution the reader as such indicators face several challenges and limitations. Nevertheless, overall, we can state that the Netherlands has implemented strong climate policies for both mitigation and adaptation favoring a low-carbon transition of the economy.

All these insights underscore the Netherlands' commitment to climate action, both nationally and within the chemical sector. However, the lack of significant progress indicates that the level required for swift decarbonization is not yet achieved. Even though Dutch climate policy is robust, additional measures are imperative, and NSAs must voluntarily contribute to climate action if the Netherlands is to attain its climate goals.

8. The effect of NSA climate action on national targets and policies in the Netherlands

As previously mentioned, this last chapter will explore the effect that NSA climate action has on national targets and policies in the Netherlands. It therefore aims to answer the following research question:

SQ5: "How does the participation of chemical sector companies in International Cooperative Initiatives affect national targets and policies in the Netherlands, and vice versa?"

Section 8.1 will commence by offering an overview of the analysis, discussing the vital variables selected for exploring the correlation between NSA and country-level climate action and their evolution over time. This builds upon the explanations provided in section 4.5.2, outlining our approach to this analysis. Subsequently, section 8.2 will reveal the results of the main analysis, presented in the form of a correlation analysis. Finally, section 8.3 will encapsulate key insights and present overall conclusions derived from our investigation.

8.1 Exploring the relationship between NSA and national climate action

In this analysis, our objective is to investigate whether the increasing level of participation in ICIs by NSAs has led to higher levels of ambition for climate targets and policies in the Netherlands. Additionally, we aim to explore if this increased ambition, in turn, positively influences NSA participation in transnational governance.

We will delve into the realm of NSA and national climate action, examining the relationship between these two aspects based on an empirical study conducted by Andonova et al. (2017). The primary objective of their study was to explore whether national policy and transnational governance act as substitutes or complements.

To achieve this, our first step involves a detailed exploration of the variables crucial to our analysis. According to Andonova et al. (2017), the relative significance of different variables in their study depends on the civil liberties of a country. In the case of countries with high civil liberties, such as the Netherlands, these variables include the EPI CCPO, the number of ratifications of InEnAs and ISO 14001 certifications within a given country, participation in INGO networks, national GDP per capita, and national CO_2 emissions levels, the latter serving as a control variable. While the EPI CCPO has already been extensively discussed in section 7.4, we will elucidate the other variables to offer a comprehensive understanding of their significance and relevance in our analysis. This additional context will contribute to a more holistic portrayal of the factors under examination.

InEnAs, defined by Mitchell (n.d.) as "intergovernmental documents intended to be legally binding with a primary stated purpose of preventing or managing human impacts on natural resources" serve as a broader measure of a nation's environmental policy. The willingness of states to be legally bound by such agreements, whether in the form of treaties, conventions, accords, or modifications of such arrangements (Aust, 2013) is indicative of a nation's commitment to safeguarding the environment. Therefore, it stands as a robust environmental policy indicator. Notably, the 2015 Paris Agreement holds prominence as the most renowned InEnA in the context of climate change. It is essential to highlight that our data exclusively encompasses ratified InEnAs that remain in force, excluding any InEnAs from which the Netherlands has withdrawn.

Secondly, the count of firms certified to the ISO 14001 standard within a specific country serves as an indicator of the broader business interest in embracing corporate social responsibility and participating in transnational governance. As highlighted by Prakash and Potoski (2007), this interest is also linked to supply chain-based demand from companies in jurisdictions that prioritize pro-environmental practices. The ISO 14001, as the most globally adopted international standard for environmental management systems, emerges as a robust variable for examining its correlation with NSA climate action.

As previously mentioned, for assessing a nation's involvement in INGO networks, we are examining its membership in the IUCN. With over 1,400 member organizations, including state and government agencies, subnational governments, national and INGOs, as well as indigenous peoples' organizations from over 160 countries, the IUCN actively addresses issues spanning biodiversity, climate change, governance, and business, finance, and economics, among others (IUCN, n.d.). This renders the IUCN, in addition to policy-related variables such as the EPI CCPO and the number of ratified InEnAs, a valuable variable for characterizing a country's dedication to national climate action.

Finally, we incorporate the variable GDP per capita to examine the correlation between a nation's wealth or domestic demand and ICI participation. This allows us to gauge societal mechanisms, such as pressure from society on companies to engage in transnational climate action, leading to increased ICI participation. Andonova et al. (2017) demonstrated that, especially in nations with high civil liberties, there is a positive and significant effect of this. Furthermore, the authors established that *CO_2* emissions, as a control variable, are positively related to participation in NSA transnational governance when making examinations on a cross-national level. Therefore, we will also include this variable in our analysis.

8.1.1 NSA and national climate action variables over time

To scrutinize the relationship between NSA and national state climate action, we meticulously gathered temporal data for each variable outlined in the preceding section. The decision to commence our analysis from 2009 is rooted in the fact that the first participation in ICIs within our company sample under study occurred in 2010. While ICI participation data was accessible for the entire study period spanning from 2009 to 2023, the availability of data for other variables was more constrained. For instance, with the exception of the number of IUCN members in the Netherlands, the data for all other variables had the last available data point in 2022. Conversely, IUCN member data only spans from 2015 since, in the years preceding, both the global IUCN and the Dutch IUCN did not report membership numbers at the country level. Furthermore, while InEnA ratification, GDP per capita, ISO 14001 certification, as well as *CO_2* data, were obtainable from 2009 to 2022, the EPI CCPO score for the Netherlands was only available from 2012 onwards.

Moreover, we curated data for ICI participation for all companies in our sample *(n=50)* headquartered anywhere in the world, as well as exclusively for those companies headquartered in the Netherlands *(n=6).* This approach was deliberate as it allowed us to discern differences in correlation between ICI participation and other variables on both a global and Dutch level. Our aim was to explore whether companies headquartered in the Netherlands engaging in transnational climate governance exhibit stronger correlations with national climate action by the state compared to companies in the entire sample, headquartered anywhere in the world. For more detailed information on ICI participation and geographical distinctions, please refer to Chapter 5. Results of the data collection for the correlation analysis conducted is depicted in Table 8.1.

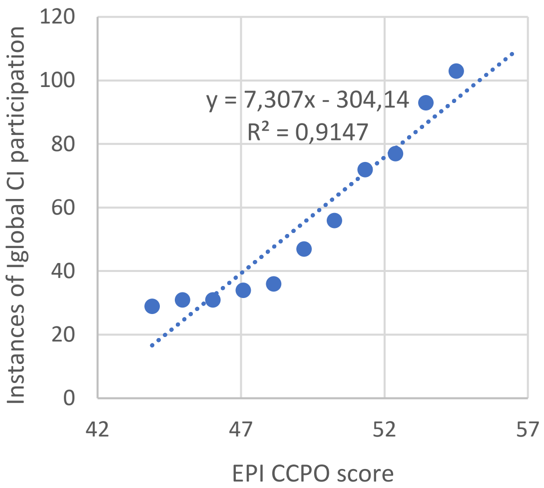
Table 8.1: Data over time of the variables used in the correlation analysis.

	ICI GLOBAL*	ICI NL**	EPI CCPO	INENA RATI-FICATIONS	GDP PER CAPITA	IUCN MEMBERS	ISO 144001 CERTI-FICATIONS	CO_2
2009	0	0	NA	135	38.160 €	NA	1326	217,7
2010	26	2	NA	136	38.470 €	NA	1494	229,9
2011	28	2	NA	136	38.880 €	NA	1681	220,9
2012	29	2	43,9	139	38.340 €	NA	2085	215,7
2013	31	2	44,96	139	38.180 €	NA	2419	211,4
2014	31	2	46,02	140	38.580 €	NA	2408	202,5
2015	34	3	47,08	140	39.170 €	36	2461	209,9
2016	36	4	48,14	141	39.810 €	37	2677	208
2017	47	8	49,2	145	40.730 €	37	2739	204,5
2018	56	8	50,26	145	41.450 €	37	2181	198
2019	72	11	51,32	147	41.980 €	37	2082	193,6
2020	77	11	52,38	147	40.130 €	39	2438	172,8
2021	93	18	53,44	147	42.390 €	40	2445	177
2022	103	19	54,5	148	43.800 €	38	2828	169,1
2023	113	20	NA	NA	NA	39	NA	NA

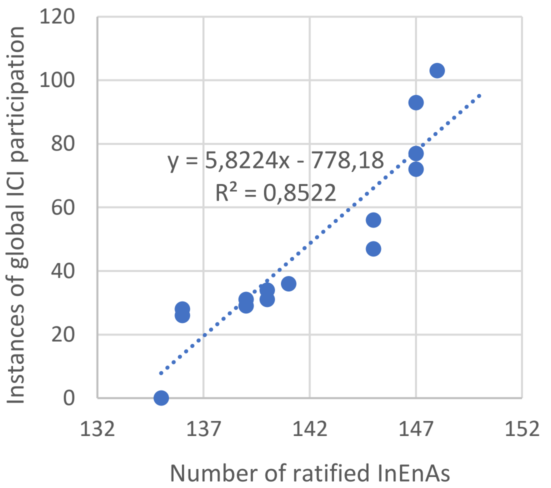
** Sum of instances of ICI participation per year of all companies in the sample, headquartered anywhere in the world (n=50)*
*** Sum of instances of ICI participation per year of sample companies headquartered in the Netherlands (n=6)*

8.2 Results of the correlation analysis

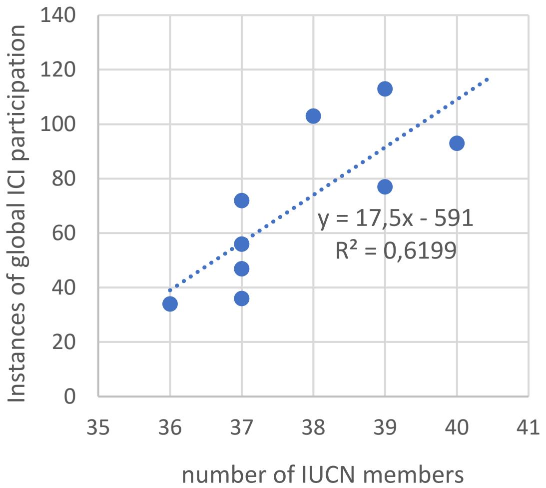
The outcomes of the correlation analysis, where we examine ICI participation of all globally headquartered companies in our sample *(n=50)* as the dependent variable and each of the aforementioned national-level climate action variables as the independent variable, are presented in Figure 8.1. It is important to note that, unlike Andonova et al. (2017), who analyzed cross-country effects, our focus is solely on effects occurring in the Netherlands. Therefore, we scrutinize the correlation of variables over time.



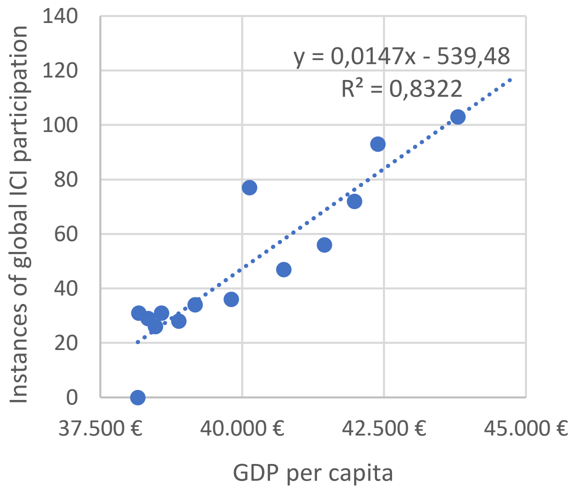
(a) ICI participation and EPI CCPO



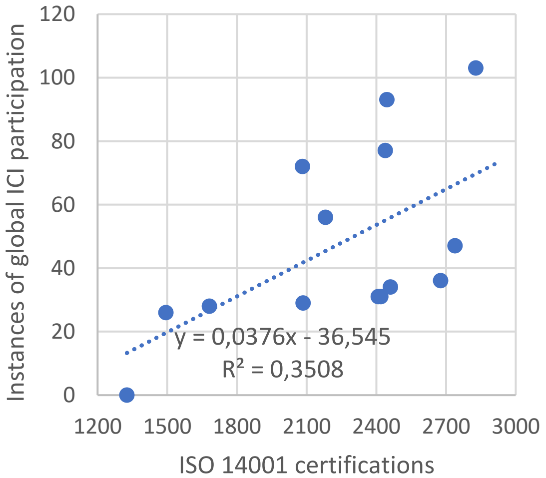
(b) ICI participation and InEnA ratifications



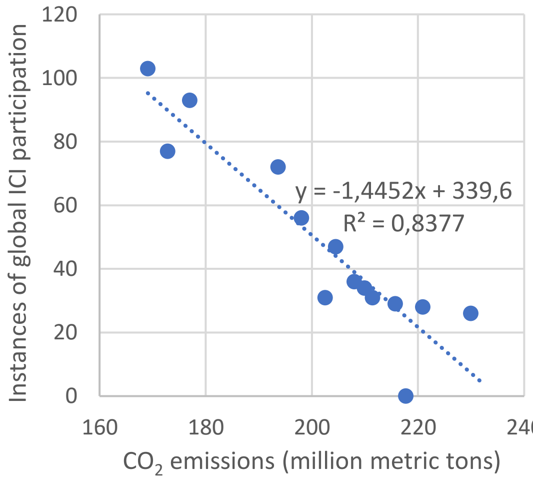
(c) ICI participation and IUCN members



(d) ICI participation and GDP per capita



(e) ICI participation and ISO 14001 certifications



(f) ICI participation and CO_2 emissions

Figure 8.1: Correlation analysis global NSA climate action and Dutch state-level climate action.

As evident, the most robust correlation emerges between NSA participation in ICIs and the Dutch national EPI CCPO score, underscoring the intimate interplay between national policy and NSA climate action, reinforcing the notion of their complementary relationship as empirically demonstrated by Andonova et al. (2017). Notably, we observe substantial correlations between InEnA ratifications, another key indicator of a nation's dedication to environmental and climate concerns, and GDP per capita. In contrast, IUCN memberships exhibit a weaker correlation, while ISO 14001 demonstrates the weakest correlation.

Interestingly, in contrast to Andonova et al. (2017), who employed national CO_2 emissions as a control variable, asserting a positive correlation between participation in transnational climate governance and GHG emissions, our findings reveal the opposite - a negative correlation between ICI participation and CO_2 emissions. Both outcomes, however, align logically when considering the distinct study designs of Andonova et al. (2017) and our own correlation analysis.

Andonova et al.'s (2017) cross-national analysis indicated a positive correlation, implying that countries with higher CO_2 emissions, indicative of greater industrialization and affluence, exhibit increased ICI participation (Andonova et al., 2017; Nangini et al., 2019). This aligns with the notion that GHG emitters, notably companies, are primary targets for both domestic policies and transnational initiatives.

Conversely, our analysis, conducted longitudinally and centered on the Netherlands, suggests that as ICI participation rises, the country's GHG emissions decline over time due to climate policies and national decarbonization strategies. While our results reveal a correlation, we refrain from asserting causation, leaving the question of whether the reduction in CO_2 emissions is a consequence of effective NSA climate action, specifically participation in ICIs, unanswered. Although our analysis is confined to establishing correlation rather than causation, it remains plausible that the observed decrease in CO_2 emissions is influenced, at least in part, by effective NSA climate action.

Moreover, as mentioned earlier, we replicated the same analysis using only instances of ICI participation by companies headquartered in the Netherlands *(n=6),* aiming to discern differences compared to global ICI participation. The graphical representations pertaining to this analysis can be found in Appendix Y. Additionally, Table 8.2 outlines the distinct coefficients of determination *(R^2)* for each variable in both analyses, first on the global and second on the Dutch national-level ICI participation of chemical companies within our sample.

Table 8.2: Coefficients of determination (R^2) for both analysis with varying dependent variables.

	R^2	
INDEPENDENT VARIABLES	**Global headquarter ICI participation**	**NL headquarter ICI participation**
EPI CCPO	0,9147	0,9001
INENA RATIFICATIONS	0,8522	0,8037
IUCN MEMBERS	0,6199	0,6316
ISO 14001 CERTIFICATIONS	0,3508	0,2849
GDP PER CAPITA	0,8322	0,8919
CO_2	0,8377	0,8121

While the outcomes of the correlation analysis, with a focus on ICI participation of chemical companies headquartered in the Netherlands, align closely with those obtained from the analysis conducted on a global level of ICI participation, notable distinctions emerge in the strength of correlations between ICI participation and IUCN memberships, as well as GDP per capita. Conversely, we observe weaker correlations for the variables EPI CCPO, InEnA ratifications, ISO 14001 certifications, and CO_2 emissions. It is crucial to acknowledge, however, that while these results suggest minor differences between both analyses, we want to emphasize the small sample size of only six companies in the Netherlands and, although ICI participation remained strong among these companies, the limited sample size necessitates caution in drawing definitive conclusions.

In concluding the result of our correlation analysis, we want to discuss and draw attention to the overall research design we applied. It is essential to emphasize that the identification of correlations among variables, whether strong or weak, does not imply causation. It is very plausible that, as we conducted our analysis over time, time itself is acting as a confounding variable influencing both the independent and dependent variables. Other factors could also be affecting our results. For instance, the increase in GDP per capita and ICI participation over time may be driven by broader social and economic development trends, rather than a direct causal relationship between these variables.

Notably, in the empirical study by Andonova et al. (2017), the confounding variable of time is effectively excluded, as their analysis is conducted across nations rather than tracking variables over time, as in our study. To replicate the author's methodology within a single country, such as the Netherlands, while mitigating the influence of temporal development, a regional subdivision could be considered. However, given the nature of certain independent variables, which are inherently representative at the national level (such as the EPI CCPO score), subdivision into regions was deemed impractical. Therefore, our analysis opted for a temporal examination of variables.

Moreover, it is essential to highlight that while we have identified correlations among variables, the nature of our research design, which examines variables over time, prevents us from asserting the definite existence of these correlations. This limitation arises because, in general, the variables under study tend to increase over time (excluding national CO_2 levels), leading to a natural emergence of correlation. This holds true even in cases where the variables may not be genuinely correlated.

However, at this point we would like to direct the reader's attention back to the study by Andonova et al. (2017), which serves as the foundation for this analysis. In their empirical results, the authors provided robust support for their main hypotheses H4 and H5 (see section 4.5.2), focusing on institutional and policy effects on NSA participation in transnational climate governance, respectively.

In our correlation analysis, we found that the ambitiousness of a nation's climate policies (EPI CCPO variable) positively correlates (with statistical significance) with NSAs participation in ICIs across all models. Andonova et al. (2017) demonstrated how climate policy acts as a particularly relevant driver for NSA participation in transnational climate governance and vice versa. Additionally, for the split-sample of countries with high civil liberties (like the Netherlands), the authors identified statistically significant correlations between NSA participation in ICIs and the number of ratified InEnAs. Furthermore, the authors indicated that in such nations, "societal and diffusion mechanisms are more likely to operate" (Andonova et al., 2017), revealing that variables related to domestic demand and transnational linkages - namely, GDP per capita and ISO 14001 certifications - have positive and significant effects, displaying strong correlations with NSA participation in transnational governance. Moreover, in more open societies such as the Netherlands, the authors found that the extent of INGO participation (IUCN membership variable) also matters and is positively correlated with NSA participation.

Despite our analysis facing the major limitation of being conducted over time, we suggest that the correlations we identified among variables likely exist, especially given that the authors found correlations between each of these variables and NSA participation in ICIs for countries with high civil liberties. Naturally, caution is warranted, but it is noteworthy that we discovered the strongest correlation between the Netherlands' EPI CCPO and the participation of companies in our sample in ICIs, aligning with Andonova et al.'s (2017) results.

As a concluding remark and to quote the authors, "for most states in Europe, transnational climate governance may reinforce, improve, and help implement national policies. It may increase the policy influence of these states internationally, particularly with countries that have limited policy commitments but in which non-state and substate actors possess significant freedom" (Andonova et al., 2017). Therefore, as a conclusion, we want to emphasize the existence of a bi-directional relationship between national policy and ICI participation.

8.3 Summary of results

This chapter aimed to examine the intricate relationship between NSA climate action and national climate targets and policies in the Netherlands, addressing the research question:

SQ5: "How does the participation of chemical sector companies in International Cooperative Initiatives affect national targets and policies in the Netherlands, and vice versa?"

To delve into this inquiry, we conducted a correlation analysis building upon an empirical study by Andonova et al. (2017). The dependent variable in our analysis was NSA participation in ICIs and the independent variables encompassed the EPI CCPO, InEnA ratifications, ISO 14001 certifications, IUCN memberships, national GDP per capita, and national CO_2 emissions, reflecting the state-level climate actions of the Netherlands.

The correlation analysis revealed notable associations between ICI participation and various variables indicative of a country's national climate action. The most pronounced correlation emerged between NSA participation in ICIs and the Dutch national EPI CCPO, reinforcing the concept of a complementary relationship between these two variables, as empirically demonstrated by Andanova et al. (2017). Interestingly, in contrast to the findings of the aforementioned authors, our study identified a negative correlation between ICI participation and CO_2 emissions. This discrepancy can be attributed to our national-level, longitudinal analysis, which revealed a decreasing emission trend alongside an increase in ICI participation.

Additionally, we anticipated that correlations might be higher when exclusively considering ICI participation of Dutch companies due to their closer relationship with national policies. However, the analysis contradicted this assumption, with only marginal increases in correlations for two variables, namely IUCN membership and GDP per capita. It is crucial to highlight, however, the potential impact of the small sample size on these results, urging caution in interpretation.

While our analysis revealed robust correlations for most variables, it is crucial to emphasize two key points. Firstly, correlation does not imply causation, and the potential influence of time as a confounding variable should be acknowledged. Secondly, given the longitudinal nature of our analysis, we cannot definitively assert that the identified correlations mirror reality. As the variables under study naturally grow over time, the observed correlations might merely reflect this temporal trend rather than true inter-variable relationships. Therefore, readers should exercise caution when interpreting these effects.

Notwithstanding these considerations, our findings align with the results presented by Andonova et al. (2017), highlighting the bidirectional relationship between transnational climate governance, exemplified by NSA participation in ICIs and national state-level climate action. In our correlation analysis, the most robust correlation emerged between the level of a nation's climate policy ambition (measured by the EPI CCPO) and NSA climate action, as indicated by the level of ICI participation among the companies in our sample. This alignment with the authors' results suggests that state-level and NSA climate actions act as complementary forces, providing a nuanced understanding of their interconnected dynamics.

9. Discussion

In this chapter, we will discuss the results of our research. Section 9.1 elaborates on the difficulties relating to obtaining data on country-level corporate GHG emissions while section 9.2 highlights how this study contributes to the academic literature. Lastly, section 9.3 discusses the limitations of both the methodology employed as well as the results of this research.

9.1 The difficulties of obtaining country-level corporate emissions

As discussed in section 4.1 on company sampling, a significant challenge encountered in our research pertained to the unavailability of country-level GHG emission data for the 50 sampled companies. While some firms provided emissions data for each continent in addition to global emissions, specific country-level data was inaccessible. Consequently, we opted for a method that employs a revenue proxy to estimate emissions for each company concerning its operations in the Netherlands. All information on this method can be found in Appendix Z.

Unfortunately, after applying this proxy to global corporate emissions and while comparing the estimated scope 1 emissions of some companies in the sample to actual emissions disclosed by the NEa (scope 1 emissions of chemical manufacturing sites in the Netherlands), we quickly saw that this "revenue-as-a-proxy" method - even if sensible from a theoretical perspective - is highly flawed.

While the NEa data helped us to scrutinize our revenue-as-a-proxy method, it was not possible to do a Netherlands-focused analysis on emission data by the NEa in the first place due to two major limitations. Firstly, the NEa data covered only 21 of the 50 sampled companies, reported solely on scope 1 emissions, and only disclosed GHG emission data for the years 2021 and 2022. Secondly, the NEa reports merely *CO_2* emissions, while we are generally considering *CO_2-equivalents* to account for the other five Kyoto GHGs emitted, namely methane, nitrous oxide, sulphur hexafluoride, HFCs and PFCs.

After comparing our estimated Dutch GHG emission data to that of the NEa for those 21 companies from our sample, it was quickly discovered that the revenue-as-a-proxy method does not deliver satisfactory results. There are several reasons for this.

Firstly, the location of manufacturing matters. For instance, if highly energy-intensive chemical processes, like naphtha cracking for ethylene production, are concentrated in the Netherlands, the Dutch GHG emissions could be significantly higher than suggested by the revenue-as-a-proxy method. Conversely, if low-energy processes, such as manufacturing polyethylene from ethylene, are situated in the Netherlands, the revenue-as-a-proxy method might yield GHG emission estimates for the Netherlands that are too low.

Furthermore, company structure is important. Not only does it matter where the company is locating its energy-intensive processes, also questions such as "Where do upstream or downstream processes occur?" are important ones to ask. Especially for the chemical sector, downstream emissions play a significant role since, in many cases, the carbon contained in chemical products is usually released later in the process, either during utilization (for example from the application of urea-based fertilizers) or through incineration or decomposition at the end of the product's life. The same consideration applies to petrochemical firms, which typically generate significant downstream emissions through fuel combustion. However, it is important to note that our analysis focuses on scope 1 and 2 emissions. Both upstream and downstream emissions fall under scope 3, making this consideration less directly relevant in this context. Nevertheless, it remains essential to bear this in mind.

Another factor that is largely affecting the proportion of emissions a company is emitting in a particular country are the energy sources and whether energy is generated or obtained from renewable or non-renewable sources. Since the Netherland is a developed and industrialized country with a lot of global trade, the proportion of renewables is higher than in developing and non-industrialized countries, as empirically shown in a study by Amri (2019).

Hence, considering all these nuanced factors, obtaining precise or near-precise GHG emissions data for a company in a particular country requires a comprehensive examination of the company's structure, processes in the specific country, machinery and appliances used, the products manufactured there, and associated upstream and downstream emissions. Additionally, understanding the energy profile of the company in that country is crucial. However, conducting such an analysis is not only time-consuming but also challenging due to issues related to data availability and accessibility. An alternative approach is - if obtainable - to rely on national-level disclosures, similar to the data provided for companies in the NEa database.

To summarize, using a revenue as a proxy did not lead to satisfactory results. Despite conducting sensitivity tests (see Appendix Z) for different subsectors and headquarter locations, no definitive and generalizable insights emerged. Nevertheless, the exploration of using proxies to downscale global corporate GHG emissions to country-level provided us with valuable insights into the complex landscape of assessing company-level GHG emissions, leading to noteworthy implications and recommendations that we were able to make.

Due to the apparent shortcomings in the revenue-as-a-proxy method and the consequent uncertainties in the company-level GHG emission data for the Netherlands, we decided to conduct the entire research - despite its focus on the Netherlands – based on global emission data sourced from the CDP questionnaires.

9.2 Contribution to the academic literature

This research contributed to the academic literature in several ways. Firstly, it conducted a novel evaluation of chemical sector companies within the context of the Netherlands, filling a gap in existing research. While acknowledging the associated limitations, which will be discussed in the following section, valuable insights were derived, leading to recommendations for the enhancement of similar research in the future.

Additionally, the study made a substantial contribution to the scientific discourse on GHG emission quantification by highlighting the limitations of using proxies for estimating country-level emissions. The complexity inherent in this task and the associated challenges that we encountered during the process of using a revenue proxy to estimate emissions as well as comparing its results to NEa data, enabled us to derive meaningful implications and make recommendations, which are detailed in sections 10.3 and 10.4.

Furthermore, through the correlation analysis examining the relationship between NSAs and national state-level climate action, this research provided support for Andonova et al.'s (2017) empirical study. Strong correlations were observed between the variables they identified to be strongly correlated in countries with high civil liberties, such as the Netherlands. However, it is crucial to approach these results with caution due to the challenges and limitations of the research design, namely, conducting the correlation analysis over time.

9.3 Limitations

To scrutinize this research holistically and critically, we analyze the limitations of this thesis on two levels: firstly, by discussing the limitations of the methodology applied, and, secondly by elaborating on the limitations of the results.

9.3.1 Limitations of the methodology

As discussed in before, using revenues as a proxy to estimate country-level corporate emissions has significant limitations. While our study initially aimed to focus on a Dutch national perspective, the global nature of climate change and transnational governance posed challenges. Our difficulties arose when attempting to estimate country-level emissions from companies' manufacturing activities in the Netherlands, leading us to abandon these estimates and instead rely on global emissions data.

This experience helped us to unveil and highlight two crucial insights, however. Firstly, it underscored the intricate and interconnected landscape of climate change mitigation, encompassing various emission scopes and specific factors influencing emissions. Questions regarding machinery, appliances, vehicles, energy sources, accounting methods for energy (market versus location-based), and the types and amounts of emitted GHGs need to be addressed on a level relating to specific company locations or even at the level of each company building separately. Secondly, it emphasized a significant lack of transparency in corporate emissions reporting. While the CDP sets a foundation for corporate reporting standards, there remains a considerable gap.

In particular, the self-reported nature of the data from CDP questionnaires introduces a significant limitation. While many companies undergo third-party verification, the achieved level of "limited assurance" raises questions about data reliability. Analyzing energy data revealed apparent flaws, primarily in mathematical accuracy. Some instances showed discrepancies in the totals of different energy categories, raising concerns about the reliability and correctness of the data. Additionally, the wrongful placement of commas by companies, a mistake that can easily occur when working with numbers, could potentially distort emission results significantly. As researchers, we lack control over such issues and have no means to verify the accuracy of the data.

An illustrative case is the substantial surge in electricity consumption by Cargill in 2020. While – as discussed - this may be attributed to increased production of commodities during the COVID-19 pandemic, it might as well be a comma error. Looking at the fact that the electricity consumption in that year increased by almost one order of magnitude while, in the following year, electricity consumption levels went back to "normal", comparable with those of 2019, this might simply be a result of a mathematical error, such as a coma in the wrong place rather than a surge in production attributed to COVID-19. Especially when considering that increased electricity consumption results from heightened electrification of processes, one would anticipate that the level of electricity consumption should remain elevated after 2020 rather than reverting to 2019 levels.

Consequently, we cannot confidently assert the reliability or correctness of the CDP data used, however, we acknowledge the limitations associated with relying on this self-reported data, emphasizing the need for more accurate and transparent reporting mechanisms.

In addition to the data limitations inherent in our methodology, the small sample size of 50 companies poses a significant challenge in generalizing results to a larger population. This limitation becomes particularly evident when conducting split-sample analyses based on companies' headquarters, subsectors, and the number of ICIs joined. In some cases, sample sizes were as small as two or three companies, preventing robust generalization or definitive statements. Despite this limitation, our decision to maintain a sample size of 50 was deliberate, allowing us to analyze the evolution of emissions per company.

Lastly, the correlation analysis conducted to explore potential relationships between chemical companies participating in voluntary climate initiatives and government climate action does not establish causality. While correlations between variables were identified, in our analysis definitive statements about both correlation and causation were and cannot be made. The challenge lies in discerning whether the initiatives and participating companies drive increased national climate action or if the growing significance of climate change and national mitigation strategies independently influence both. The potential influence of time as a confounding variable adds complexity to this analysis, and caution should be exercised in drawing definitive conclusions about correlations and causation. Nevertheless, as our results align with the empirical study by Andonova et al. (2017), who conducted this analysis on a cross-national rather than longitudinal basis, we suggest that the correlations observed reflect, even if just partly, reality and there is a bi-directional influence of national state-level and NSA climate action.

9.3.2 Limitations of the results

The first limitation in our findings is the absence of an assessment of the efficiency of mitigation while evaluating companies within the SBTi that have set absolute scope 1+2 targets. Neither for these companies nor for the other companies in our sample did we analyze efficiency metrics, such as inputs like monetary or human resources applied. Time constraints played a role in this limitation, as an in-depth examination of climate mitigation efficiency would have required extensive company-level research for all 50 companies, exceeding the scope of this research. While we can identify companies with successful mitigation efforts, hence, effectiveness, we cannot determine if these efforts are efficient. In some cases, companies may achieve effectiveness but at an unsustainable cost, potentially affecting their competitiveness and overall viability.

Consider a hypothetical example to illustrate this point: Company A, fully dedicated to climate change mitigation and investing significant resources, may become less competitive over time. If Company A loses market share to a less climate-focused competitor, like Company B, the overall emissions for the same output could end up even higher than they were before. While this scenario is extreme and unlikely, it underscores the importance of investigating efficiencies alongside effectiveness to make comprehensive claims about a company's mitigation success.

Additionally, our analysis did not cover other forms of climate action, such as internally driven corporate climate mitigation efforts. These efforts involve companies setting internal targets and reducing GHG emissions without joining specific programs or initiatives. As a result, we cannot definitively state whether a company's emission reduction is a direct outcome of participation in ICIs or stems from internally driven initiatives, therefore our results are limited to making claims about causalities when it comes to ICI participation and the level of GHG emissions.

10. Conclusion

The final chapter encapsulates the findings derived from this research. In section 10.1, we revisit the primary research question along with all the sub-questions, offering comprehensive answers to each. Moving on to section 10.2, we synthesize the results, unifying the various insights garnered throughout this paper and interconnecting the diverse topics explored to formulate our ultimate statement and conclusion. Section 10.3 delves into the broader implications of this study, while section 10.4 presents targeted policy recommendations tailored for decision-makers. Lastly, section 10.5 proposes recommendations for future research.

10.1 Answering the research questions

This research aimed to answer the following main research question:

"What effect do International Cooperative Initiatives have on the climate achievements of the chemical sector in the Netherlands and how does that influence national targets and policies?"

To do so, we employed several different methods for analyzing the ICI participation of chemical and petrochemical sector companies with the largest revenues in the Netherlands, that fall within the classification of SBIs 19-22. We evaluated the climate mitigation progress these entities made so far and explored the relationship their participation in ICIs has with Dutch national targets and policies. While our analysis was focused on the Netherlands, we used global emission data reported by companies due to the unavailability of more granular GHG data as well as the challenges associated with estimating country-level GHG emissions using a proxy.

To provide answers to each of the different components of the main research question, we will be doing so by answering the sub-questions and drawing an overall conclusion at the end.

SQ1: "What type of climate action programs can the chemical sector engage in, in the Netherlands?"

The Dutch chemical sector, being the tenth-largest chemical industry globally, plays a pivotal role in mitigating global GHG emissions. Companies within the sector can actively engage in climate action by participating in initiatives or contributing to emission reductions by increasing energy efficiencies or the use of renewable energy. Within the landscape of corporate climate action, both top-down and bottom-up approaches are relevant.

In the Netherlands, 368 NSAs are involved in climate actions, with 232 being companies. These companies voluntarily commit to climate action and engage in initiatives that contribute to global efforts. A list of 33 relevant ICIs was comprised, of which eight initiatives were scrutinized based on their applicability to the Dutch chemical sector and research relevance. The selected initiatives include Business Ambition for 1.5°C, Climate Ambition Alliance, Climate Neutral Now, SBTi, RE100, Climate Action 100+, and Responsible Corporate Engagement in Climate Policy. While, naturally, there are many more ICIs the chemical sector in the Netherlands can participate in, these initiatives were selected to be studied based on their exclusive focus on climate mitigation or climate policy, as well as their high participant numbers.

SQ2: "What are the climate achievements of chemical industry companies that have joined International Cooperative Initiatives?"

The study reveals a substantial increase in company participation in ICIs over the past years, with about 86% of all companies in the sample having joined either one or two initiatives by 2023. Notably, Dutch companies show a higher proportional involvement, indicating a potentially elevated commitment to climate action. However, our results showed that, as opposed to our assumption, an unexpected trend emerged, with emissions from Dutch companies increasing despite an overall -11% decrease in emissions for the entire sample between 2018 and 2022. The analysis therefore suggests that increased ICI participation may not necessarily correlate with greater success in climate action, posing questions about the motivations behind participation.

Besides this revelation, a closer examination identified that the five major emitters, namely ExxonMobil, Shell, SABIC, TotalEnergies, and Air Liquide, who are responsible for approximately 50% of emissions, achieved a collective GHG emission reduction of -12% from 2018 to 2022. Due to the importance of these companies as a result of their significant contribution to emissions, this decrease, which is even 1% higher than the decrease of the overall company sample, instills hope for the chemical sector to achieve its climate goals. Some companies on the other hand exhibited notable emission increases, which may however be linked to acquisitions of other companies or new assets.

SQ3: "What climate mitigation progress has been achieved so far by companies in the chemical sector that participate in the Science-Based Targets initiative?"

Upon examining the four types of progress - ambition, robustness, implementation, and substantive progress - with a focus on scope 1 and 2 emissions, the results reveal a complex relationship between SBTi participation and emission outcomes, indicating that increased involvement may not necessarily correlate with greater success. While target ambitions remained high across companies with absolute scope 1+2 SBTs, in line with scenarios by the IPCC and the IEA, these commitments did not align with the actual GHG emissions observed. In fact, while the emissions of the overall company sample have decreased by -11%, those of companies participating in the SBTi, having set absolute 1+2 SBTs even increased by a staggering 26% (while committed companies decreased emissions by about -6%) between 2018 and 2022. The findings also suggest that robustness in practices is lacking, and, while some companies showed their dedication to climate mitigation by obtaining a significant amount of their energy consumption from renewable sources, some other businesses even decreased their proportion of energy from renewables.

While we observe an apparent lack in overall emission reductions, we can see the same trend at the company level. The number of companies being on track on their targets is steadily decreasing, with merely one-third of companies still being on track on their targets in 2022. Even though the results suggest poor overall performance, the company-level analysis revealed that the largest contributor, Air Liquide, increased its emissions significantly over the past five years and is largely responsible for the observed trend. If the company were to be excluded from the sample, scope 1+2 emissions would remain below the combined ambitions of all absolute scope 1+2 SBTs. Furthermore, analysis revealed that companies with earlier base year show greater success in mitigating their emissions, opposed to companies having joined the SBTi at a later point in time, with the base year set in 2021. This underscores the initiative's effectiveness over time in aiding companies to curtail their emissions.

SQ4: "What are the current Dutch national climate targets and which climate policies are relevant for the chemical industry in the Netherlands?"

The Dutch government aims to achieve a 55% reduction in GHG emissions by 2030, aligned with the European Green Deal and the Paris Agreement, and aims for climate neutrality by 2050. The chemical industry faces an even more challenging target of a 59% reduction by 2030, necessitating an additional 14.3 *Mt* CO_2eq reduction beyond existing policies, emphasizing the need for NSA climate action. The regulatory landscape, both at the EU and national levels, encompasses rules regarding emissions, energy efficiency, and chemical safety, with governmental support crucial for a fair transition.

Strategies for the chemical sector include EU and national policies including various policy tools, like pricing mechanisms, voluntary agreements, subsidies, and infrastructure programs. Despite a notable emissions drop from chemical companies in 2022, which is most likely attributed to decreased production as a result of higher energy prices, challenges persist, emphasizing the need for robust climate policies. The government's substantial financial commitment underscores intensified climate efforts, including increased CO_2 taxes and industrial carbon neutrality mandates. Even though the Netherlands has implemented an array of strong climate policies for both mitigation and adaptation, favoring sustainable practices and supporting the economy in its endeavor towards a low-carbon transition, additional measures are vital for achieving ambitious climate goals. NSAs in the chemical sector must actively contribute to climate action for the Netherlands to meet its targets.

SQ5: "How does the participation of chemical sector companies in International Cooperative Initiatives affect national targets and policies in the Netherlands, and vice versa?"

The analysis conducted to answer this sub-question revealed significant correlations between NSA participation in ICIs and various variables related to a country's national climate action. Notably, a strong correlation was found between NSA participation in ICIs and the Dutch EPI CCPO supporting the idea of a complementary relationship between these variables. Unlike previous studies, our research identified a negative correlation between ICI participation and CO_2 emissions, possibly due to our national-level, longitudinal analysis showing decreasing emissions alongside increased ICI participation as opposed to cross-country evaluations. While we assumed potentially stronger correlations when focusing our sample on companies headquartered in the Netherlands, we did not observe significant differences between the effects of ICI participation of the entire company sample and those of Dutch businesses.

While robust correlations were identified, it is essential to recognize that these correlations might simply be the result of both variables growing over time, rather than being indeed correlated. Furthermore, we want to emphasize that the identified correlation does not imply causation, and the influence of time as a potential confounding variable should be acknowledged here as well. Nevertheless, our findings align with previous research, emphasizing the bidirectional relationship between transnational climate governance such as NSA participation in ICIs, and national state-level climate action, highlighting their complementary roles in shaping global climate action.

10.2 Synthesis of the results

As we have seen, NSAs play a vital role in complementing national policies and influencing global climate action. However, we note a distinct lack of emission reductions within the chemical sector. Although certain chemical businesses are successfully decarbonizing in alignment with corporate and global climate goals, this trend is not universal across the industry. The actions of major emitters are pivotal, as their successes or failures significantly impact the overall emissions trajectory. Therefore, focusing support on these influential companies is crucial to enhance the prospects of achieving mid-century climate mitigation targets.

Moreover, our analysis did not reveal a direct correlation between the level of participation in ICIs and a company's mitigation success. Instead, economic factors such as acquisitions and divestments of companies or assets, as well as the engagement in novel activities like hydrogen production exert a more substantial influence. Moreover, external factors beyond companies' control such as pandemics or geopolitical events like the Russia-Ukraine war resulting in major energy fluctuations, can have a major influence of the decarbonization trajectories of businesses, with some ambitious companies facing constraints in their climate action endeavors.

Nevertheless, ICIs play a pivotal role in steering the global low-carbon transition by raising awareness of the topic, helping to inform investors, consumers, and other stakeholders. This, in turn, increases the pressure on companies, forcing those companies currently lacking a commitment to decarbonization that goes beyond greenwashing to take corporate mitigation more seriously.

Furthermore, as we have seen, a bidirectional relationship exists between NSA climate action in the form of companies participating in ICIs and state-level climate action. While ICI participation may not guarantee substantial progress in GHG emission mitigation at the company level, increased participation positively affects society, the economy, and politics, mutually reinforcing these positive effects. This interconnected relationship accelerates the transition to a greener and more sustainable future for all of us.

10.3 Implications

This section consolidates the findings from all preceding chapters to extract insights about the implications relating to the effectiveness of ICIs and their effect of NSAs and the Dutch government. While this section discusses implications on a broader level, the next section focuses on specific implications and recommendations for policymakers and decision-makers.

On a general level, as a result of our analyses, this study underscored the complexity of global climate action and emphasizes the time-consuming yet crucial nature of analyzing companies' climate action progress. Therefore, the identified implications primarily pertain to facilitating the assessment of corporate climate action. This involves addressing transparency and data availability issues and making recommendations to ICIs on enhancing their approach.

As a first implication, we want to draw the reader's attention to the issues relating to corporate emissions reporting, where we advocate for enhanced standardization. Although the GHG Protocol offers a robust foundation for emissions accounting, certain issues persist. The first issue concerns the discrepancy between companies asserting that their emission quantification and management practices align with the GHG Protocol methodology, and the observed variability in information, data disclosure, and target metrics reported in corporate sustainability reports and CDP questionnaire responses. Additionally, such variabilities extend across different initiatives, complicating comparisons and necessitating in-depth analyses of data and various target metrics. We therefore call to align approaches, having initiatives cooperate to implement standardized and transparent methods, and reporting standards.

The second issue pertains to the dual scope 2 accounting methods—market-based and location-based. While a growing number of companies opt for market-based figures in reporting their scope 2 emissions, some variability remains, making cross-company comparisons challenging when different scope 2 accounting methods are employed. Consequently, we emphasize the need to standardize the scope 2 accounting method. While both approaches have their merits and drawbacks, standardization would facilitate more meaningful comparisons across companies.

Besides advocating for more standardization, we also call for increased transparency. While acknowledging the commendable efforts of the CDP, it's crucial to note that extracting data from CDP questionnaires is not only a time-intensive process, but the CDP imposes constraints on the number of accessible questionnaires, and exceeding this quota incurs substantial costs for additional access. This restricted accessibility poses challenges for individuals seeking information on a company's climate action progress or, as in our case, conducting a study. We recommend enhancing the accessibility and availability of such data for broader use. Section 10.4 delves deeper into a potential approach to address this issue.

We furthermore recommend implementing a validation test for the questionnaires submitted to the CDP, before the responses are being published. Particularly when evaluating energy metrics for the assessment of progress on implementation, we encountered various mathematical errors. While some of these errors merely related to wrongly calculated totals (which we corrected in our data), some others raised genuine concerns. One example we encountered to illustrate this is the spike in electricity consumption by Cargill in 2020. The cause of this spike, whether a significant production variation due to the COVID-19 pandemic or a mere mathematical error (such as a misplaced comma), remains uncertain. However, if it is indeed a minor error, it could significantly impact results. Introducing validation tests before publicizing questionnaire responses would help mitigate such issues.

Another crucial implication pertains to the lack of readily available information on companies' progress toward their SBTs. While the SBTi is a globally recognized initiative, public accessibility to target information is not accompanied by insights into whether companies are on track on their SBTs. Obtaining such information requires delving into sustainability reports or CDP questionnaires, which may be challenging for non-experts. We propose that the SBTi not only disclose companies' set targets but also provide information on their progress. This transparency would encourage companies to take their climate targets more seriously, fostering a more accountable corporate environment.

Furthermore, we recommend that the SBTi establishes distinct scope 1 and 2 targets. Currently, only combined scope 1+2 targets are in place, making it challenging to differentiate between the two scopes and assess progress in specific areas. This differentiation is particularly crucial for the chemical sector, given its substantial scope 1 emissions resulting from the use of fossil fuels as feedstock. Having separate scope 1 and 2 SBTs would enable the identification of chemical and petrochemical companies making strides in transitioning to renewable feedstocks. In a “green chemistry future”, is imperative to recognize materials, currently considered low-value waste, as renewable feedstocks, thereby shifting the paradigm from linear to circular processes (Zimmerman et al., 2020). This transformation would be reflected in a company's scope 1 emissions, allowing for the identification of businesses committed to circularity. However, for assessing this progress in the context of the SBTi, this distinction would only be feasible and discernible with separate scope 1 and 2 SBTs.

10.4 Policy recommendations

One primary implication of our findings is the challenge of obtaining country-level company emissions data, making it hard to understand where certain business locations are performing well versus badly in a GHG emission context. As we showed, estimating such country-level emissions is a difficult task, and trying to do so using a proxy did not lead to satisfying results. Despite our focus on the Dutch chemical industry, the lack of granular data, and the nature of target-setting and reporting practices occurring on a global level, made this analysis challenging. The absence of detailed information hampers the assessment of how well companies align their processes with mitigation targets.

To address this issue, we recommend mandating country-level climate reporting. This would address this issue, enabling consumers, investors, policymakers, and society as a whole to identify companies genuinely committed to sustainability. At the same time, it would unveil companies responsible for carbon leakage. We want to emphasize that global corporations, particularly those operating in multiple countries, need to provide more specific information and granular data to facilitate informed decision-making. To address the issue of businesses, particularly those involved in greenwashing activities, being reluctant to voluntarily disclose their emissions at the country level, implementing mandatory reporting would be an effective solution.

Remaining within the realm of corporate emission data, as previously emphasized, we advocate for increased accessibility to data provided by the CDP. While recognizing the non-profit nature of the CDP and its need to cover operational costs, we assert that universal access to comprehensive corporate climate data is a fundamental right. Hence, we propose fostering collaboration between governments and organizations like the CDP, with governments contributing funds that offset these associated costs. It is our suggestion that the CDP should maintain its fee structure for investors, academic institutions, and financially capable entities. Simultaneously, a collaborative effort between policymakers and the CDP could facilitate free access to data for individuals. A plausible approach could involve allowing limited access to questionnaires per day instead of an overall limit. Therefore, each individual with a CDP account is granted access to a specified number of questionnaires per day. This access quota is reset to zero at the beginning of each subsequent day. This strategy not only promotes free data accessibility for individuals but also mitigates the risk of entities misusing this "free plan", as such entities usually necessitate to access large amount s of data each day.

This study also highlights the significance of major emitters to global climate mitigation. Policymakers should concentrate efforts and resources on supporting these large companies in their decarbonization journey, ensuring competitiveness while minimizing the risk of carbon leakage. While support should naturally also extend to smaller emitters for fairness, the transition to low-carbon processes is often more costly for larger companies due to their scale and rigid practices. The Dutch government's tailored agreements with the 20 largest emitters, as discussed in section 7.3, serve as a commendable approach and, if proven effective in the future, could be implemented in other countries. Additionally, we suggest continuing to allocate funds at varying levels based on a company's size and extending this approach to other funding schemes. This is already integrated into the existing Dutch climate policies, wherein some funds are specifically earmarked for SMEs, while separate funds are designated for larger companies.

As revealed in our analysis of companies' climate mitigation progress, while certain firms appear not to act upon the targets they set, there is a notable level of commitment and substantial progress demonstrated by others. Given the bi-directional influence between NSAs and national governments, we recommend collaboration between these "climate-champion companies" and Ministries or state officials. This partnership can facilitate knowledge exchange, allowing policymakers to learn from successful climate practices of businesses and implement supportive policies accordingly. Publicizing such collaborations and putting these climate-champion companies in the spotlight can serve as a powerful motivator for companies to enhance their climate action efforts, benefiting from improved brand reputation. This positive publicity, in turn, attracts climate-conscious consumers and investors, ultimately contributing to business growth. This collaborative approach would also help to mitigate concerns about companies becoming less competitive when investing in climate-positive practices as in the end, this effect would be offset by the new customers and investors attracted.

10.5 Recommendations for future research

As highlighted throughout this thesis, there are several areas where we recommend conducting further research or replicating our analyses with larger sample sizes to obtain more meaningful and generalizable insights.

Firstly, the revenue-as-a-proxy method employed to estimate company-level GHG emissions in the Netherlands exhibited various flaws, as extensively discussed in Appendix Z. Our analysis aimed at identifying potential headquarters locations or company subsectors where the method might work better did not yield valuable insights. While certain headquarters locations and subsectors hinted at a more favorable trend, the sample size was insufficient to draw conclusive findings. We, therefore, propose replicating the approach with a significantly larger sample of chemical companies to ascertain whether the revenue-as-a-proxy method demonstrates better performance in specific geographical locations or subsectors. It is important to note, however, that for reliable results, such quantification should be conducted on a company level, considering various factors influencing a company's emissions, including the type of energy source used, energy consumption, types of buildings, vehicles, machinery, and products manufactured, et cetera. Particularly in a chemical sector context, the type of products manufactured, and related processes play a crucial role as the chemical industry uses fossil fuels as feedstocks and not only for generating energy.

Similar recommendations for further research apply to the analysis of the relationship between ICI participation and GHG emissions. Replicating the study with a larger sample would enhance the reliability and robustness of the results. Additionally, our observation that Dutch companies displayed proportionally higher ICI participation while performing less effectively in mitigating climate emissions led us to speculate that ICI participation might be a response to internal mitigation challenges or simply a strategy to enhance brand reputation. A company-level investigation is warranted to uncover the specific reasons behind a company's participation in certain ICIs.

Lastly, in our examination of company progress in the SBTi, the results from various split-sample analyses lack the certainty needed for broad generalization to a larger population. The findings were somewhat ambiguous, and we strongly advocate replicating our analyses using a more extensive company sample. Company-level analysis would moreover facilitate a comprehensive assessment of both the effectiveness and efficiency of companies' climate action endeavors. By examining the specific measures taken to mitigate climate emissions and the inputs used, we would be able to make claims about how efficient companies are decarbonizing their processes while being able to identify companies efficiently decarbonizing their processes. This could offer valuable insights for others to learn from best practices.

The study therefore emphasizes the need for continuous efforts in climate mitigation, increased transparency of emissions reporting and progress of climate goals, targeted support for major emission emitters within the chemical sector, as well as public-private collaboration.

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APPENDIX

A. SBI codes 19-22

SBI CODE	(DUTCH) TITLE	ENGLISH TRANSLATION
19	**Vervaardiging van cokesovenproducten en aardolieverwerking**	**Manufacture of coke oven products and petroleum processing**
191	Vervaardiging van cokesovenproducten	Manufacture of coke oven products
1910	Vervaardiging van cokesovenproducten	Manufacture of coke oven products
192	Aardolieverwerking	Petroleum processing
1920	Aardolieverwerking	Petroleum processing
19201	Aardolieraffinage	Petroleum refining
19202	Aardolieverwerking (geen -raffinage)	Petroleum processing (not refining)
20	**Vervaardiging van chemische producten**	**Manufacture of chemical products**
201	Vervaardiging van chemische basisproducten, kunstmeststoffen enstikstofverbindingen en van kunststof en synthetische rubber in primaire vorm	Manufacture of basic chemicals, fertilizers and nitrogen compounds and of plastics and synthetic rubber in primary form
2011	Vervaardiging van industriële gassen	Manufacture of industrial gases
2012	Vervaardiging van kleur- en verfstoffen	Manufacture of dyes and colorants
2013	Vervaardiging van overige anorganische basischemicaliën	Manufacture of other basic inorganic chemicals
2014	Vervaardiging van overige organische basischemicaliën	Manufacture of other basic organic chemicals
20141	Vervaardiging van petrochemische producten	Manufacture of petrochemical products
20149	Vervaardiging van overige organische basischemicaliën (geen petrochemische producten)	Manufacture of other basic organic chemicals (not petrochemical products)
2015	Vervaardiging van meststoffen en stikstofverbindingen	Manufacture of fertilizers and nitrogen compounds
2016	Vervaardiging van kunststof in primaire vorm	Manufacture of plastics in primary forms
2017	Vervaardiging van synthetische rubber in primaire vorm	Manufacture of synthetic rubber in primary forms
202	Vervaardiging van verdelgingsmiddelen en overige landbouwchemicaliën	Manufacture of pesticides and other agrochemicals
2020	Vervaardiging van verdelgingsmiddelen en overige landbouwchemicaliën	Manufacture of pesticides and other agrochemicals
203	Vervaardiging van verf, vernis e.d., drukinkt en mastiek	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
2030	Vervaardiging van verf, vernis e.d., drukinkt en mastiek	Manufacture of paints, varnishes and similar coatings, printing ink and mastics

204	Vervaardiging van zeep, wasmiddelen, poets- en reinigingsmiddelen, parfums en cosmetica	Manufacture of soaps, detergents, cleaning and polishing preparations, perfumes and cosmetics
2041	Vervaardiging van zeep, wasmiddelen, poets- en reinigingsmiddelen	Manufacture of soaps, detergents, cleaning and polishing preparations
2042	Vervaardiging van parfums en cosmetica	Manufacture of perfumes and cosmetics
205	Vervaardiging van overige chemische producten	Manufacture of other chemical products
2051	Vervaardiging van kruit en springstoffen en van lucifers	Manufacture of gunpowder and explosives and matches
2052	Vervaardiging van lijm en bereide kleefmiddelen	Manufacture of glues and prepared adhesives
2053	Vervaardiging van etherische oliën	Manufacture of essential oils
2059	Vervaardiging van overige chemische producten (rest)	Manufacture of other chemical products (residual)
206	Vervaardiging van synthetische en kunstmatige vezels	Manufacture of man-made fibers
2060	Vervaardiging van synthetische en kunstmatige vezels	Manufacture of man-made fibers
21	**Vervaardiging van farmaceutische grondstoffen en producten**	**Manufacture of basic pharmaceutical products and pharmaceutical raw materials**
211	Vervaardiging van farmaceutische grondstoffen	Manufacture of basic pharmaceutical products
2110	Vervaardiging van farmaceutische grondstoffen	Manufacture of basic pharmaceutical products
212	Vervaardiging van farmaceutische producten (geen grondstoffen)	Manufacture of pharmaceutical products (not raw materials)
2120	Vervaardiging van farmaceutische producten (geen grondstoffen)	Manufacture of pharmaceutical products (not raw materials)
22	**Vervaardiging van producten van rubber en kunststof**	**Manufacture of rubber and plastic products**
221	Vervaardiging van producten van rubber	Manufacture of rubber products
2211	Vervaardiging van rubberbanden en loopvlakvernieuwing	Manufacture of rubber tires and retreads
2219	Vervaardiging van producten van rubber (geen banden)	Manufacture of rubber products (not tires)
222	Vervaardiging van producten van kunststof	Manufacture of plastic products
2221	Vervaardiging van platen, folie, buizen en profielen van kunststof	Manufacture of plastic sheets, film, tubes and profiles
2222	Vervaardiging van verpakkingsmiddelen van kunststof	Manufacture of plastic packing goods
2223	Vervaardiging van kunststofproducten voor de bouw	Manufacture of plastic building products
2229	Vervaardiging van overige producten van kunststof	Manufacture of other plastic products

Source: CBS and Kruiskamp (2022).

B. Cooperative Initiatives in which the Netherlands is engaged in

NAME OF INITIATIVE	AREA OF FOCUS	NUMBER OF PARTICIPANTS	SHORT DESCRIPTION / KEY CHARACTERISTICS
CLIMATE AMBITION ALLIANCE	Mainly mitigation	11428	Enhance cooperation in the pursuit of reaching net-zero CO_2 emissions by the year 2050.
CENTRAL AFRICAN FORESTS INITIATIVE (CAFI)	Mainly mitigation	17	Acknowledge and safeguard the significance of Central African forests for the purpose of mitigating climate change, alleviating poverty, and promoting sustainable development.
RESILIENCE AND ADAPTATION CALL FOR ACTION	Mainly adaptation/ resilience	177	Urges an immediate climate response, aid to the most vulnerable, and prioritizing climate risk in decision-making for building resilient futures.
CLIMATE AMBITION ALLIANCE: NET ZERO 2050	Mainly mitigation	136	Enhance cooperation in the pursuit of reaching net-zero CO_2 emissions by the year 2050.
SUPPORT FOR SMALLHOLDER FARMERS	Mainly adaptation/ resilience	10	Strengthen the ability to withstand climate-related shocks and extreme events for 300 million small-scale farmers, boost household incomes, ensure food security, and reverse ecological degradation.
INSURESILIENCE GLOBAL PARTNERSHIP (IGP)	Mainly adaptation/ resilience	114	Connects governments, multilateral entities, private sectors, and civil society to expand Climate and Disaster Risk Finance and Insurance, shielding 500 million vulnerable individuals from climate shocks by 2025.
CLIMATE ACTION FOR JOBS INITIATIVE	Equally mitigation & adaptation/ resilience	47	Nations committing to developing a plan for a just transition.
INITIATIVE ON GENDER AND CLIMATE CHANGE	Equally mitigation &adaptation/ resilience	51	Acknowledges the distinct effects of climate change on different genders, empowers women and girls to take the lead in all climate efforts, and elevates ambitions across all sectors.
CLIMATE CHANGE IMPACTS ON CULTURAL AND NATURAL HERITAGE (CCICH)	Mainly adaptation/ resilience	94	Nations pledge to adjust cultural and natural heritage to withstand the effects of climate change.
LEADERSHIP GROUP FOR INDUSTRY TRANSITION (LEADIT)	Mainly mitigation	34	Expediting the transformation of all industrial sectors toward low-carbon trajectories to achieve net-zero carbon emissions by 2050.

4/1000 INITIATIVE – SOILS FOR FOOD SECURITY AND CLIMATE	Equally mitigation & adaptation/ resilience	659	Worldwide healthy and carbon-rich soils to combat climate change and ensure food security, and engaging stakeholders in shifting towards resilient agriculture and agroforestry.
CCAC: OIL & GAS METHANE PARTNERSHIP (OGMP)	Mainly mitigation	30	Lower methane emissions from operations by systematically inspecting nine critical emission sources and publicly disclosing the proportion of their operations that are managing these sources.
CCAC: PHASING DOWN CLIMATE POTENT HFCS / HFCS INITIATIVE	Mainly mitigation	59	Diminish the utilization and discharge of potent HFCs, advance energy efficiency, and attain a 30-50% decrease in HFC emissions from refrigerant servicing within a decade.
ADAPTATION FOR SMALL HOLDER AGRICULTURE PROGRAMME (ASAP)	Equally mitigation & adaptation/ resilience	52	Enhance climate resilience and food security for 8 million impoverished smallholder households globally by 2020.
CLIMATE RISK AND EARLY WARNING SYSTEMS INITIATIVE (CREWS)	Mainly adaptation/ resilience	9	Raise $100 million by 2020 to substantially boost the capabilities of Multi-Hazard Early Warning Systems in Small Island Developing States (SIDS) and Least Developed Countries (LDCs).
GLOBAL GEOTHERMAL ALLIANCE (GGA)	Equally mitigation & adaptation/ resilience	89	A collaborative effort to promote the adoption of geothermal energy.
INTERNATIONAL SOLAR ALLIANCE (ISA)	Mainly mitigation	121	Galvanize over $1 trillion in investments by 2030 to facilitate the widespread implementation of cost-effective solar energy.
INTERNATIONAL ZERO-EMISSION VEHICLE ALLIANCE (ZEV ALLIANCE)	Mainly mitigation	14	Establish challenging yet attainable objectives for the adoption of zero-emission vehicles.
MISSION INNOVATION	Mainly mitigation	23	A worldwide endeavor sparking a ten-year period of action and investments in RD&D to render clean energy cost-effective, appealing, and available to everyone.
BLUE GROWTH INITIATIVE	Equally mitigation & adaptation/ resilience	17	Decrease CO_2 emissions by 10% within 5 and 25% within 10 years, while curbing overfishing by 20% in the first 5 and 50% within the following 10 years in 10 developing nations.
THE NEW YORK DECLARATION OF FORESTS	Mainly mitigation	212	Reduce the global loss of natural forests by 50% by 2020 and halt all forest loss by 2030.
UNDER2 COALITION	Mainly mitigation	278	Enable and act on behalf of states and regions that are dedicated to achieving net-zero emissions by 2050 or earlier.

CLIMATE-SMART AGRICULTURE BOOSTER (CSA BOOSTER)	Equally mitigation & adaptation/ resilience	75	Lead the way in promoting the shift to climate-resilient agriculture throughout Europe and globally.

Source: UNFCCC (2023b).

C. Cooperative Initiatives for companies with participants located in the Netherlands

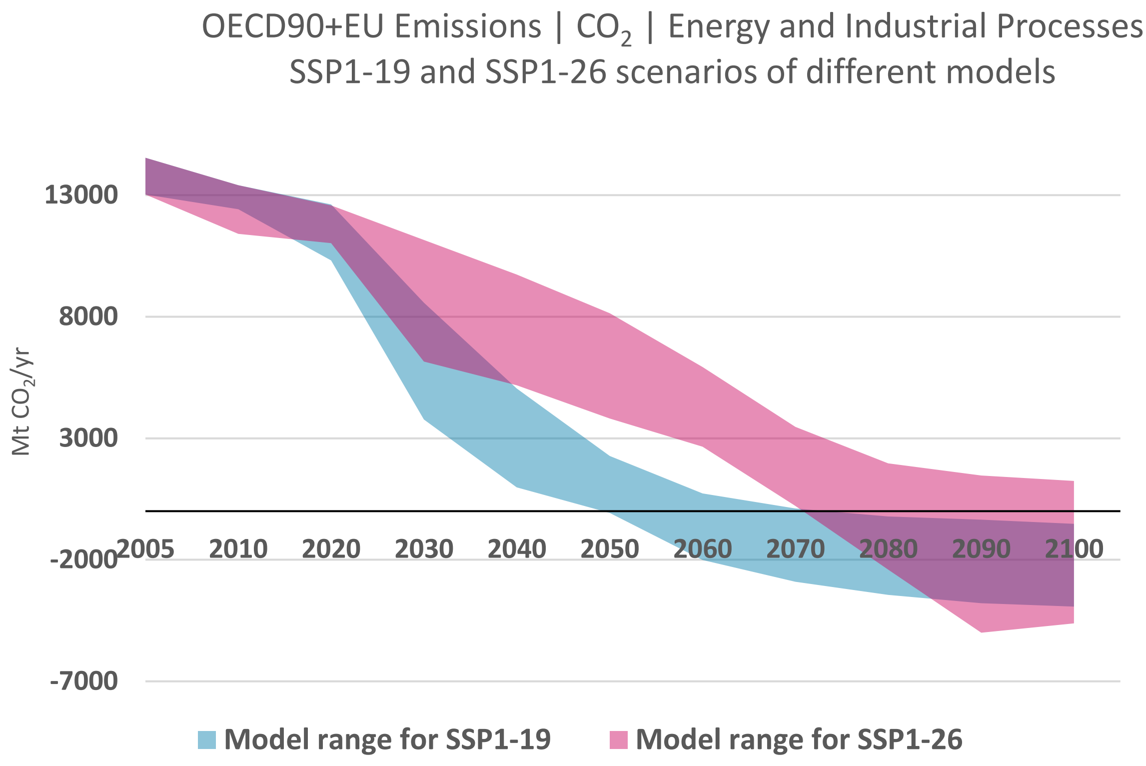
NAME OF INITIATIVE	AREA OF FOCUS	NUMBER OF PARTICIPANTS	SHORT DESCRIPTION / KEY CHARACTERISTICS
2050 PATHWAYS PLATFORM	Mainly mitigation	253	Strengthen climate resilience for communities, farmers, and laborers throughout value chains.
4/1000 INITIATIVE – SOILS FOR FOOD SECURITY AND CLIMATE	Equally mitigation & adaptation/ resilience	659	Worldwide healthy and carbon-rich soils to combat climate change and ensure food security, and engaging stakeholders in shifting towards resilient agriculture and agroforestry.
AIRPORT CARBON ACCREDITATION	Mainly mitigation	409	Motivate and facilitate airports in adopting top-tier carbon management practices and attaining reductions in emissions.
BELOW50	Mainly mitigation	20	Expand the global market for the most environmentally sustainable fuels.
BUILDING EFFICIENCY ACCELERATOR	Mainly mitigation	121	Accelerate urban building energy efficiency improvements by 2030 by combining global market insights with local policy actions, capacity building, and technical assistance for piloting and expanding best practices.
BUSINESS AMBITION FOR 1.5°C	Mainly mitigation	633	Calls on companies to establish science-based targets that align with a 1.5°C pathway toward achieving a net-zero future.
CEM: GLOBAL LIGHTING CHALLENGE	Mainly mitigation	29	Rapidly install 10 billion high-efficiency light bulbs.
CLIMATE AMBITION ALLIANCE	Mainly mitigation	11428	Enhance cooperation in the pursuit of reaching net-zero CO_2 emissions by the year 2050.
CLIMATE AMBITION ALLIANCE: RACE TO ZERO	Mainly mitigation	11292	Uniting non-state actors to halve global emissions by 2030 for a fairer, healthier, carbon-neutral world.
CLIMATE NEUTRAL NOW	Mainly mitigation	800	Encourage every segment of society to take action towards realizing a climate-neutral (net zero) world by 2050.
COALITION FOR CLIMATE RESILIENT INVESTMENT (CCRI)	Mainly adaptation/ resilience	96	Promote pioneering solutions that spearhead a systemic transformation aimed at facilitating global capital investment in resilient infrastructure.

EV100	Mainly mitigation	122	An international consortium of companies dedicated to transitioning to electric fleets and implementing EV charging infrastructure across their organizations by 2030.
FASHION INDUSTRY CHARTER FOR CLIMATE ACTION	Mainly mitigation	100	Set a decarbonization pathway for the fashion industry and aim for a 30% reduction in greenhouse gas emissions by 2030.
GETTING TO ZERO COALITION (GTZ COALITION)	Mainly mitigation	206	Establish commercially viable Zero Emission Vehicles (ZEVs) on deep-sea trade routes by 2030, with comprehensive infrastructure for scalable zero-carbon energy systems.
GLOBAL ALLIANCE FOR BUILDINGS AND CONSTRUCTION (GLOBALABC)	Equally mitigation & adaptation/ resilience	246	Heading towards an efficient, resilient, and zero-emission buildings and construction sector by coordinating stakeholders, private sector, governments, research & civil society.
GLOBAL RESILIENCE PARTNERSHIP (GRP)	Mainly adaptation/ resilience	69	Collaborate towards a world where individuals and communities endure, adapt, and evolve in the presence of shocks, unpredictability, and transformations.
IMPLEMENT THE RECOMMENDATIONS OF THE TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES	Equally mitigation & adaptation/ resilience	19	Adopt the TCFD (Task Force on Climate-related Financial Disclosures) recommendations for disclosing financial information related to climate impacts.
IMPROVE WATER SECURITY – BUSINESS ALLIANCE FOR WATER AND CLIMATE	Equally mitigation & adaptation/ resilience	51	Assess and reduce risks and consequences associated with water and climate change.
LCTPI	Mainly mitigation	96	Implement corporate solutions to expedite the transition to a low-carbon state.
LCTPI RENEWABLES - RESCALE	Mainly mitigation	23	Back the installation of an extra 1.5 terawatts (TW) of renewable energy sources worldwide by 2025.
LEADERSHIP GROUP FOR INDUSTRY TRANSITION (LEADIT)	Mainly mitigation	34	Speeding up the transformation of all industrial sectors toward low-carbon trajectories to achieve net-zero carbon emissions by 2050.
MISSION EFFICIENCY (FORMERLY THE THREE PERCENT CLUB FOR ENERGY EFFICIENCY)	Mainly mitigation	80	Combination of actions, pledges, and objectives undertaken by a coalition of governments, organizations, and initiatives working collaboratively to expedite the global shift toward energy-efficient economies.

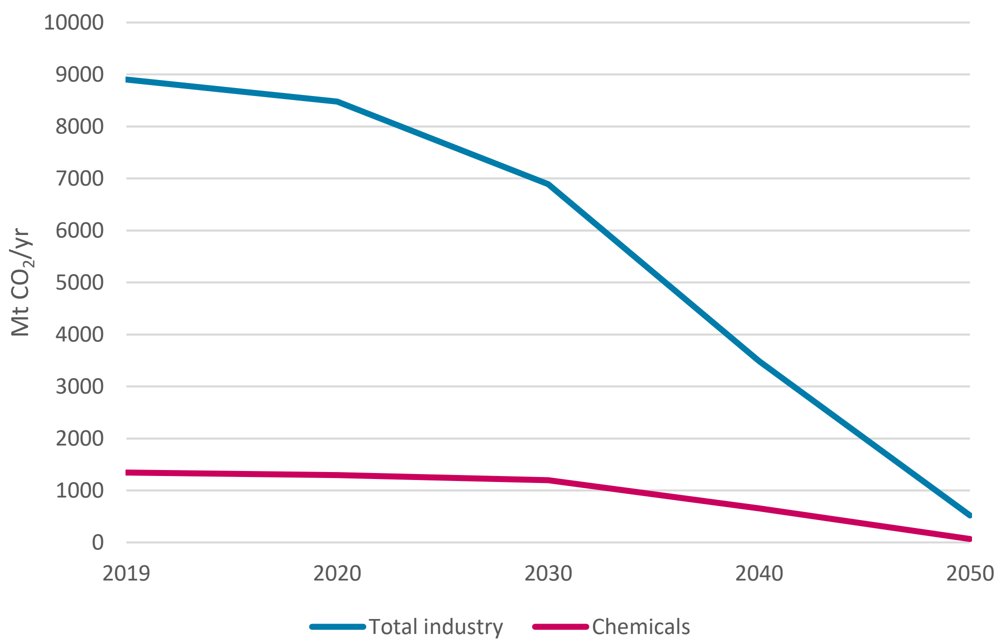
OCEAN RISK AND RESILIENCE ACTION ALLIANCE (ORRAA)	Equally mitigation & adaptation/ resilience	58	Attract a minimum of $500 million in investments for coastal and ocean natural resources and introduce at least 50 innovative financial products by 2030.
ONE PLANET BUSINESS FOR BIODIVERSITY	Mainly mitigation	27	Initiate profound systemic change and spur efforts to safeguard and recover biodiversity, combat climate change, involve decision-makers, and formulate policy suggestions.
PUBLIC TRANSPORT DECLARATION ON CLIMATE LEADERSHIP (UITP)	Mainly mitigation	1900	Increase the proportion of public transportation by two-fold by 2025.
PUT A PRICE ON CARBON – BUSINESS LEADERSHIP CRITERIA ON CARBON PRICING	Mainly mitigation	78	Establish an internal carbon cost and publicly promote and communicate the progress made.
RAILWAY CLIMATE DECLARATION	Mainly mitigation	35	Represents rail interests and brings together the global railway community, urging UIC members to commit to carbon neutrality by 2050 and supporting the SDGs.
RE100	Mainly mitigation	212	Source 100% of electricity from renewable resources.
REMOVE COMMODITY-DRIVEN DEFORESTATION	Mainly mitigation	55	Eliminate deforestation resulting from commodity production from all supply chains by 2020.
RESILIENCE AND ADAPTATION CALL FOR ACTION	Mainly adaptation/ resilience	177	Urges an immediate climate response, aid to the most vulnerable, and prioritizing climate risk in decision-making for building resilient futures.
RESPONSIBLE CORPORATE ENGAGEMENT IN CLIMATE POLICY	Mainly mitigation	124	Ethical corporate participation in climate policy.
SCIENCE-BASED TARGETS INITIATIVE	Mainly mitigation	722	Adopted a GHG emission reduction target that is based on science.
TAXI4SMARTCITIES	Mainly mitigation	24	Speed up the transition to alternative energy sources for their vehicle fleet by 2020 and 2030.

Source: UNFCCC (2023b).

D. IPCC and IEA scenarios



Modeled based on data by the AR6 Scenario Explorer hosted by IIASA



IEA Net Zero by 2050 Scenario for the global industry and the chemical sector

E. Verification standards accepted by the CDP

Verification standards accepted by CDP	**Non-verification standards**
AA1000AS	Australian Government's National Carbon Offset Standard
ABNT NBR ISO 14064-3:2007 (Associação Brasileira de Normas Técnicas)	The Clean Development Mechanism (CDM)
Advanced technologies promotion Subsidy Scheme with Emission reduction Target (ASSET)	The CLEEAR Standard
Airport Carbon Accreditation (ACA) des Airports Council International Europe	EN 45011
Alberta Specified Gas Emitters Regulation	EPA Climate Leaders Review
ASAE3000	EPA Part 75
AT-C 105 with AT-C 205 for Examination engagements	The GHG Protocol Corporate Reporting & Accounting Standard
AT-C 105 with AT-C 210 for Review Engagements	Global Reporting Initiative (GRI)
Australia National Greenhouse and Energy Regulations (NGER Act)	ISO 14001
California Mandatory GHG Reporting Regulations (also known as Californian Air Resources Board regulations)	ISO 14040-49
Canadian Institute of Chartered Accountants (CICA) Handbook: Assurance Section 5025	ISO 14065
Carbon Trust Standard	ISO/EC 17021
Chicago Climate Exchange verification standard	ISO 19011
The Climate Registry's General Verification Protocol (also known as California Climate Action Registry (CCAR))	ISO 50001
Compagnie Nationale des Commissaires aux Comptes (CNCC)	OFWAT
Corporate GHG Verification Guidelines from ERT	PAS 2050
DNV Verisustain Protocol/ Verification Protocol for Sustainability Reporting	TN-CC-003:2009-01
Earthcheck Certified	VfU (Verein fur Umweltmanagement) Indicators
ERM GHG Performance Data Assurance Methodology	VfU (Verein fur Umweltmanagement) Indicators Standard
IDW PS 821: IDW Prüfungsstandard: Grundsätze ordnungsmäßiger Prüfung oder prüferischer Durchsicht von Berichtenim Bereich der Nachhaltigkeit	
IDW AsS 821: IDW Assurance Standard: Generally Accepted Assurance Principles for the Audit or Review of Reports on Sustainability Issues	
ISAE 3000	
Dutch Standard 3000A	
ISAE 3410, Assurance Engagements on Greenhouse Gas Statements	
ISO 14064-1	
ISO 14064-3	
JVETS (Japanese Voluntary Emissions Trading Scheme) Guideline for verification	
Korean GHG and energy target management system	

NMX-SAA-14064-3-IMNC: Instituto Mexicano de Normalización y Certificación A.C	
RevR 6 Bestyrkande av hållbarhetsredovisning (RevR 6 Assurance of Sustainability)	
RevR6 Procedure for assurance of sustainability report from Far, the Swedish auditors professional body	
Saitama Prefecture Target-Setting Emissions Trading Program	
Standard 3810N Assurance engagements relating to sustainability reports of the Royal Netherlands Institute of Registered Accountants	
SGS Sustainability Report Assurance	
Spanish Institute of Registered Auditors (ICJCE)	
SSAE 3000	
State of Israel Ministry of Environmental Protection, VERIFICATION OF GREENHOUSE GAS EMISSIONS AND EMISSIONS REDUCTION IN ISRAEL GUIDANCE DOCUMENT FOR CONDUCTING VERIFICATIONS, Process A.	
Swiss Climate CO_2 label	
Thai Greenhouse Gas Management Organisation (TGO) Greenhouse Gas (GHG) Verification Protocol	
Toitū Envirocare's carbonreduce certification standard	
Toitū climate positive	
Toitū net carbonzero	
Tokyo Emissions Trading Scheme	
Verification under the EU Emissions Trading Scheme (EU ETS) Directive and EU ETS related national implementation laws	

Source: CDP (n.d.).

F. Companies participating in the CDP (2018-2022)

Company Name	2018	2019	2020	2021	2022
Air Liquide					
Air Products and Chemicals					
Akzo Nobel					
Arkema					
Astellas Pharma					
Avery Dennison					
BASF					
Borealis Group					
BP					
Cargill					
Chemours					
Corbion					
Darling Ingredients					
DSM					
ExxonMobil					
FUJIFILM					
Gilead Sciences					

Givaudan					
Dow Chemical Company					
Henkel					
Huntsman					
ICL					
Indorama Ventures					
International Flavors & Fragrances IFF					
Kraton					
Kuwait Petroleum Corporation					
LANXESS					
Linde					
LyondellBasell					
Merck & Co. Inc.					
Neste					
Nouryon					
OCI N.V.					
Oriflame					
PPG Industries					
PTT Global Chemical					
Roche Holding					
SABIC					
Saint-Gobain					
Shell					
Shin-Etsu Chemical					
Synthomer plc					
Takeda Pharmaceutical Company Limited					
Teijin					
Teva Pharmaceutical Industries					
TotalEnergies					
Tronox					
Valvoline					
Westlake Chemical					
Yara					

Cells shaded green: CDP data obtainable. Cells shaded orange: CDP data not obtainable.

G. Companies excluded from the sample

COMPANY NAME	REASON FOR EXCLUSION
EBN	Partly owned by the Dutch state
TRANSTERMINAL DORDRECHT	Mainly a logistics solution company. Even though they blend dry fertilizers, they do not produce the chemicals themselves.
BERNA RHEIN	Only provides professional analytic or diagnostic services for the medical profession, not manufacturing pharmaceuticals.
NVD LOGISTICS	Is a logistics company. Even though they provide services for blending and filling of liquid chemicals, they do not manufacture them themselves.
URENCO	Is owned to one-third by the Dutch government. Also, it only provides enrichment plant design services and gas centrifuge technology for enrichment plants, not really chemical manufacturing.
PETROGAS	Is only concerned with the transportation and processing (no refining) of petroleum.
SPGPRINTS	Rather a textile printing service provider. Even though they supply lacquers and other consumables, it is a rather small part of their business.
VIDEOJET TECHNOLOGIES EUROPE B.V.	Industrial printer manufacturer. They also manufacture chemical coatings etc. but their main business is the production of printers.
AGROCARE ENERGY B.V.	Is a horticulture company. Even though they also manufacture basic chemicals to some part, this is not their main business.
BN INTERNATIONAL	No emissions data found
EDEL YARNS & EXTRUSION	No emissions data found
SYNTHON	No emissions data found
PERENCO	No emissions data found
NORDIC GROUP	No emissions data found
KOPPERT BIOLOGICAL SYSTEMS	No emissions data found
ROYAL HERKEL	No emissions data found
FIBRANT	No emissions data found
EUROLIQUIDS	No emissions data found
ADD ADDITIVES	No emissions data found
DALLI GROUP	No emissions data found
CURIUM PHARMA	No emissions data found
UNIPOL EPS GRANULATES	No emissions data found
TRANSNATIONAL BLENDERS	No emissions data found
VP GROUP	No emissions data found
DE OLIEBRON	No emissions data found
N-XT FERTILIZERS	No emissions data found

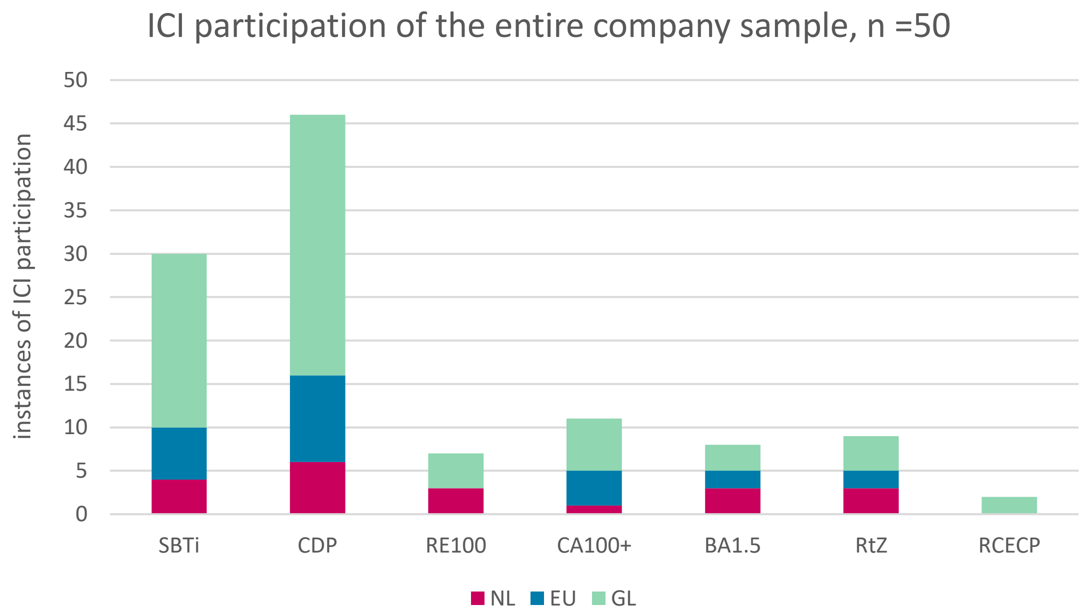
H. Company Participation in ICIs in 2023

COMPANY	SBTI	CDP	RE100	CA100+	BA1.5	RtZ	RCECP	TOTAL*
AKZO NOBEL	Yes	Yes	Yes	No	Yes	Yes	No	**5**
CORBION	Yes	Yes	Yes	No	Yes	Yes	No	**5**
DSM	Yes	Yes	Yes	No	Yes	Yes	No	**5**
GIVAUDAN	Yes	Yes	Yes	No	Yes	Yes	No	**5**
INTERNATIONAL FLAVORS & FRAGRANCES IFF	Yes	Yes	Yes	No	Yes	Yes	No	**5**
SAINT-GOBAIN	Yes	Yes	No	Yes	Yes	Yes	No	**5**
FUJIFILM	Yes	Yes	Yes	No	No	No	Yes	**4**
HENKEL	Yes	Yes	No	No	Yes	Yes	No	**4**
TAKEDA PHARMACEUTICAL COMPANY LIMITED	Yes	Yes	No	No	Yes	Yes	No	**4**
AIR LIQUIDE	Yes	Yes	No	Yes	No	No	No	**3**
GILEAD SCIENCES	Yes	Yes	Yes	No	No	No	No	**3**
LYONDELLBASELL	Yes	Yes	No	Yes	No	No	No	**3**
PTT GLOBAL CHEMICAL	No	Yes	No	Yes	No	No	Yes	**3**
TEIJIN	Yes	Yes	No	No	No	Yes	No	**3**
ARKEMA	Yes	Yes	No	No	No	No	No	**2**
ASTELLAS PHARMA	Yes	Yes	No	No	No	No	No	**2**
AVERY DENNISON	Yes	Yes	No	No	No	No	No	**2**
BASF	No	Yes	No	Yes	No	No	No	**2**
BP	No	Yes	No	Yes	No	No	No	**2**
CARGILL	Yes	Yes	No	No	No	No	No	**2**
CHEMOURS	Yes	Yes	No	No	No	No	No	**2**
DARLING INGREDIENTS	Yes	Yes	No	No	No	No	No	**2**
DOW CHEMICALS COMPANY	No	Yes	No	Yes	No	No	No	**2**
ICL GROUP	Yes	Yes	No	No	No	No	No	**2**
INDORAMA VENTURES	Yes	Yes	No	No	No	No	No	**2**
LANXESS	Yes	Yes	No	No	No	No	No	**2**
LINDE	Yes	Yes	No	No	No	No	No	**2**
MERCK & CO. INC.	Yes	Yes	No	No	No	No	No	**2**
ORIFLAME	Yes	Yes	No	No	No	No	No	**2**
PPG INDUSTRIES	Yes	Yes	No	No	No	No	No	**2**
SABIC	No	Yes	No	Yes	No	No	No	**2**
SHELL**	No	Yes	No	Yes	No	No	No	**2**
SYNTHOMER PLC	Yes	Yes	No	No	No	No	No	**2**
TEVA PHARMACEUTICAL INDUSTRIES	Yes	Yes	No	No	No	No	No	**2**
TOTALENERGIES**	No	Yes	No	Yes	No	No	No	**2**
YARA	Yes	Yes	No	No	No	No	No	**2**
AIR PRODUCTS AND CHEMICALS	No	Yes	No	No	No	No	No	**1**

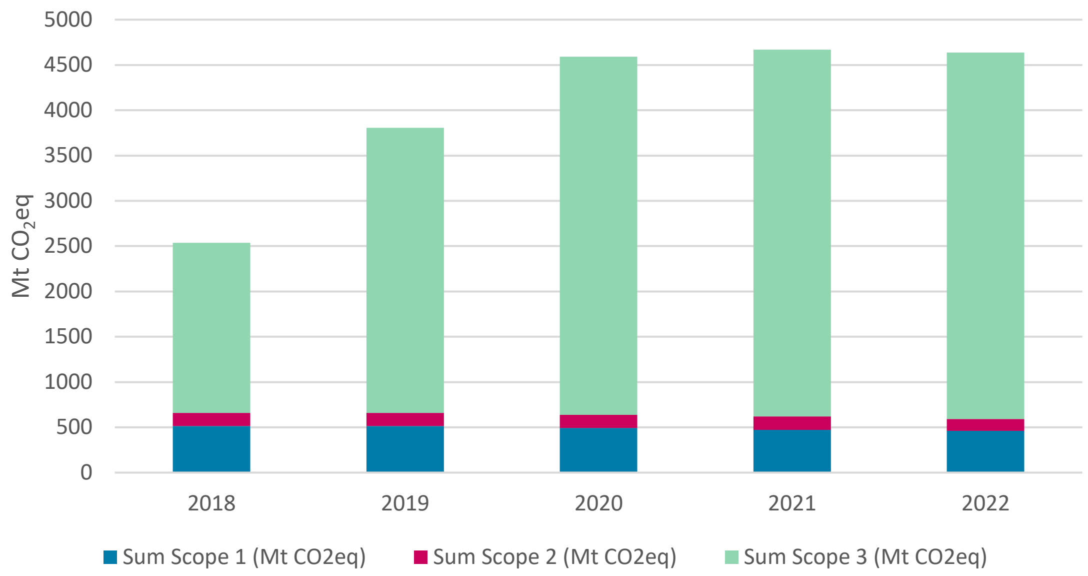
BOREALIS GROUP	No	Yes	No	No	No	No	No	**1**
EXXONMOBIL**	No	No	No	Yes	No	No	No	**1**
HUNTSMAN	No	Yes	No	No	No	No	No	**1**
KRATON CORPORATION	No	Yes	No	No	No	No	No	**1**
NESTE**	No	Yes	No	No	No	No	No	**1**
NOURYON	No	Yes	No	No	No	No	No	**1**
OCI N.V.	No	Yes	No	No	No	No	No	**1**
ROCHE HOLDING	Yes	No	No	No	No	No	No	**1**
SHIN-ETSU CHEMICAL	No	Yes	No	No	No	No	No	**1**
VALVOLINE**	No	Yes	No	No	No	No	No	**1**
WESTLAKE CHEMICAL	No	Yes	No	No	No	No	No	**1**
KUWAIT PETROLEUM CORPORATION**	No	No	No	No	No	No	No	**0**
TRONOX	No	No	No	No	No	No	No	**0**
TOTAL	**30**	**46**	**7**	**11**	**8**	**9**	**2**	**113**

**Total number of ICIs a company is participating in. Sorted from companies with the most participation to those with the least.*
***Oil/gas/fossil fuels company, marked in red*

I. Participation levels per ICI in 2023, by headquarter location

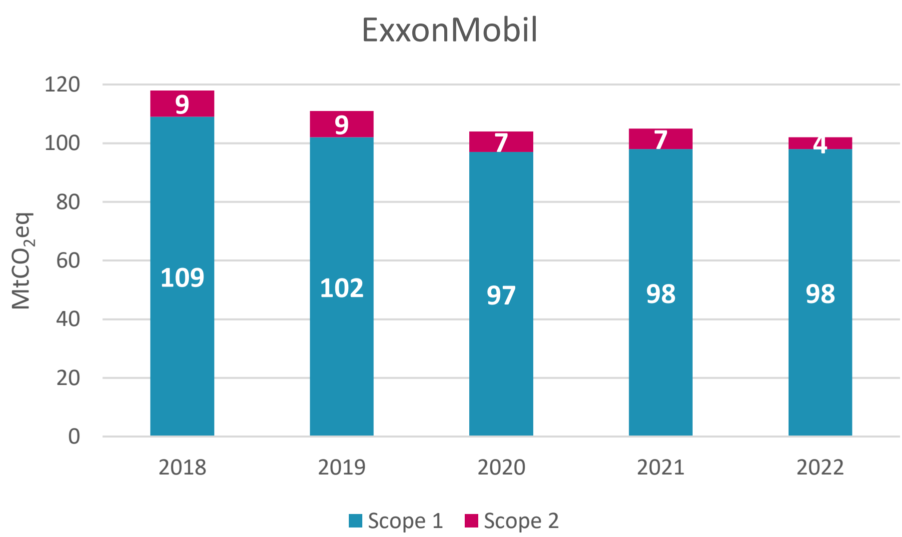


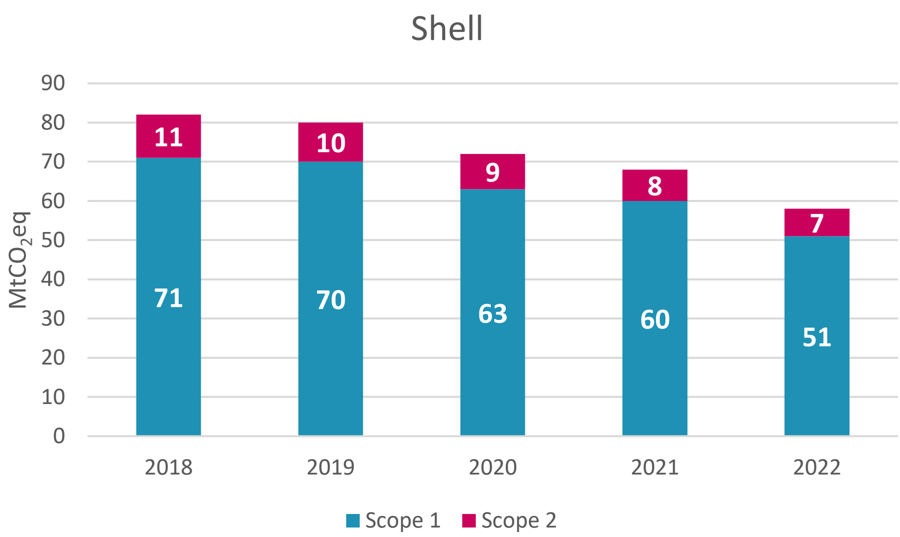
J. Total scope 1, 2, and 3 emissions of the entire company sample

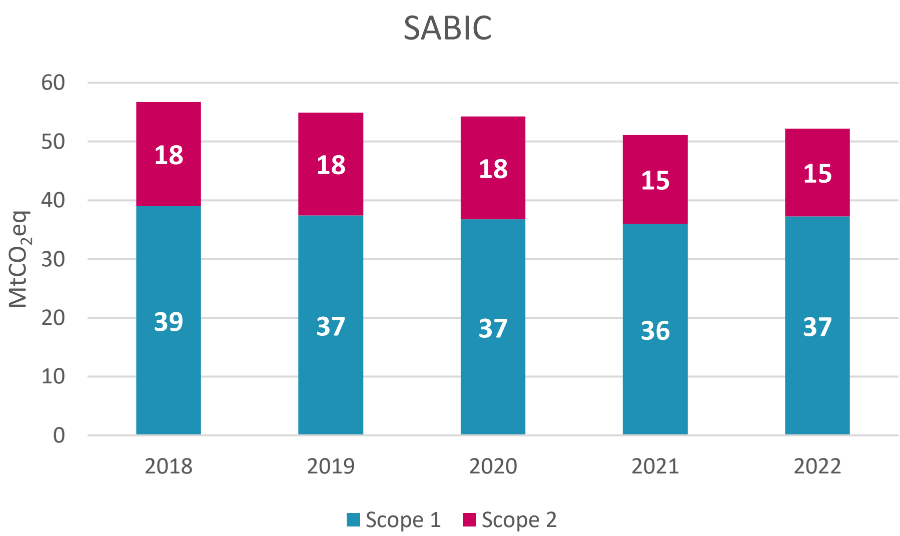


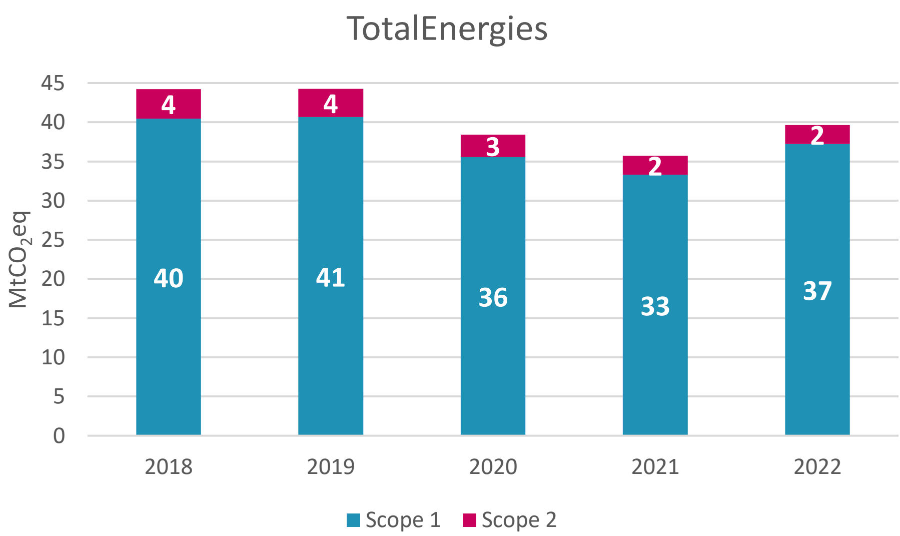
Entire company sample, n=50.

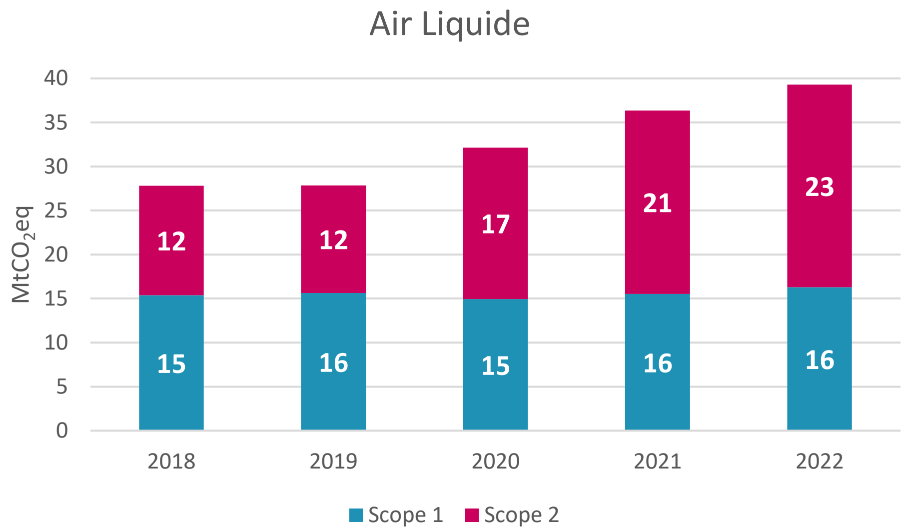
K. Total scope 1 and 2 emissions of the five largest emitters




Shell
90
80
70
60
50
40
30
20
10
0
$MtCO_2eq$
11
10
9
8
7
71
70
63
60
51
2018
2019
2020
2021
2022
Scope 1
Scope 2

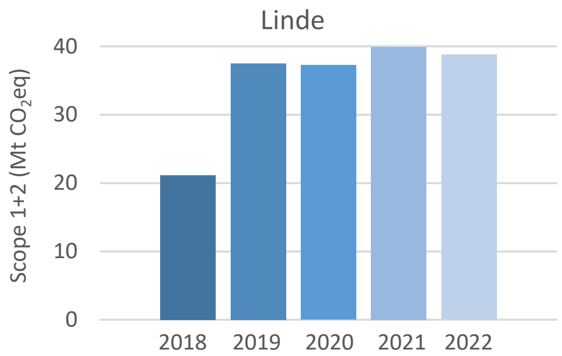

SABIC
60
50
40
30
20
10
0
$MtCO_2eq$
18
18
18
15
15
39
37
37
36
37
2018
2019
2020
2021
2022
Scope 1
Scope 2

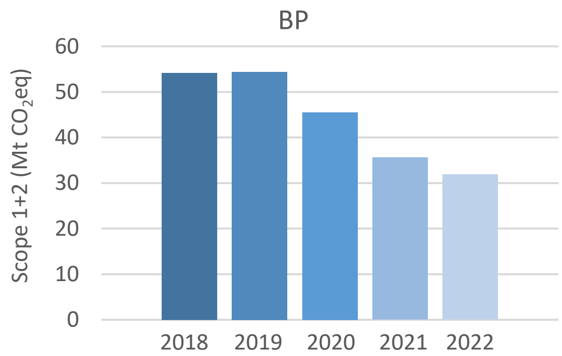

TotalEnergies
45
40
35
30
25
20
15
10
5
0
$MtCO_2eq$
4
4
3
2
2
40
41
36
33
37
2018
2019
2020
2021
2022
Scope 1
Scope 2

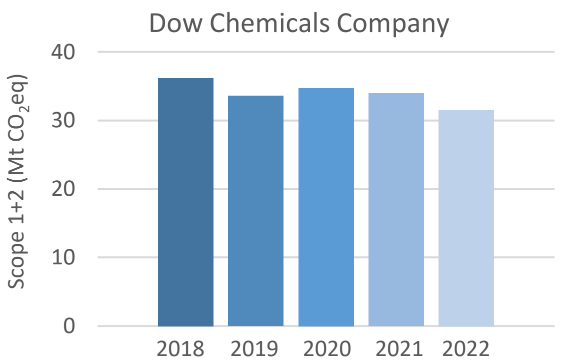


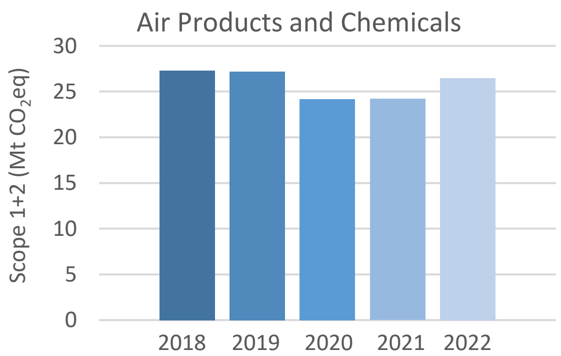
L. Combined scope 1+2 emissions per company (2018-2022)

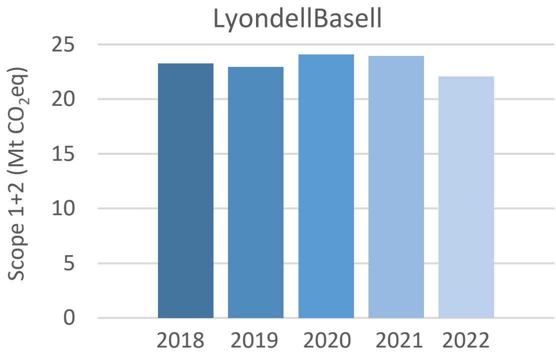
Graphs sorted by companies with the highest GHG emissions in 2022, in descending order (from left to right).

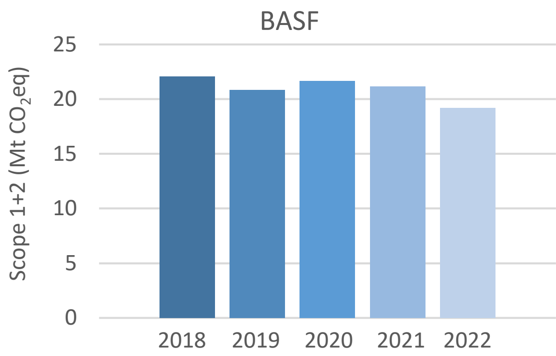


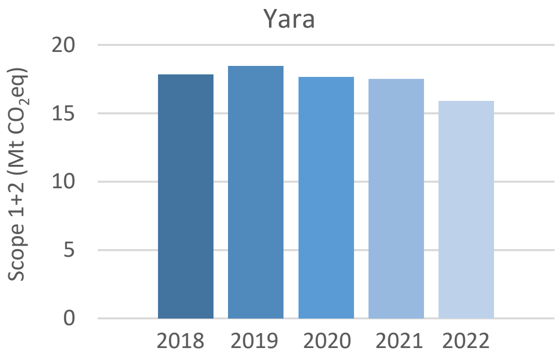


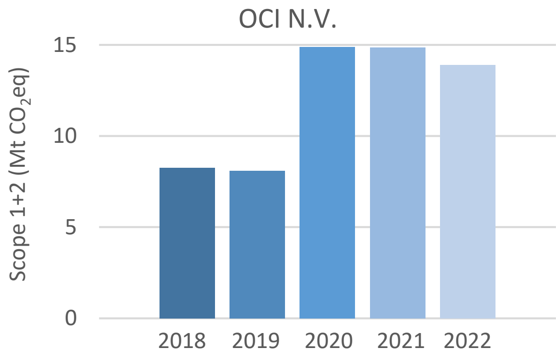


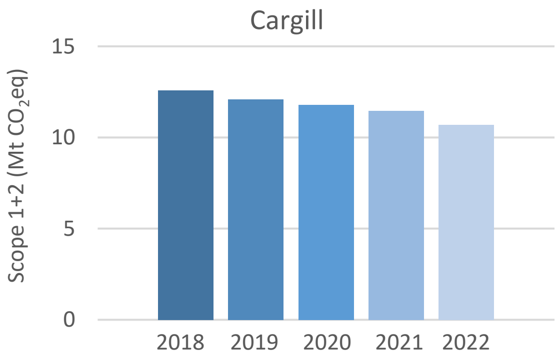


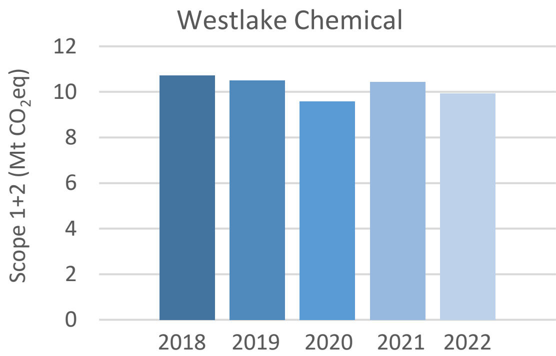

LyondellBasell
Scope 1+2 (Mt CO2eq)
0
5
10
15
20
25
2018
2019
2020
2021
2022

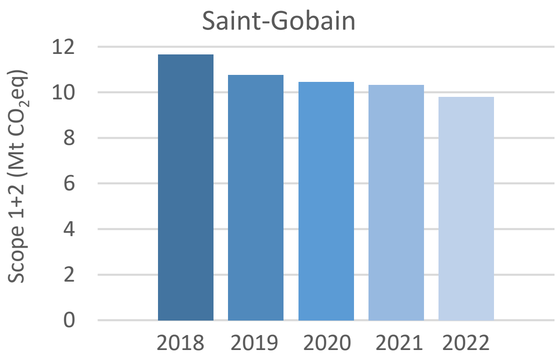

BASF
Scope 1+2 (Mt CO2eq)
0
5
10
15
20
25
2018
2019
2020
2021
2022

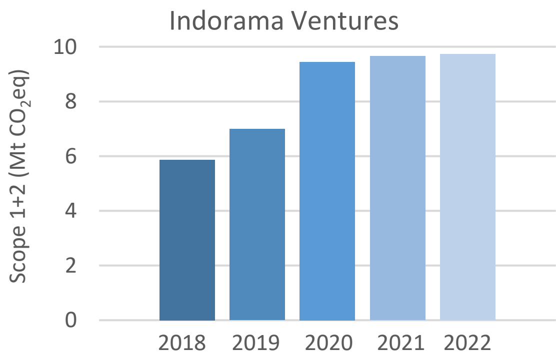

Yara
Scope 1+2 (Mt CO2eq)
0
5
10
15
20
2018
2019
2020
2021
2022

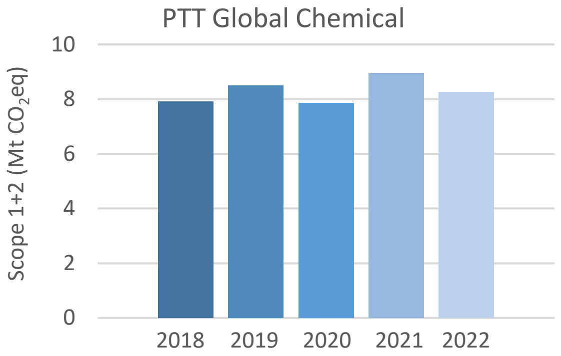

OCI N.V.
Scope 1+2 (Mt CO2eq)
0
5
10
15
2018
2019
2020
2021
2022

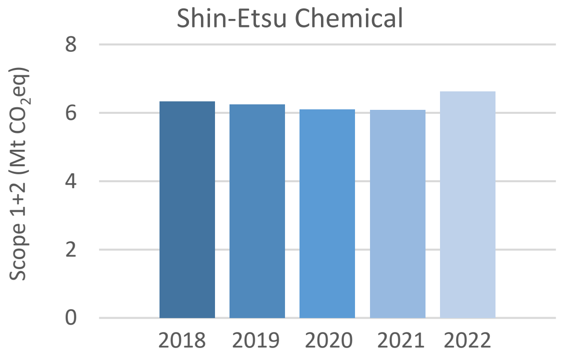

Cargill
Scope 1+2 (Mt CO2eq)
0
5
10
15
2018
2019
2020
2021
2022

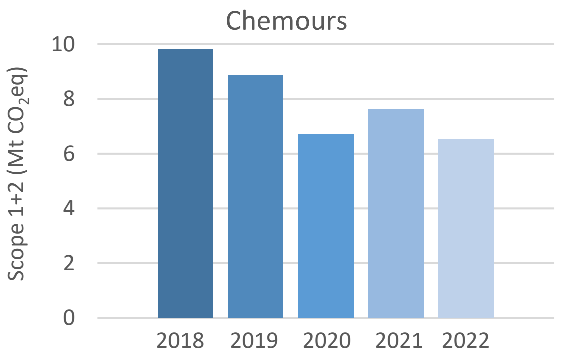

Westlake Chemical
Scope 1+2 (Mt CO2eq)
0
2
4
6
8
10
12
2018
2019
2020
2021
2022

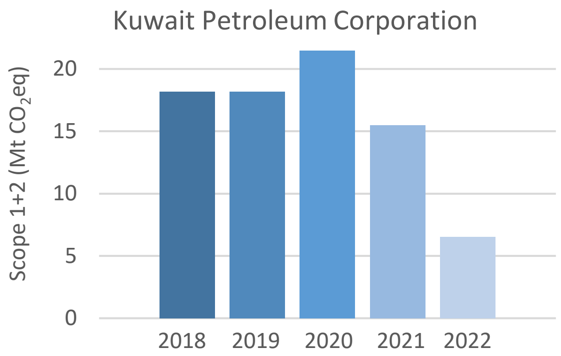

Saint-Gobain
Scope 1+2 (Mt CO2eq)
0
2
4
6
8
10
12
2018
2019
2020
2021
2022

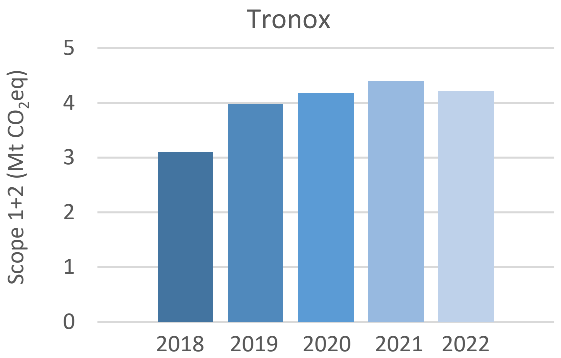

Indorama Ventures
Scope 1+2 (Mt CO2eq)
0
2
4
6
8
10
2018
2019
2020
2021
2022

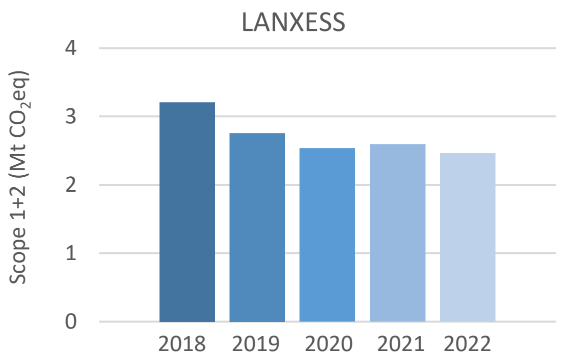

PTT Global Chemical
Scope 1+2 (Mt CO_2eq)
10
8
6
4
2
0
2018
2019
2020
2021
2022

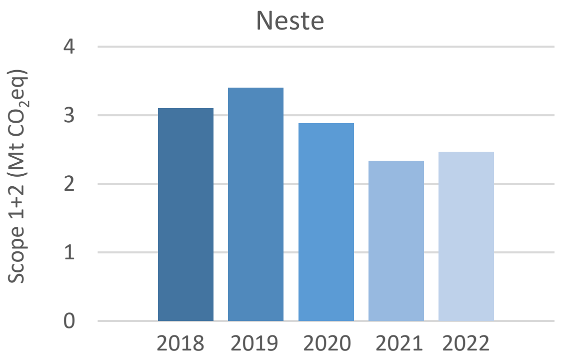

Shin-Etsu Chemical
Scope 1+2 (Mt CO_2eq)
8
6
4
2
0
2018
2019
2020
2021
2022

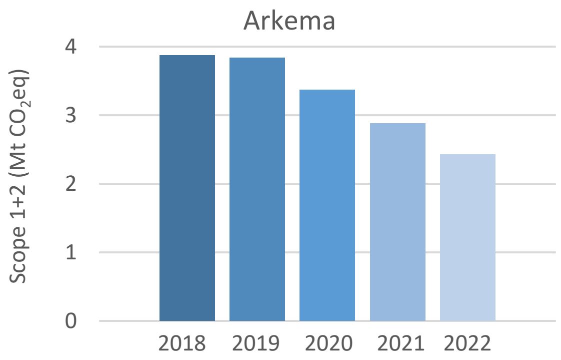

Chemours
Scope 1+2 (Mt CO_2eq)
10
8
6
4
2
0
2018
2019
2020
2021
2022

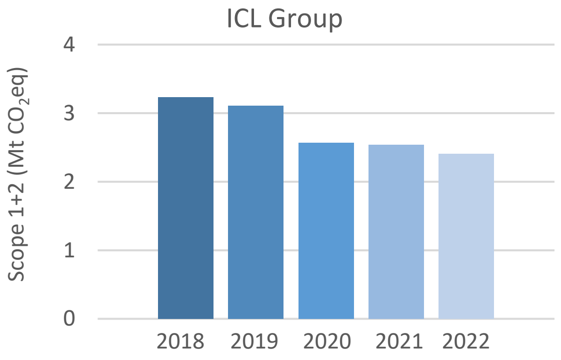

Kuwait Petroleum Corporation
Scope 1+2 (Mt CO_2eq)
20
15
10
5
0
2018
2019
2020
2021
2022

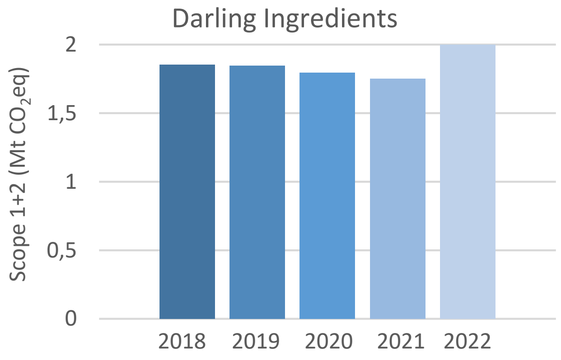

Tronox
Scope 1+2 (Mt CO_2eq)
5
4
3
2
1
0
2018
2019
2020
2021
2022

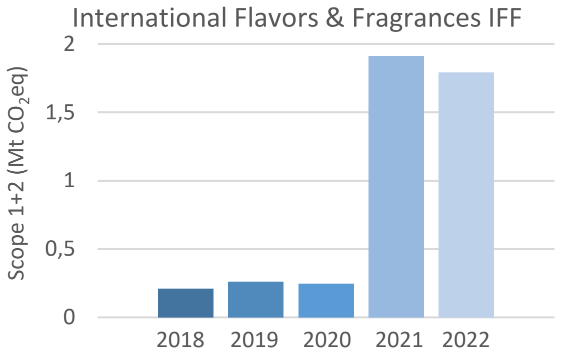

LANXESS
Scope 1+2 (Mt CO_2eq)
4
3
2
1
0
2018
2019
2020
2021
2022

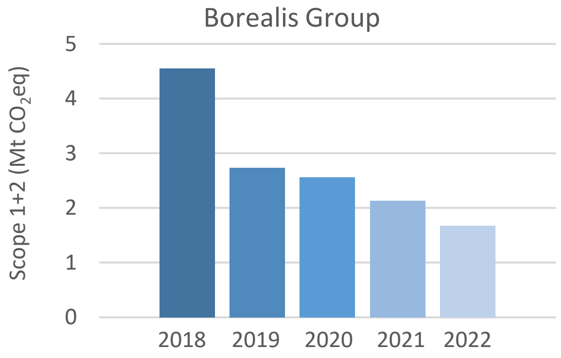

Neste
Scope 1+2 (Mt CO_2eq)
4
3
2
1
0
2018
2019
2020
2021
2022

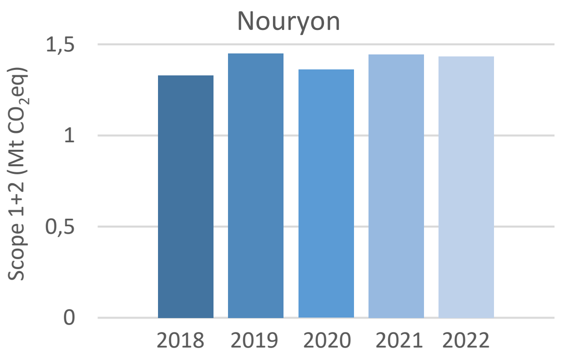

Arkema
Scope 1+2 (Mt CO_2eq)
4
3
2
1
0
2018
2019
2020
2021
2022

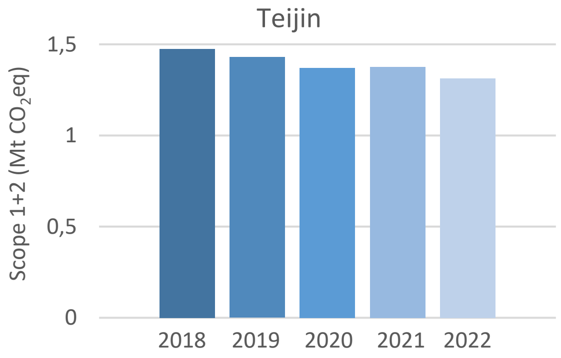

ICL Group
Scope 1+2 (Mt CO2eq)
4
3
2
1
0
2018 2019 2020 2021 2022

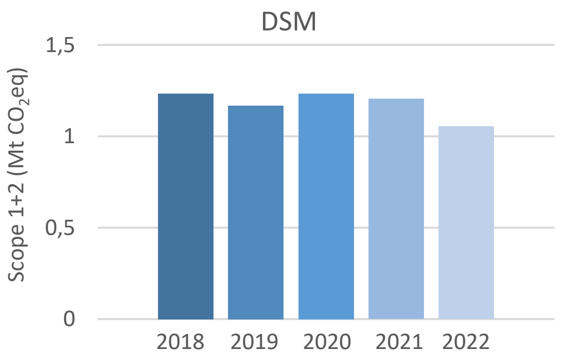

Darling Ingredients
Scope 1+2 (Mt CO2eq)
2
1,5
1
0,5
0
2018 2019 2020 2021 2022

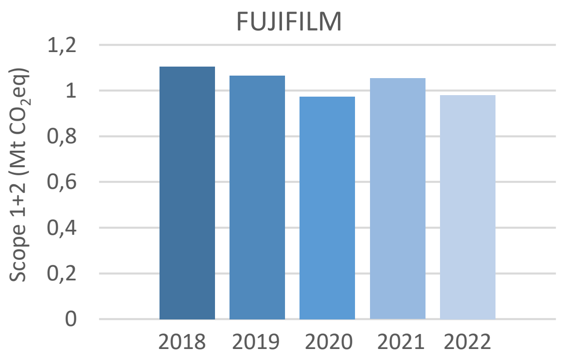

International Flavors & Fragrances IFF
Scope 1+2 (Mt CO2eq)
2
1,5
1
0,5
0
2018 2019 2020 2021 2022

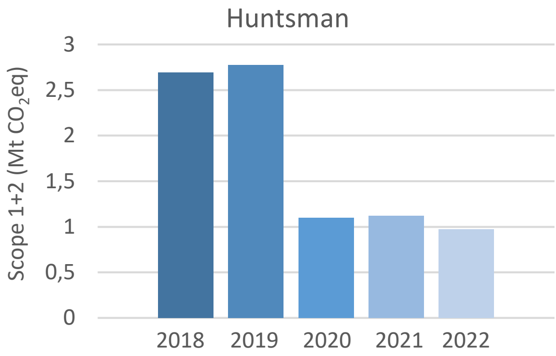

Borealis Group
Scope 1+2 (Mt CO2eq)
5
4
3
2
1
0
2018 2019 2020 2021 2022

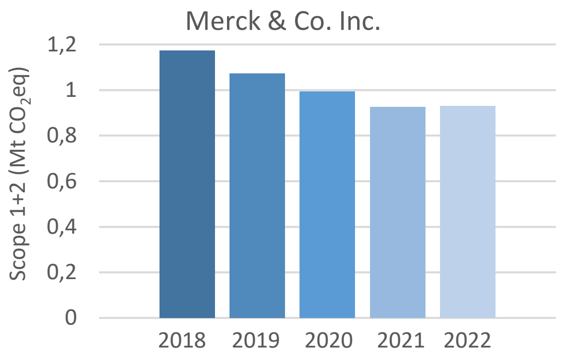

Nouryon
Scope 1+2 (Mt CO2eq)
1,5
1
0,5
0
2018 2019 2020 2021 2022

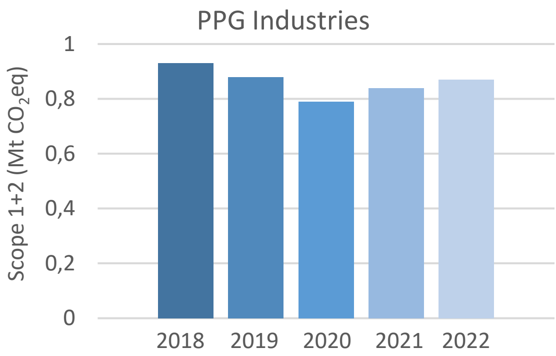

Teijin
Scope 1+2 (Mt CO2eq)
1,5
1
0,5
0
2018 2019 2020 2021 2022

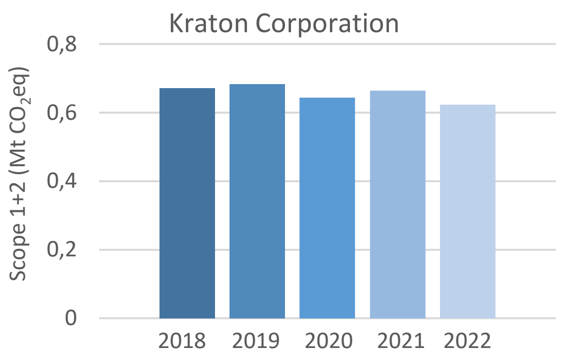

DSM
Scope 1+2 (Mt CO2eq)
1,5
1
0,5
0
2018 2019 2020 2021 2022

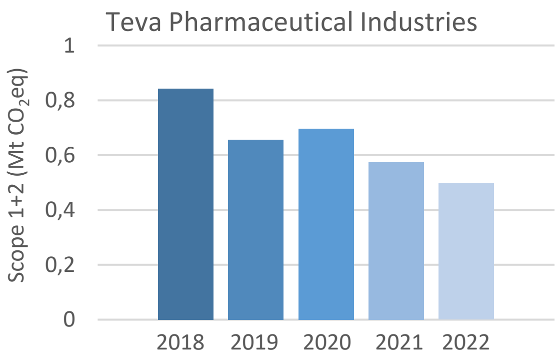

FUJIFILM
Scope 1+2 (Mt CO2eq)
1,2
1
0,8
0,6
0,4
0,2
0
2018 2019 2020 2021 2022

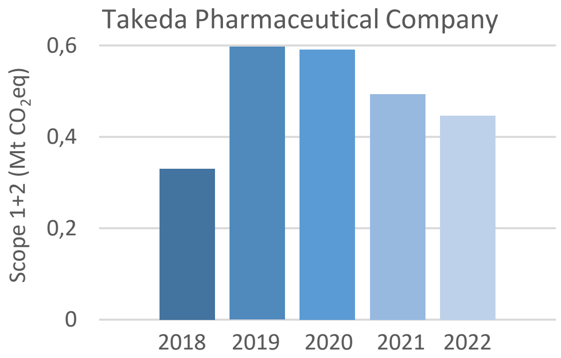

Huntsman
Scope 1+2 (Mt CO2eq)
0 0,5 1 1,5 2 2,5 3
2018 2019 2020 2021 2022

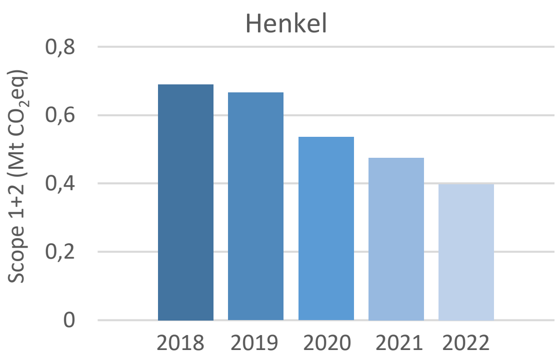

Merck & Co. Inc.
Scope 1+2 (Mt CO2eq)
0 0,2 0,4 0,6 0,8 1 1,2
2018 2019 2020 2021 2022

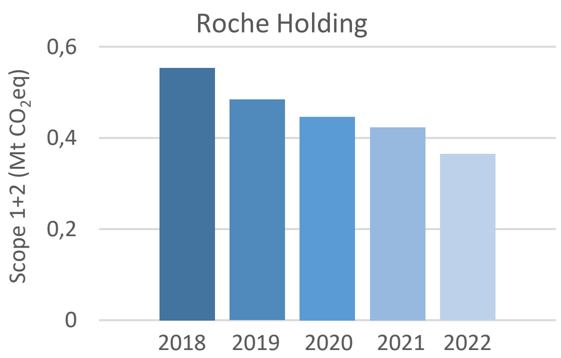

PPG Industries
Scope 1+2 (Mt CO2eq)
0 0,2 0,4 0,6 0,8 1
2018 2019 2020 2021 2022

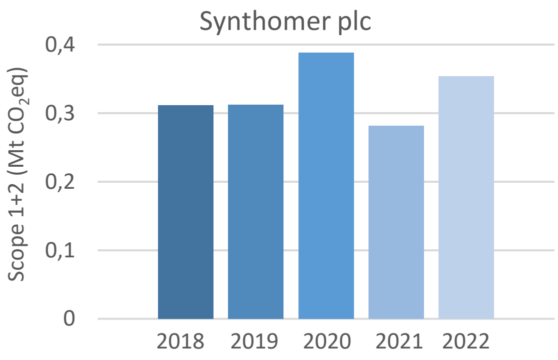

Kraton Corporation
Scope 1+2 (Mt CO2eq)
0 0,2 0,4 0,6 0,8
2018 2019 2020 2021 2022

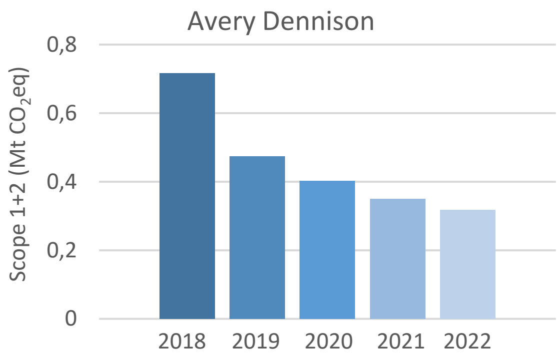

Teva Pharmaceutical Industries
Scope 1+2 (Mt CO2eq)
0 0,2 0,4 0,6 0,8 1
2018 2019 2020 2021 2022

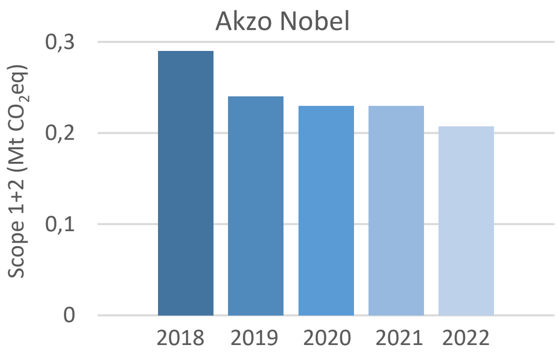

Takeda Pharmaceutical Company
Scope 1+2 (Mt CO2eq)
0 0,2 0,4 0,6
2018 2019 2020 2021 2022

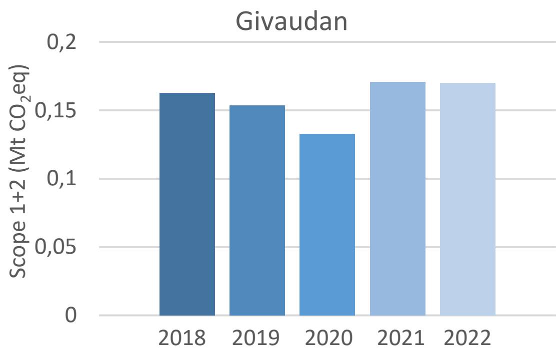

Henkel
Scope 1+2 (Mt CO2eq)
0 0,2 0,4 0,6 0,8
2018 2019 2020 2021 2022

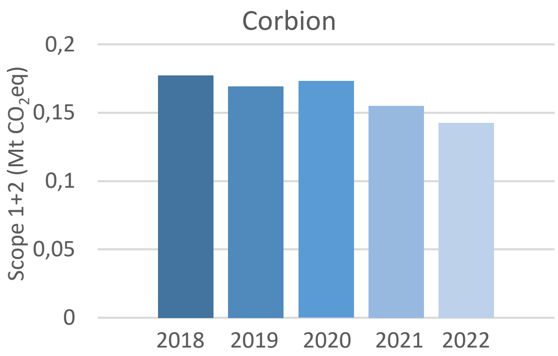

Roche Holding
Scope 1+2 (Mt CO2eq)
0 0,2 0,4 0,6
2018 2019 2020 2021 2022

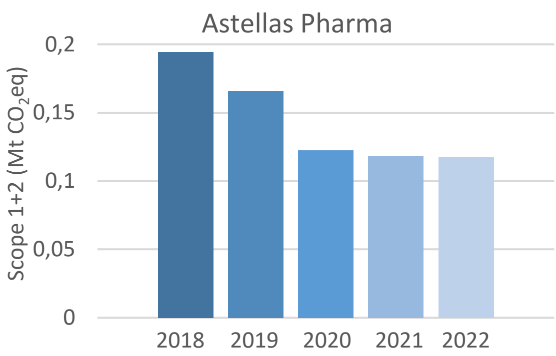

Synthomer plc
Scope 1+2 (Mt CO_2eq)
0,4
0,3
0,2
0,1
0
2018 2019 2020 2021 2022

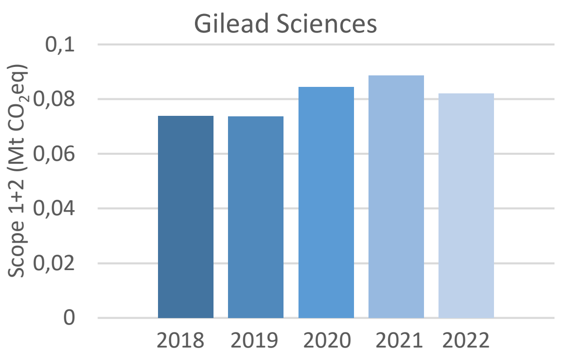

Avery Dennison
Scope 1+2 (Mt CO_2eq)
0,8
0,6
0,4
0,2
0
2018 2019 2020 2021 2022

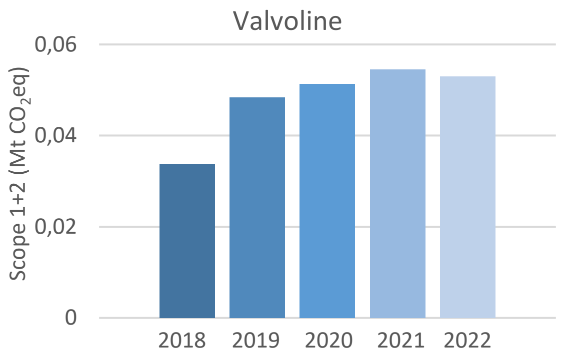

Akzo Nobel
Scope 1+2 (Mt CO_2eq)
0,3
0,2
0,1
0
2018 2019 2020 2021 2022

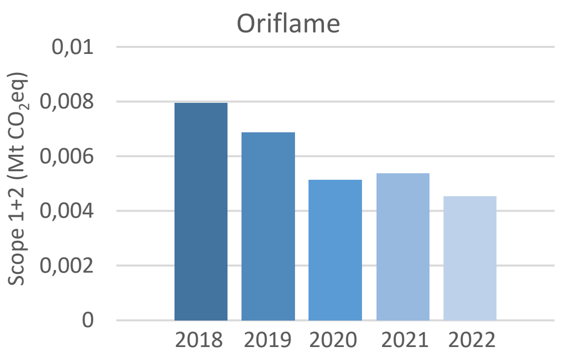

Givaudan
Scope 1+2 (Mt CO_2eq)
0,2
0,15
0,1
0,05
0
2018 2019 2020 2021 2022


Corbion
Scope 1+2 (Mt CO_2eq)
0,2
0,15
0,1
0,05
0
2018 2019 2020 2021 2022


Astellas Pharma
Scope 1+2 (Mt CO_2eq)
0,2
0,15
0,1
0,05
0
2018 2019 2020 2021 2022



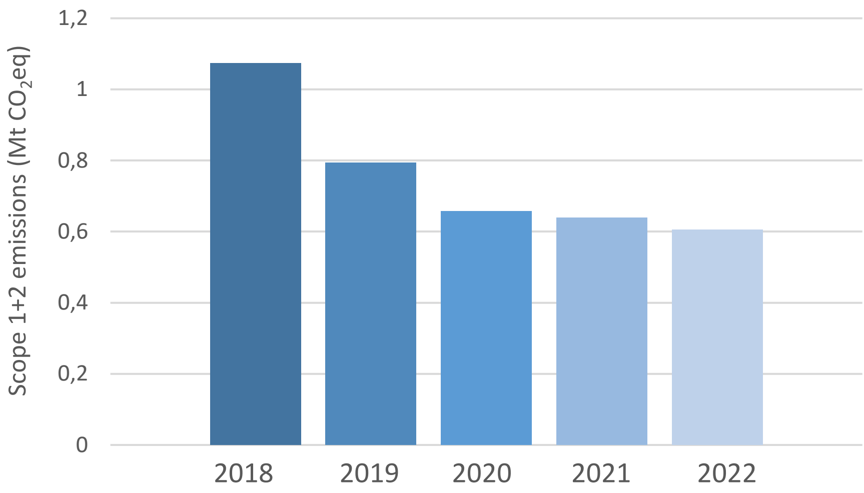




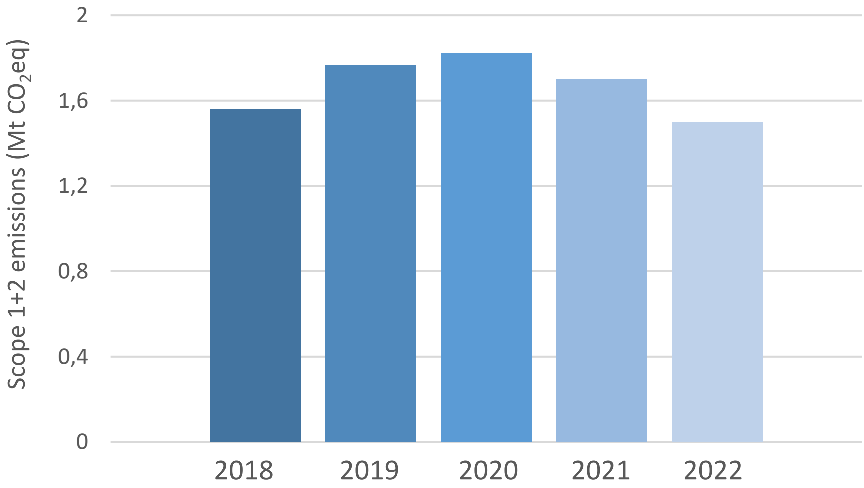
M. Emissions of SBTi and non-SBTi members

	TOTAL SAMPLE (N=50)	SBTI MEMBERS WITH APPROVED TARGETS (N=23)	COMMITTED FIRMS IN THE SBTI (N=7)	NON-SBTI MEMBERS (N=20)
SCOPE 1+2 (MT CO_2) 2018	**660.3**	**90.2**	**62.5**	**507.6**
SCOPE 1+2 (MT CO_2) 2019	659.7	104.2	62.7	492.8
SCOPE 1+2 (MT CO_2) 2020	636.6	106.5	62.7	467.4
SCOPE 1+2 (MT CO_2) 2021	619.9	113.8	63.4	442.7
SCOPE 1+2 (MT CO_2) 2022	**589.8**	**113.2**	**59.0**	**417.6**
EMISSIONS CHANGE 2018 TO 2022	**-70.5**	**23.0**	**-3.4**	**-90.0**
% CHANGE	**-10.7%**	**25.5%**	**-5.5%**	**-17.7%**

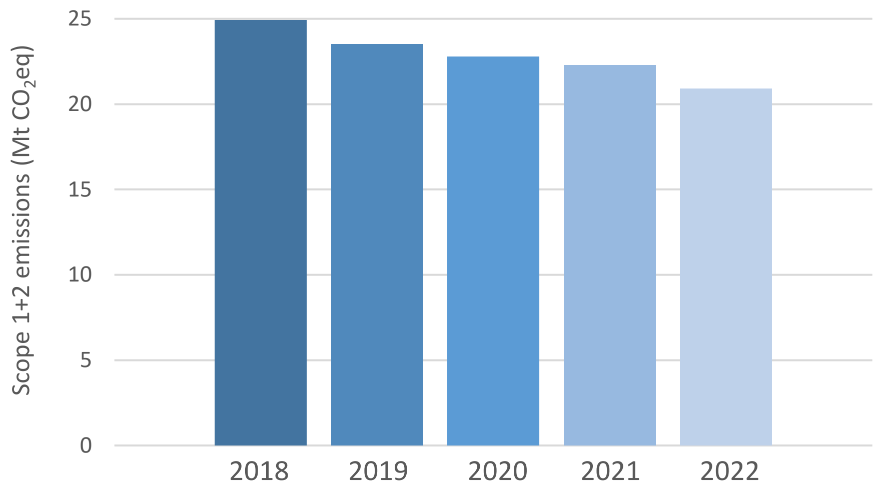
N. Combined scope 1+2 emissions of companies (2018-2022) per SBT base year



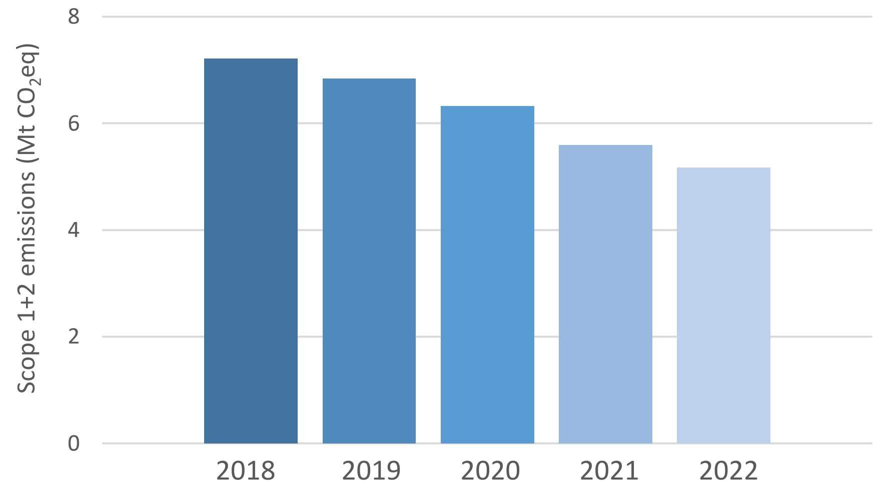
Evolution of scope 1+2 emissions of companies with absolute scope 1+2 targets.
Base year 2015, n=3 (Astellas Pharma, Avery Dennison, Givaudan)



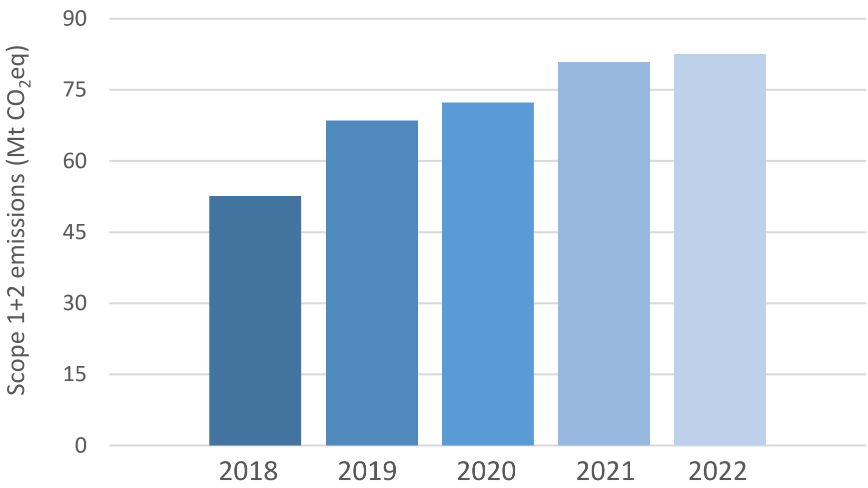
Evolution of scope 1+2 emissions of companies with absolute scope 1+2 targets.
Base year 2016, n=2 (DSM, Takeda Pharmaceutical Company)



Evolution of scope 1+2 emissions of companies with absolute scope 1+2 targets.
Base year 2017, n=3 (Cargill, Henkel, Saint-Gobain)

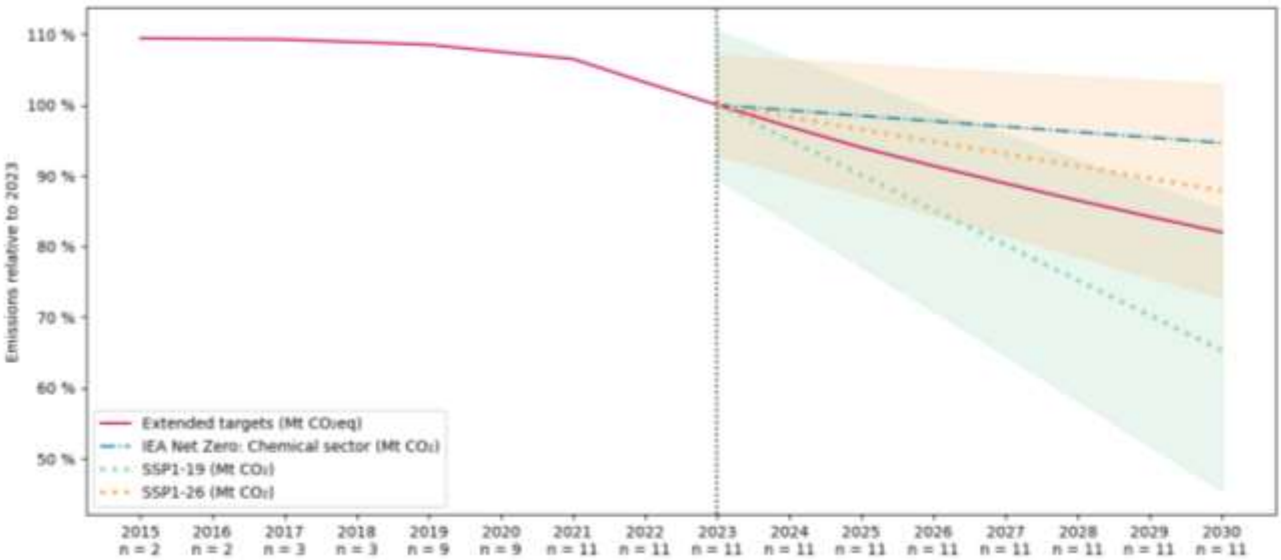


Evolution of scope 1+2 emissions of companies with absolute scope 1+2 targets.
Base year 2019, n=7 (Arkema, Gilead Sciences, Merck & Co. Inc., Oriflame,
PPG Industries, Synthomer, Teva Pharmaceutical Industries)

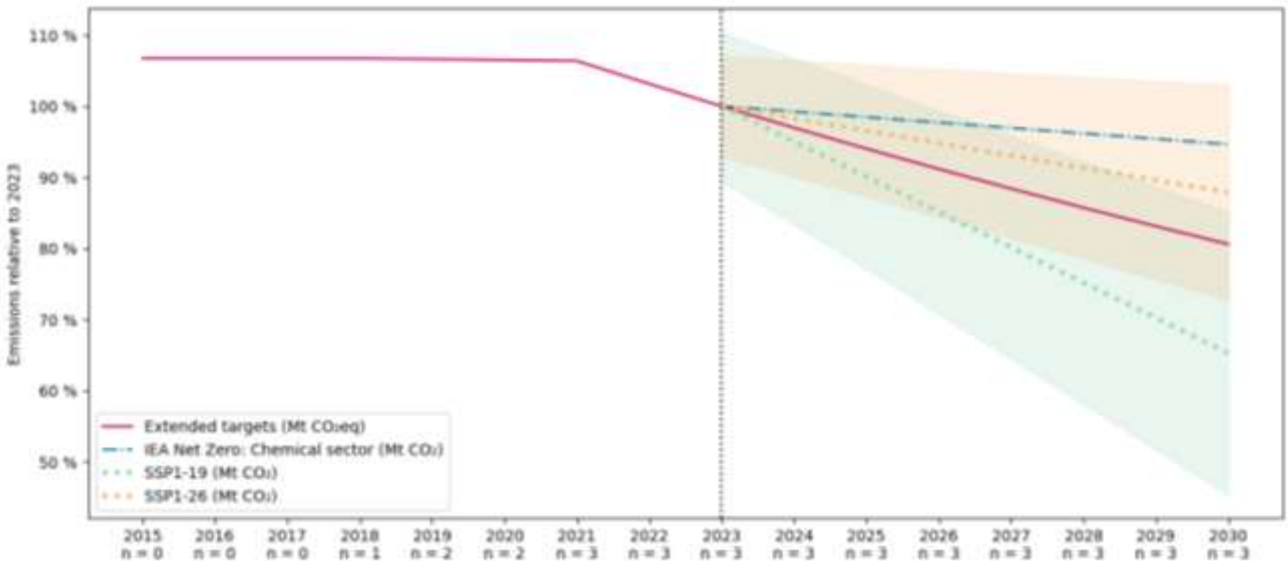


Evolution of scope 1+2 emissions of companies with absolute scope 1+2 targets.
Base year 2021, n=5 (Air Liquide, Corbion, International Flavors & Fragrances IFF, LANXESS, Linde)

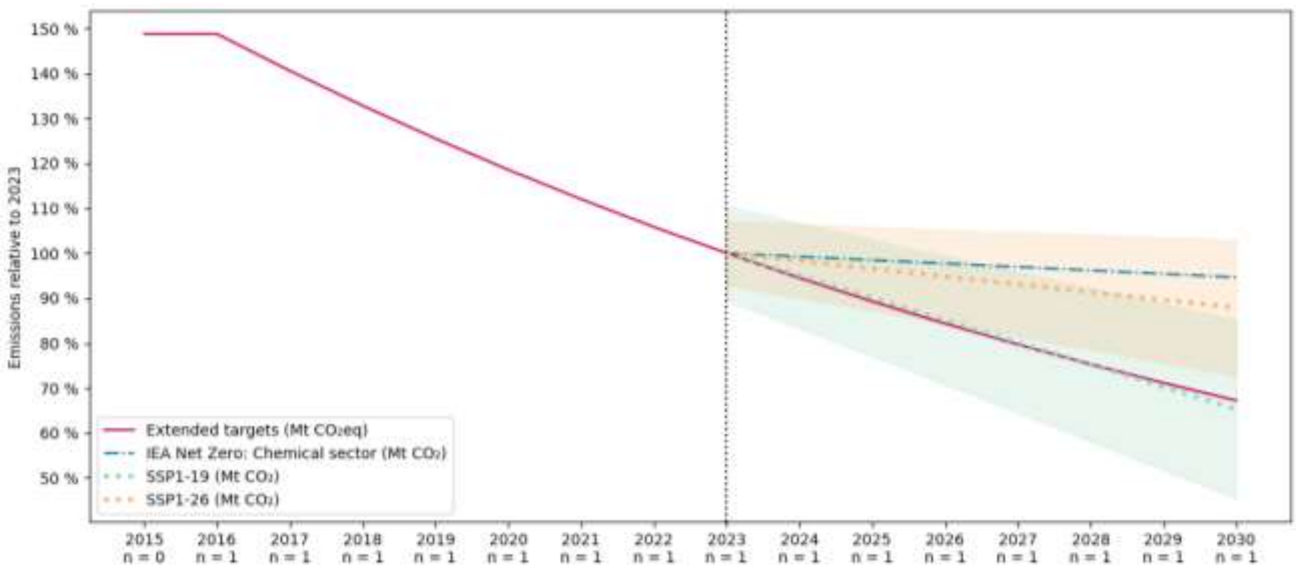
O. Ambition results per number of ICIs joined



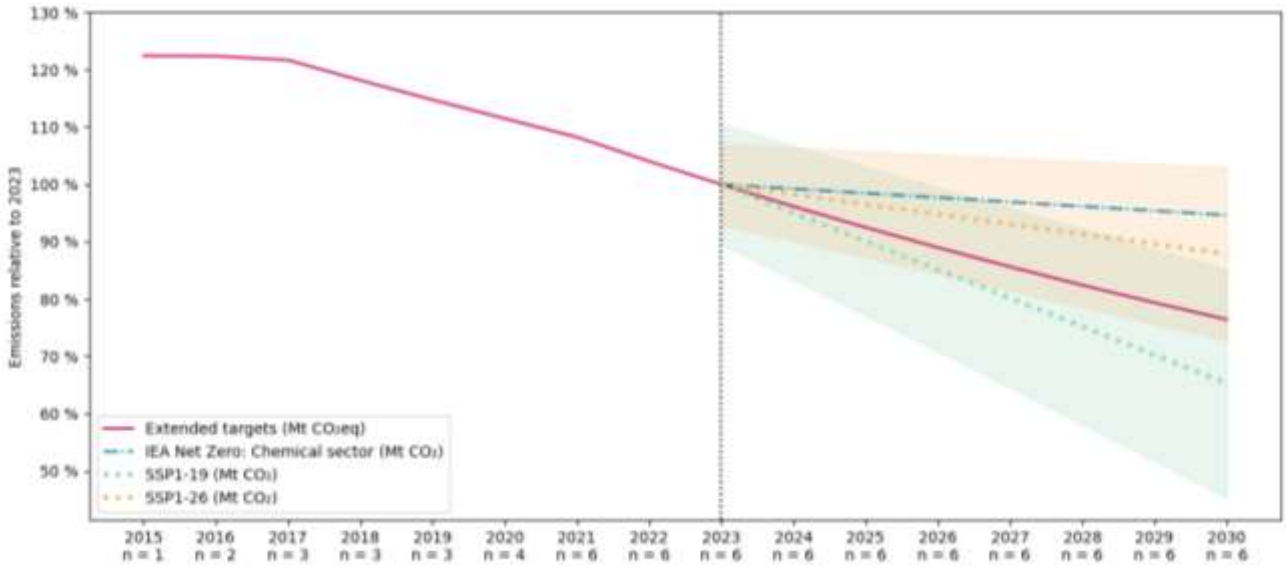
Combined ambitions (weighted by emission levels) of companies having joined two ICIs – SSP1-19 and SSP1-26 OECD90+EU Industrial and Energy



Combined ambitions (weighted by emission levels) of companies having joined three ICIs – SSP1-19 and SSP1-26 OECD90+EU Industrial and Energy



Combined ambitions (weighted by emission levels) of companies having joined four ICIs – SSP1-19 and SSP1-26 OECD90+EU Industrial and Energy

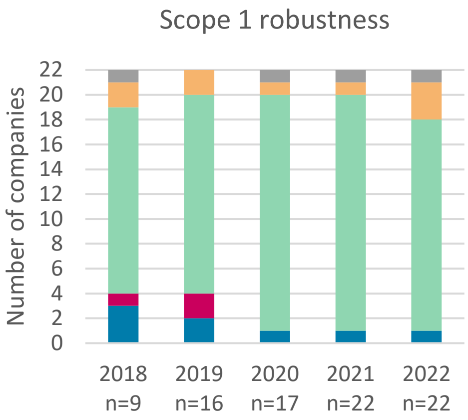


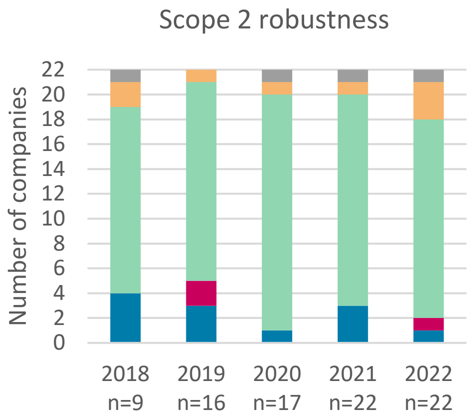
Combined ambitions (weighted by emission levels) of companies having joined five ICIs – SSP1-19 and SSP1-26 OECD90+EU Industrial and Energy

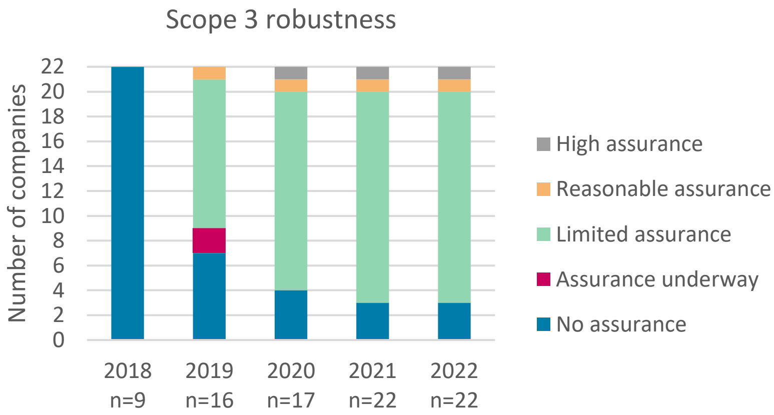
P. Ambition trajectories of companies with absolute scope 1+2 SBTs

Company	2023	2030
Avery Dennison	100%	57%
Givaudan	100%	57%
International Flavors & Fragrances IFF	100%	58%
Astellas Pharma	100%	63%
DSM	100%	64%
Oriflame	100%	64%
PPG Industries	100%	64%
Arkema	100%	65%
LANXESS	100%	65%
Takeda Pharmaceutical Company Limited	100%	67%
Teva Pharmaceutical Industries	100%	67%
Merck & Co. Inc.	100%	68%
Gilead Sciences	100%	68%
Synthomer plc	100%	68%
Akzo Nobel	100%	68%
Corbion	100%	69%
Saint-Gobain	100%	81%
Air Liquide	100%	81%
Linde	100%	81%
Teijin	100%	81%
Cargill	100%	97%

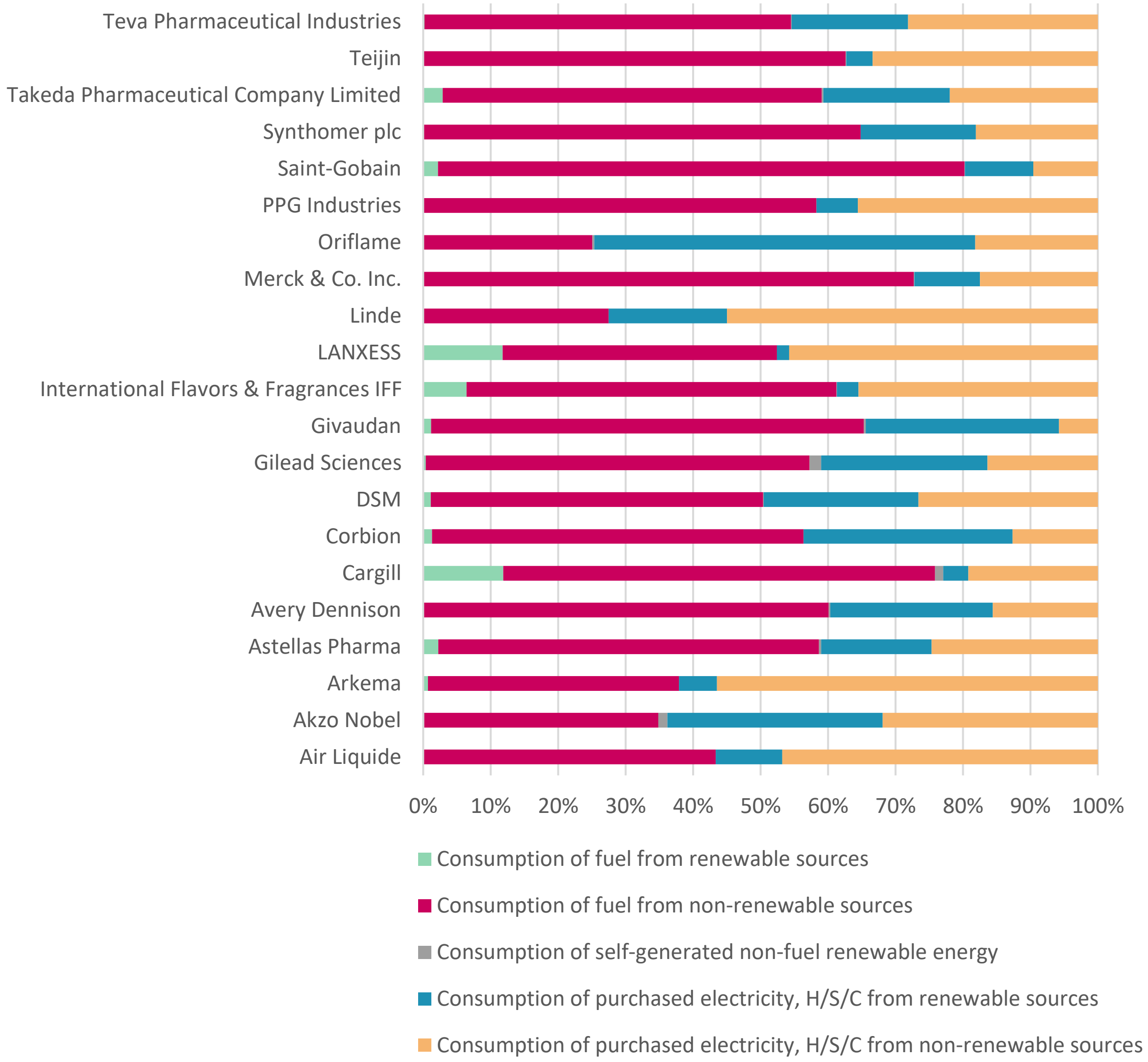
Q. Robustness results for companies with absolute scopes 1,2, or 3 targets





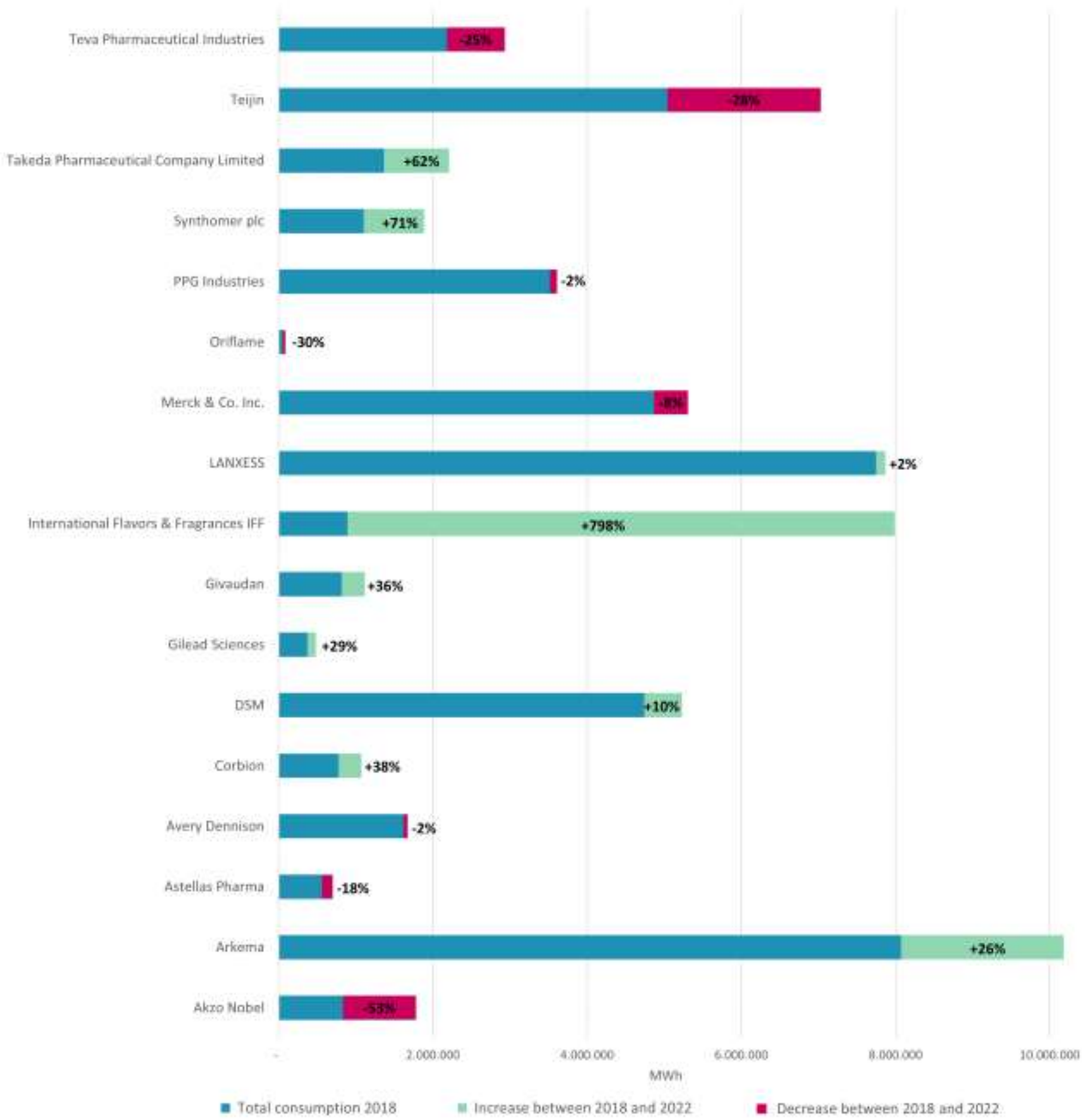


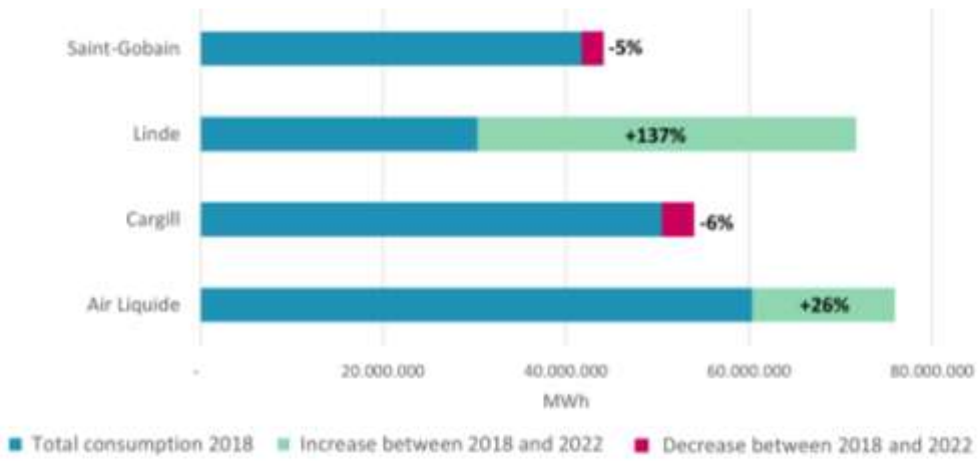
R. Consumption of different energy sources per company with absolute scope 1+2 SBTs



S. Changes in energy consumption between 2018 and 2022 of companies with absolute scope 1+2 targets

Energy is expressed as a total of renewable and non-renewable fuels and electricity, in MWh.





The (changes in) energy consumption of Saint-Gobain, Linde, Cargill, and Air Liquide are depicted in a separate plot as the levels of consumption are much higher than those of the other companies.

T. Scope 1 and 2 emissions of companies in the SBTi

	SCOPE 1 (MT CO_2EQ)					SCOPE 2 (MT CO_2EQ)				
COMPANY	**2018 n=8**	**2019 n=15**	**2020 n=16**	**2021 n=21**	**2022 n=21**	**2018 n=8**	**2019 n=15**	**2020 n=16**	**2021 n=21**	**2022 n=21**
AIR LIQUIDE	15,390	15,641	14,955	15,536	16,273	12,422	12,207	17,184	20,829	23,033
AKZO NOBEL	0,060	0,060	0,060	0,060	0,060	0,230	0,180	0,170	0,170	0,147
ARKEMA	2,720	2,698	2,268	1,822	1,527	1,155	1,142	1,103	1,061	0,905
ASTELLAS PHARMA	0,082	0,071	0,063	0,064	0,061	0,112	0,095	0,059	0,055	0,056
AVERY DENNISON	0,213	0,196	0,192	0,190	0,188	0,503	0,278	0,210	0,160	0,130
CARGILL	7,422	7,071	7,787	7,288	6,928	5,156	5,020	3,999	4,186	3,779
CORBION	0,094	0,101	0,114	0,106	0,107	0,083	0,068	0,059	0,049	0,035
DSM	0,761	0,633	0,612	0,613	0,573	0,471	0,536	0,622	0,592	0,482
GILEAD SCIENCES	0,047	0,052	0,048	0,055	0,055	0,027	0,022	0,036	0,034	0,027
GIVAUDAN	0,109	0,102	0,098	0,140	0,146	0,054	0,051	0,034	0,031	0,024
INTERNATIONAL FLAVORS & FRAGRANCES IFF	0,125	0,151	0,162	0,889	0,828	0,085	0,109	0,085	1,023	0,961
LANXESS	1,524	1,383	1,263	1,284	1,235	1,685	1,369	1,270	1,307	1,231
LINDE	8,325	16,461	16,247	16,321	16,813	12,824	21,012	20,969	23,573	21,981
MERCK & CO. INC.	0,784	0,755	0,738	0,696	0,712	0,390	0,317	0,255	0,230	0,219
ORIFLAME	0,005	0,005	0,003	0,004	0,003	0,003	0,002	0,002	0,002	0,001
PPG INDUSTRIES	0,410	0,380	0,326	0,391	0,390	0,520	0,500	0,464	0,447	0,480
SAINT-GOBAIN	8,582	8,052	7,916	8,403	8,396	3,083	2,707	2,531	1,927	1,406
SYNTHOMER PLC	0,148	0,151	0,201	0,211	0,242	0,164	0,161	0,187	0,070	0,111
TAKEDA PHARMACEUTICAL COMPANY LIMITED	0,160	0,302	0,303	0,316	0,277	0,170	0,295	0,288	0,178	0,169
TEIJIN	0,712	0,683	0,707	0,774	0,748	0,764	0,747	0,662	0,603	0,564
TEVA PHARMACEUTICAL INDUSTRIES	0,377	0,301	0,327	0,288	0,255	0,467	0,355	0,370	0,286	0,244
SUM	**48,049**	**55,249**	**54,391**	**55,450**	**55,818**	**40,367**	**47,173**	**50,561**	**56,813**	**55,986**

U. Combined scope 1+2 emissions change of companies in the SBTi

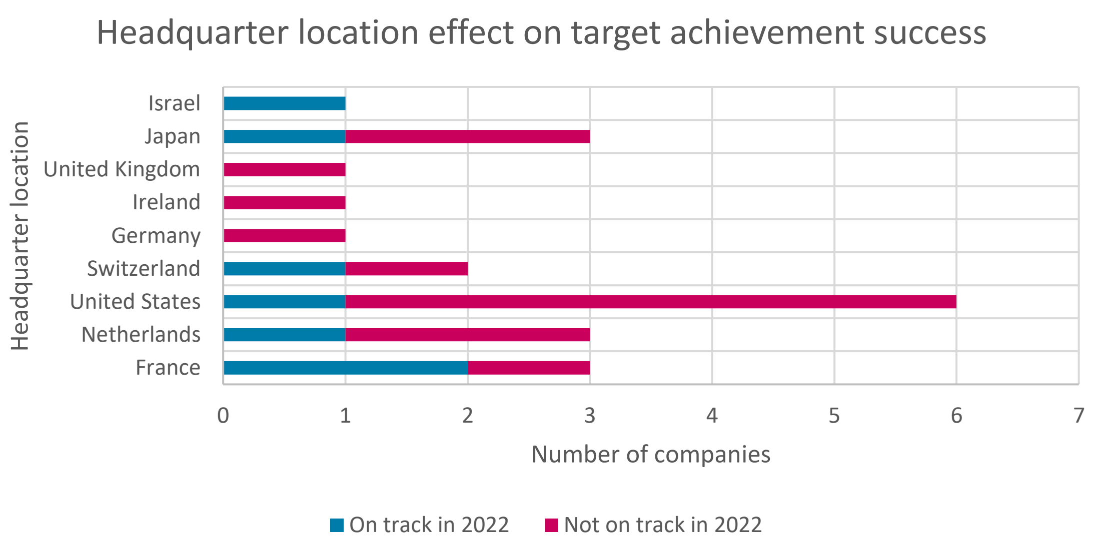
COMPANY	SCOPE 1+2 (MTCO$_2$EQ) 2018	SCOPE 1+2 (MT CO$_2$EQ) 2022	CHANGE FROM 2018 TO 2022
AIR LIQUIDE	27,81	39,31	41%
AKZO NOBEL	0,29	0,21	-28%
ARKEMA	3,88	2,43	-37%
ASTELLAS PHARMA	0,19	0,12	-39%
AVERY DENNISON	0,72	0,32	-56%
CARGILL	12,58	10,71	-15%
CORBION	0,18	0,14	-20%
DSM	1,23	1,05	-14%
GILEAD SCIENCES	0,07	0,08	11%
GIVAUDAN	0,16	0,17	4%
INTERNATIONAL FLAVORS & FRAGRANCES IFF	0,21	1,79	750%
LANXESS	3,21	2,47	-23%
LINDE	21,15	38,79	83%
MERCK & CO. INC.	1,17	0,93	-21%
ORIFLAME	0,01	0,005	-43%
PPG INDUSTRIES	0,93	0,87	-6%
SAINT-GOBAIN	11,66	9,80	-16%
SYNTHOMER PLC	0,31	0,35	13%
TAKEDA PHARMACEUTICAL COMPANY LIMITED	0,33	0,45	35%
TEIJIN	1,48	1,31	-11%
TEVA PHARMACEUTICAL INDUSTRIES	0,84	0,50	-41%
TOTAL	**88,42**	**111,80**	**26%**

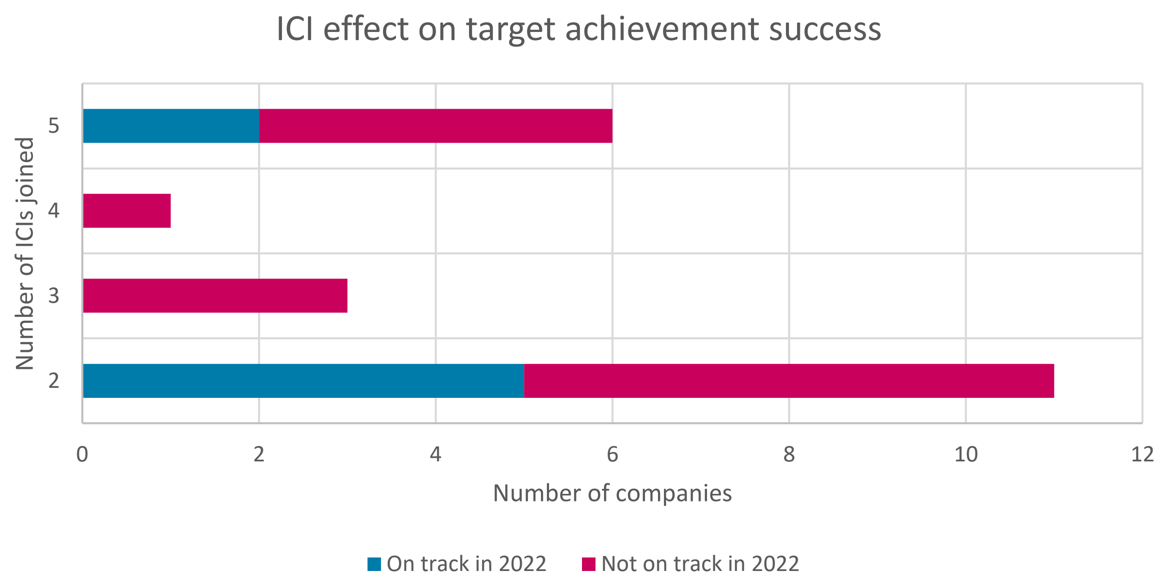
V. Companies on track versus not on track

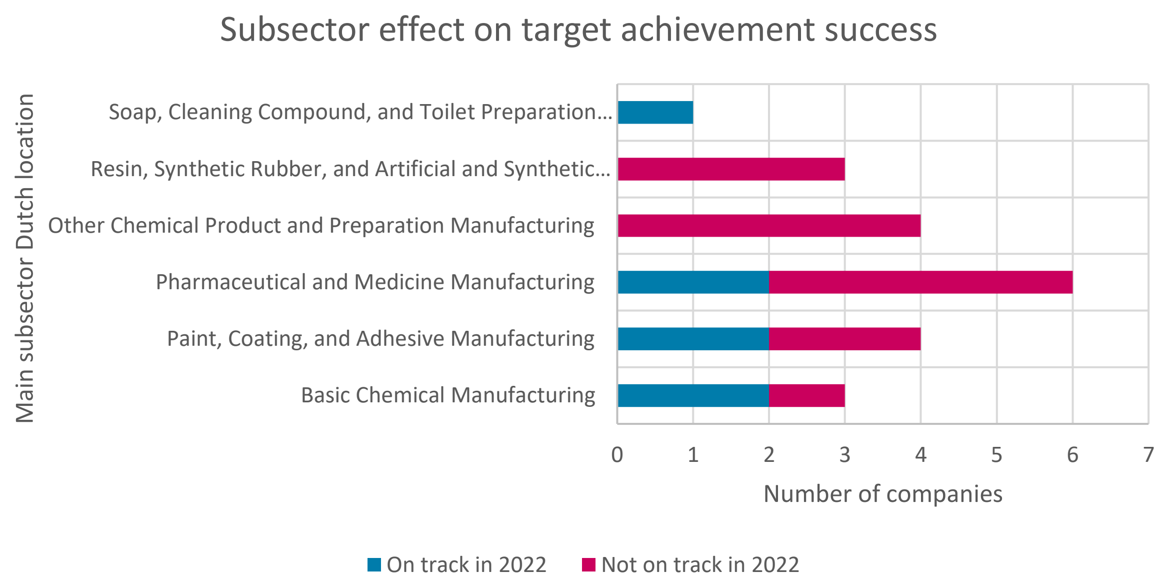
Company	2018 on track?	2019 on track?	2020 on track?	2021 on track?	2022 on track?
Air Liquide	Yes	Yes	Yes	Yes	No
Akzo Nobel	No	No	Yes	No	No
Arkema*	No	Yes	Yes	Yes	Yes
Astellas Pharma*	No	Yes	Yes	Yes	Yes
Avery Dennison	No	No	No	No	No
Cargill*	Yes	Yes	Yes	Yes	Yes
Corbion*	No	No	No	Yes	Yes
DSM	Yes	Yes	No	No	No
Gilead Sciences	No	Yes	No	No	No
Givaudan	No	No	No	No	No
International Flavors & Fragrances IFF	Yes	Yes	Yes	Yes	No
LANXESS	No	No	Yes	Yes	No
Linde	Yes	Yes	Yes	Yes	No
Merck & Co. Inc.	No	Yes	Yes	Yes	No
Oriflame*	No	Yes	Yes	Yes	Yes
PPG Industries	No	Yes	Yes	No	No
Saint-Gobain*	Yes	Yes	Yes	Yes	Yes
Synthomer plc	Yes	Yes	No	No	No
Takeda Pharmaceutical Company Limited	Yes	No	No	No	No
Teijin	Yes	Yes	Yes	No	No
Teva Pharmaceutical Industries*	No	Yes	No	Yes	Yes

** Companies on track in 2022*

W. Effect of company headquarter location, number of ICIs, and subsector on target success




ICI effect on target achievement success
Number of ICIs joined
5
4
3
2
0
2
4
6
8
10
12
Number of companies
On track in 2022
Not on track in 2022


Subsector effect on target achievement success
Main subsector Dutch location
Soap, Cleaning Compound, and Toilet Preparation...
Resin, Synthetic Rubber, and Artificial and Synthetic...
Other Chemical Product and Preparation Manufacturing
Pharmaceutical and Medicine Manufacturing
Paint, Coating, and Adhesive Manufacturing
Basic Chemical Manufacturing
0
1
2
3
4
5
6
7
Number of companies
On track in 2022
Not on track in 2022

X. Environmental regulations for the chemical sector

Given the extensive range of different emissions to air, water, and soil stemming from the chemical industry's production of chemical goods, numerous rules and regulations come into play. These regulations are applicable both on a general European level as well as a more specific national level in the Netherlands. The subsequent paragraphs seek to illuminate the organizational structure of these regulations and identify those that hold significance for the chemical sector in the Netherlands.

On the EU level, the primary tool for overseeing and regulating pollution emissions from industrial facilities is the Industrial Emissions Directive. It provides a framework that is in line with the European Green Deal and the Zero Pollution Action Plan. This directive, which has been revised in 2022, mandates that industrial installations undertaking the industrial activities listed in Annex I of the Directive (approximately 52,000 installations throughout the EU) must function under a permit that signifies their dedication to emission reduction. This commitment often involves implementing Best Available Techniques and investing in environmentally friendly equipment. To enable public access to the emission data of member states, the EU established the European Pollutant Release and Transfer Register (E-PRTR), which has also been revised in 2022. This facilitates the availability of environmental information concerning significant industrial operations (European Commission, 2023b).

In the Netherlands, different regulations apply to companies according to their respective size and level of GHG emissions. The "Big Twelve", Netherlands' major energy-intensive companies which are key players in the aforementioned industrial clusters, account for over 60% of the Dutch industry's GHG emissions. These companies, among others, fall under the European Emissions Trading System, the EU ETS (Government of the Netherlands, 2019), which will be further discussed in section 8.5. These "Big Twelve" are (in order of climate impact): Shell, Tata Steel, Dow Benelux, Yara Sluiskil, ExxonMobil, OCI Nitrogen, BP, Zeeland Refinery, Air Liquide, Air Products, SABIC, and Nobian Chemicals, formerly Akzo Nobel (Sengers & De Vos, 2023).

In addition to the prominent "Big Twelve" corporations, around one thousand companies have demonstrated their dedication to reducing GHG emissions by actively participating in the long-term energy efficiency agreements, MJA-3 and MEE, which have been terminated in 2020 (refer to section 7.3 strategies and policies).

The remaining companies are subject to the Environmental Management Act, the *Wet milieubeheer (Wm).* The *Wm* holds a pivotal role as the primary environmental law, dictating the application of various legal mechanisms to safeguard the environment. Among these mechanisms are environmental plans and programs, quality requirements, permits, general regulations, and enforcement actions. Moreover, the *Wm* incorporates provisions related to financial instruments, such as levies, contributions, and damages (Ministerie van Infrastructuur en Waterstaat, 2023).

In essence, the *Wm* hence serves as a general framework as well as an extensive legal toolkit for environmental protection. It is undergoing regular amendments, driven, in part, by changes resulting from European regulations. The *Wm* establishes overarching guidelines encompassing a wide range of topics, including substances, waste materials, enforcement measures, public access to environmental data, and options for recourse. More specific rules are then elaborated in decrees and regulations by different Ministries. The *Wm* also governs the allocation of government permits and the formulation of plans by various authorities.

The new Environment and Planning Act *(Omgevingswet),* in which the *Wm* is incorporated, will apply from 1 January 2024. In the domains of space, housing, infrastructure, environment, nature, and water, an extensive array of legislation is expected, including over 20 laws, 120 Orders in Council, hundreds of regulations, and approximately 40 plan forms. Currently, the *Wm* does not encompass all environmental laws. Notably, significant individual laws, such as the Noise Abatement Act, the Water Act, the Soil Protection Act, and the Fertilizers Act, are still separate. Nevertheless, the intention is to integrate these regulations into the Environmental Act, similar to the approach taken with the *Wm* (Ministerie van Infrastructuur en Waterstaat, 2023).

As previously mentioned, the specific environmental rules are elaborated in decrees and ministerial regulations. The pivotal regulation for entities, particularly companies, engaged in environmentally impactful activities is the *Activiteitenbesluit milieubeheer* (Environmental Management Activities Decree). The *Activiteitenbesluit,* which has been in force since the first of January 2008, incorporates the general regulations and reporting requirements, alleviating the need for many companies to seek an environmental permit. Since 2016, the fourth tranche of the *Activiteitenbesluit* is in force (Kortekaas, n.d.).

In the *Activiteitenbesluit,* establishments are classified into type A, B and C establishments depending on their size, operations and other requirements described in the decree. Some companies may be subject to additional environmental regulations beyond the *Activiteitenbesluit* and the standard environmental permit. When these companies initiate or modify their operations, they are required to notify the *Activiteitenbesluit.* However, others may need to obtain an environmental permit or a limited environmental assessment permit *(Omgevingsvergunning Beperkte Milieutoets, OBM).* The *OBM* is a simplified permit suitable for activities that are too complicated or significant to be governed solely by general rules. These specific activities, outlined in Appendix I of the *Activiteitenbesluit,* demand an environmental permit. In the case of the *OBM*, regulations within the *Activiteitenbesluit* pertain to the activity subject to this limited environmental assessment. Certain activities cannot easily conform to the general rules and require prior testing through the *OBM*. This testing encompasses factors like local nuisance (noise, odor, air quality), as well as effective waste management (Rijkswaterstaat Ministerie van Infrastructuur en Waterstaat, n.d.).

If companies want to determine which rules and regulations apply and if an environmental permit or an *OBM* is needed, they can make use of the *Activiteitenbesluit* Internet Module *(AIM),* an online tool by the Ministry of Infrastructure and Water Management, in question-answer style that provides easy guidance.

To identify the environmental regulations pertinent to companies in the chemical sector, one should follow the question structure outlined in the *AIM*. The initial step involves defining the business type, which, in this instance, falls under the category of "Industry." Proceeding along the *AIM* framework, the next classification pertains to the industry subdivision, specifically denoted as "Chemical industry and refineries." In accordance with the *AIM* and consistent with the previously for this research defined scope of the chemical industry , encompassing all activities under SBI codes 19 to 22 (refer to section xxx), the "chemical industry and refineries include all industrial activities related to the production or processing of chemicals or the refining of petroleum and purification of natural gas.

The production or processing of chemical substances not only includes the production of basic chemicals but also the production of semi-finished and end products from chemical raw materials. Examples of products from the chemical industry are base chemicals, polymers (raw material for rubber and plastics industry), agricultural chemicals, pharmaceuticals, cosmetics, pigments, fibres, enzymes, paint, varnish, ink or glue, detergents, as well as cleaning or maintenance products." (Ministerie van Infrastructuur en Waterstaat, n.d.).

On top of the business type and industry subdivision, the *AIM* continues asking about other factors and activities including waste materials, industrial pollution prevention and control installations, as well as other installations such as boilers, wind turbines, or cooling or freezing installations. Based on the specific elements that pertain to a particular company, the *AIM* proceeds by posing more detailed questions regarding the characteristics of the waste materials and installations in question. This approach facilitates a straightforward determination of the applicable environmental regulations.

In addition to the previously mentioned regulations specific to a company's installations and processes, Dutch businesses are also obligated to pay an energy tax, known as *energiebelasting.* The tax rate is contingent upon the volume of energy consumed. The implementation of the energy tax serves as an incentive for businesses to curtail their energy consumption, leading to reduced tax liabilities. Moreover, the Dutch government provides various subsidy schemes related to energy reduction, which will be elaborated on in greater detail in section 8.5.

The Dutch industrial sector operates within a comprehensive framework of energy-related regulations, designed to enhance sustainability and efficiency. These regulations depend on a company's size and energy consumption and encompass a range of obligations and requirements that companies must adhere to, ensuring responsible energy consumption and environmental considerations.

For example, if the annual energy consumption of a company or organization (per location) amounts to a minimum of 50,000 *kWh* or a natural gas consumption of 25,000 m^3 (or an equivalent in another fuel), firms must meet the energy efficiency obligation and are therefore legally obligated to develop an energy reduction plan (energy efficiency notification obligation). This plan outlines strategies for implementing energy-saving measures with a payback period of five years or less and necessitates reporting on their execution every four years. An overview of these energy-saving measures with a payback time of five years or less can be found in the Recognized List of Energy Saving Measures (*Erkende maatregelenlijsten)* provided by the RVO, which consists of three parts: Buildings, Facilities, and Processes, and is frequently updated. The Dutch government recently – on the 1st of Juli 2023 - updated the *Erkende maatregelenlijsten* to speed up the transition and to signal its commitment to achieving its ambitious national climate goals (Rijkswaterstaat Ministerie van Infrastructuur en Waterstaat, 2023).

Currently, the energy efficiency obligation is stated in the *Activiteitenbesluit*, however, this requirement - alongside all other environmental legislation - will soon fall under the *Omgevingswet*, which, as previously mentioned, will take effect starting with the first of January 2024 (RVO, 2023b). For company facilities consuming over 10 million *kWh* of electricity or 170,000 m^3 of natural gas (or an equivalent) annually, there is an obligation to conduct an energy-saving assessment. Primarily concentrating on manufacturing processes, this investigation seeks to explore potential measures for energy conservation. It also mandates the prompt implementation of energy-saving measures with payback periods of five years or less.

Besides the energy efficiency and investigation obligations that apply to smaller firms, large companies fall under the scope of the European Energy Efficiency Directive (EED). Firms are classified as large firms if they do not have SME (small and medium-sized enterprise) status, in other words, if they have either a minimum of 250 full-time employees (including participation of or in partner companies and affiliated companies) or "an annual turnover of more than €50 million and an annual balance sheet total of more than €43 million, including participating interests of or in partner companies and affiliated companies" (RVO, 2023a). The EED's implementation into Dutch legislation necessitates companies to conduct regular energy audits. The EED audit obligation ensures that these companies assess and optimize their energy usage to enhance overall efficiency and reduce environmental impacts by delivering energy reduction plans and executing those. Additional obligations may be required depending on the government organization responsible for establishing environmental regulations applicable to a company's respective situation.

Lastly, very large companies, in particular those encompassing stationary installations such as power plants, industrial facilities, and other major energy consumers, along with airlines, fall under the EU ETS and are subject to specific regulations. The EU ETS aims to control GHG emissions by establishing a cap-and-trade mechanism, influencing participating companies to manage and reduce their emissions effectively. The EU ETS will be discussed further in detail at a later point in this chapter. Overall, these energy-related regulations underscore the commitment of the Dutch industrial sector to sustainable practices, energy efficiency, and responsible environmental stewardship, contributing to a greener future for both businesses and the environment.

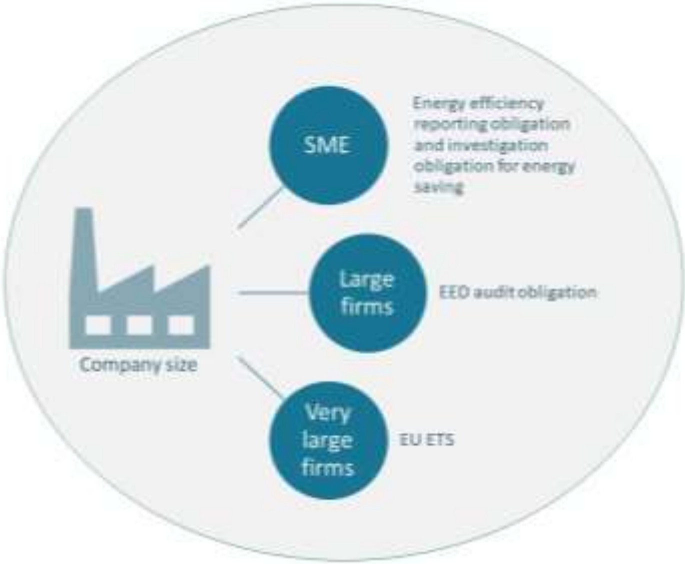


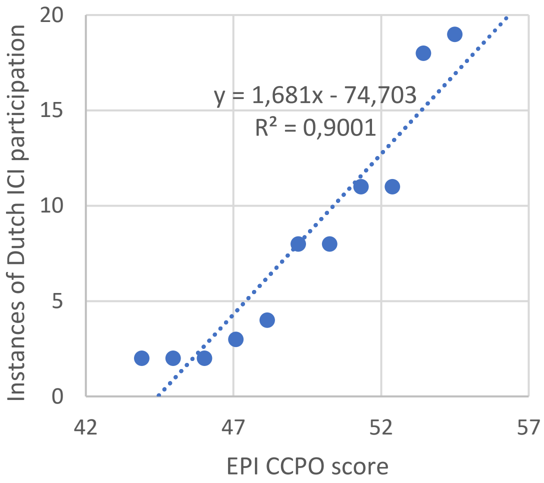
Figure AX.1: Overview of energy-related obligations by firm size. According to RVO (2023a, 2023b).

As previously noted, in addition to energy-related aspects like electrification, process efficiency, and heat utilization, the circular utilization of raw materials is another key focus area. In the context of materials, it is essential to recognize that, given the chemical sector's dual role as a user and producer of potentially hazardous substances, numerous regulations are in place to ensure their safety.

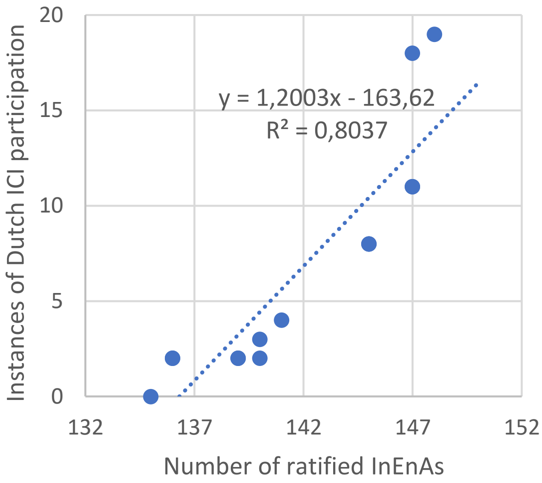
The European Union possesses an extensive and safeguarding regulatory framework for chemicals, currently including around 40 EU laws regulating chemicals, underpinned by a sophisticated knowledge foundation. Some of the key regulations for the chemical sector include the REACH (Registration, Evaluation, Authorization, and Restriction of Chemicals), the POP (Poorly degradable (persistent) substances), or the CLP (Classification, Labeling, and Packaging) regulation. Since European regulations hold direct applicability within the Netherlands, Directive 2011/95/EC of the EU, which acts as the legal framework for product safety in the EU, has been transposed into Dutch law and expanded upon through the Commodities Act. The Commodities Act serves as a comprehensive foundational statute, while precise regulations for individual substances and products are established in decrees and regulations under the Commodities Act. Moreover, the aforementioned *Wm* as well as the Water Act bear significance for substances and products in a more general context (RIVM, n.d.). Regarding the categorization of hazardous chemicals in the Netherlands, the RIVM (Ministry of Health, Welfare and Sports) has compiled a comprehensive list, housing all Substances of Very High Concern (*Zeer Zorgwekkende Stoffen*). This list is accessible on the RIVM's official website.

In summary, it is evident that numerous environmental regulations apply, particularly for the energy-intensive industry, which the chemical sector belongs to. Yet, to facilitate a fair transition to a more environmentally friendly and low-carbon chemical sector, governmental support is essential in the form of strategies, roadmaps, and supportive policies.

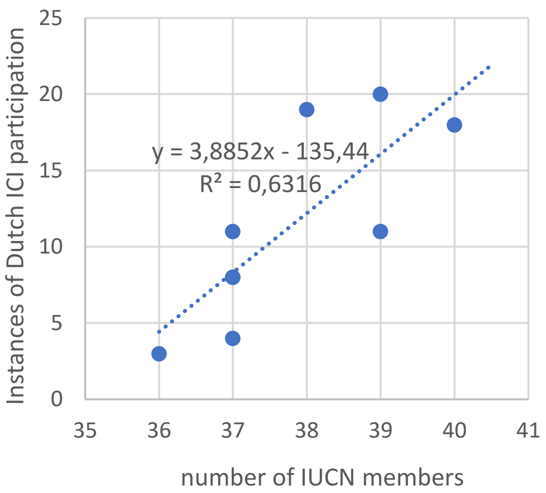
Y. Correlation analysis for companies headquartered in the Netherlands



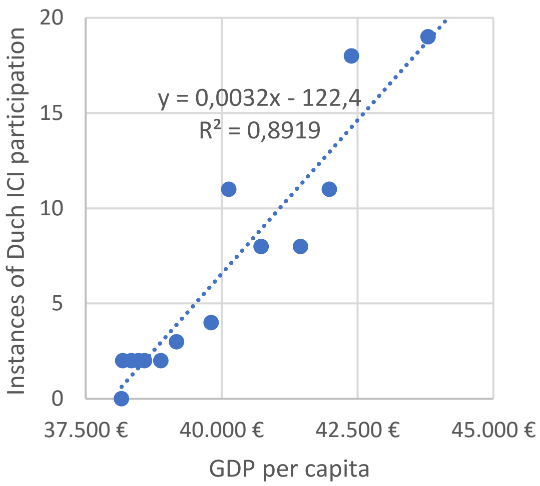
(a) ICI participation and EPI CCPO



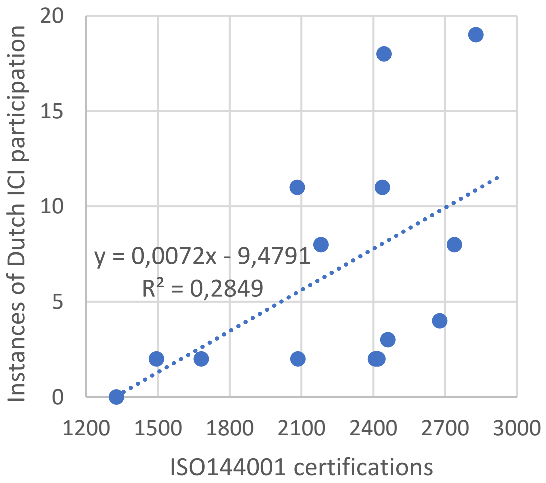
(b) ICI participation and InEnA ratifications



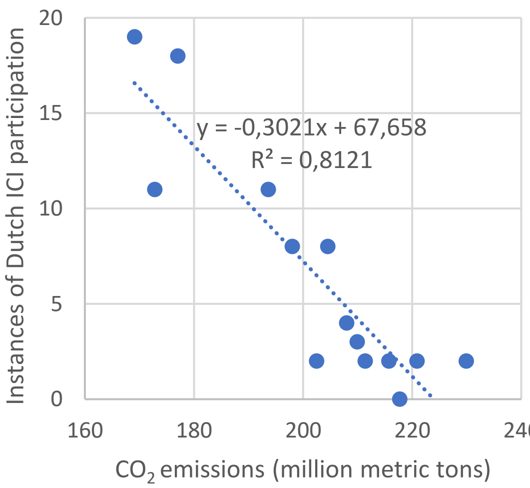
(c) ICI participation and IUCN members



(d) ICI participation and GDP per capita



(e) ICI participation and ISO 14001 certifications



(f) ICI participation and CO_2 emissions

Correlation analysis Dutch national NSA climate action and Dutch state-level climate action.

Z. Revenue-as-a-proxy for downscaling global GHG emissions

The method

As discussed in section 10.1, we aimed at estimating corporate country-level emissions using a proxy. To do so, we first evaluated various proxies were evaluated based on their suitability for estimating GHG emissions in the chemical sector and the availability of country-level data. The outcomes of this preliminary exploration are presented in Table AZ.1 below.

Table AZ.1: Initial evaluation of different proxies for data availability and fitness for estimating country-level GHG emissions.

PROXY	DATA AVAILABILITY
TYPE OF CHEMICALS PRODUCED	Data obtainable both globally and on country-level
NUMBER OF EMPLOYEES	Data obtainable both globally and on country-level
ASSETS	Country-level data difficult to obtain
PRODUCTION/SALES VOLUME	Country-level data difficult to obtain
REVENUE/SALES	Data obtainable both globally and on country-level
ENERGY CONSUMPTION	Country-level data difficult to obtain
FEEDSTOCK CONSUMPTION	Country-level data difficult to obtain
PROCESS EMISSIONS INTENSITY	Country-level data difficult to obtain
WASTE GENERATION	Country-level data difficult to obtain

As indicated in Table AZ.1, acquiring country-level data can be challenging due to the limited granularity of information available in public disclosures by companies. However, three proxies stand out as exceptions, allowing access to both global and country-level data. These three proxies underwent further scrutiny to assess their suitability for estimating country-level GHG emissions:

Firstly, "Type of chemicals produced". While this data is accessible at the country level, estimating GHG emissions would also require knowledge of production volumes. As demonstrated, obtaining production volumes at the country level is challenging. Therefore, the type of chemicals produced will not be utilized as a proxy. Secondly, "Number of employees", even if obtainable at country level, relates to all employees in the Netherlands working in manufacturing, administration, sales, HR, and so on, making this proxy less reliable. Finally, let us consider the "Revenue/sales" proxy. Although, in theory, it might be challenging to distinguish Dutch revenues from chemical products manufactured elsewhere from those actually manufactured in the Netherlands thus making the GHG emission estimation less reliable, we were able to obtain sales revenue data per company location, including manufacturing sites, in the Netherlands (refer to section 4.7.1).

It is important to note that there is a correlation between a company's GHG emissions and its revenue, as revenue is often used as a proxy for company size and scale of operations, and big firms with large-scale operations emit more GHG emissions. The relationship between company size and profits has been described in the academic literature by Selcuk and Kiymaz (2017), arguing that "while highly levered firms are less profitable, larger firms have higher profits", while Ravallion (2000) confirmed the correlation between company revenue and GHG emissions by stating that "economic growth generally comes with higher emissions.". Furthermore, larger companies tend to generally have higher GHG emissions due to increased energy consumption (Lei et al., 2012) and resource usage. This notion is also supported by Sherafatian-Jahromi et al. (2017), who demonstrated in their research that a significant increase in emissions is the result of economic activities and energy consumption.

The method employed to estimate Dutch country-level GHG emissions will hence be the "revenue-as-a-proxy" method. This approach functions as follows: firstly, we calculate the revenue ratio by summing up the revenues of all chemical amnufacturing locations and subsidiaries in the Netherlands per parent company and dividing this figure by the overall revenue of the parent company, obtained through a *Google* search. Subsequently, we apply that percentage to the global GHG emissions of the parent company, serving as an approximation to determine the share of GHG emissions attributable to the company's Dutch operations. This revenue-as-a-proxy approach is based on the aforementioned academic background of correlating an enterprise's revenue with its GHG emissions.

Analyzing the method based on subsectors and headquarter locations

Even though we found out that the revenue-as-a-proxy method is flawed (as thoroughly discussed in section 10.1), we conducted analyses to analyze whether there is any particular subsector or company headquarter location for which the method seems to work better. To do so, we color-coded the compared scope 1 emission of our own calculations and the data from the NEa. The color code is as follows:

- Green: If the larger emission number is less than double the smaller number.
- Yellow: If the larger number is between two and four times greater than the smaller number.
- Red: If the larger number is more than four times greater than the smaller number.

Subsector analysis

We started these additional analyses by looking at the different subsectors of companies. For the subsector analysis, two distinct analyses were initially conducted. The first compared the NEa scope 1 emission data with our calculated emissions derived from applying the revenue ratio to the total revenues of all parent company (and subsidiary) locations in the Netherlands. In the second analysis, a new revenue ratio was calculated based on solely these locations that precisely matched those listed in the NEa data. Subsequently, this new ratio was applied to overall group GHG emissions for each company and the resulting emissions were compared only to the sum of emissions from the matching locations in the NEa dataset to assess whether narrowing the analysis to these specific locations enhanced the accuracy of the revenue-as-a-proxy method. Surprisingly, in the second analysis, the results were even less accurate. The color-coded results of these two analyses are depicted in Tables AZ.2 and AZ.3, respectively.

Table AZ.2: Overall Dutch company locations (incl. subsidiaries) compared against all locations found in NEa dataset (n=21), using the color code described before.

Company Name	Revenue ratio estimate Dutch emissions	Allocated Dutch scope 1 GHGs 2022 (tons CO_2eq)	NEa Scope 1 GHG data 2022 (tons CO_2)	Allocated Dutch scope 1 GHGs 2021 (tons CO_2eq)	NEa Scope 1 GHG data 2021 (tons CO_2)
Air Liquide	8,88%	1.444.277	1.005.233	1.378.866	1.234.536
Air Products and Chemicals	2,57%	431.694	610.542	380.302	842.844
Borealis Group	1,81%	27.869	8.362	34.438	16.481
BP	0,21%	64.018	1.938.767	69.914	2.117.592
Cargill	0,30%	20.838	256.728	21.920	297.295
Chemours	4,32%	225.045	35.847	266.178	58.561
Corbion	81,71%	87.652	26.362	86.881	24.172
DSM	81,85%	468.808	56.926	501.956	54.338
ExxonMobil	7,00%	6.857.489	2.761.379	6.857.489	2.474.594
FUJIFILM	1,53%	8.860	25.512	9.669	25.353
Dow Chemical Company	2,11%	575.895	3.493.676	596.979	3.911.793
Indorama Ventures	3,44%	247.460	140.716	249.262	189.491
LyondellBasell	7,33%	1.078.344	305.606	1.185.687	339.826
OCI N.V.	3,05%	401.872	1	432.967	274.114
PPG Industries	3,95%	15.392	49.684	15.436	52.870
SABIC	2,74%	1.022.588	215.625	988.237	231.952
Saint-Gobain	1,85%	155.042	49.260	155.162	51.247
Shell	29,36%	14.974.883	6.628.486	17.617.509	6.990.152
Shin-Etsu Chemical	0,98%	21.976	98.050	20.329	92.753
TotalEnergies	4,05%	1.508.469	1.762.798	1.349.597	1.644.880
Yara	10,01%	1.494.478	2.749.881	1.653.902	3.190.000
TOTAL		**31.132.947**	**22.219.441**	**33.872.680**	**24.114.844**

Table AZ.3: Only those Dutch company locations (incl. subsidiaries) exactly coinciding with those in NEa dataset (n=17) compared against coinciding locations in the NEa dataset, using the color code described before.

Company Name	**New revenue ratio for coinciding branches/ subsidiaries**	**Coinciding NEa scope 1 GHG data 2021 (tons CO_2)**	**Estimated coinciding Dutch scope 1 GHGs 2021 (tons CO_2eq)**	**Coinciding NEa scope 1 GHG data 2022 (tons CO2)**	**Estimated coinciding Dutch scope 1 GHGs 2022 (tons CO_2eq)**
Air Liquide	4,3082%	1.234.536	669.316	1.005.233	701.068
Air Products and Chemicals	2,5696%	842.844	380.302	610.542	431.694
Borealis Group	1,8097%	16.481	34.438	8.362	27.869
BP	0,2081%	2.117.592	69.085	1.938.767	63.258
Chemours	4,3162%	58.561	266.178	35.847	225.045
Corbion	76,0228%	24.172	80.829	26.362	81.547
ExxonMobil	0,6626%	94.540	649.396	87.098	649.396
FUJIFILM	1,5275%	25.353	9.669	25.512	8.860
Dow Chemical Company	2,1090%	3.911.793	596.626	3.493.676	575.554
Indorama Ventures	3,4223%	189.491	248.037	140.716	246.244
LyondellBasell	7,2013%	326.159	1.165.402	295.359	1.059.895
PPG Industries	0,2616%	52.870	1.023	49.684	1.020
SABIC	1,7817%	231.952	641.551	215.625	663.851
Shell	29,3479%	6.990.152	17.608.758	6.628.486	14.967.445
Shin-Etsu Chemical	0,0005%	92.753	10	98.050	11
TotalEnergies	0,0884%	1.469.808	29.447	1.592.627	32.913
Yara	8,3662%	3.190.000	1.381.662	2.749.881	1.248.480
TOTAL		**20.869.057**	**23.831.728**	**19.001.827**	**20.984.148**

The results of both subsector analyses were then averaged and are depicted in Figure AZ.1.

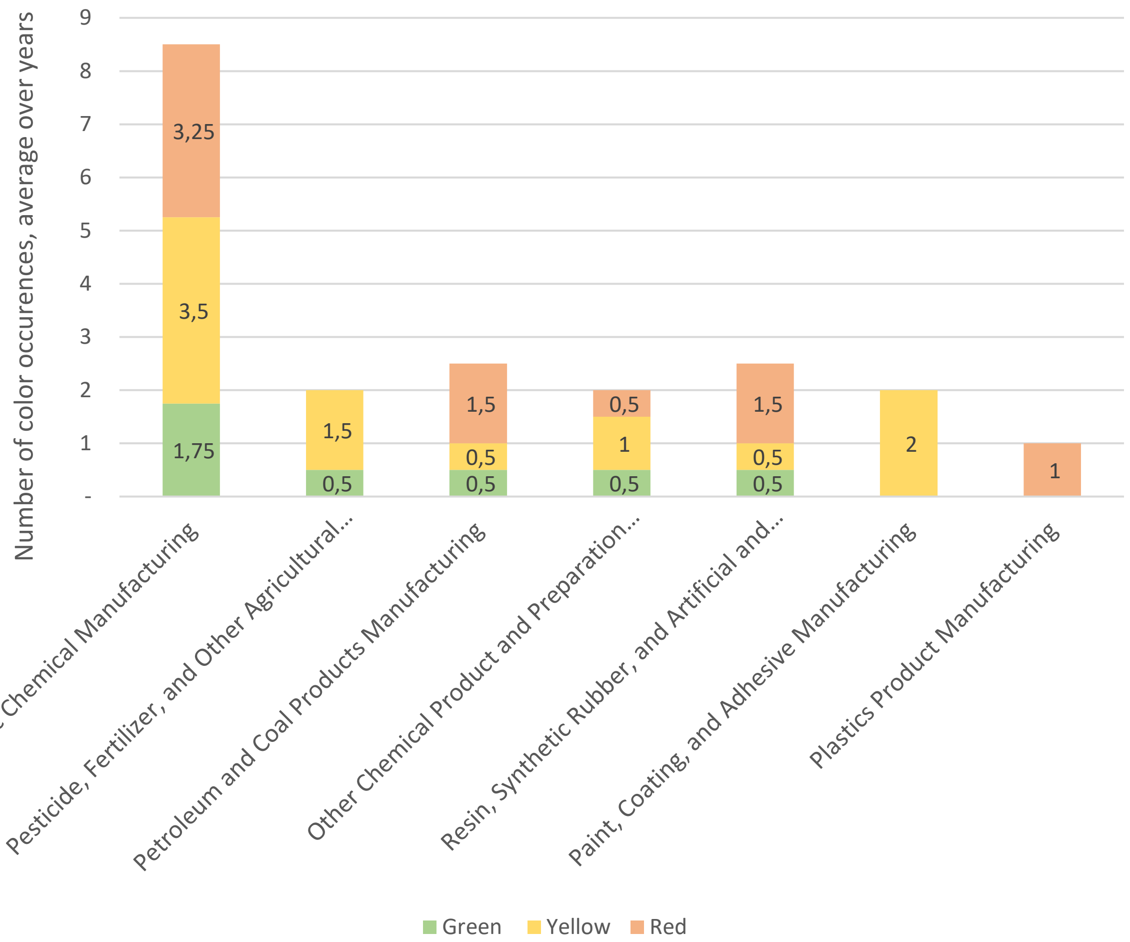


Figure AZ.1: Average results of both subsector analyses using color codes. Color occurrences calculated as an average over years.

Given the varying numbers of subsector representations, the next step involved assigning scores to the different colors: 3, 2, and 1 point for green, yellow, and red, respectively. Subsequently, the total score was divided by the number of occurrences of each color for each subsector, resulting in overall scores for each subsector, as illustrated in Table AZ.4.

Table AZ.4: Results of the subsector analysis using the scoring method. Scores ranked in descending order.

Subsector ranking	Score
Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	2.25
Other Chemical Product and Preparation Manufacturing	2
Paint, Coating, and Adhesive Manufacturing	2
Basic Chemical Manufacturing	1.83
Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	1.6
Petroleum and Coal Products Manufacturing	1.6
Plastics Product Manufacturing	1

As can be seen, the subsector "Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing" is the sector where the revenue-as-a-proxy method seems to have worked best, and "Plastics Product Manufacturing" the sector where the method did not work. Nevertheless, it's crucial to note that these scores might not be representative of the truth due to the small sample size of 21 companies and the varying number of company classifications into subsectors. A more accurate assessment can only be made with a larger sample.

Headquarter analysis

After conducting the subsector analysis and obtaining inconclusive results, a subsequent analysis was undertaken to assess whether the headquarters' location has a more pronounced influence on the effectiveness of the revenue-as-a-proxy method, potentially yielding more meaningful results.

To achieve this, the same approach as the one employed for the subsector analyses was adopted, utilizing identical color codes and the scoring method. The results for the color-coding as well as the scoring method are depicted below in Figure AZ.2 and Table AZ.5, respectively. However, in this analysis, we omitted the additional examination of only considering coinciding company locations. This is firstly due to the subsector analysis, where the results did not provide further insights, rendering this extra analysis somewhat redundant. Moreover, this supplementary analysis is not as relevant when scrutinizing headquarter locations, as we are primarily concerned with the parent company's headquarter location and not focusing on specific locations and subsidiaries. Additionally, it would further reduce our already small sample of 21 companies to 17. Given these considerations, we opted to forgo the additional analysis.

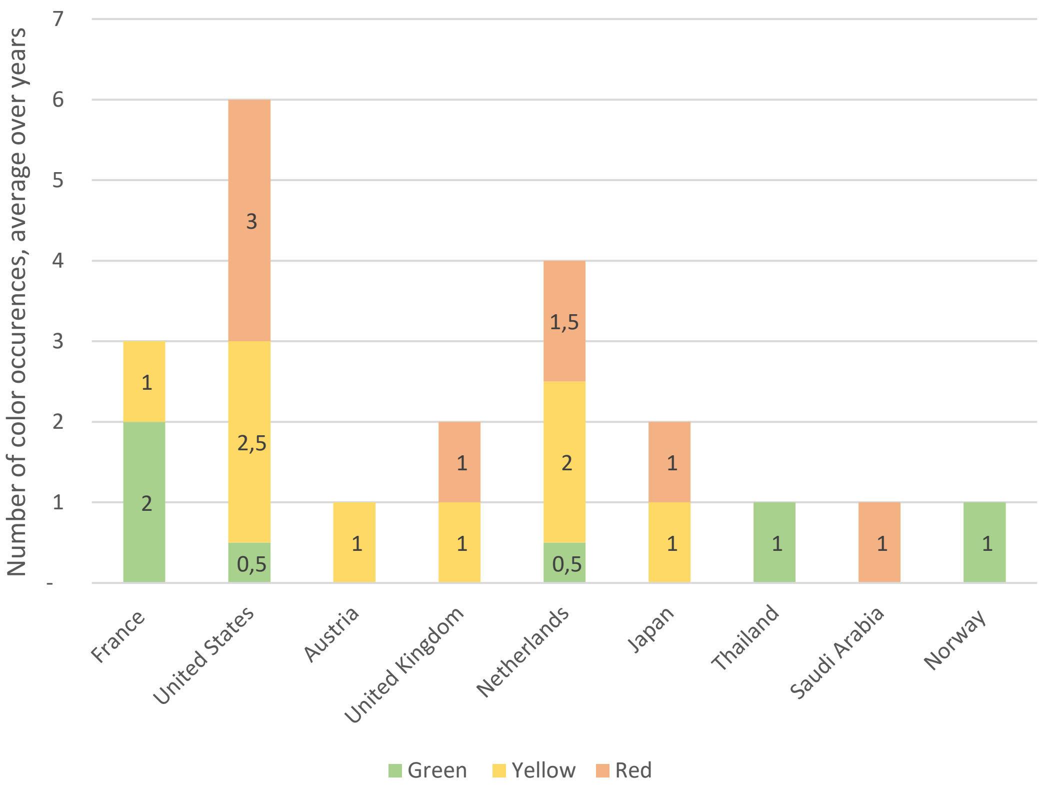


Figure AZ.2: Results of headquarter analysis using color codes. Color occurrences calculated as an average over years.

Table AZ.5: Results of the headquarter analysis using the scoring method. Scores ranked in descending order.

Headquarter location ranking	Score
Thailand	3
Norway	3
France	2.67
Austria	2
Netherlands	1.75
United States	1.58
United Kingdom	1.5
Japan	1.5
Saudi Arabia	1

Although the ranking of the scoring method may suggest that the revenue-as-a-proxy method performs better when considering headquarter locations rather than subsectors (with Thailand and Norway achieving the highest score of 3 points), the method is inherently flawed due to the small sample size. For example, both Thailand and Norway only have one company headquartered there, and coincidentally or not, the method seems to have worked for them. Nevertheless, it is evident that we cannot draw generalizations from these results, similar to the subsector analysis.

To summarize, the headquarter analysis showed slightly better results than the subsector analysis, suggesting that the correlation between revenues and GHG emissions of companies is more dependent on the location of a business's headquarters rather than the subsector in which it operates. However, given the small sample size, this relationship might lessen or disappear when increasing the sample size. We therefore recommend replicating the approach taken with a significantly larger sample of chemical companies to determine whether the revenue-as-a-proxy method exhibits varying degrees of success in different scenarios.