Assessing Non-state Climate Action in Big Businesses

Evaluating Fortune Global 500 companies in the SBTi and RE100 initiatives

MSc thesis by Ivan Ruiz Manuel

TU Delft

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by

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For Mireille, Sulette and Sulette

Preface

Dear reader,

This thesis marks the end of just over nine months of work that were in equal parts stressful, thrilling and gratifying. Coming in, I knew next to nothing about the topic, why some put hopes in it, or the reasoning behind the worries it generates in others. If someone told me that climate and energy policy would be the subjects that sparked the most interest in me before leaving México I would have responded with a confused stare. Up to that point I had only worked in fields where problems are focused on developing better algorithms or devices. Trying to understand behavioral change and its effects was an enriching change of pace. I have TU Delft, the TPM department and my fellow students to thank for broadening my horizons.

Policies and behaviors have a big part in defining the environments we live in, the opportunities we have access to, and the problems we are confronted with. Global warming is one of such problems. It is the result of many things: of industrial and technological revolutions that currently bring many benefits to some, and may leave lasting damage to the many in the future. Of an economic model that ignored its dangers for far too long, and still struggles to implement solutions that acknowledge its effects. Of the relation between our current ways of living, our desires and concepts of success, and the unseen damage they generate. Of incumbent infrastructure, institutions and processes that are hard to change, and on whose operation depends the lives of many people.

The topic of this study relates to large companies and how they target to achieve changes that put them in line with global climate accords. They are, then, some of those large institutions struggling to adapt to changing tides. It is undoubtedly a loaded subject given how currently we are confronted with increasing inequality, humanitarian crises and a fair share of scandals that have eroded trust in institutions worldwide. The concept of private companies claiming to be allies in the pursuit of halting global warming is met with suspicion, which I believe is justifiable seeing as how many of them appear only do it as long as we are looking. If that is the case, then let us look and broaden our understanding on how they are changing, and how they are not.

Given the complexity of the topic, I did my best in trying to approach it with the seriousness it demands, covering as much ground as possible, and presenting information holistically. This thesis is the product much effort, and work I take pride in sharing. There are no doubts in me that there is much left to be done, since the study only covers a few initiatives, a small part of their membership, and a small portion of the emissions related to their activities. Compromises had to be made due to the difficulties in gathering information, and my own limits in knowledge. Still, I hope the reader finds the end result interesting and insightful.

Ivan Ruiz Manuel
Delft, September 13, 2021

Acknowledgements

I came to TU Delft hungry for knowledge and to achieve a goal I had set for myself since before I began my Bachelor's, and I can say with joy that I found much more. Aside from doing well in my studies, I also lead a team in a humanitarian NGO dedicated to bringing renewable energy to refugee camps, joined a team that created sustainability scenarios for an aerospace company through the Joint Interdisciplinary Project, and most of all, met a lot of wonderful people that shared these experiences with me and helped me grow as a person. All this happened in the midst of a global pandemic, and a personal health issue that left my vision damaged for life making me come to terms with my own limits. This thesis would have been impossible without the support of many people and institutions, who cannot go unmentioned.

I would like to thank the COECYTJAL and CONACYT institutes, for granting me the scholarship that allowed me to realize my dream of obtaining a Masters in sustainability. Promoting knowledge and investing in education is crucial for the development of México. I hope such support continues in the future so that others might achieve their dreams too, and Mexico strengthens its place in the research community.

Everyone at TU Delft that made this thesis possible has my gratitude. First, I would like to thank my supervisor Prof. Kornelis Blok, whose guidance and patience were crucial factors in the work; thank you for always keeping my expectations in line with what was possible, for sharing your knowledge and enabling me to work on such an interesting topic. Second, my thanks to the members of the thesis committee, Professors Arno Smets and Enno Schröder, whose comments were invaluable to improve my work. Third, I am indebted to Prof. Linda Kamp, for her help in finding the thesis topic, for enabling my interest in policy and for her aid during the process of producing this work. Finally, special thanks go to my great friends Mohamed Elabbas and Monika Šalandová, whose feedback was crucial in improving this thesis in many ways.

I would also like to thank all the people that supported me during this stage of my life. Moving to a different country, and adapting to my eyesight problems often left me feeling lost. My thanks go to Diego Quan, who is a true friend and an example for me. My endless gratitude to Sang Jae, Maria and Onsi, your friendship made the struggle of taking classes during a pandemic much less harsh. To my teammates in Energy for Refugees, for going through a tough process of successes and failures together, and for putting your trust in me. To my friends back in México who I missed dearly: Oscar, Alejandro, Luis Eduardo, Pablo, Gustavo and Omar. To Aura and Marielle, for listening to my pains and encouraging me. I could have not done it without you all.

And most important of all, I am deeply grateful to my family: my grandmother, my mother and my sister. Your love and support carried me this far. As I step into the next phase of my life, I wish to use the knowledge I gained in ways that repay for all the aid I received, benefiting society so that others may have their chance. This thesis is for you.

Acronyms

4BDC Four Basic Design Criteria for effective mitigation.

AAGR Average Annualized Growth Rate.

BaU Business as Usual.

C-FACT Corporate Finance Approach to Climate-stabilizing Targets.

CA100+ Climate Action 100+.

CNP Current National Policies.

COP Conference of the Parties.

EACs Energy Attribute Certificates.

EII Energy Intensive Industry.

ETIP PV European Technology Innovation Platform for Photovoltaics.

EUCoM EU Covenant of Mayors.

F-gas Fluorinated gas.

FOF Function-Output-Fit.

G500 Fortune Global 500.

GEVA GHG Emissions per unit of Value Added.

GHG Greenhouse Gas.

GHG Protocol Greenhouse Gas Protocol Corporate Standard.

GICS Global Industry Classification Standard.

GRI Global Reporting Initiative.

HSC Heat, Steam and Cooling.

IAM Integrated Assessment Model.

ICI International Cooperative Initiative.

IPCC Intergovernmental Panel on Climate Change.

IRENA International Renewable Energy Agency.

ISIN International Securities Identification Number.

LERTY Linear Emission Reduction to Target Year.

LULUCF Land Use, Land Use Change and Forestry.

MRV Monitoring, Reporting and Verification.

NAZCA Non-state Actor Zone for Climate Action.

NDC Nationally Determined Contribution.

NGO Non-governmental organization.

NSA Non-state and Subnational Actor.

NYSE New York Stock Exchange.

OECD Organisation for Economic Co-operation and Development.

OGCI Oil and Gas Climate Initiative.

PPA Power Purchase Agreement.

RE Renewable Energy.

SBTi Science Based Targets initiative.

SDA Sectorial Decarbonization Approach.

SMEs Small and Medium Sized Enterprises.

SRT Sustainability Reporting Tool.

SSP Shared Socioeconomic Pathway.

TCG Transnational Climate Action.

UNEP United Nations Environmental Programme.

UNFCCC United Nations Framework Convention on Climate Change.

WRI World Resources Institute.

WWF World Wide Fund for Nature.

Executive summary

Introduction

Non-state and Subnational Actors (Non-state and Subnational Actors) like cities, regions and businesses have had an increasing role in climate talks such as the Paris accord, and several studies have proposed that they could be a crucial aid in the process of bridging the gap between Current National Policies (CNP) and compatibility with keeping global warming below 1.5°C, which can only be achieved by reducing global Greenhouse Gas (GHG) emissions. Such actors tend to group together in order to form an International Cooperative Initiative (ICI), with several of them surfacing to tackle different aspects of global emissions: businesses committing to reduce their carbon footprint, cities and regions setting similar targets, collectives aiming at halting global deforestation, etc.

By the end of 2019, the difference between the predicted growth in emissions with CNP and 1.5°C compatibility stood at a predicted 34 $GtCO_2e$ by 2030. The most recent NSA studies estimated that current commitments could reduce the gap by 1.2–2.0 $GtCO_2e$ by 2030. If ICIs manage to meet their intended growth, this reduction could grow further to reach 18.0–20.0 $GtCO_2e$ by the same year.

However, although ex-ante estimations abound in the literature, there are few ex-post studies on how such initiatives are actually progressing. In particular, quantitative evaluations are rare; mostly caused by information issues since most databases stop at the national level, some of these actors do not have the monetary or technical capacity to do proper emissions accounting, or they may not even have control over the emissions they aim to reduce. The lack of data is of special concern when it comes to initiatives lead by businesses, which tend to draw criticism due to risks of greenwashing and effort fragmentation.

To aid in this research gap, this study focused on developing a strategy that allowed evaluation of prominent business initiatives by narrowing down the group of companies and initiatives studied. The goal was to avoid overlaps caused by subsidiary companies, and reduce informational issues by ensuring that all companies had the monetary capacity to properly account for their GHG emissions, and that the initiatives had clear targets embedded into their processes.

The group of companies selected was the Fortune Global 500 (G500), a global ranking of companies by their revenue which is pre-pruned for subsidiaries. Two initiatives were selected: the Science Based Targets initiative (SBTi) and RE100.

The SBTi focuses validating GHG reduction targets set by companies in order to ensure that they are compatible with Paris-goals of keeping global warming at least well-below 2°C. As of 23rd February 2021, 1205 companies have become members, with 593 of them earning the "Targets Set" status given after a company passes the validation tests developed by the initiative. Estimates predict that this initiative might grow to 2000 members in 2030, providing additional emission reductions of 2.7 $GtCO_2e$ by 2030.

RE100 instead focuses on making its members commit to reach 100% renewable electricity usage by 2050 at the latest. This initiative reached at total of 289 members as of 23rd February 2021, with all of them having set targets, and ex-ante estimates put its potential for additional emissions reductions at 1.9 to 4.0 $GtCO_2e$, if it manages to reach 2000 members by 2030.

By combining these three groups of companies and analysing progress between 2015–2019 this thesis aims to answer the following question:

> *To what extent have the SBTi and RE100 cooperative initiatives directly contributed to climate change action and the renewable transition via reductions in emissions and shifts to renewable electricity usage between the Paris agreement and today?*

Methodology

This study developed several guidelines to avoid or minimize the impact of issues seen in ICI documentation and company Sustainability Reporting Tools (SRTs):

1. Select a group of companies with high potential impact and enough means for good sustainability disclosure, which has been pre-pruned to remove overlaps generated by subsidiary companies.
2. Select ICIs that have clear target-setting methodologies for their members to follow.
3. Avoid tracking intensity targets with varying metrics to simplify data gathering.
4. Develop a method to determine baselines if they are not disclosed, and linearize targets.
5. Establish an information collection methodology that sets preferences for the source of information, preferring compounded databases over individual company reports, and clarify how changes in the collection methodology of such databases will be handled.
6. Evaluate the collected data in order to detect and correct mistakes, inconsistencies and other oversights.

Selecting the G500, SBTi and RE100 came as a result, which required identifying overlaps between their members. Information on company targets was collected using data provided by the initiatives themselves, but they did not disclose the amount of emissions or electricity consumption of each member, making accurate comparisons impossible. That kind of sustainability data had to be gathered using questionnaires submitted to another initiative, CDP (previously known as the Carbon Disclosure Project), and individual company sustainability reports. It was found that both CDP questionnaires and sustainability reports suffer from a plethora of yearly errors and pervasive longitudinal errors (i.e. issues preventing year-by-year comparisons), which required developing a series of validation tests to identify and correct them whenever possible. Finally, logical frameworks were developed to evaluate progress in each initiative in ways that matched their intended goals.

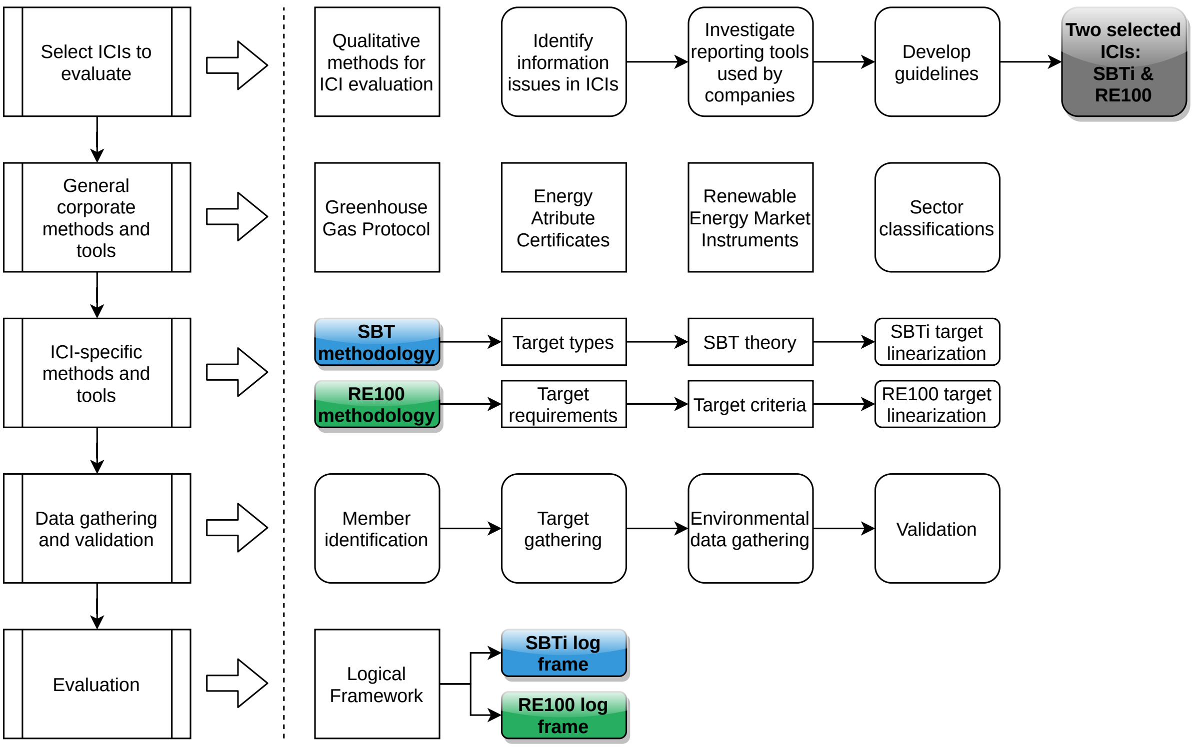

Figure 1: General steps followed to produce this study, subdivided into their relevant sub-sections. Rounded rectangles (right side) represent methods developed or adapted by the author, while non-rounded ones are methods or theories developed by other authors or organizations.

Distribution of participants in the initiatives

G500 participation in the SBTi and RE100 was identified by employing both automated algorithms and manual tests. It was found that a total of 137 companies joined either of these initiatives, with 48 affiliating in both. SBTi has the majority of single members, with a total of 68, leaving RE100 with only 21.

Participants tend to have their headquarters in industrialized nations, with European companies being the majority at 72. Most of the rest are located in either the U.S. or Japan, each with 40 and 16 respectively. Chinese companies are largely absent despite being the country with the largest amount of companies in the G500 ranking, only one of them has joined either initiative. When it comes to the global south and other developing nations, the G500 generally does not feature many companies from them. Still, the percentage of participation in such nations was found to be significantly low.

It was also found that both initiatives are largely composed of light industries and service companies, sectors that generally have low emissions in comparison to others. RE100 in particular has a large amount of service companies exclusive to it, most of them being banks and other financials. Only the SBTi had a handful of participants in high emitting sectors such as electric utilities and Energy Intensive Industry (EII). No companies in the fossil fuel production energy sector participate in either of them, although one company that provides services to that sector committed to set a target in the SBTi.

Evaluation of the SBTi

Although a total of 116 companies in the G500 joined this initiative, only 64 had targets that could be tracked: those aiming at reducing absolute GHG emissions either directly emitted by the company, or indirectly attributed to them through their purchases of electricity, heat, steam and cooling. Seven companies set intensity targets instead, which tie their intended emissions reduction to a secondary metric (e.g. tCO_2e emitted per-car made), and they were only evaluated partially. Another 38 companies were only committed to the initiative, and have no valid target. Finally, the remaining seven companies could not be included at all due to lack of information.

Ambition was evaluated by comparing global scenarios of Current National Policies (CNP), 2°C and 1.5°C against the predicted emission reductions targeted by the 64 companies with absolute targets. These companies cover around 300 $MtCO_2e$ in 2015, and if they successfully meet their targets they should reduce it to 170 $MtCO_2e$ in 2030, matching a well-below 2°C pathway. Ambition decreases the more energy intensive a sector is: service companies match a 1.5°C pathway, and Energy Intensive Industry (EII) only aim for 2°C compatibility. The three electric utilities match a well-below 2°C trend, and in combination with the two EIIs they cover half of total emissions. Ambition closely resembles the requried trends at a global level, and targets match the process and designations given by the initiative well. However, the initiative should consider a more tailored approach since most of these companies are in industrialized nations which are expected to reduce emissions faster than the global mean.

Robustness was assessed by looking into the type of third-party emission assurance used by the 70 members who set a target between 2015–2019. Good assurance levels are associated with higher levels of trust among users of sustainability data, and are an essential part of the emission accounting methodology used by the SBTi to define its processes. It was found that most companies already performed some level of external assurance in 2015, but some small improvements could still be seen as eight members implemented the process, leaving only one company without it in 2019. However, assurance is typically done at a limited level, the lowest according to CDP classifications, and there is little evidence of improvement. Less than $1/5^{\text{th}}$ of the total reaches assurance at reasonable or high levels, with no EIIs and only French utilities reaching it in the case of large emitters.

Implementation was judged by looking into the energy trends of companies who set targets between 2015 and 2019. Five utilities were evaluated by looking into their net-electricity generated, subdividing it into renewable, nuclear and fossil-based; collectively these companies showed trends in decreasing fossil fuel use and increasing renewable generation as a primary causes of reductions in emissions, although fossil fuels were already in the minority by 2017. Energy users showed differing behaviors depending on their energy sector. EIIs were the only sector that achieved reductions in fossil fuels used directly (i.e. within their operations). All other sectors reduced emissions indirectly by increasing the share of renewables in the energy they purchased. A deeper look into the market instruments they used to purchase this renewable energy showed a heavy preference for instruments labeled as having low additionality, meaning that their use might not result in net-increments in the total share of renewables (i.e. the non-renewable energy they stopped using might be used by other actors meaning those emissions still occur). Besides this, the use of self-generated renewable energy and renewable fuels remained low.

Substantive progress was measured by comparing the emissions generated between 2015–2019 by companies with absolute targets against target predictions, showing good trends with almost all sectors collectively exceeding commitments. In the case of companies with intensity targets only the emissions were analysed, since no target trends were created for these members due to information barriers. Regardless, these members also showed good trends in emission reductions.

Among the biggest over-achievers were the utilities, which reached a combined average trend of -14.5% per year on direct emission reductions. Generally, companies appear to have been reducing their emissions even before the baseline year of their target, a trend that can be seen in members who set a target in 2018 or earlier. End-use sectors followed the trends established by their energy consumption: EIIs achieved mostly direct emission reductions, while other sectors only showed solid evidence of indirect mitigation. If companies with both absolute and intensity targets are combined, their emissions reduced from 775 to 501 $MtCO_2e$ between 2015–2019, at a pace of -10.29%. Most of it came from utilities or EIIs, which went from 613 to 371 $MtCO_2e$.

The emissions of 27 companies who committed to the SBTi between 2015–2019 were also analysed. Progress in this sub-group was poor, with emissions actually increasing, a trend primarily determined by the performance of EIIs, and large transportation companies.

Evaluation of the RE100

In the case of RE100, of the 69 G500 companies two had missing data and one joined in 2021 meaning it fell out of the scope of the analysis. Of the remainder, 58 joined between 2015–2019, and 8 joined in 2020 setting their baseline in 2019 allowing for ambition evaluations. Since this initiative has standardized target metrics, requiring that companies reach 100% use of renewable electricity by 2050 at minimum, no sub-groups were necessary.

Ambition was evaluated by comparing the targets of 66 members against IPCC scenarios of the share of renewables in the electricity of OECD nations. Two scenarios were used: a baseline "middle-of-the-road" trend, and one consistent with a 1.5°C pathway. Most members were shown to be quite ambitious, exceeding the 1.5°C scenario and collectively reaching over 90% renewable use by 2030. The 66 companies covered an estimated 181 TWh, over half of all the electricity consumption of the whole initiative according to their recent reports. A small caveat is that the initiative appears to be inconsistent in enforcing its own rules of minimum interim goals (60% by 2030, 90% by 2040). Several members, including recent ones, were below such trends, but they were not enough significantly alter collective ambition.

Robustness was rated for 58 members who joined at or before 2019 by creating a visibility metric, defined as the ratio between renewable energy purchases with clearly disclosed purchase methods over total claimed renewable purchases. It was found that visibility decreased from 95% in 2015 to below 77% in 2019, primarily due to changes in CDP questionnaires that allowed companies to claim to purchase renewables without disclosing further information. Although RE100 might still have access to such information, it implies that the disclosure processes of RE100, CDP and companies are not converging, which decreases transparency.

Implementation was reviewed by subdividing the renewable energy used by the 58 members into different market instruments, ordered by their degree of additionality. Again, higher additionality means a better likelihood of net-increases in total renewables installed. These were, from low to high additionality: Unbundled Energy Attribute Certificates, Utility Green Products, Power Purchase Agreements and self-consumed renewable electricity. It was found that initiative has managed to positively influence its members into sourcing more renewable energy through Power Purchase Agreements, which now make up a third of all renewable energy use. However, low additionality instruments are still the norm. The decreasing visibility affects this evaluation, but if companies have not changed their purchase preferences it is likely that Unbundled Energy Attribute Certificates are still the most popular sourcing method. Self-generation is low overall, less than 3.3%, with most of it stemming from light industries in the Information Technology sector.

Substantive progress compared the trends in renewable electricity use against the targets set by these 58 members. A clear offset error was identified between targets and actual renewable electricity use, caused mostly by a single company, and highlighting the importance of converging reporting methodologies to identify such problems. Despite this offset, companies showed good progress by increasing renewable electricity use from 24 to 74 TWh between 2015–2019, reaching a 44% share of renewables. Most of this progress occurred after members joined the initiative and, offset errors notwithstanding, most sectors appear to be at or just below their collective goals.

This progress was further contextualized by looking into the emission reductions achieved. Most members are either light industries or service companies, and mitigation focused entirely on indirect reduction, a behavior similar to that of SBTi companies in those sectors. Progress in indirect reductions was good with an average yearly rate of -9.4%, while direct emissions remained basically unchanged. However, actual impact is significantly lower than in the SBTi due to the absence of energy intensive members. Total GHG emissions changed from 95.7 to 73.9 $MtCO_2e$ between 2015–2019, at a yearly rate of -6.26%.

Policy Recommendations

A good degree of collective success against targets is apparent, meaning these companies are translating their membership into carbon footprint reductions in terms of direct emissions and indirect emissions caused by energy purchases. Given that they match at least the expected global trend for 2°C, their achievements could serve as examples to other international businesses in how it is possible to shift towards sustainability. SBTi members have collectively achieved large emissions reductions, pitting this initiative as the one with the largest impact. However, most of this progress is centered in a reduced number of utility companies and EIIs, meaning its success may hinge on just a handful of companies. Similarly, its targets may not reflect the actual measure of ambition required given how most members are located in developed nations and currently they collectively only target global trends. Since collectively their results appear to exceed their ambition, emboldened targets could aid in sending a stronger message. RE100's ambition is quite high, and the initiative has been successful in promoting a larger use of high-additionality instruments when compared to the SBTi. However, it lacks members in emission intensive sectors and its targets mostly cover only indirect emissions, reducing its impact considerably.

In both initiatives, progress in indirect reductions appears disconnected from the problem at large, as shown by the purchasing preferences of energy use companies when it comes to renewable energy. If such trends continue, the additional impact on global GHG emissions may not match what ex-ante studies have predicted. Additionality in these two initiatives can be improved by:

- Encouraging direct mitigation within the boundaries of their members, with a particular focus on light industries and service companies.
- Disclosing progress in scopes 1 and 2 separately per-member in order to identify areas of improvement more easily.
- Promoting the use of high-additionality instruments such as Power Purchase Agreements and self-generation, and using that data to contextualize scope 2 reductions whenever possible.
- Requiring targets in line with UNFCCC principles of common but differentiated responsibility (i.e. companies in developed nations must do more than just match the required global trend).

- Focusing on achieving membership growth in sectors with high emission intensity and in developing nations.

The larger issues, however, are the lack of convergence seen in reporting mechanisms and the many errors found in them, and which are worsened by the lack of transparency in metrics that allow the progress and contributions of members to be individually contextualized. Environmental information is not truly open and widely accessible, which only hampers the ability of these actors and initiatives to be make a strong point. Given how collective trends are good, there is a strong incentive to improve the ways in which data is disclosed, as it can only embolden the message sent by these companies to policymakers and other businesses.

- All target data, and all progress metrics, should be open and easily accessible to the public.
- Steps must be taken to ensure that companies report data with longitudinal consistency.
- Emissions and energy data disclosed must relate to the same operational boundaries.
- Databases should strive to improve convergence with one another. This means using similar names for members and striving to use the same boundaries for target tracking.
- Data, and energy data in particular, should be mathematically consistent whenever possible.
- Validation tests must be employed to identify preventable mistakes before submissions.
- Members should be encouraged to ensure that their emission reporting schemes are of high quality.

It is likely that the companies featured in this study are performing better than the norm when it comes to setting appropriate targets and disclosing sustainability data. Understanding the differences between these firms and those that have not joined any initiatives would require an even stronger system of emissions disclosure, a point that nations should consider as we advance through this decade.

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1. Introduction

In 2015, global leaders convened in Paris in the 25th Conference of the Parties (COP). They had one objective: to come to an agreement on how to tackle global warming, a phenomenon caused by Greenhouse Gas (GHG) emissions created by human activities which poses a severe risk to human development and natural ecosystems due to increased extreme weather events, sea level rise, ocean acidification and loss of biodiversity (IPCC, 2018b). In that conference, they agreed to work together towards keeping global warming below 2°C, and strive to limit it to 1.5°C (UNFCCC, 2015).

More than five years have passed, and global GHG emissions have not slowed down: approximately 59.1 $GtCO_2e$ were emitted in 2019 alone, with a continuing average growth of 1.4% per year since 2010 (UNEP, 2020). Current national policies are not enough to bring the world in a path compatible with 2°C, much less to 1.5°C or below. With each passing year this gap grows wider.

Non-state and Subnational Actors (NSAs) such as cities, regions and businesses, along with the International Cooperative Initiatives (ICIs) created to coordinate them, have been posed as a solution to the complex set of challenges that the world faces on its effort to mitigate emissions (Hsu et al., 2020a). With their aid, bridging the gap between national policies and Paris goals might be possible, as they could embolden nations to commit to more ambitious targets. Several studies estimating the impact of these initiatives have been published, some evaluating the likelihood of their success qualitatively (Chan et al., 2018; Michaelowa et al., 2017), while others quantitatively estimating the impact of the current targets set by NSAs and the potential mitigation that would be achieved if ICIs achieve a certain level of growth (Kuramochi et al., 2020; Lui et al., 2020).

The aim of this chapter is to introduce the reader to the topic of at the core of this study, the approach taken, and the research gap that it aims to fulfill. It is structured as follows: Section 1.1 elaborates on the many unknowns in relation to this kind of initiatives. Section 1.2 describes the research strategy followed to select relevant initiatives and produce results. Section 1.3 speaks about the social relevance of this thesis. Section 1.4 states the main research question, as well as its accompanying sub-questions. Finally, section 1.5 describes the structure of the rest of the thesis.

1.1. Knowledge gap

Non-state action has been subjected to scrutiny due to risks of greenwashing, effort fragmentation and lack of transparency (Kachi et al., 2020; Widerberg et al., 2015). Similarly, there is a lack of ex-post quantitative literature evaluating how such initiatives have progressed, mostly due to informational barriers (Hale et al., 2020). Recent studies related to city initiatives have given positive signs of progress, but are still affected by lack of proper reporting by the participants themselves (Hsu et al., 2020c).

Quantitative ex-post evaluations of initiatives focused on climate mitigation by businesses are also affected by this lack of transparency. Studies assessing if companies in particular initiatives have been successfully meeting their targets have shown that most of them appear to be on-track (Giesekam et al., 2021), but they are unable to translate this progress into the impact this will have on global GHG emissions, or the carbon footprints of the companies themselves. Corporate ICIs do release reports stating their ambition, potential benefits and even achievements, but usually there is not enough information to contextualize them: most initiatives are unclear on the targets that their members are pursuing, and for those that do disclose such targets it is often impossible to compare the contributions of each member, as results are usually given in dimensionless metrics. Similarly, no studies evaluate how objectives are being realized, with many questions remaining about the methods, effectiveness and validity of the claims made by companies in regard to additional greenhouse gas emission mitigation.

In short, there is a knowledge gap of how businesses participating in corporate-focused ICIs perform. In particular, quantitative ex-post studies evaluating the abated GHG emissions are scarce. Questions remain about the methods employed by companies in these initiatives to reduce their carbon footprint, and whether they are effective strategies that could translate into additional mitigation at a global scale.

1.2. Research strategy

The primary goal of this study will be to assess companies participating in prominent ICIs that have been described by previous studies as having the capacity to bring emissions reductions that are additional to the current policies established by nations. Quantitative methods will be employed in order to determine if the ambition of their targets is adequate, whether their methods are robust enough to give credibility to their claims, to understand the ways in which they implement improvements to reach their intended goals, and finally to assess the impact of their results.

To do so, the information barriers that have prevented this type of evaluation had to be overcome. The following steps were the main strategy followed by the author in order to produce this study.

- Narrow down the scope to a specific group of ICIs and companies, by using qualitative methods developed by other authors and thoroughly evaluating initiative and company reports in order to understand how information is disclosed.
- Comprehend the theory and processes used by companies to track GHG emissions and energy use, and develop a method to group different companies in a homogeneous way.
- Understand ICI-specific methodologies and requirements in order to properly track progress
- Develop a data gathering and validation strategy that is as through, complete and accurate as possible; creating carefully curated databases as a result.
- Evaluate progress in a way that not only assesses targets and progress, but that also constructively reviews the robustness of said progress, and the ways in which it is implemented.

The group of companies selected for the study was the Fortune Global 500 (G500), a global ranking of large businesses by revenue (Fortune, 2021). Two initiatives that have featured prominently in ICI estimation studies were also selected: the Science Based Targets initiative (SBTi) and RE100 (We Mean Business, 2016; NewClimate Institute et al., 2019). The former aims to aid companies in setting adequate GHG emission reduction targets, while the latter promotes the use of renewable electricity in businesses.

Results will be presented in a descriptive manner using the logical framework developed by Hale et al. (2020). With it, the targets set by companies will be compared against benchmarks in order to contextualize their ambition, metrics will be developed to assess the robustness of their claims, the ways in which they have implemented change, and how they have substantively progressed towards their collective goals. To do so, disclosure platforms such as CDP (previously the Carbon Disclosure Project), initiative websites and public company reports will be used in order to generate a thorough database with the emissions, targets, energy use and energy purchase methods of these companies, among others.

The study will evaluate results from 2015 to 2019, from the year when the Paris agreement was drafted to the end of the decade. To the knowledge of the author, it is the first longitudinal ex-post evaluation of non-state action by companies and International Cooperative Initiatives of this nature.

1.3. Social Relevance

Non-state action towards climate mitigation is a contested subject. Undoubtedly, it has the capacity to set goals that go beyond the ambition of nations in order to reduce the gap between current national policies and a 1.5°C compatible world (NewClimate Institute et al., 2019). But it can also reduce cohesion between the approaches taken by nations, with climate action by businesses in particular facing criticism due to risks of greenwashing, which is pretending business-as-usual activities are actual efforts towards a more sustainable world (Hsu et al., 2015). At the core of the non-state action dialogue is the issue of additionality (Widerberg et al., 2015): can these businesses legitimately claim to have benefited the world in ways that go beyond repackaging current trends or governmental policies?

Transparency issues are at play too: more than half a decade has passed since the Paris accord was drafted, yet studies related to NSAs still mention how many informational issues are preventing their evaluation (Hale et al., 2020; Hsu et al., 2019). In the case of businesses environmental reporting has increased, with some European nations even requiring it although still in ways that enable a lot of flexibility in how it is done (Bednárová et al., 2019). Large databases focused on gathering sustainability metrics for businesses exist, and have been steadily improving their methods (Matisoff et al., 2013). Why, then, are ex-post evaluations still rare?

This thesis contributes to the scientific world by shedding light into how companies that joined two of the most prominent business-focused ICIs operate, disclose information and progress towards their targets. This is done by first understanding the underlying reporting structure that companies use to disclose their information, finding the most suitable methods to collect and validate data, understanding the geographical distribution of the companies that joined and what that implies, and finally evaluating if the progress made suits the benefits that NSAs and ICIs are described to have in the literature. By doing this hopefully a better picture of the actions taken by these companies can be formed, which in turn could translate into guidance that aids policymakers and society in their decisions when it comes to private climate claims, and sustainability disclosure.

1.4. Research questions

The main research question in this study is:

To what extent have the SBTi and RE100 cooperative initiatives directly contributed to climate change action and the renewable transition via reductions in emissions and shifts to renewable electricity usage between the Paris agreement and today?

By focusing on the larger members of these initiatives, achieved by limiting the scope of the research to companies featured in the Fortune Global 500 ranking of 2020, the author hopes to capture an extensive picture of the impact that these initiatives might have. Evaluation is broken down in the following steps, which are the formulated sub-questions of this study.

SQ1: *What is the degree and distribution of participation of G500 companies in the SBTi and RE100 initiatives?*

This aims is to contextualize the type of company that tends to join these initiatives, and where they are located geographically since previous research on NSA activity has noted how it tends to occur in industrialized nations with good civil liberties and strong national policies on climate matters (Andonova et al., 2017). Companies will also be grouped by energy and economic sectors in order to evaluate if membership is heterogeneously distributed among them, or if there are any sectors with strong preferences to enroll in either of these two initiatives.

SQ2: *Are these companies setting appropriate targets and what impact can be expected of them?*

With it, the study hopes to bring more clarity to the ambition seen on each initiative. This will be achieved by selecting benchmarks that are appropriate for the specific goals of each ICI, and then comparing them to the added collective effect of members with targets. By quantitatively comparing target trends and benchmarks, this study hopes to bring clarity on the level of commitment that companies have towards a 1.5°C compatible world.

SQ3: *Through which methods are these companies improving their capacity to deliver on their targets?*

The goal of this question is to contextualize progress towards GHG emission reductions, done so by evaluating the robustness of the environmental data disclosed by companies, and the ways in which they have implemented changes in the energy that is produced or used by them. These assessments will be carried out in ways that are consistent with the different targets specified by each of the two initiatives evaluated in the study: reviewing data on the use of third-party emission verification, looking into the evolution of energy consumed/produced, or the market instruments employed to purchase renewable energy.

SQ4: *To what level has the collective work of these companies lead to substantive climate mitigation?*

The goal of this question is to assess the collective progress of companies towards their targets, and identifying the prime drivers behind it by combining these metrics with the implementation mechanisms preferred by different sectors. Special attention will be put on whether such changes happen within the boundaries of these companies (i.e. *internal* focus), or if they depend on actions performed by other entities (i.e. *external* focus). Studies on NSA effects have differentiated between *direct* and *indirect* impact (Chan et al., 2018), and the possibility on whether progress achieved by ICIs can be displaced by less ambitious actors is mentioned in some studies (Kuramochi et al., 2020; Hsu et al., 2020a). This research hopes to contribute to this conversation by shedding light on the ways companies progress towards their goals.

1.5. Reading guide

The general structure of this thesis is as follows.

Chapter 2 is a literature review featuring studies related to the current climate emergency, the role that NSAs and ICIs have played in global policy, and the current literature evaluating their possible future impact, and the progress they have shown so far. The aim is to introduce the reader to several concepts used throughout the study, and to justify the relevance of the topic in question.

Chapter 3 describes the specific group of companies and initiatives investigated in this study. It frames the scope of the research by characterizing the Fortune Global 500, describing how such ranking is constructed, and listing studies estimating emissions of large corporations. In the case of the SBTi and RE100 initiatives it will describe how they select members, their growth since their inception and how they perform in ex-ante literature.

Chapter 4 relates to the methodology followed to produce results. It consists of five main steps. First, understanding information issues in order to select the initiatives and companies featured. Second, describing corporate accounting tools for energy and emissions. Third, comprehending the methodologies employed by each initiative. Fourth, designing software tools to automate the data gathering process and correct for errors. Finally, describing the framework that will be employed to evaluate each initiative.

Chapter 5 describes participation of Global 500 companies in the SBTi and RE100 initiatives. The analysis is subdivided into the geographical distribution of members, and sectorial participation. Special focus will be put in evaluating the degree of overlap between both initiatives.

Chapter 6 and chapter 7 are the evaluation of the SBTi and RE100 respectively; each subdividing results into four types of progress: ambition, robustness, implementation and substantive impact. Analysis of the SBTi focuses mostly on metrics related to GHG emissions, while RE100's is centered around the use of renewable electricity.

Chapter 8 discusses how both initiatives contrast one another, the transparency issues seen while collecting information, and the implications of the high concentration of ICI participants in a few geographical regions.

Finally, chapter 9 will conclude by answering the main research question and each sub-question. The results will be used to give policy recommendations, as well as to discuss the implications of the study. Several limitations of the approach taken by the author are also addressed as a reflection on the research.

2. Literature review on the hopes behind International Cooperative Initiatives

This chapter aims to introduce the reader to the history, actions and actors that paved the way for this study by answering the following question:

Why are International Cooperative Initiatives a topic of interest in relation to global climate ambition?

By giving this information it is hoped to convey the importance of the topic and to allow the reader to understand all the groundwork literature referenced or displayed in this document in equal footing to the author.

The chapter is structured as follows: section 2.1 describes the global climate situation, and the pace at which it must be tackled. Section 2.2 explains why non-state and subnational actors are considered to be an important part of the transition to a more sustainable world. Section 2.3 describes the impact that these actors are expected to have by compiling the best available literature. Section 2.4 then compliments this information with the actual impact that has been measured, while explaining the hurdles that quantification studies face. Finally, section 2.5 concludes and summarizes the chapter.

2.1. The climate emergency

In 2015, the United Nations Framework Convention on Climate Change (UNFCCC) convened for its 21st Conference of the Parties in what would be remembered as the Paris Accord. They agreed to halt the increase in the global average temperature to well below 2°C above pre-industrial levels, pursuing a more ambitious 1.5°C limit, while also fostering adaptation and resilience to the adverse effects that climate change would cause (UNFCCC, 2015). Members would aim to peak and rapidly decrease their respective GHG emissions via Nationally Determined Contributions (NDCs), which would be transparently prepared, maintained and updated through a ratcheting mechanism. According to the first United Nations Environmental Programme (UNEP) emission gap report comparing against a 1.5°C pathway, the gap between national policies and 1.5°C was of 20 $GtCO_2e$ in 2015 (UNEP, 2016b).

During Paris, a request to the Intergovernmental Panel on Climate Chane (IPCC) was made, petitioning a special report on the effects of a 1.5°C scenario. In this report the IPCC stated that net-zero CO2 emissions should be reached before 2050 in order to limit global warming to 1.5°C with limited overshoot (IPCC, 2018b). Doing so would significantly decrease the expected impacts on human populations and natural habitats, and decrease the damage to water availability and extreme weather events, among others. Deep emission reductions are required in all sectors at a scale never seen before. Among other things, all scenarios point towards vast electrification, with 70 to 85% of this electricity being generated through renewable technologies by 2050 (IPCC, 2018b). Most of this transition is expected to happen before 2030, as there is high likelihood that global warming will reach 1.5°C between 2030

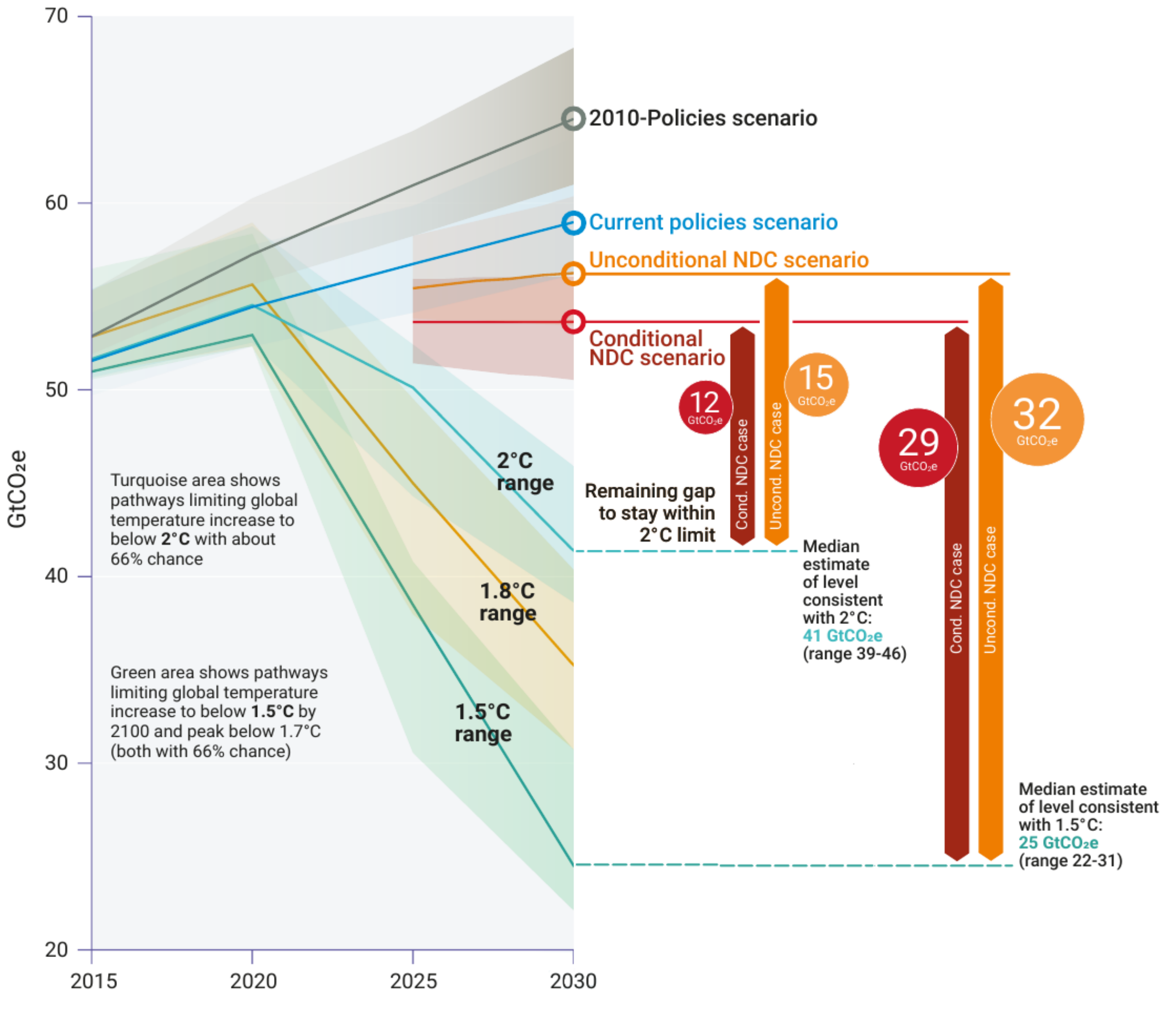


Figure 2.1: Global GHG emissions for different scenarios as shown in the Gap Report of 2020. None of the policy scenarios achieve an emissions pathway at or below 2°C (Source: UNEP (2020)).

and 2052 at the current pace (IPCC, 2018b).

Sadly, the world has been unable to stop the growth of emissions so far. According to the latest UNEP Gap report, released five years after Paris, the situation has become even more dire: Current National Policies (CNP) would leave a gap of 34 $GtCO_2e$ by 2030 (an increase of 70% since Paris), with countries collectively underachieving both their unconditional and conditional NDC commitments as shown in figure 2.1.

Although many nations have set NDCs, with as many as 126 having set or considering net-zero goals (UNEP, 2020), the last decade of political action has been largely unsuccessful at bringing much needed change: the needed pace of the transition to 1.5°C has now become a yearly reduction of 7% of global GHG emissions, an increase of nearly 4 times the pace of a 2°C path in 2010 (2% per year) (Höhne et al., 2020a). Such an increment means that the transition must happen wherever possible, as developed nations are no longer capable of reversing the trend by themselves under many effort sharing approaches that could be considered fair (van den Berg et al., 2020). In essence, it is now a question of who will pay for the transition, not where it should occur (Höhne et al., 2020b).

2.2. The role of non-state and subnational actors

Nations were not the only participants in the Paris accord. It also featured in increased involvement of Non-state and Subnational Actors (NSAs), which can be regions, cities, companies, civil associations, universities and investors (Hsu et al., 2019). Such actors can contribute on their own, but they often collaborate between them to form an International Cooperative Initiative (ICI), which is defined as any international activity outside the UNFCCC that is driven by a coalition of NSAs (Lui et al., 2020). This type of activity is sometimes referred to as Transnational Climate Action (TCG) (Andonova et al., 2017).

To further enhance such participation the UNFCCC became an orchestrator by providing a centralized platform to account such actions in the Non-state Actor Zone for Climate Action (NAZCA) (Held et al., 2018), now known as Global Climate Action, and the Marrakech Partnership for Global Climate Action which hopes to guide and increase NSA ambitions with its Climate Action Pathways for sectors, and by keeping account of actions occurring worldwide (Marrakech Partnership for Global Climate Action, 2020a; Marrakech Partnership for Global Climate Action, 2020b). In their latest report, the Marrakech Partnership has identified a total of 27,174 actions by 18,279 actors, with cities and businesses being the main contributors (Marrakech Partnership for Global Climate Action, 2020c).

Both NSAs and ICIs can bring ambitious contributions that are additional to NDC commitments (Hsu et al., 2015), and thus many hopes and expectations have been placed upon it. It is believed that such additional action can be used to enhance national pledges by invigorating ambition if it is successfully fed back into the UNFCCC process (Blok et al., 2012). Some studies have argued similar things: that there is a symbiotic relationship between government ambition and NSAs, with initiatives proliferating under increased ambition and then reinforcing it with their success (Andonova et al., 2017; Graichen et al., 2017).

In essence, linking the global climate regime with the diversity and flexibility of NSAs may enable players to maximize the benefits of both approaches and facilitate the development of a dynamic global governance ecosystem (Chan et al., 2015; Held et al., 2018).

However, NSA involvement might have downsides: some have called for deep monitoring in fear of effort segmentation (Widerberg et al., 2015). Another potential danger is actively regressive tactics such as diversion of political support, greenwashing and even repackaging current policy trends as additional contributions (Hsu et al., 2015). Others have dismissed their potential outright, seeing them as incapable of driving ambitions beyond the scope of current national action due to low ambition in their targets and being overdependent in the willingness to mitigate at the international level (Michaelowa et al., 2017).

2.3. The estimated potential of NSA action

The reasons that make NSA activity so important have been established, but where are these actions taking place? Just how much potential are they perceived to have?

Several qualitative studies have looked into initiatives in order to determine things such as their core focus, potential for success, adherence to goals and geographical distribution. For example, Andonova et al., 2017 showed that ICI activity tends to flourish in countries that have strong climate policy, and that they play key roles in nations with significant civil liberties and generally unambitious goals. This was corroborated in Kuramochi et al., 2017 by analysing the commitments of cities, states and companies in the US after leaving Paris; concluding that NSA action alone would allow the country to meet half of its unconditional NDC goal of reducing GHG emissions 26% below 2005 levels.

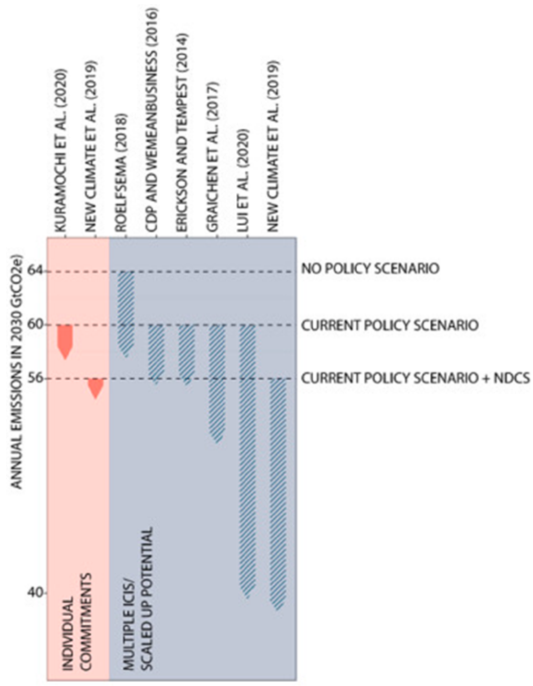
Another key distinction in NSA action is differentiating between direct and indirect impacts (Chan et al., 2018). Direct impacts are actions clearly targeting mitigation such as on-the-ground installation of renewable technologies, technological developments or efficiency improvements. Indirect impacts are those that only relate to climate action tangentially: lobbying and campaigning, knowledge production or dissemination, training or funding activities, policy planning, etc. Several studies have concluded that only a small minority of actions or initiatives had direct impacts, with the most successful actions being those taking place in developed nations or targeting energy topics (Chan et al., 2018; Andonova et al., 2017; Michaelowa et al., 2017).

An even bigger body of literature of quantitative ex-ante studies estimating the potential impact of NSA/ICI activity has surfaced. Table 2.1 summarizes some of the most prominent ex-ante studies. These can be subdivided in two categories of evaluation: ICI potential and individual NSA commitments.

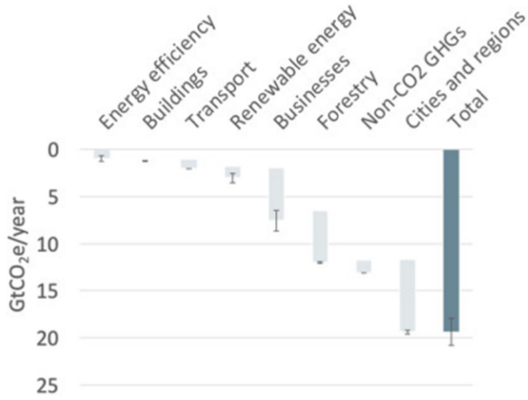
ICI potential studies describe idealized scenarios where initiatives achieve their maximum goals. This is highly influenced by the assumptions made in the study and the ICIs sampled. Among these studies four stand as highlights of maximum potential: Blok et al. (2012), We Mean Business (2016), Graichen et al. (2017) and Lui et al. (2020). All of them surpass an average estimated reduction of at least 8 $GtCO_2e$. Other ICI potential studies feature more cautious future projections, a smaller sample of initiatives, estimate more overlap among them, or just evaluate the potential of an ICI's membership against its main goal at a specific point in time. Ignoring nation-specific studies, these range between 2.3-5 $GtCO_2e$. Finally, individual NSA commitment studies feature the smallest mitigation, ranging between 0.36-2.0 $GtCO_2e$, since they only evaluate actors that already have targets.

Table 2.1: Compounded information of quantitative ex-ante studies in journals and grey literature. Target year represents when the mitigation should have been achieved.

Authors	Description	$GtCO_2e$	Target year	Baseline
Max. ICI potential				
Blok et al. (2012)	21 self-proposed initiatives	10.0	2020	BaU
We Mean Business (2016)	5 ICI (ambitious scenario)	10.0	2030	CNP
Graichen et al. (2017)	Potential of 19 ICIs	5.0-11.0	2030	NDCs
Lui et al. (2020)	Potential of 17 ICIs	18.0-21.0	2030	CNP
ICI potential				
Wouters (2013)	Evaluation of 6 of Blok's wedges	2.3-3.5	2020	Pledges
Höhne et al. (2015)	5 German initiatives	0.01-0.02	2020	NDCs
Hsu et al. (2015)	5 ICIs created at the NY summit	2.54	2020	BaU
UNEP (2016a)	15 ICIs	2.9	2020	BaU
Roelfsema et al. (2018)	10 global ICIs created before Paris	5.0	2030	No-policy
We Mean Business (2016)	4 ICIs	3.7	2030	CNP
NSA commitment				
Kuramochi et al. (2017)	NSAs in the US after leaving Paris	0.36-0.56	2025	CNP
Kuramochi et al. (2020)	Global NSA commitments	1.2-2.0	2030	CNP



(a) Aggregated NSA and ICI ex-ante estimates (Source: Hsu et al. (2020a)).



(b) Estimated mitigation potential of 17 ICIs in different sectors (Source: Lui et al. (2020)).

Figure 2.2: Mitigation potential of NSA action in the literature, as presented in Hsu et al. (2020a).

The gap between current NSA commitments and global maximum ICI potential is significant. In the most comprehensive study done to date estimated this difference to be of around twelve times as large (1.2-2.0 to 18.0-21.0 $GtCO_2e$), with 6000+ businesses and 10200+ cities and regions in the data sample (NewClimate Institute et al., 2019; Kuramochi et al., 2020; Lui et al., 2020).

There are other compilations of ex-ante potential in the literature, displayed in fig. 2.2. In Hsu et al. (2020a) several global level studies were compared by adjusting them according to their baseline scenarios, with the result shown in fig. 2.2a (a similar study focusing only on European actions was performed by Smit et al. (2020)). Different baseline choices can obscure comparisons, as no-policy scenarios expect larger increases in GHG emissions than those using Current National Policies, which in turn expects higher emissions than studies using Nationally Determined Contributions as reference. In general, NSA commitments are smaller than what ICIs aim for.

Figure 2.2b displays the most comprehensive study on the sectorial potential of ICIs to date by Lui et al. (2020), showing that the main contributors to be cities and regions, businesses and forestry. Although it paints a generally positive picture, initiatives related to eliminating deforestation, such as Zero Deforestation and the New York Declaration on Forests, have been generally unsuccessful at slowing it down (Global Forest Watch, 2021). This type of initiatives feature prominently in many studies (Hsu et al., 2020a; NewClimate Institute et al., 2019; Roelfsema et al., 2018; Graichen et al., 2017).

2.4. Actual delivery of NSA action

Despite the diversity of ex-ante analyses, ex-post literature quantifying NSA delivery remains rare (Hsu et al., 2020a; Hale et al., 2020; Kuramochi et al., 2020). This is mainly due to gaps in reporting: data collection platforms exist, like CDP and the carbon*n* project, but reported information is often incomplete, or the method of submission makes aggregation difficult (Hsu et al., 2019).

Table 2.2: List of available ex-post studies of GHG emission reduction from NSA action, including years analysed and the database used to source information.

Authors	Years	Sample	Database	Study conclusion
Doda et al. (2016)	2009–2010	433 companies	CDP	No mitigation
Khan et al. (2016)	1990–2012	25 cities	carbon*n*	No mitigation
Haque et al. (2018)	2002–2014	256 UK firms	ASSET4	No mitigation
RE100 (2020a)	2015–2019	261 companies	RE100/CDP	42% renewable electricity
SBTi (2021e)	2015–2019	338 companies	CDP	25% GHG reduction since 2015
Hsu et al. (2020c)	2008–2020	1066 cities	EUCoM	15% GHG reduction from baseline

According to Hale et al., 2020 three key issues can explain this lack of data. First, most existing tracking platforms have been designed with country emissions in mind (e.g. Climate Watch, Climate Action Tracker), meaning that granularity stops at a national level. Second is that many NSAs are under harsh capacity limitations, something that prevents even national governments from doing proper reporting to this day.

Finally, plenty NSAs do not have direct control over some of their climate outcomes: cities may find it difficult to influence polluting businesses in their boundaries, and businesses can struggle to enforce targets in their supply chains. Some models have been developed to try to estimate such emissions properly (M. Li et al., 2019), but they tend to suffer from double counting.

Table 2.2 summarizes six available ex-post studies on effective NSA/ICI mitigation efforts in journals and grey literature. Three of them analyse data before Paris, with similar conclusions stating that little to no mitigation occurred. More recent studies have shown better results that outpace global trends.

From this overview it can be concluded that efforts have become increasingly effective since the Paris agreement came into fruition, possibly due to a more inclusive governance process towards NSA activities (Held et al., 2018), and the focus on direct mitigation that these initiatives have. However, these recent positive results should be taken with care. In the case of Hsu et al. (2020c) only 10% of EU Covenant of Mayors (EUCoM) signers provided enough data to the platform to be included in the study, and although the 15% reduction in this sample is good it falls short from the 23.5% average target, and the 20% reduction of national goals. In the case of SBTi (2021e) the measured 338 companies do not represent the total of 478 companies with approved targets, and it is just one third of all members (1040 by 2020). Also, the fact that this SBTi report and the one for RE100 were produced by the initiatives themselves might raise questions of legitimacy. Per-member data is lacking and there is little information on implementation methods in the case of SBTi, and emissions abated for RE100's.

2.5. Summarizing the current context

The purpose of this chapter was to answer the question:

Why are International Cooperative Initiatives a topic of interest for global climate ambition?

This was asked with the purpose of contextualizing the reader on the current global situation regarding climate change, Non-state and Subnational Actor (NSA) action, the capabilities of such actors and what their results have been so far. To do so, the best available literature on global GHG emission trends, NSA potential and delivery was summarized.

It was seen that global emission trends have not slowed down since the Paris accord making the last decade a failure in regard to effective climate mitigation. Global GHG emissions must be reduced at a pace of 7% each year, reaching net-zero CO2 emissions by 2050; vast electrification measures must take place, with at least 70% of it being generated via renewable sources by 2050. However, current national goals do not match the needed emissions trend, not even fulfilling the commitments made during the Paris accord, and leaving society at large with an emission gap of 34 $GtCO_2e$ by 2030 from a 1.5°C compatible pathway.

NSA and ICI action has been highlighted as a possible answer to the disappointing measures at the national level, with many believing in their potential to achieve additional mitigation, reinforce national commitment or partially substitute it in cases where it is weak. To further strengthen their activity, the UNFCCC began acting as an orchestrator, providing guidance and accounting the measures taking place.

Not everything points towards this activity being perfect, however. Some have called its potential into question, fearing effort segmentation, greenwashing or diversion of political support. Similarly, literature has shown that many of these initiatives lack direct mitigation goals.

Despite these concerns, a healthy amount of literature has surfaced to show their potential direct and indirect impacts. Current global NSA commitments are estimated to a reduction of 2.3 to 5 $GtCO_2e$ by 2030, with ICI potential reaching up to 21 $GtCO_2e$ by the same year. The three main contributors are believed to be cities and regions, forestry initiatives and businesses.

Literature showing NSA and ICI deliver on their potential is scarcer. This is due to many reasons, chief among them being a lack of adequate tracking platforms, capacity limitations that prohibit these actors from measuring their progress correctly and in some cases lack of direct control over climate outcomes. There are reasons to believe that delivery is improving; the most recent studies and reports have shown results from ICIs that outpace global trends, but they tend to feature a limited sample of the actors participating in an initiative.

In short, NSA and ICI action have the potential to accelerate the transition and push nations to do better. However, tracking their progress has proved incredibly difficult for climate science. Thus, the aim of this study should be to bring such action into the light, evaluate it against its own goals, and against the global targets it should be aiming at achieving.

3. Characterizing the Global 500, and the SBTi and RE100 initiatives

This chapter will focus on the climate impact originating from the G500, as well as the current degree of participation and the fitness for emissions mitigation that the SBTi and RE100 initiatives are perceived to have, in order to answer the following question:

What are the current characteristics of the Global 500, the SBTi and the RE100 initiatives?

By doing so, the chapter aims to explain and justify the reasons behind this particular choice of companies and initiatives.

Section 3.1 explains what the Fortune Global 500 list is and how the ranking works, detailing the advantages of using these companies as the boundary for this study. An overview of literature featuring emission estimates of similar company groupings is also given. Section 3.2 and section 3.3 are overviews of the SBTi and RE100 initiatives, respectively [1]. For each the following information is given: first, an explanation of the initiative's goal and how and when it was founded. Second, an overview of the selection process and rules that member companies must follow. Third, the current status of the initiative's membership and its evolution over the years. Fourth, an assessment of the implementation likelihood of each initiative and a summary of quantitative ex-ante potential for mitigation estimated in the literature. Finally, section 3.4 summarizes the chapter and provides conclusions.

[1]If the reader wishes to know which initiatives were investigated but ultimately discarded, this information is briefly summarized in appendix A.

3.1. The Fortune Global 500

The G500 is a ranking of the top companies in the world by revenue, which is defined as the positive cash flows resulting from a company's profit-seeking activities (Williams, 2012, p. 52). Ranking high should, in theory, be a good estimate of a firm's size. It is published annually by Fortune, a US media company focused on covering business activities founded in 1929 (Fortune, 2020), and the list has rankings going all the way back to 1995. The most recent 2020 ranking had its cut-off date at 31st March 2020 meaning that the data is, for the most part, within 2019.

An important caveat is that revenue should not be confused with market capitalization (also known as market cap), which is how a firm is valued by the stock market (Fern et al., 2021). A high ranking does not mean that a company is profitable (e.g., Mexican crude-oil producer Pemex ranked 133 with $72.8 Billion USD, but ended up in the red with -$18 Billion USD in profits). Nor does it reflect current preferences in investment. For example, investors price Tesla Motors higher than both Ford and General Motors combined, yet that company did not make it to the list while the others did due to their large sales numbers (Randewich, 2020).

The ranking undergoes a series of tests before being released. Subsidiaries and other operations are included in the calculation and data verification is provided by at least two other organizations aside from Fortune itself (Fortune, 2021). This is expected to reduce overlaps within their respective boundaries as risks of double counting are reduced if subsidiary companies are not present (see section 4.1 for more information). The list is compromised of both public and private companies. In 2020, the list compounded an estimated sum of $33.3 trillion US dollars in revenue, almost 38% of Global GDP (Fortune, 2020; World Development Indicators Database, 2021).

It is expected that the activities of this group of companies will encompass a significant amount of emissions (please see section 3.1.1 below). Besides emissions, two other important factors behind the selection of this group of companies are its high reported carbon disclosure and good ICI participation. According to a study by the NewClimate Institute, 450 out of the Fortune G500 disclosed information to CDP in 2018 (NewClimate Institute et al., 2019). In the most recent SBTi report it was stated that one fifth are members in the initiative (SBTi, 2021e). Although the ranking changes each year, it is reasonable to expect that this number will remain high.

3.1.1 Emission estimates of top companies in the literature

To the knowledge of the author, no study on the total GHG emissions of Fortune's ranking in particular exists. However, a report using Thomson Reuters' ranking (which also uses revenue) was produced by Moorhead et al. (2016), which estimated an increase in emissions between 2010 and 2015 of 1% in this group of companies. Other rankings are used in some studies, with listings ordering by market cap being a fairly popular choice. Table 3.1 summarizes the GHG emission estimations found in the literature, which account only for emissions directly emitted by a company (scope 1), and emissions indirectly caused by the energy they purchase and use (scope 2) by employing the GHG Protocol [2].

Table 3.1: List of reports estimating scope 1+2 GHG emissions of large national or multinational companies ranked under different criteria. In the case of de Jong, utility emissions were calculated separately and are given in parentheses. This study ranked companies by turnover, assumed to be the same as revenue.

Group	Sample	Year	Criteria	$GtCO_2e$	Reference
Top 2000	2000	2008	Revenue	6.3 (4.0)	de Jong (2011)
Top 500	404/500	2011	Market cap	3.8	CDP (2011)
Top 500	389/500	2013	Market cap	3.58	CDP (2013)
Top 500	500	2015	Revenue	5.0	Moorhead et al. (2016)

[2]See section 4.2.1 for an in-depth description of this protocol.

The emissions impact of large companies is estimated to be between 3.58 to 5 $GtCO_2e$ when using market cap as the determinant. CDP studies hint at a possible reduction in emissions, but it is important to keep in mind that each study had a different sample of companies in them making comparisons misleading (Stanny, 2018). This initiative has produced a more recent Global 500 report, but no emission calculations are disclosed in it (CDP, 2019c), shifting its focus to climate risks entirely; an odd choice for an initiative originally made with the goal of increasing carbon disclosure.

Studies that managed to complete their selected sample give higher estimates, between 5.0 and 10.3 $GtCO_2e$ (Moorhead et al., 2016; de Jong, 2011). The large estimation by de Jong should come as no surprise since it has four times the amount of companies. Unfortunately, the study does not disaggregate the into Top 500, but it does provide details for the Top 1000, 100 and 10; finding that the Top 1000 and Top 100 were collectively responsible for 5.4 and 1.5 $GtCO_2e$ respectively (excluding utilities). In fact, this is the only study that accounts for potential overlaps between companies, with all the other studies just summing scope 1 and scope 2 emissions indiscriminately.

3.2. The Science Based Targets initiative

The Science Based Targets initiative (SBTi) has the objective of improving company climate targets, and then collecting and evaluating their progress towards achieving sustainability. It was created in 2015 by a coalition of CDP, the United Nations Global Compact, the World Wide Fund for Nature (WWF) and World Resources Institute (WRI) (SBTi, 2021e). As stated in their website, their targets "provide a clearly-defined pathway for companies to reduce Greenhouse Gas emissions, helping prevent the worst impacts of climate change and future-proof business growth" (SBTi, 2021d). To do this, the initiative publishes and updates guiding documents and reports frequently.

This section gives a quick overview of the initiative's enrollment process, its current membership, their achievements and the estimated emission mitigation potential of the initiative in the literature.

3.2.1 The five steps for would-be SBTi members

The SBTi has updated its criteria numerous times along the years, with the most recent version (4.1) released in 2020 (SBTi, 2020). Generally, new members are subjected to a five-step approval process, visualized in fig. 3.1.

First, companies commit to set a target, and are given a grace period of two years to develop it according to SBTi criteria (SBTi, 2021f). Committed companies are included in SBTi databases and reports, but without further details. It is unclear how the initiative deals with companies that fail to comply with the 24-month grace period, but some reports have stated that several of them have been removed along the years due to opportunistic behavior and lack of true ambition (Cuff, 2021).

Step two is where a company develops a target, which is usually comprised of four elements: a unit of measurement (usually tCO_2e), a base year, a target year and a percent of reduction[3].

Companies that manage to develop targets can submit them for evaluation and, if successful, will proceed to the fourth step of the process. Only when this fourth stage is reached will SBTi mark the company as "Targets Set", signaling that their goals have been endorsed by the initiative and including the company's target on the SBTi website and databases (SBTi, 2021b).

The fifth and final stage involves disclosure, updating and Monitoring, Reporting and Verification (MRV). Companies must publicly disclose their emissions, be it through CDP questionnaires or annual

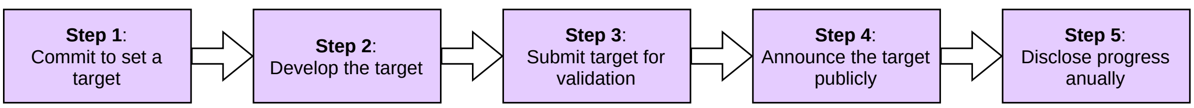


Figure 3.1: The five steps for membership as defined by the Science Based Targets initiative (adapted from SBTi (2021f)).

[3]See section 4.3 for a more detailed look into how companies set their targets.

reports. They also must recalculate and update their targets at least every five years, or if the boundary of the company changes significantly due to mergers, acquisitions or similar events (SBTi, 2020). The initiative recently began to track progress of its members in annual reports, the first being released in 2020, and is currently developing more guidance on annual reporting (SBTi, 2021e; SBTi, 2021c).

SBTi allows any type of company to become a member, including Small and Medium Sized Enterprises (SMEs) and subsidiary companies, although it encourages parent companies to be the ones who make targets in the case of the latter (SBTi, 2020). The only exception are oil and gas companies, who can commit to setting targets, but cannot be set as approved for the time being (SBTi, 2021c).

3.2.2 Current status of the SBTi

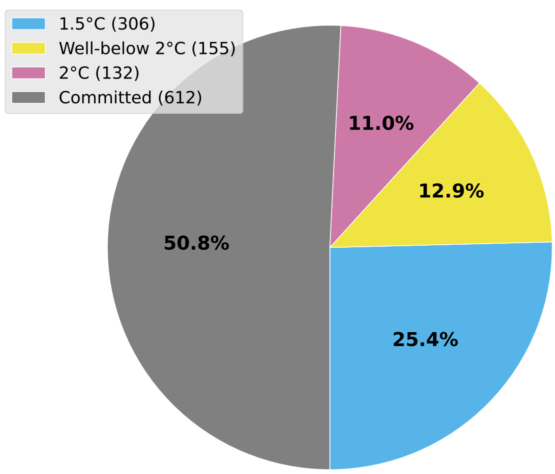
The initiative has gained plenty of momentum since its creation, with overall membership increasing at an accelerated pace. Figure 3.2 gives a look into trends in membership until now. Each year appears to break previous records in therms of new companies joining, with 370 new members in 2020 alone. The split between committed companies and those with approved targets has also improved along the years, inching closer to a 50/50 split at the time of this study.

Approved companies are disaggregated further into three categories: 2°C, well-below 2°C or 1.5°C compliant; reflecting different levels of alignment towards halting climate change (fig. 3.2b). At the moment the initiative only approves companies if they meet "well-below 2°C" criteria (SBTi, 2020). 2°C is a legacy classification of members who joined before this was made mandatory in 2019, and must update their ambition to reflect this new rule by 2025 at the latest (SBTi, 2021e).

Surprisingly, 1.5°C is the most popular alignment with over one quarter of total membership and more than the other two approved target classifications combined. The "Business Ambition for 1.5°C" campaign launched by the United Nations Global Compact and the SBTi in 2019 may explain this. The general goal of the campaign is to encourage companies to set 1.5°C targets (SBTi, 2021a), and was made in response to the 1.5°C report by the IPCC (2018b). At the time of this study a total of 407 companies, a third of all members, had signed.

Arguments regarding SMEs in the initiative could be raised to put these numbers into question. These businesses are defined as those with fewer than 500 employees by the initiative, and are not required to set scope 3 targets (SBTi, 2020). However, they account only for 10.1% of companies with approved targets (60 in total), a relatively low amount, and this study does not deal with them.

(a) SBTi membership across the years, ignoring drop-out companies (Source: adapted from SBTi (2021e))



(b) Distribution in SBTi membership classifications as of 23/02/2021 (Source: data from SBTi, 2021b; own figure).

Figure 3.2: Evolution and distribution of SBTi membership.

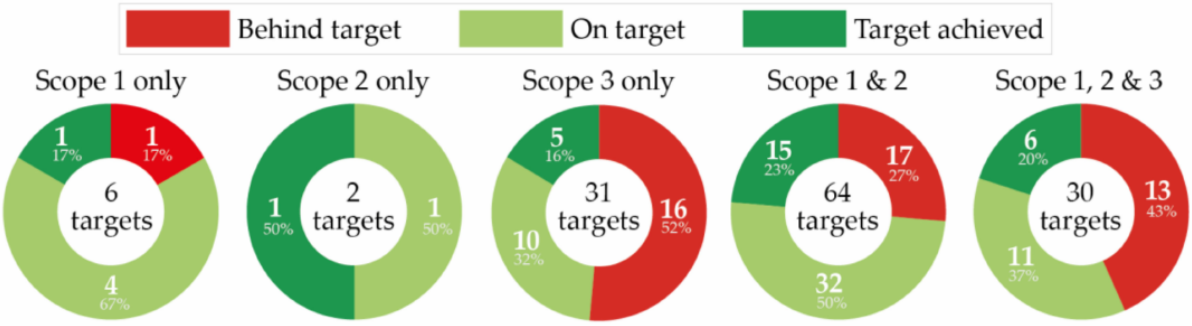


Figure 3.3: Evaluation of 133 targets from 81 companies that joined the SBTi before Feb. 2018. Target achieved means the percentage of emissions reduction stated in the company's target was met (Source: Giesekam et al. (2021))

Members have also begun showing good progress in abating emissions. According to the initiative's own reports, a sample of 338 companies with approved targets collectively reduced emissions by 25% between 2015–2019 (SBTi, 2021e). This reduciton is equivalent to an annual rate of 6.25%, close to the 7% currently required to stay within 1.5°C (Höhne et al., 2020a). Caution should be taken when interpreting these results though: the initiative did not account for overlaps between electricity-consuming and electricity-generating companies within its sample. Without this step there is a risk of double counting emission reductions (Kuramochi et al., 2020).

Another study by Giesekam et al. (2021) evaluating the progress towards targets of 81 companies in the initiative concluded that a majority of them had been already been achieved or where on track (see fig. 3.3), with scope 1 and 2 targets being the better performing ones. However, a somewhat worrying conclusion was 89% of achieved targets (i.e. exceeding the emission reduction stated in the target) had already achieved their targets when they were approved by the initiative. This does not necessarily mean poor ambition entirely: the initiative does not accept targets that were already achieved by the date of submission (SBTi, 2020). The slow approval rate displayed in fig. 3.2a or rapid decarbonization programs in joiners on the year of approval could be possible explanations.

3.2.3 Ex-ante analysis of the SBTi

A fair amount of attention has been given to the capacity for emissions mitigation of the SBTi, which has been calculated in several ex-ante analyses and other types of studies. Table 3.2 compounds all the information that could be found in scientific and grey literature and estimations made in this study.

First, qualitative estimations of the initiative's implementation likelihood are given (table 3.2, left side), using Michaelowa's Four Basic Design Criteria for effective mitigation (4BDC) and Chan's Function-Output-Fit (FOF)[4].

The initiative scores high in 4BDC. This is due to its target-oriented design, which establishes clear goals, baselines and performs Monitoring, Reporting and Verification. The only missing criteria are financial incentives stemming directly from the initiative towards its members.

The SBTi achieves a perfect FOF score. Chan's scoring system rewards a rich documentation process, good data-keeping and institutional capacity building (Chan et al., 2018). A good FOF score points at a good knowledge dissemination and policy planning process in the initiative, and that such processes match with the initiative's intended purpose. Overall, it can be concluded that the SBTi has an excellent implementation likelihood.

Second, ex-ante estimations of impact were accounted (see table 3.2, right side) with the most recent study by Lui et al. (2020) estimating a reduction of 2.7 $GtCO_2e$. The initiative itself also offers some data on the current covered scope 1+2 emissions of its members, and how they expect this amount to grow in future years as more join (SBTi, 2021e). These are 1.2 in 2020, and approximately 7.9 $GtCO_2e$

[4]Please see section 4.1.1 for more information on these qualitative methodologies.

Table 3.2: Qualitative and quantitative ex-ante estimates for SBTi in scientific and grey literature. FOF value taken from Lui et al. (2020).

Qualitative		Quantitative ex-ante estimates ($GtCO_2e$)				
4BDC	**FOF**	**Study**	**N. companies**	**Year**	**Current**	**Future**
3/4	100%	UNEP (2016a)	39	2015	0.040	-
		We Mean Business (2016)	2000	2030	-	1.9
		Lui et al. (2020)	2000	2030	-	2.7

by 2025 respectively. Note that these are the emissions of which member companies are responsible, and may not be within their targets.

3.3. The RE100 initiative

RE100 is an initiative launched during the 2014 UN Climate Summit in New York as a collaboration between businesses and NGOs like The Climate Group and CDP (RE100, 2014). Its stated goals are to create a level playing field for renewable electricity by removing regulatory barriers, creating renewable electricity markets, collaborating with utility companies, promoting direct investment in renewable technologies and supporting the use of Energy Attribute Certificates (EACs) (RE100, 2020b).

This section gives a brief overview of the initiative's joining criteria, its membership and its expected impact in literature studies.

3.3.1 RE100 joining criteria

According to RE100's own documentation, companies must fulfill at least one of the following criteria if they wish to become members (RE100, 2020c):

1. Be a recognized brand, either nationally or globally.
2. Be a major multi-national (i.e. Fortune top 1000 or similar).
3. Consume more than 100 GWh of electricity annually.
4. Have clear international or regional influence in ways that benefit the initiative's goals.

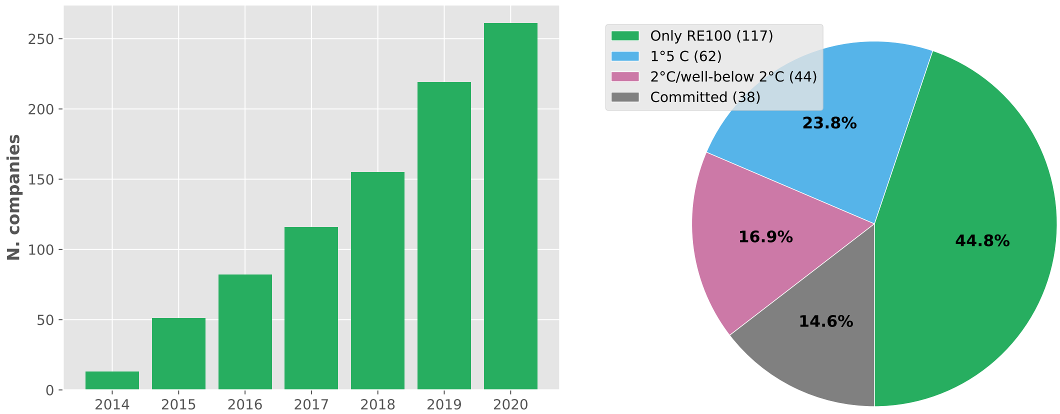
RE100 allows companies already sourcing 100% renewable electricity to join. Otherwise, they are given one year to develop a strategy if they do not have one when joining the initiative. Members are free to establish their own deadlines, as long as they fulfill some minimum target requirements, with 2050 being the farthest for 100% renewable consumption[5].

The initiative generally requires companies to join at the group level. Subsidiaries are not allowed to join independently unless they fulfill both of the following two characteristics: have large electricity consumption ($> 100\ GWh$), and "a clear separate branding from the parent company" (RE100, 2020c). This is important as it reduces the chances of double-counting in the initiative's own estimations, although it still leaves room for such mistakes in the case of companies that fulfill the criteria to be accepted as exceptions.

3.3.2 Current status of RE100

This section deals with the development and status of membership in RE100 up to the end of 2020. Most of the data comes from RE100's own annual reports (RE100, 2020a; RE100, 2018a) and similar documents. Figure 3.4 summarizes past and current membership trends, as well as overlaps between SBTi and RE100. The initiative has experienced steady growth since its inception, with an average of 42 new members per year (fig. 3.4a), reaching 261 total companies at the end of 2020 (this number increased to 289 at the time of this study). This growth is quite modest when compared to that of the

[5]Please see section 4.4.1 for more information on RE100 target-setting.



(a) Cumulative RE100 membership across the years, ignoring drop-out companies (Source: data from RE100 (2020a), own figure).

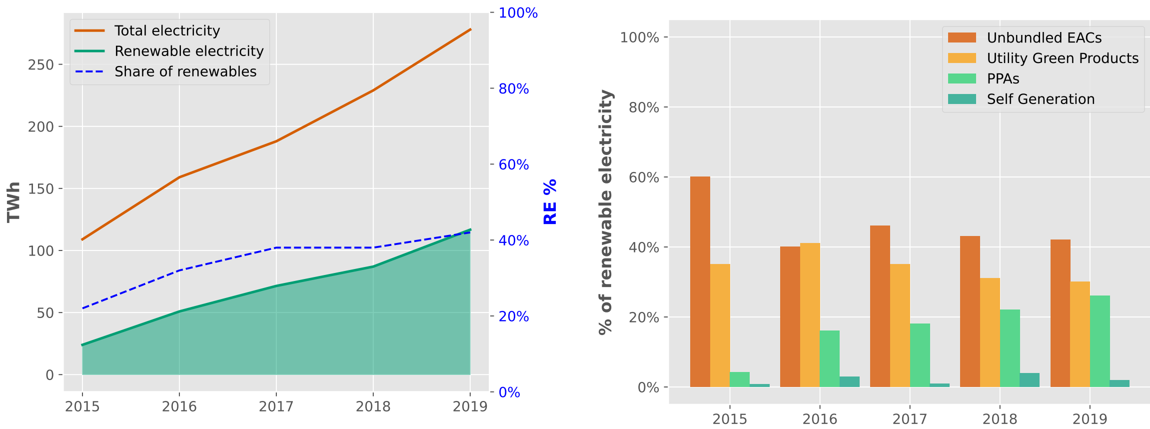
(b) Membership overlap between SBTi and RE100 in 2020 (Source: data from RE100, 2020a; own figure).

Figure 3.4: Information on RE100 membership

SBTi, specially considering that RE100 was created one year before. Nonetheless, current membership is still a significant change from the 13 initial members.

Evidence points towards both initiatives being complementary: 40% of RE100 members have set Science-Based Targets (fig. 3.4b), and 14% are committed to do so in the near future. Similar to fig. 3.2b, 1.5°C is the preferred qualification. This overlap is not surprising since both initiatives have CDP as a founding partner, and appear to collaborate between them when establishing guidelines: RE100 even aided in drafting renewable electricity guidelines for SBTi (SBTi, 2020).

Overall trends in the initiative are summarized in fig. 3.5. The total electricity consumption covered by the initiative has more than doubled since 2015. At the end of 2019 it reached around 278 TWh, almost as large as the electricity consumption of Mexico (IEA, 2021b). The share of renewable electricity among these companies has also increased, almost doubling in the same time span and reaching 41% at the end of 2019. This could mean several things: that the renewable electricity increase of old members has not been out-sped by the new members with lower ratios, that new members had larger renewable use and thus made the trend better, or a mixture of both.



(a) Evolution of total and renewable electricity consumption.

(b) Market instruments used to source renewables.

Figure 3.5: Progress in active RE100 members across the years (Source: data from RE100 (2020a)).

The initiative also encourages members to source renewable electricity through instruments with better additionality (see: section 4.2.3), such as Power Purchase Agreements or self-generation. Figure 3.5b showcases the evolution of renewable sourcing methods in RE100 members. Unbundled Energy Attribute Certificates (U-EACs) are still the preferred method of sourcing. However, a clear trend towards PPAs can be seen, which are steadily displacing unbundled EACs and utility green products.

3.3.3 Ex-ante analyses of RE100

RE100 generally scores well in both qualitative and quantitative ex-ante studies. Table 3.3 summarizes how this initiative has been evaluated in literature, as well as the qualitative 4BDC score estimated in this study.

Qualitatively, the initiative shows good potential for effective mitigation, fulfilling three out of four basic design criteria, the same score earned by SBTi. Targets, baselines and MRV are in place, and are compounded in reports released by the ICI evey year since 2018 (RE100, 2018a), two years earlier than SBTi. The only missing criteria consists of financial incentives. It must be clarified that Michaelowa et al. (2017) only consider incentives stemming from the initiative *itself* as valid. This does not mean that companies joining the initiative do not benefit from moving to renewable energy, just that the initiative does not pay them to do it. In fact, 68% of companies (from a sample of 129) have stated that cost savings are a prime driver of their move towards renewables (RE100, 2020a).

The Function-Output-Fit of the initiative is not as strong, scoring only 75% (Lui et al., 2020). This means that some of the initiative's outputs (be it published documents, events or projects) did not fully fit the intended function of the initiative as chosen by the authors. A possible explanation would be that the initiative appears to have both a "technical" aim, and a lobbying one. If only the first was chosen by the authors, then any lobbying activities would have lowered the score (or vice-versa).

Quantitative studies give the initiative strong future potential for abating emissions. RE100 tends to appear in similar studies as those that feature SBTi. For example: both studies by Lui et al. (2020) and We Mean Business (2016) featured both. The former estimated that RE100 would have a larger impact (average of 2.95 $GtCO_2e$ to SBTi's 2.7), while the latter gave SBTi the advantage.

There are little studies clearly stating current impacts on GHG emissions. The value estimated by Graichen et al. (2017) was most likely calculated for a minimal sample of companies [6], which would explain the stark difference in emissions. This number of companies was not specified, meaning that there is way this could be verified. None of the annual reports of the initiative estimated impacts on GHG emissions either.

Table 3.3: Qualitative and quantitative ex-ante values estimated for RE100 in the literature. FOF value taken from Lui et al. (2020).

Qualitative		**Quantitative ex-ante estimates ($GtCO_2e$)**				
4BDC	**FOF**	**Study**	**N. companies**	**Year**	**Current**	**Future**
3/4	75%	We Mean Business (2016)	3000	2030	-	1.2-1.5
		Graichen et al. (2017)	-	2020	0.017-0.034	-
			-	2030	0.024-0.050	-
		Lui et al. (2020)	2000	2030	-	1.9-4.0

[6]Unfortunately, the annex with specifics on the companies featured and the quantification methodologies used to evaluate RE100 could not be found for this study.

3.4. Summarizing the characteristics of the G500 and SBTi/RE100 initiatives

This chapter set out to answer the question:

What are the current characteristics of the Global 500, the SBTi and the RE100 initiatives?

The objective was to explain the reasoning behind this choice of companies and initiatives. Research papers and reports in grey literature were analysed in order to estimate the current and future impacts of each group.

The Fortune Global 500 list is graded by revenue. Preferring this economic rating over others should aid in including large sizes, and also reduce double counting issues since subsidiaries are accounted for in Fortune's methodology. Although there is no recent estimates of the emissions for these businesses, older reports estimated a total impact of 5.0 $GtCO_2e$ (scopes 1+2). Reports using other economic rankings (such as market capitalization) gave lower estimates of around 3.8 $GtCO_2e$, but they did not complete their respective samples.

This group of companies appears to have good ICI participation, with at least a quarter of them being members in the SBTi. Information disclosure also appears high: 450 companies in a previous ranking (2018) disclosed information to CDP.

The Science Based Targets initiative was created in 2015 and has since grown significantly in membership and covered emissions, with current estimates saying that 478 members with approved targets are collectively responsible for 1.2 $GtCO_2e$. At the time of this study the SBTi has 593 members with approved targets, and 612 companies committed to setting them in the near future. Their projections are quite ambitious: the initiative expects to cover a total of 7.92 $GtCO_2e$ by 2025.

The SBTi has been rated positively in scientific studies. Its clear target setting process, use of MRV; and constant output of guiding documentation gives it an excellent likelihood for implementation. Similarly, quantitative ex-ante studies give a positive outlook: the most recent independent study estimated a potential to mitigate 2.7 $GtCO_2e$ by 2030.

Member companies have already begun showing progress: according to the most recent annual report of the initaitive, a sample of 338 companies managed to reduce emissions by 25% between 2015–2019. A recent independent study also showed that the majority of targets related to scope 1 or scope 2 emissions are on track or already achieved. However, scope 3 targets tended to be less successful.

RE100 is a slightly older initiative, created in late 2014 at the UN Climate Summit in New York. It has the aim of promoting renewable electricity usage in businesses, and removing barriers towards sourcing these technologies. Membership has increased more than tenfold since its creation, reaching 289 companies at the time of this report.

This initiative also performs well in scientific studies with qualitative evaluations saying also has good implementation likelihood. Ex-ante estimates for mitigation estimates tend to be above 1.2 $GtCO_2e$, with the most recent one giving an average of 2.95 $GtCO_2e$ (higher than that of SBTi).

Unfortunately, no evaluations of the emissions covered by RE100 members exists. The initiative does disclose total covered electricity which reached above 278 TWh in 2019, with 41% of it coming from renewable sources. Such an amount would put RE100 above some G20 nations in terms of total electricity use. A significant push for sourcing with high additionality is happening among its members, with instruments such as Power Purchase Agreements seeing more use across the years.

Both initiatives appear to have a good fit for significant emission mitigation. In fact, there appears to be some complementarity between them: CDP is among the founding partners for both, and there is some evidence of cross-collaboration while developing guidance documentation. At least 55% of RE100 companies are also involved in the SBTi.

4. Methodology

This chapter describes the steps followed by the study in order to produce results for the two initiatives featured in it. Figure 4.1 gives a general overview of how this was achieved in five steps. First was ICI selection, which details the problems and guidelines that lead to the specific choice of companies and ICIs featured in this study. Second was understanding the protocols, instruments and methodologies needed to effectively evaluate corporate environmental performance. Third was investigating the methods used by each initiative to set targets for its members, and designing a way to evaluate said targets quantitatively. Fourth, target and environmental data had to be gathered for all companies. Finally, a methodology to evaluate and contextualize the progress of each ICI had to be selected and developed further to fit the goals of each initiative.

The chapter follows a similar structure. Section 4.1 explains why the two initiatives featured in this study were selected, as well as informational issues that ICI ex-post evaluations face and how this study aimed to solve them. Section 4.2 deals with methodologies and tools used to account corporate emissions and energy purchases, as well as the sector classifications used by this study to group companies with similar profiles. Then, section 4.3 and section 4.4 explain the theory and methodology used by each initiative to set targets, and how individual company targets were linearized in order to evaluate them. The data gathering and validation step was the most involved process in the study, and is explained thoroughly in section 4.5. Lastly, section 4.6 explains the logical framework used to evaluate results in an overall way, and then details how it was applied to each initiative individually.

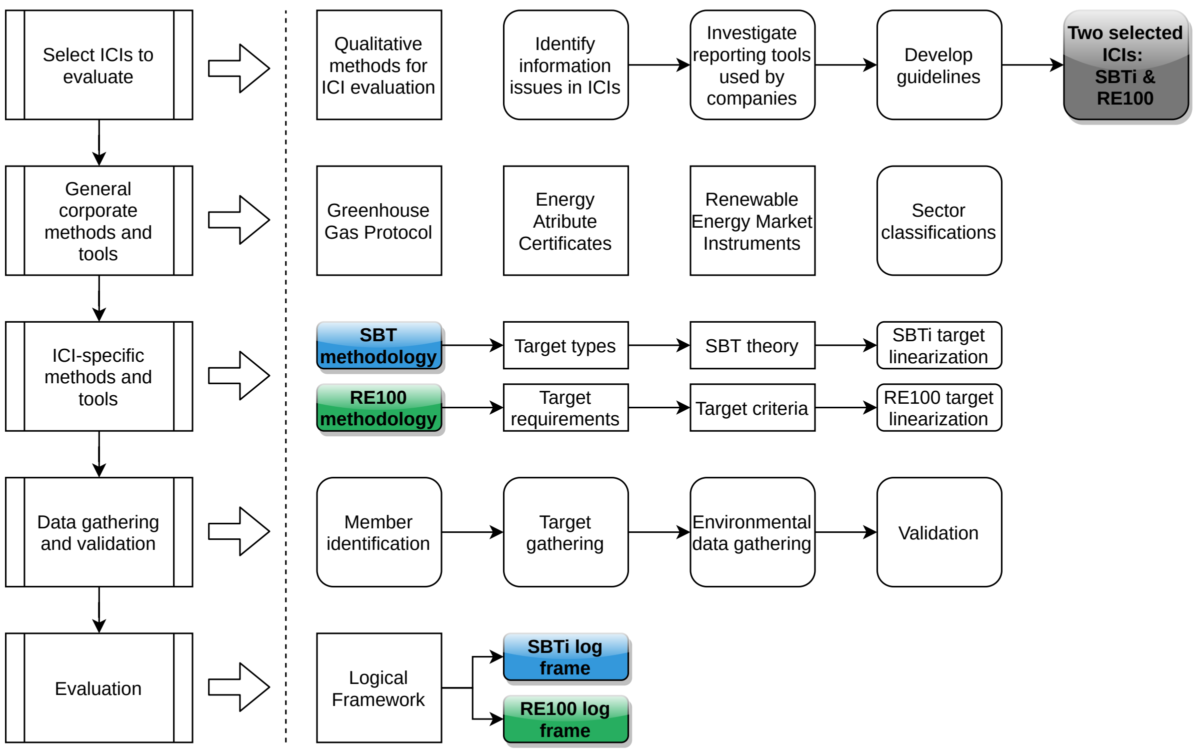


Figure 4.1: General steps followed to produce this study, subdivided into their relevant sub-sections. Rounded rectangles (right side) represent methods developed or adapted by the author, while non-rounded ones are methods or theories developed by other authors or organizations.

4.1. Selecting the ICIs to be evaluated

The aim of this study is to evaluate ICIs with actual impact on the environment, or at least the potential to do so. However, this necessitates that these initiatives comply with a certain level of quality in their design, and that there is enough data to enable any sort of evaluation. Many ICIs lack funding, permanent staff or goals achievable within the capacity of their organization (Chan et al., 2018). Hsu et al. (2019) identified that a big shortfall of many NSA studies is the lack of assessment of implementation likelihood. Data availability is considered the greatest hurdle to properly analysing NSA activity, an issue that is only exacerbated for related topics such as energy efficiency and renewable energy targets (Hsu et al., 2019; Hale et al., 2020). These data gaps had to be properly understood before selecting any initiatives or group of companies to analyse, which is the topic of this section.

4.1.1 Qualitative analysis of the initiatives

Qualitative ICI analysis has the main goal of assessing the potential and fitness of an initiative to reach its goals. Although this study focuses on quantitative ex-post analysis, qualitative evaluations can be helpful in ensuring that the selected initiatives are robust enough to warrant the effort. In order to be effective, ICIs must have a comprehensive approach that encourages ambition, and have the means to achieve results. These can be characteristics such as having enough manpower and permanent staffing, access to monetary resources, a carefully designed methodology, and being able to actively exert influence over outcomes. Without proper design, they run the risk of failure or even actively harming progress (Chan et al., 2015).

Two methodologies in the literature were identified that aim to provide assessments of implementation likelihood: Michaelowa's Four Basic Design Criteria for effective mitigation (4BDC) (Michaelowa et al., 2017) and Chan's Function-Output-Fit (FOF) framework (Chan et al., 2018).

Michaelowa's Four Basic Design Criteria for effective mitigation criteria are shown in table 4.1. The method is meant to be simple, as only the existence of the criteria is enough to fulfill it. Targets, Baselines, and Monitoring, Reporting and Verification (MRV) are self-explanatory, and ensure that an initiative's goals are trackable and progress is transparent. Incentives will be interpreted only as those coming from *within the initiative* towards the participating NSAs.

The Function-Output-Fit framework evaluates the stated function of an ICI (e.g., lobbying, technical "on the ground" action, standard-setting) against the activities it outputs in terms of published documents, creation or attendance to events, its communication platforms, funding, etc (Chan et al., 2018). Due to the involved process in gathering such information, it was not possible to do so for all the initiatives mentioned in this study. Thankfully, Lui et al. (2020) have already applied this framework to a plethora of initiatives (including the SBTi and RE100, which this study deals with). Values from their work will be borrowed for the ICIs evaluated in this study as a way to compare the 4BDC rating.

The scores given by these two methodologies are given for each of the two selected ICIs (SBTi and RE100) in chapter 3 as part of their characterization. They were not the only initiatives analysed, and the rest are given in appendix A for completeness.

Table 4.1: The four basic design criteria for effective mitigation (adapted from Michaelowa et al., 2017).

Criteria	Description
Targets	Mitigation targets must be clearly defined.
Incentives	Financial incentives must exist.
Baseline	Specification of baselines must be apparent.
MRV	Monitoring, reporting and verification methods must be defined.

4.1.2 Information and disclosure issues in ICI documents

An extensive review of reports and databases released by key ICIs featured prominently in ex-ante studies or grey literature was carried out.

These analysed ICIs were:

- CDP (previously known as the Carbon Disclosure Project).
- Climate Action 100+ (CA100+).
- The partner initiatives EP100 and RE100.
- The European Technology Innovation Platform for Photovoltaics (ETIP PV).
- The Science Based Targets initiative (SBTi).

The goal was to identify which kind of information is disclosed per member company, which would in turn generate a clearer picture of their methods and their level of transparency when reporting results. The compounded results of this analysis are given in the appendix table B.1.

Four key issues were identified:

1. There is a general lack of transparency when it comes to disclosure of environmental data in most initiatives. Very few reports disclose actual GHG emissions, meaning that absolute environmental data needs to be obtained elsewhere. Some of these initiatives require members to release this information publicly on an annual basis (SBTi, 2020), but this is not the norm.
2. Accounting for overlaps may also become difficult, since large firms may also submit targets for their subsidiaries if the initiatives allow it. The opposite is also possible (i.e. only subsidiaries join the initiative, but the parent company does not).
3. ICI reports tend to leave data gaps for company targets. Even the most detailed initiatives, such as RE100, EP100 and SBTi, do not disclose baselines in absolute units, opting to present the percentage achieved instead.
4. Intensity targets are complicated to track, adding additional complexity to data collection. In some cases even the initiative itself was not able to track progress of members using such targets (SBTi, 2021e). As metrics become more varied, the harder it is to track them.

The first two issues mean that trying to analyse all the members of a single initiative may be too challenging. Small or unprepared members may leave significant data gaps in their annual reports, making tracking year-by-year trends difficult . Similarly, without a proper method of identifying subsidiaries any study of a whole initiative's membership will likely incur in double counting.

Meanwhile, issues three and four imply the need to define how baselines will be set in the absence of proper reporting, and which type targets will be collected for initiatives that allow varying target setting methodologies. This process will likely need to be ICI-specific, as each initiative has different aims and tracks different indicators.

4.1.3 Frameworks and standards for company sustainability disclosure

All the issues previously mentioned point towards the importance of sourcing the emissions and energy data effectively since no ICI document reports them in a sufficient manner. A plethora of Sustainability Reporting Tools (SRTs) have been developed to aid companies in their reporting. These tools can be put into three categories: frameworks, standards, and ratings & indices (Siew, 2015). The first two are meant to aid companies in their disclosure practices, while the last one is meant to inform on company progress qualitatively and is therefore not the focus of this study. Regarding the other two categories, the key SRTs for GHG emissions and energy disclosure are the the Global Reporting Initiative (GRI) and CDP questionnaires (Siew, 2015).

The GRI was launched in 1997 and focuses on guiding company self released reports by applying the triple bottom line principle, which tracks economic, environmental and social indicators (Bednárová et al., 2019). It is a widely used methodology, with as many as 60% of Fortune's Global 100 companies using it in annual reports and similar documents in 2017 (Bednárová et al., 2019).

The GRI does not gather data on individual metrics, but it does collect reports published by companies who use their standard (Global Reporting Initiative, 2021). A great degree of freedom in the ways in which companies track emissions is left, which has garnered a fair amount of criticism due to the possibility of producing misleading assessments that this lax approach to standardization can provoke (Moneva et al., 2006; Fonseca et al., 2014). This is especially troublesome for quantitative studies as companies might decide to disclose emissions as percentage changes instead of absolute numbers meaning the total is left unknown (see Walmart (2020) as an example).

CDP, on the other hand, does compound information under a common method. A not-for-profit charity founded by investors in 2000, CDP is a disclosure platform for businesses and subnational entities that gathers data on climate, water and forest issues (CDP, 2020a). When it comes to businesses, the initiative operates by requesting disclosure through questionnaires. They have received a dramatic increase in response rates since their since they sent their first requests in 2003, although it has leveled off since, with responses from companies in top 500 lists always around the 380 to 400 mark (Kolk et al., 2008; NewClimate Institute et al., 2019; CDP, 2019c). The initiative has aided in converging the ways in which businesses report and account for emissions, with the GHG Protocol being the preferred method (see section 4.2.1 for more information) and visible improvements in the technical quality of the information reported (Kolk et al., 2008; Matisoff et al., 2013).

However, CDP is not without issues. The initiative allows for both public and private disclosure, with the second only being available to investors. Private disclosures showed a worrisome increasing trend up to 2010 (Matisoff et al., 2013), and public disclosures have to be accessed individually and in limited quantity, since the dataset is not free to the public (CDP, 2021a). An even bigger problem is the initiative's tendency to update the questionnaires over time. This is understandable since changes are necessary quality improvements, but this trend complicates comparative analysis over time, with even responding companies ignoring the updates and answering in previous formats in some cases (Kolk et al., 2008). The last large update to the questionnaire happened in 2018 (CDP, 2017; CDP, 2018), falling right within the scope of this study.

The trends seen in these two SRT frameworks add two more issues to our study:

5. Information in company annual or corporate social responsibility reports may be difficult to translate into quantitative values due to inconsistencies across companies.

6. Changes in reporting methods, either in companies or disclosure platforms, adds complexity to longitudinal analysis (i.e. studies that evaluate data for several consecutive years).

The first implies that information coming from sources with high convergence in methodology should be preferred, while the second points towards the need to identify key changes in the way information is collected along the years in such a platform.

4.1.4 Guidelines for the scope of the study

To get around these hurdles rules were established to shape the scope of the study as a way to minimize their impact. These define not only the ICIs and companies selected, but also the information collection methods that will be applied. They are the following:

1. Select a group of companies with high potential impact and enough means for good sustainability disclosure, which has been pre-pruned to remove overlaps generated by subsidiary companies. For this study this group was the Fortune Global 500 (G500) (see section 3.1 for more information).

2. Select ICIs that have clear target-setting methodologies for their members to follow. The Science Based Targets initiative (SBTi) and RE100 both fulfilled this criteria (see section 3.2 and section 3.3, respectively).

3. Avoid tracking intensity targets with varying metrics to simplify data gathering. EP100 was not selected for this reason (see appendix A to learn more about this initiative).

4. Develop a method to determine baselines if they are not disclosed, and linearize targets (see section 4.5.2).

5. Establish an information collection methodology that sets preferences for the source of information, preferring compounded databases over individual company reports, and clarify how changes in the collection methodology of such databases will be handled (see section 4.5.3).

6. Evaluate the collected data in order to detect and correct mistakes, inconsistencies and other oversights (see section 4.5.4).

4.2. General tools and classifications needed to evaluate companies on sustainability metrics

Evaluating how companies achieve progress towards sustainability, regardless of whether they have joined an initiative or not, requires a good understanding of different protocols, tools and classifications used to report emissions, purchase energy and group companies with similar characteristics. This section is dedicated to explaining the ones used by this study in order to assess and display results, as a way to aid the reader in contextualizing the assessment of the initiatives and companies.

4.2.1 The Greenhouse Gas Protocol

The Greenhouse Gas Protocol Corporate Standard (GHG Protocol) is an SRT developed by the World Resources Institute and the World Business Council for Sustainable Development to help companies produce truthful and comparable emissions reports through a standardized approach (World Business Council for Sustainable Development et al., 2004). As seen in fig. 4.2, it can be summarized in four steps: setting organizational boundaries, identifying operational boundaries, quantifying the organization's carbon footprint and reporting/verifying the results (Gao et al., 2014).

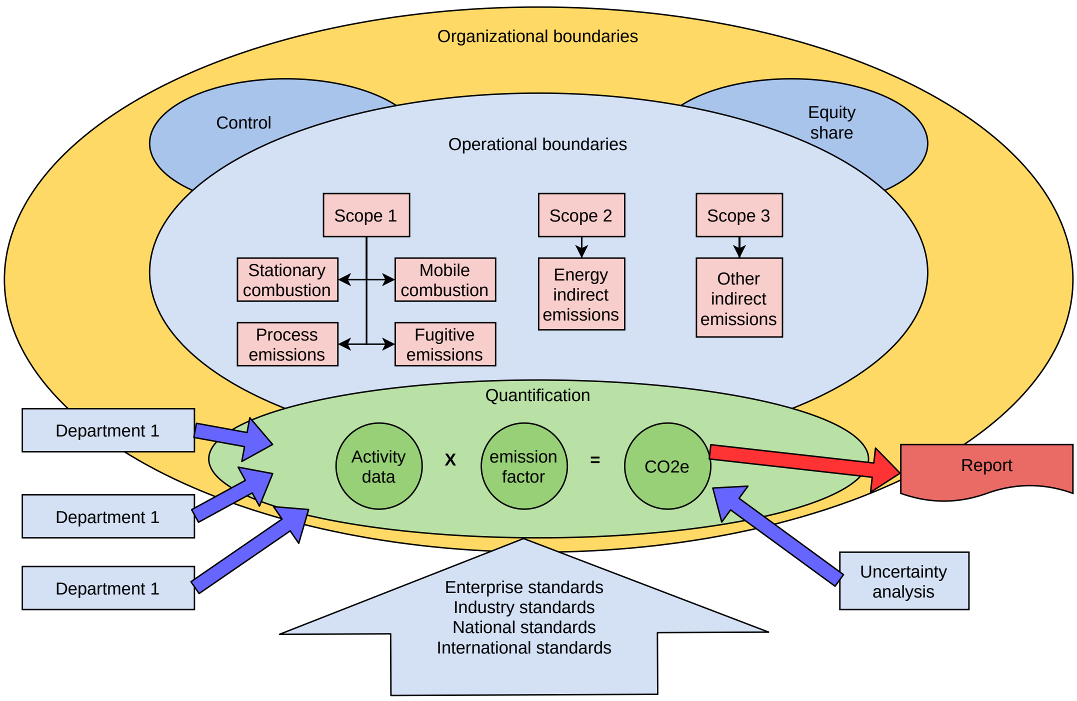


Figure 4.2: Summarized steps of the GHG Protocol (Source: adapted from Gao et al. (2014)).

Organizational boundaries define the portion of the company that will be accounted within the carbon footprint. Two methods exist for this: the equity share approach, and the control approach. In the former boundaries are defined by the percentage of owned equity in operations that the company is involved in (e.g. if company A owns 50% of company B, then they are responsible for 50% of company B's emissions). For the latter, a company will account for 100% of the emissions of an operation if they can exert control over it. Control can be defined in two ways: financial control (e.g. company A is responsible for all the emissions of company B if they own 50% or more of it) or operational control (e.g. if company A rents and operates a facility owned by company B, then A is fully responsible for its emissions). For simplicity, this study makes no distinction between company organizational boundaries used, assuming that there are no overlaps between companies using different approaches. Otherwise, full knowledge of the operations or equities of all companies is needed, which would increase complexity significantly.

The second step, setting **operational boundaries**, is defined as a set of three different emission scopes (see fig. 4.3). Scope 1 (direct emissions) are all the emissions occurring within the organizational boundary, such as boilers, furnaces, company owned cars, etc. Scope 2 (indirect emissions) is made up of all the emissions stemming from electricity and heat, steam and cooling (HSC) purchases that flow into the organizational boundary. It is subdivided into two accounting methods: market-based (MB) where emission factors are determined by the energy mix specific to each market instrument used to purchase the energy, and location-based (LB) where emission factors are based on the average emissions produced by the energy grid in the specific location of a facility (Sotos, 2015). Scope 3 (other indirect emissions) is made up of any other emissions generated during upstream and downstream activities (e.g. business travel, waste generated from operations, processing of sold products, etc). Information from suppliers and end users is often required, making it significantly more difficult to track. Scope 3 emissions are usually larger than the other two scopes (M. Li et al., 2019).

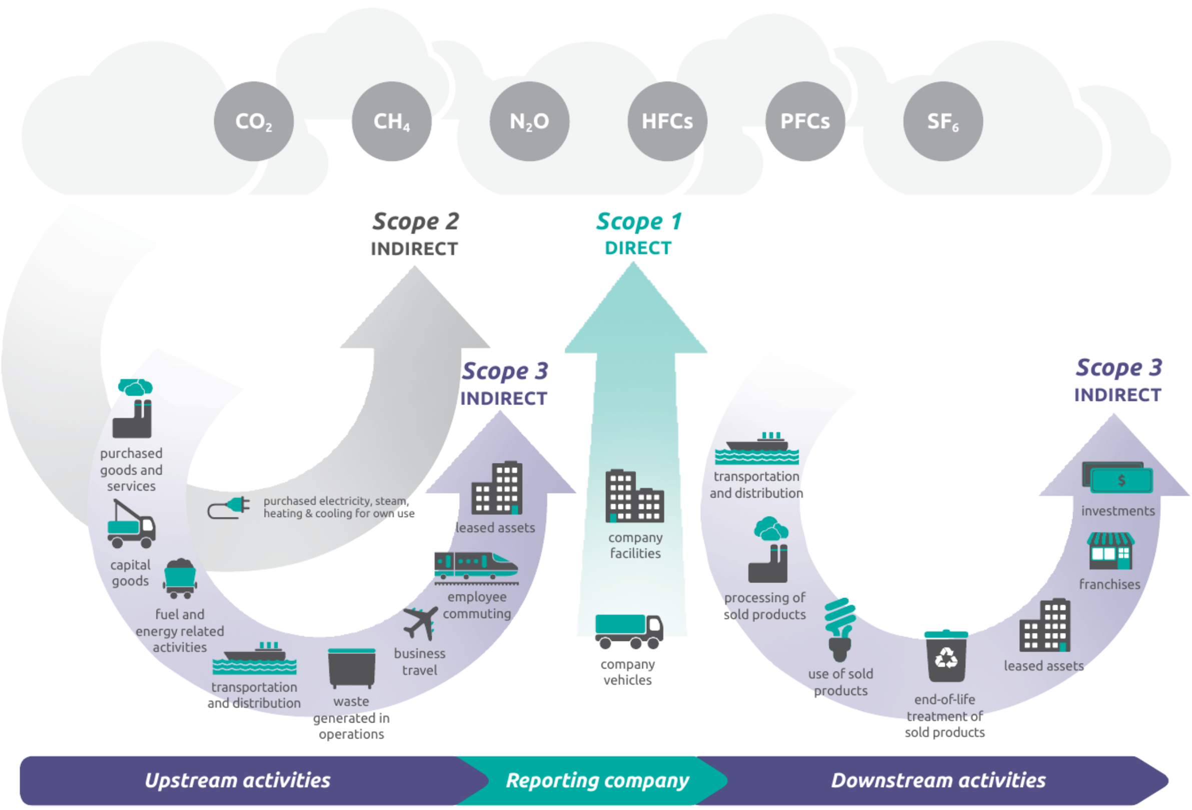


Figure 4.3: The three scopes determined by a company's operational boundary: scope 1 (direct), scope 2 (indirect) and scope 3 (other indirect) (Source: World Resources Institute (2011)).

Quantification requires an underlying emission tracking scheme within the organization, targeting six different GHGs established under the Kyoto protocol: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6) (UNFCCC, 2021). Such a scheme usually entails identifying the emission sources, establishing calculation approaches, regularly collecting data and applying emission factors (usually with the aid of the GHG Protocol's own calculation tools), and finally delivering the data to a corporate level, as emission tracking is usually deployed at a facility level (World Resources Institute, 2011).

The last step, **reporting and verification**, involves publishing the results and subjecting them to internal and external audits to assess the quality of the emission tracking scheme. Third-party verification helps in giving stakeholders confidence in the results, and should aid in detecting double counting or important omissions. At minimum, a public report should include the boundaries chosen, the reporting period and separate data for scopes 1 and 2 (for each individual GHG), information about recalculations or significant boundary changes (such as acquisitions or divestitures) and details on exclusions (World Resources Institute, 2011).

The GHG Protocol has filled gaps in policy making when it comes to GHG emissions accounting by corporations, being promptly updated with guidelines stemming from IPCC reports, and it is coupled with several accounting tools widely used by companies (Hickmann, 2017). CDP, SBTi and RE100 all base their methods on it in some way, and it was also used as a template for ISO-14064, another widely used emissions standard, being fully compatible with it (Gao et al., 2014).

4.2.2 Explaining Energy Attribute Certificates

An essential concept behind claims of low-carbon energy purchases is the use of Energy Attribute Certificates (EACs) to prove their legitimacy. Electricity grids are interconnected systems that must balance demand and supply at all times: every energy user essentially shares a collective physical energy mix, meaning sourcing methods have to be tracked through other methods. Improper management of ownership of low-carbon sources can generate a "free-rider effect", where consumers who do not install or purchase any low-carbon energy benefit from a reduced grid-average emission factor, making claims of emission reductions that they had no part in (Chuang et al., 2018).

EACs eliminate this problem by describing the attributes of a specific amount of energy generated (fig. 4.4). They are "a category of contractual instrument that represents certain information [...] about the energy generated, but does not represent the energy itself" (Sotos, 2015). At minimum they specify the amount of energy produced, and an emission factor. Many country and technology-specific versions of this instrument exist: Tradable Renewable Certificates (TRCs), (International) Renewable Energy Certificates/Credits (REC, I-REC), Guarantees of Origin (GO), etc. They may be paired with a specific contract, such as a specific package sold by a utility or an agreement with an independent energy producer, or purchased separately as "unbundled" credits.

In order to avoid double counting, an EAC must be "retired" after an entity claims its use, which renders the credit void and as such it is no longer part of the energy market (IRENA, 2018). System owners may choose to retire the credit themselves, or to sell it to another entity as an unbundled credit in order to profit from it (thus losing the capacity to claim it). After all the EACs have been retired from the marketplace, the remaining energy is known as the residual mix. The emission factor associated with the residual mix is what should be used to estimate emissions of all the purchased energy with no EACs, removing the free-rider effect. Another important detail is that the use of EACs only makes sense for grid-connected systems. Off-grid and direct-line systems should be accounted separately in order to avoid outsider effects, as they are isolated and should not affect the emission factor of the residual mix (Chuang et al., 2018).

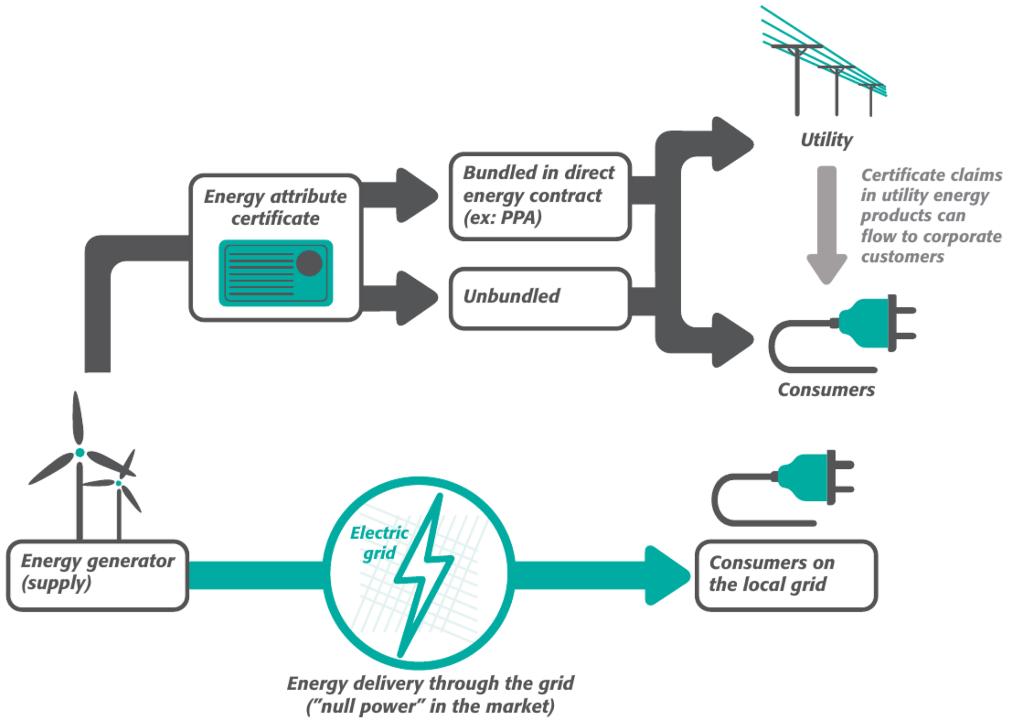


Figure 4.4: Creation and distribution of EACs in a grid, from producer to consumer (Source: Sotos (2015)).

4.2.3 Market instruments for sourcing renewable electricity and their additionality

One of the key policy goals of some ICIs is to "promote direct investments in on-site and off-site renewable electricity projects" (RE100, 2020b). Essentially, this means promoting the use of renewables in ways that are *additional*, which in the context of corporate purchases is defined as "the net incremental capacity added to the energy system as a direct result of corporate sourcing" (IRENA, 2018). Additionality as a concept has been present in climate policy texts as far as the Kyoto protocol (Shrestha et al., 2002). Although the use and validity of the notion of end-user additionality in energy markets has been contested in literature (Menges, 2003), the concept will be used by this study by subdividing the renewable energy used by the companies in this study into different market instruments.

The International Renewable Energy Agency (IRENA) defines four different ways in which businesses can source renewable electricity. These are, in decreasing likelihood of being additional: production through self-generation, a Power Purchase Agreement (PPA), utility green products, and unbundled EACs (IRENA, 2018).

Self-generation is fairly obvious: a company buys, installs and owns a certain amount of renewable generation. This can vary from a photovoltaic system installed on the roof of a facility, to generators running on biomass. The key concept here is ownership: leased systems are not self-generation under the GHG protocol. Self-generation falls within scope 1, while energy obtained through other market instruments is accounted under scope 2 because the operational control is on another entity (Sotos, 2015, page 34). Since an increase in self-generation implies a high likelihood of it being new, it is easy to see why this is considered to be the sourcing method with the most additionality.

PPAs are an agreement between an energy user and an independent producer that ensures a certain energy output to the user and gives long-term economic certainty to the producer thanks to contracts that can last for 10 years or more (IRENA, 2018; World Bank, 2021). This long-term characteristic, and the fact the contract can be directly traced to a specific facility, explain the good additionality of this instrument. PPAs have seen increased use by companies thanks to price-drops for renewables, with newer versions of the instrument such as Virtual PPAs surfacing in recent years (Miller, 2020).

Utility green products (a.k.a. utility green procurement programmes) is a type of market instrument where the end user pays extra in order to claim that its consumption of electricity has a larger share of renewable energy than the standard offered by the utility. This renewable energy may come from existing projects, and not be additional. The utility may give the EACs to the company, or retire them on their behalf. Green "premium" options and green tariffs fall within this category (IRENA, 2018).

Unbundled EACs (U-EACs) were already explained in section 4.2.2. Their key characteristic is that they can be purchased separately from energy contracts (e.g. a company can purchase residual mix electricity, obtain U-EACs by purchasing them from another party, and then claim its consumption as renewable). Low-carbon claims through this method have been scrutinized because of the low prices associated with it, calling into question their material contribution to the creation of more renewable power and even the validity of contractual emission factors as an accurate measure of actual GHG mitigation (Miller, 2020; Brander et al., 2014; Matthew Brander et al., 2021). In many cases certificate users have no way to prove that their purchase has led to additional renewable installations (Kachi et al., 2020), raising questions on whether their use actually has mitigation impact.

4.2.4 Sector classifications

Using the Global 500 implies that a large amount of companies with heterogeneous characteristics will be featured in this study, which means that compounding results presents its own set of unique challenges. Proper grouping through careful categorization is a good way of solving this issue.

Fortune's G500 list categorizes companies using 21 sectors and over 70 industries. These are generally based on the Global Industry Classification Standard (GICS), which has a market oriented perspective (S&P, 2018). However, a significant issue is that Fortune's categorizations do not fully follow the GICS standard. E.g.: both "Energy" and "Oil & Gas Equipment, Services" are used as industries, but the first encompasses the second in the standard. The opposite also applies: "Industrials" and "Motor Vehicles & Parts" are both listed as sectors, but the second is a subset of the first. Using Fortune's sector classifications as-is could generate confusion and may lead to low levels of homogeneity across groups. The assigned industries are better indicators, but the large number of different categories makes meaningful analysis complicated.

Instead, this study corrects the economic sector classifications used by Fortune to ensure they fit GICS criteria, and also chooses to develop its own energy sector classification. The following subsections will how each classification was developed and applied. First, a general explanation of GICS sectors is given. Next, an explanation of how the energy sector classification was developed is outlined, as well as the process followed to classify companies with it.

Economic sectors

To solve the issues previously mentioned, companies were reclassified following the most recent GICS version available (S&P, 2018). The main reason why this classification was chosen was convenience, as the industry namings used by Fortune were already based on it. The GICS has other advantages: studies have shown that it has more homogeneity than competing standards when it comes to market metrics (Hrazdil et al., 2014).

Overall, the GICS is composed of eleven main sectors:

- Communication Services: including cellphone networks and media companies.
- Consumer Discretionary: apparel, motor vehicles, general stores and restaurants.
- Consumer Staples: composed mostly of the food industry, food retailers and cosmetics.
- Energy: exclusively fossil fuel related companies, including those providing services to them.
- Financials: banks, insurance and credit card companies.
- Health Care: includes pharmaceuticals, pharmacies and medical facilities.
- Industrials: aerospace, transportation, construction and electrical equipment companies.

- Information Technology: mostly manufacturers of electronics, and IT services.
- Materials: metals, chemicals, building materials and mining.
- Real Estate: land managers and equity investment trusts (REITs).
- Utilities: electric, heat and water utilities.

Table G.1 in the appendix shows how the Fortune industries were classified. In the case of companies participating in ICIs, extra steps were taken to verify their GICS sector by consulting financial websites such as Fidelity, Bloomberg and Forbes.

Energy sectors

Neither Fortune's or the GICS classifications aid in energy analysis because several of their sectors mix production companies with service providers (e.g., grouping both pharmaceuticals and healthcare service companies under the "Health Care" sector, "Information Technology" having both software and hardware companies). This necessitates a second classification that focuses on how these companies are expected to consume energy. It was created by combining a list of high impact sectors identified in Climate Policy literature, and industry classifications typically used in Energy Analysis literature.

The final list of energy use sectors has the following six categories:

- Electricity Generation: electric utility companies and multi-utilities with significant electricity production.
- Fossil Fuel Production: oil and gas producers, and coal companies.
- Energy Intensive Industry: industrials where energy costs make up a significant portion of their total production costs.
- Light Industry: any industrial that does not classify as energy intensive.
- Transport: includes businesses with a focus on transportation by railway, sea and air (car manufacturers are not included).
- Services: companies whose activities do not entail manufacturing or extraction of physical goods. Financials, software companies and retail fall into this category.

Table G.2 in the appendix shows the energy sector given to each of the industry classifications used by Fortune.

These six categories were created in the following way. First, sectors with high impact were identified. According to the IPCC, just five economic sectors covered an estimated 85% of total GHG emissions in 2010: power, transport, buildings, industry and LULUCF (Victor et al., 2014). Similarly, review of successful climate mitigation policies in the largest emitting countries identified seven similar sectors with high potential for GHG mitigation: electricity generation, fossil fuel production, industry, transport, F-gas usage and LULUCF (Fekete et al., 2021). Other studies list similar areas of interest, but replace F-gas usage with CO_2 removal (Kuramochi et al., 2018).

Sectors like LULUCF, F-gas use and agriculture were removed either because they are too heterogeneous, too difficult to classify with, or because they fall outside the scope of the study. Then, the power sector was subdivided into electricity generation and fossil fuel extraction, following the example of (Fekete et al., 2021). This leaves us with four chosen sectors: electricity generation, fossil fuel production, industry, transport and buildings.

The second step was to subdivide or rename these four sectors. To make comparisons fairer, the industry sector was disaggregated further into energy intensive industry and light industry. Energy Intensive industry applies to businesses with high energy expenses, and is usually compounded of ferrous and non-ferrous metal production, basic chemicals (including fertilizers and refining), mineral production (cement, lime, ceramics and glass), pulp and paper (Blok et al., 2021; European Commission et al., 2019).

Light industry is an umbrella term covering all other types of industries, such as manufacturing (vehicles, machinery, plastics, furniture, etc.), and staples like food, drinks or tobacco (Blok et al., 2021). Non-manufacturing industries, such as construction and mining, were also classified as light industry for simplicity. Compared to energy intensive and light manufacturing industries, non-manufacturing makes up a relatively small amount of global energy demand (U.S. Energy Information Administration, 2016). Lastly, since the buildings sector covers primarily the emissions of service companies and households (Höhne et al., 2020b), it was reclassified as "services" to avoid confusion.

4.3. Methodologies specific to the Science Based Targets initiative

This section aims to give a concise introduction to the different types of science-based targets used by the SBTi, the methodologies that determine them and how such targets were linearized to enable evaluation. The goal is to showcase how targets were constructed transparently. However, it does not detail how such information was collected. Please refer to section 4.5.2 for that information.

4.3.1 Differences between absolute and intensity targets

Member targets in the SBTi can fall within two types: absolute and intensity targets.

Absolute targets track emission reductions within a company's organizational boundary in terms of total tCO_2e emitted, assigning a given year when a certain percentage reduction must be achieved. It is simplistic in nature, making it the easiest target to track since all the information needed is the target itself and the emissions. The following is an example of a typical absolute target of a company in the SBTi:

> *Apple commits to reduce absolute combined scope 1, 2 and 3 GHG emissions 62% by FY2030 from a FY2019 base year. Apple also commits to continue annually sourcing 100% renewable electricity through FY2030.**
>
> **The target boundary includes biogenic emissions and removals from bioenergy feedstocks. The targets covering greenhouse gas emissions from company operations (scopes 1 and 2) are consistent with reductions required to keep warming to 1.5°C .*

Intensity targets tie emission reductions to a secondary indicator in order to couple the company's progress to it. This indicator can be a monetary one (usually value added), or an activity based one (e.g., the total cars produced for automakers, or generated kWh of an electric utility). The SBTi have additional requirements for intensity targets that discourage their use, but they are otherwise permitted (SBTi, 2020). Here is an example of a company setting only intensity targets:

> *Multinational automobile manufacturer GROUPE RENAULT commits to reduce scope 1 and 2 GHG emissions 60% per car produced by 2030 from a 2012 base-year. GROUPE RENAULT commits to reduce scope 3 GHG emissions from use of sold products 41% per vehicle kilometer by 2030 from a 2010 base-year.*
>
> *The targets covering greenhouse gas emissions from company operations (scopes 1 and 2) are consistent with reductions required to keep warming to Well-below 2°C .*

According to Giesekam et al. (2021), intensity targets require additional data gathering, sometimes necessitating unofficial sources (those unrelated to the initiative, or the company). This makes evaluating them significantly more difficult, since not do they require individual, per-company metrics, but also necessitate extended searching and proofing of the indicator. Due to this, their evaluation will remain outside the scope of this study.

4.3.2 The theory behind Science Based Targets

As seen in the SBTi targets included in section 4.3.1, a typical target is made up of five elements: a base year, the base year's emissions, the targeted GHG Protocol scopes, a target year and a value for

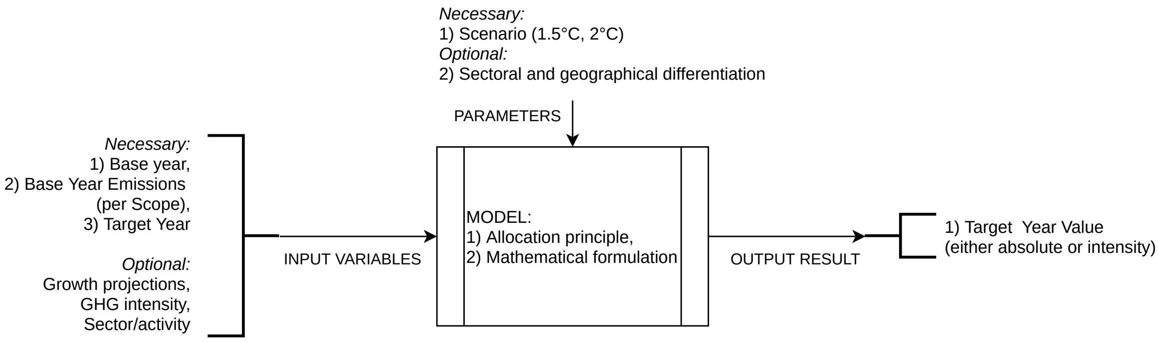


Figure 4.5: Framework of science-based target setting methodologies (Source: adapted from Faria et al. (2019)).

the targeted reduction. These essentially state the start and end points of the target, and clarify the boundaries that are covered within it.

Faria et al. (2019) condensed the typical target-setting methodology into a framework consisting of **inputs** (base year, base emissions, scopes and target year at minimum), a **model** consisting of an emission allocation principle and a mathematical function (based on the chosen methodology), **parameters** such as the targeted global scenario or company specific-data like its geographical region, and an **output**, which is the targeted reduction itself (see fig. 4.5).

This aids in understanding that, beyond the five elements of the typical science-based target, the chosen model and parameters can significantly alter the emission pathway of the company, determining if emissions will be mitigated in the near term or long term. There are several science-based target methods in the literature. Absolute targets are typically set using one model: the Linear Emission Reduction to Target Year (LERTY), first defined in literature by Faria et al. (2019) but already commonly used among companies before that.

Intensity targets are produced by a plethora of different methods, like the Sectorial Decarbonization Approach (SDA) by Krabbe et al. (2015), the GHG Emissions per unit of Value Added (GEVA) by Randers (2012) and the Corporate Finance Approach to Climate-stabilizing Targets (C-FACT) by Stewart et al. (2009). Of these, only SDA incorporates non-economic activity based indicators, which are the only intensity-based method allowed for scopes 1 and 2 targets under the most recent SBTi methodology. However, several economic intensity targets were found for these scopes; it is likely that other methods were allowed in previous SBTi criteria. It is important to specify that any intensity target produced by the these methods could be converted into an absolute target by using a predicted value of the intensity indicator (Krabbe et al., 2015). However, this extra step may add ambiguity for economic indicators as it is difficult to predict such values over long time-spans, likely the reason why the initiative discourages them, and the reason why this study will mostly deal with absolute targets instead.

Table 4.2: Characteristics of each SBT methodology (Source: Faria et al. (2019) and Bjørn et al. (2021)).

Method	Type	Pathway	Allocation principle	Assumption	SBTi: Allowed GHG scope
LERTY	Absolute	Linear	Grandfathering	Compression	1, 2, 3
GEVA	Intensity (economic)	Exponential	Grandfathering	Compression	3
C-FACT	Intensity (economic)	Exponential	Grandfathering	Compression	Unknown
SDA	Intensity (economic, activity)	Sigmoid	Grandfathering	Convergence	1, 2, 3

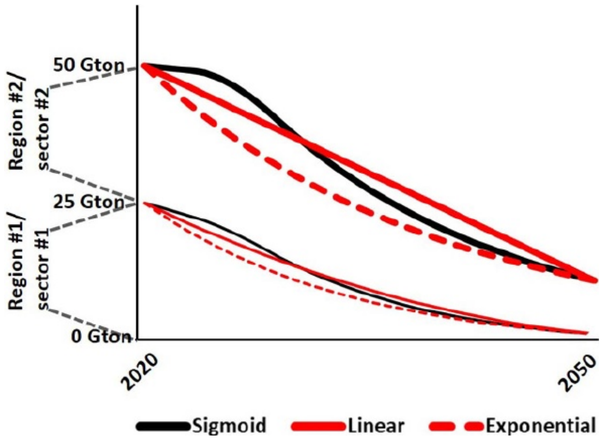


Figure 4.6: Different emission pathway shapes produced by science-based target setting methodologies (Source: Bjørn et al. (2021)).

Each method also determines three key features: the emissions' pathway, the allocation principle for emissions and the underlying assumption behind how targets are collectively achieved. Table 4.2 summarizes all the characteristics of each target setting method, as well as their current usage within the SBTi. Bjørn et al. (2021) state that pathways can take three shapes: sigmoid, linear, or exponential (fig. 4.6). Sigmoid and linear pathways can be considered the least ambitious ones, since they either displace abatement towards the future (sigmoid), or evenly between the near and long term (linear). These least challenging pathways are associated with the LERTY and SDA methodologies, while most economically oriented tools (GEVA and C-FACT) produce exponential pathways (Bjørn et al., 2021).

Another important factor is the allocation principle used by these models. Generally, all models are based on a grandfathering approach since the pathways are primarily determined by the emissions at the baseline, large emitters are allowed to keep said large emissions as their starting point (Faria et al., 2019). Grandfathering appears to be a common feature due to the voluntary nature of these commitments, since SBTs do not account for carbon pricing schemes such as carbon taxes or carbon markets within their framework.

Finally, the underlying assumption of how emission reductions are achieved over time can be two: by compression of absolute emissions over time, where a company's emissions are reduced proportionally to those in the scenario (part of LERTY, C-FACT, GEVA, see Faria et al. (2019)), or convergence of intensity values, where a company keeps their current emission factor at the start but eventually converges to a sectorial standard by 2050 (only SDA, see Krabbe et al. (2015)).

4.3.3 Linearizing SBTi absolute targets

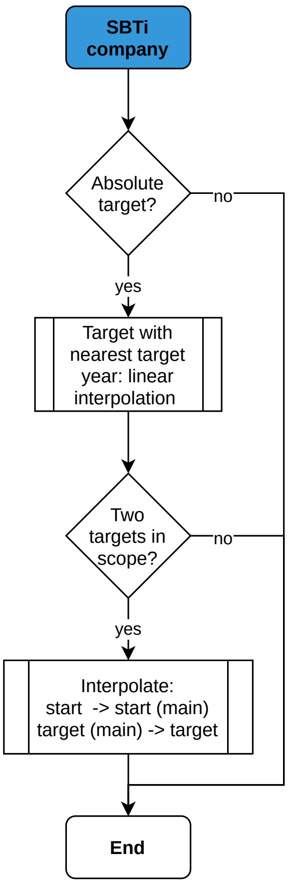
The most important assumption in the analysis of this initiative is that all absolute targets are presumed to be linear. This was necessary as the initiative does not reveal the methodology that each member employed to set their targets (Bjørn et al., 2021), an omission that complicates comparing goals between members, and even between different targets set by the same company. Linear targets are less ambitious than an equivalent exponential target (Bjørn et al., 2021), and this study poses that they are at the very least a bare-minimum in terms of ambition. They are, however, more ambitious than SDA targets in the near term. Linear targets also require less information to generate, as all other target setting methods need some type of indicator (Faria et al., 2019). It could be argued that more stringent target pathways would be a better measure of progress given the regional distribution of these companies. However, such an analysis would also increase complexity and data requirements, and would likely prevent the inclusion of more companies.

Absolute targets in the SBTi may be mostly created using LERTY anyways. Current SBTi guidelines are clear enough on the current use of the method (SBTi, 2019), but it is unknown if this was the case for previous years. It is also technically possible to set an absolute target with other methodologies, in particular the SDA , which said to be also widely used by companies in the SBTi (Giesekam et al., 2021). However, it is impossible to identify such cases. Thus, this analysis assumes all absolute targets follow the LERTY method.

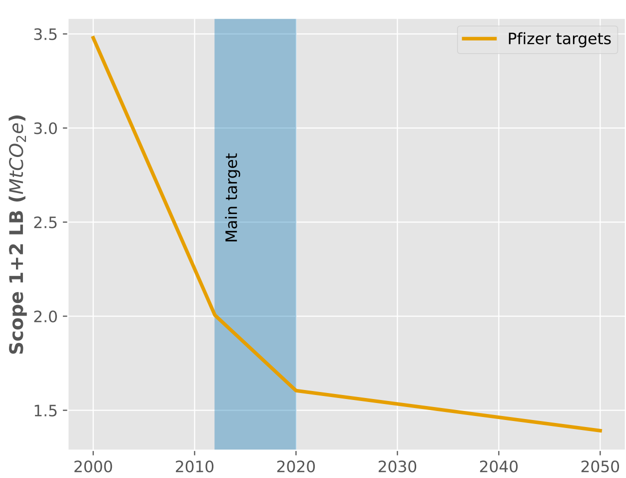
A second issue that needed to be dealt with was how to combine targets. Although it was possible to complete all five target elements (base year, base year emissions, target year, targeted reduction and targeted scope(s), see fig. 4.12a), some companies had two overlapping targets for the same scope. These usually only differed in the target year and targeted reduction, but in some cases there was an overarching target that the company had set almost a decade ago. For example, pharmaceutical company Pfizer had two targets for S1+2 LB (the scope covered was taken from CDP responses):

> *Research-based pharmaceutical company Pfizer commits to reduce GHG emissions from operations 20 percent by 2020 from a 2012 base-year. This 2020 goal will keep the company on track to achieve a 60 to 80% reduction by 2050 from a 2000 base-year.*

In such cases, the absolute target with the closest end year was taken as the main objective, and the second target with the farthest end year was coupled into it using linear interpolation. Figure 4.7 shows a simple diagram of how this was achieved, along with an example using the same Pfizer target mentioned above.



(a) Pseudocode of target interpolation.



(b) Example of linear interpolation of two overlapping targets for SBTi member Pfizer. The main target, with the nearest target year, is shown in blue.

Figure 4.7: Methodology followed to linearize absolute targets, coupling overlapping targets using start and target years.

4.4. The methodology behind the targets of the RE100 initiative

In this section the target requirements and technical criteria used by the RE100 initiative will be described, as well as the way in which individual company targets were linearized. With this information the reader should be able to understand how members in the initiative set targets, and how their progress is tracked in this study. Similar to the previous section, the ways in which target information was collected are not explained. Such details are summarized in section 4.5.2.

The structure is as follows: section 4.4.1 will explain the criteria that all RE100 members should be following when setting their targets. Then, section 4.4.2 summarizes the technical requirements that members should comply with when claiming renewable energy use. Finally, section 4.4.3 explains how RE100 targets were linearized.

4.4.1 Target requirements for members of the RE100

To the knowledge of the author, RE100's target setting strategy has not been defined in any particular scientific paper (in contrast to the SBTi, whose methodology is based on different published SBT methods). Instead, they have chosen to establish a set of minimal requirements that all members are supposed to adhere to. There is no distinction between energy sectors, economic activity or firm size, with the only exception being that power generation companies are not allowed to join (defined as any company where sold power exceeds 50% of annual turnover). When joining the initiative, all corporate members must develop a scheme that at least fulfills the following minimal targets for sourcing renewable electricity (RE100, 2020c):

- An interim target of 60% renewable electricity by 2030.
- An interim target of 90% renewable electricity by 2040.
- A final target of 100% renewable electricity by 2050.

According to scenarios developed by the IPCC for 1.5°C pathways with no or limited overshoot, the share of renewables in global electricity use should be between 47 to 65% by 2030, and 69 to 86% by 2050 (IPCC, 2018b). Thus, it can be said that RE100's minimal requirements appear to exceed them, at least in terms of individual targets.

In practice, however, the initiative has several members with less ambitious goals. Looking into the most recent progress report published by the initiative, at least 13 members (some of them G500 companies) have interim targets for 2030 with percentages of less than 60% (RE100, 2020a). The reasoning behind these special cases is unclear, as several of them joined as recently as 2020.

4.4.2 Technical criteria for members of the RE100

RE100 defines several requirements that its members must follow when claiming progress. These can be classified into defining coverage of the operations within targets, how companies can make claims on the sourcing of renewables and how this progress is disclosed to the initiative in order to assess progress.

Coverage requirements follow definitions set by the GHG protocol (see section 4.2.1), and are related to the operational boundary that the company has set (RE100, 2020c). Essentially, all the electricity consumed within the boundary established by these rules falls within RE100 requirements. They are the following three rules:

1. All electricity purchased that falls within scope 2 emissions falls within RE100 targets.
2. All self-consumed electricity that falls within scope 1 emissions (i.e. emissions from fuel for transport, HSC or any other non-electrical use are not included) falls within RE100 targets.
3. Subsidiaries under the brand's organizational control, including those where >=50% is owned (those with less ownership are reviewed "case-by-case") fall within RE100 targets.

For simplicity, it will be assumed that companies submit information to CDP and disclose it in their company sustainability reports in a way that is consistent with these statements, unless a clear mistake could be identified.

Claims of renewable use are generally associated with EACs (RE100, 2018b). While claiming renewable consumption of grid-connected systems, the member must ensure that the EACs associated with it are retired. Some regions do not have tracking instruments however. For such cases, the company is responsible for ensuring that there is no free-riding effect via other means. In the case of self-generation and direct-line purchases, no certificates are needed.

In some very specific cases the initiative allows companies to report grid-mix electricity with no certificates as renewable (on grids that have 95% or more renewables in their mix). Since there is no way to distinguish such cases in CDP questionnaires from erroneous submissions, if encountered they were labeled as "unknown" renewable electricity (see section 4.5.4 for more information on this issue).

Candidates are also required to report on their progress annually through a specialized spreadsheet and CDP questionnaires (if the company reports to that initiative). These are in turn are subjected to a verification process. RE100 also encourages members to disclose data publicly, but this is not obligatory (RE100, 2021b).

4.4.3 Linearizing RE100 targets

In order to evaluate this initiative, targets were once again assumed to be linear. This was necessary because RE100 does not specify any particular shape in their documentation, unlike the SRT methodologies used by SBTi. They do require minimum interim targets as seen in section 4.4.1, but they are not applied consistently throughout all of their members. Due to this, these minimum interim targets were only applied if the target year for 100% electricity was 2050. In any other case, the target was left as-is.

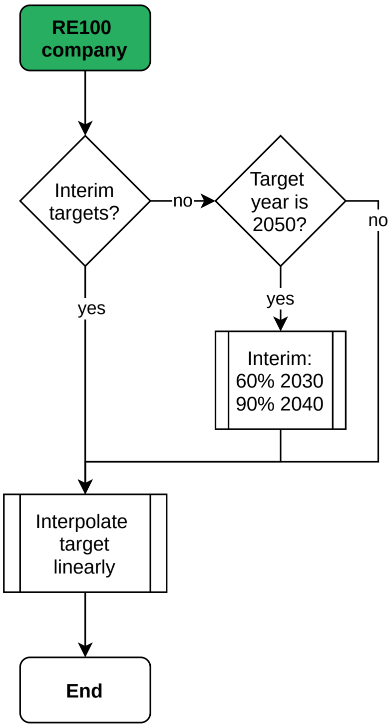
RE100 targets are essentially intensity targets meaning a metric (renewable electricity) is tied to a secondary denominator (total electricity used) to obtain a rate. I.e: to obtain the targeted renewable use of a company in a certain year one must multiply their total electricity used by a targeted renewable ratio. This means that one cannot infer the electricity consumption of a company from its target alone. Similarly, if the baseline is not disclosed it is necessary to collect energy data of both renewable and non-renewable electricity consumption for that year in order to produce it.

The most up to date version of RE100 targets are listed in the initiative's website (RE100, 2021a). However, these seldom include the interim targets set by members, joining years or any other information necessary to properly construct a target. Due to this, targets present in the initiative's most recent progress report were preferred where available (RE100, 2020a). RE100 provides all the necessary information to complete a target trend in it: baseline year, baseline RE electricity %, interim targets and their specific years, and final year (the final target is always 100% RE electricity).

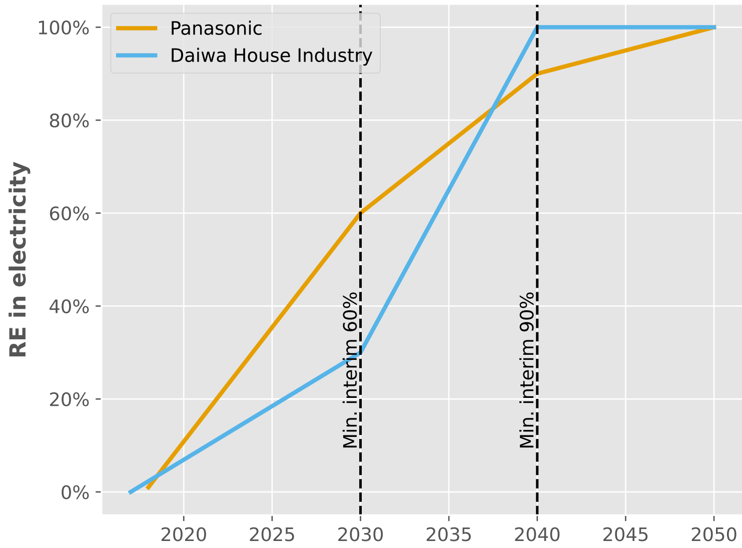
The following are two examples of RE100 targets as they appear on the RE100 website:

> *Panasonic Corporation has a goal to achieve 100% renewable electricity for its global business operations by 2050.*
> *Daiwa House Group has set a target to achieve 100% renewable electricity for its entire global operations by 2040.*

Panasonic has no interim targets, thus defaulting to the minimum interim requirements for companies with a target year of 2050. At first glance it may appear that Daiwa is more ambitious, but this company has set an interim target of 30% RE electricity by 2030, shifting their commitment towards the long-term. Figure 4.8 explains the process behind RE100 target linearization in detail (baseline year and target baseline taken from RE100 (2020a)).



(a) Pseudocode of target interpolation.



(b) Example of a linearized RE100 target using minimum requirements for member company Panasonic, and company with stated interim targets Daiwa House Industry.

Figure 4.8: Methodology followed to linearize RE100 targets. Note that minimum interim targets only apply to companies with a final target year equal to 2050.

4.5. Data gathering and validation

Since most of the evaluation of these actors and initiatives is quantitative and data driven, it is essential to explain how the information was obtained and validated, as well as the detailing the challenges faced during this process. This section deals these topics in a structured way, explaining the guidelines set to define the scope of how information was gathered, the different ways in which companies disclose data publicly, and the many issues present in this data. Figure 4.9 showcases these steps, along with the inputs and outputs after each in the form of total number of companies. It should provide a clear picture of how many companies were filtered at each stage of the study.

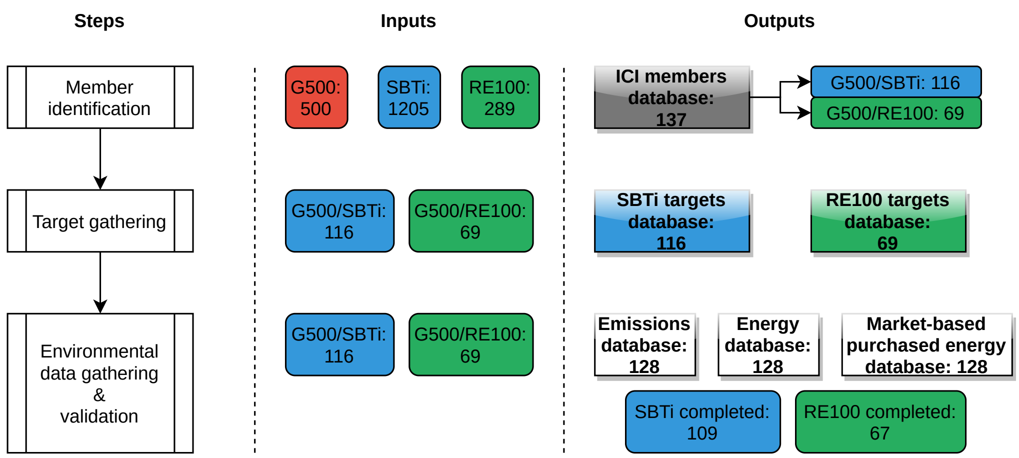


Figure 4.9: Data gathering steps, inputs, and outputs. Numbers represent the total number of companies at each stage of the process.

4.5.1 Member identification

Proper analysis implies establishing limits in time and scope. Companies may enter or exit these ICIs as time goes on, new versions of company rankings may be released, names of businesses might change, etc. Initiatives also allow companies to update their targets, which would pollute the analysis of progress if undetected.

To shield this study from such changes it was decided to create three databases, each with all the members of the G500, the SBTi and RE100 as of 23rd February 2021. These were then compared to find overlaps using automated algorithms and visual checks in order to reduce the sample to 137 G500 companies that are members of at least one of the two initiatives.

Company databases for the G500, the SBTi and RE100

This subsection explains the process behind creating a database of the companies in each group. Figure 4.10 gives a summary the source of each database, the method used to obtain the information (if no file was available for download), and the type of data that was given by each source. The most recent Fortune Global 500 list was used, which was released in late 2020 and is composed of revenues of the Fiscal Year 2020, which ends 31st March 2021 at the latest (Fortune, 2020; Fortune, 2021). For both initiatives, data was retrieved from their respective websites at the same date: 23rd February 2021. The SBTi and RE100 provide lists of their current members, along with their target at the very least (SBTi, 2021b; RE100, 2021a). This information was taken as-is, and was not updated if further dates to prevent mismatches in target evaluations.

Unfortunately only the SBTi provides a downloadable data file with up-to-date information. For the G500 and RE100, an automated web scrapping script was developed to retrieve data from their respective websites using Python libraries. This method was preferred because it is less error-prone than manual collection. The final list of companies consisted of: 500 for the Global 500, 1205 for the Science Based Targets initiative and 289 for RE100 (fig. 4.10).

The amount of information disclosed varied by source, with Fortune and the SBTi both providing a significant amount of details of each company. RE100, in contrast, provided minimal information: just name, targets and a link to the company's website. After having these databases ready, the next step was to identify the overlaps between each group.

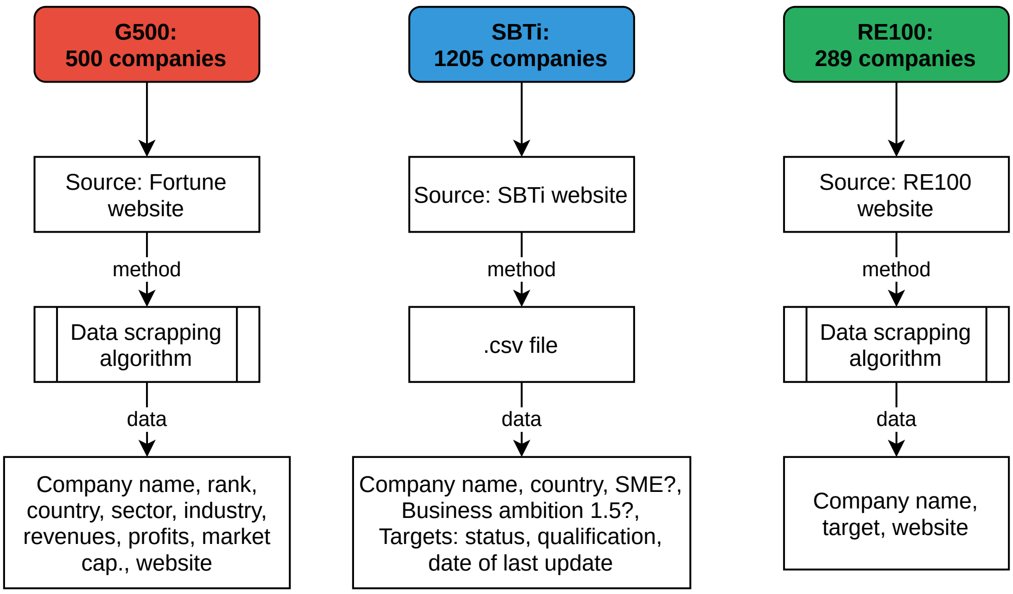


Figure 4.10: Summary of the source, method and information available for companies in each group as of 23rd February 2021.

Identifying overlaps between groups

Finding which companies belonged to more than one group presented its own set of challenges. First, it was quickly identified that each source used slightly different namings for the same company (e.g., "Walmart", "Walmart Inc." and "Walmart Stores, Inc."). Second, there was no consistency in the identifiers used in each group: Fortune used company websites and NYSE stock symbols (also called "tickers") which are abbreviations of public company names of up to five characters (Hayes et al., 2020). The SBTi provided a International Securities Identification Number (ISIN) for some, but not all, companies. RE100 just linked to each company's website. Third, and last, was that the combined number of company entries (close to 2000) was too large for manual validation. Attempting to find overlaps one-by-one would not only be tedious, but prone to human error.

Clearly, all these issues imply the need for a more efficient method of overlap identification. To speed up comparisons, a combination of automated approximate string matching and visual validation was used. The steps taken to identify overlaps are summarized in fig. 4.11.

The first portion of the test was an automated comparison between each company name in the G500 database, and those used by each initiative. Developing such a tool was outside the scope of this study, so all of these comparisons were done utilizing a pre-developed approximate string matching algorithm available in Python libraries. The chosen score for a valid name was 90/100[1].

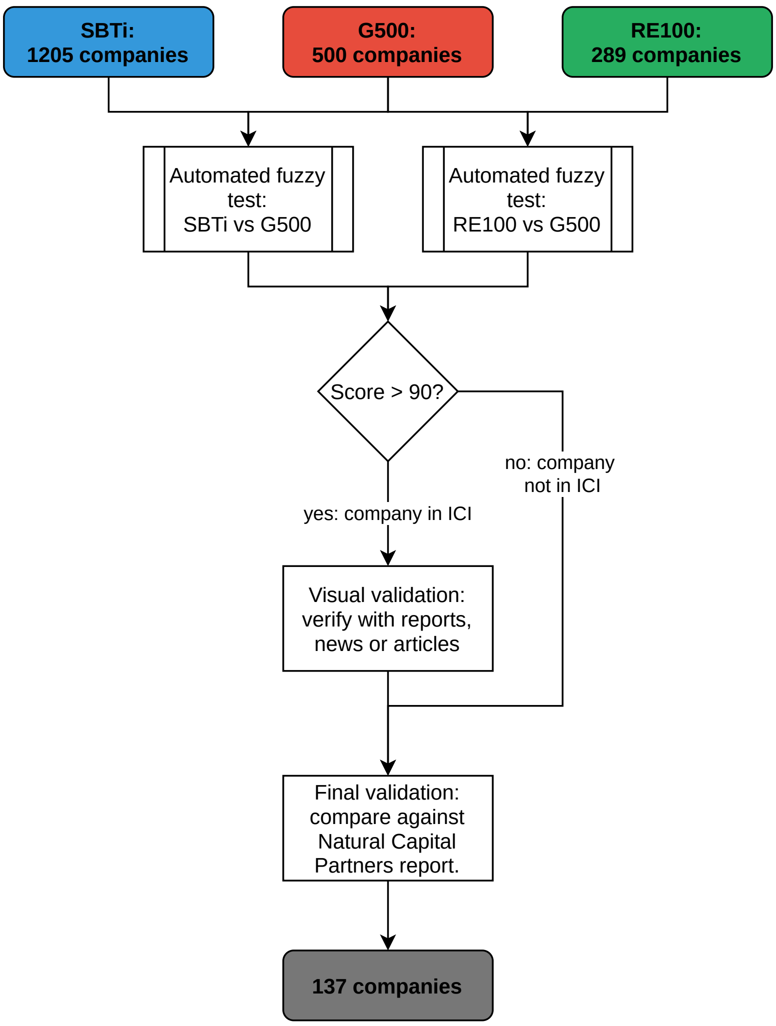


Figure 4.11: Steps used to identify overlaps between each ICI database and the G500 ranking.

[1]Please see appendix C for more information on tools used, and the supplementary materials for the developed code.

Approximate string matching (also known as "fuzzy" searching) is a method of text string comparison that allows errors, or inequalities, between the strings being compared. Fuzzy searches have many uses, with text retrieval and comparison being among the oldest (Navarro, 2001). A popular method of doing these searches is by measuring the Levenshtein distance, sometimes referred as "edit distance", between two sets of characters. The Levenshtein distance is defined as the minimum cost of transforming one set of characters into another through a sequence of weighted edit operations such as adding, removing or substituting characters (Yujian et al., 2007). This distance is usually normalized, giving a higher score pairs of strings that are much alike.

For the visual validation portion, each company that scored higher than 90 was reviewed using data from the three databases in fig. 4.10. References to the initiative were searched in company reports, or in news updates in the initiative's website. It was verified that they were participating at a company level; any entries with participation stemming only from subsidiaries were removed.

As a final validation step, the report by Natural Capital Partners (2020) evaluating participation of these three groups was compared against the final results of fig. 4.11. This was only used as a quick check, as not all the companies marked as participating in the report by Natural Partners were current members (e.g., carmakers Toyota Motor and Nissan Motor had lost their status as committed members in the SBTi at the time of this study). Regardless, using this report proved useful to identify some companies that scored just below the cut-off value of 90 in the Levenshtein test.

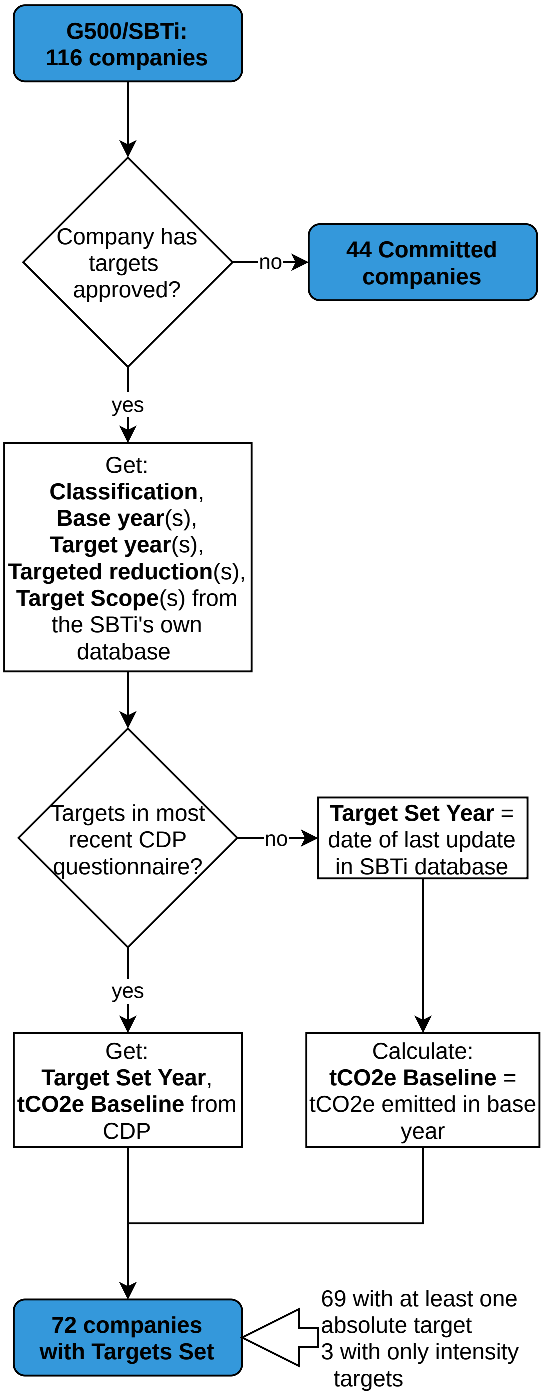
Another advantage of this last validation step was detecting differences in membership of companies with overtly similar names. Most of these issues surfaced with companies that belong to the Japanese Keiretsu: several groups of large businesses that share long-term relationships and do cross-shareholding between each other, but maintain operational independence (Collinson, 2015). E.g.: Sumitomo, Sumitomo Life Insurance and Sumitomo Electric Industries are all different companies present in Fortune's list, with only the latter participating in the SBTi as a committed member. Other examples of Keiretsu companies are those with Mitsubishi, Panasonic or Toyota in their names, among others (Collinson, 2015; Flath, 1996). For the purpose of this study these companies were handled as individual entities since they could not be interpreted as subsidiaries.

4.5.2 Target gathering

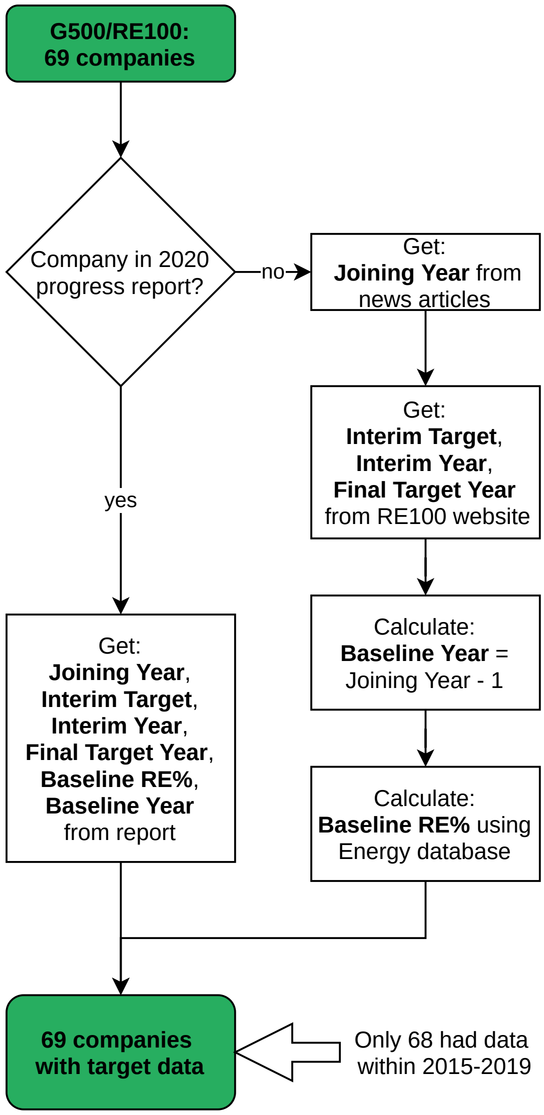
The next steps of data gathering were to obtain all the necessary target information, and fill any data gaps left by the initiative's documentation. Generally, both initiatives did not fully disclose baseline data for their members. Although both the SBTi and RE100 show progress in terms of percentages in their most recent annual reports (RE100, 2020a; SBTi, 2021e), this method obscures the initial amount of emissions and electricity used by these companies. Members may vary by size and energy use dramatically; showing progress with only percentages will lead to unfair comparisons. Figure 4.12 showcases the methodology followed for each of the initiatives. For both, the baseline year, the targeted year, and the targeted emission reductions/renewable electricity use were obtainable for each member.

The SBTi posed higher difficulty when organizing the information (fig. 4.12a). First, they had 44 members that had no approved goals. These committed members may have set targets internally, but these still fall outside the initiative's criteria and responsibility. These companies were accounted for, but no further target collection was done for them. For members with targets set, the initiative has sub-classifications which reflect varying degrees of ambition: 2°C, well-below 2°C and 1.5°C compatible. These sub-classifications were also collected as they could to aid in data analysis.

The biggest issue during data collection for the SBTi was the variety of ways in which the initiative allows members to set targets. Each company may have at least one scope 1+2 target (scope 3 targets are only obligatory if they exceed a 40% threshold according to SBTi (2020)). However, the initiative is very flexible in how said targets are set: although absolute targets were the most common, many companies opted for intensity targets instead. Some companies even had both types for different scopes. Adding to this complexity was the varying number of targets that each company chose to set. There appears to be no upper limit to this, each company is able to disaggregate their targets as much as they



(a) Order followed to gather SBTi classifications and target data.



(b) Steps followed to gather or calculate RE100 target data.

Figure 4.12: Target gathering methodologies followed for both initiatives. In the case of SBTi, only the most recent CDP questionnaire was used because in several cases older questionnaires showed previous targets, which might include older baselines.

want. The most extreme example in the sample, French materials company Saint-Gobain, set seven different absolute targets with most of them covering specific scope 3 categories.

For each target baseline emissions had to be collected. To do this the most recent CDP questionnaire (version 2020) was used if available. If the target was mentioned in the questionnaire, and it coincided with the target given in the SBTi database, the baseline emissions in the CDP questionnaire were taken as they were. For cases where the target in the questionnaire differed from the one in the SBTi website, the baseline emissions were taken only if the base year coincided, keeping all the other values. This was done to preserve the most recent version of the target. If the target was not mentioned in the CDP questionnaire in any shape or form, the baseline emissions were calculated using the emission database generated for this study (see section 4.5.3).

RE100 disclosed progress year-by-year in their report, and the simplicity of their targets made collection straight forward (see fig. 4.12b). All members have similar goals and track the same indicator (percentage of renewable energy in used electricity). Data such as the joining and target years (including interim targets) were readily available in either their most recent report, or their website. Similarly, all companies target 100% RE usage in electricity consumption as their final target, meaning that this value could be pre-assumed.

Since the energy usage of each company was collected (see section 4.5.3), the baseline RE ratio given in the RE100 2020 report was enough in most cases. Generally, the initiative sets the baseline year at one year before membership (a few companies had it at the year of joining, but these were far from the norm). The earliest ratio disclosed in this report was taken as the baseline for the 69 RE100 members in the G500. For a few cases where the company was not present in the report (all of them relatively new members), the baseline was calculated as the RE ratio in their electricity use one the year before joining the initiative.

4.5.3 Environmental data gathering

The last portions of data gathering involved collecting environmental data. As seen in section 4.1, actual emissions and energy data is not easy to collect using company environmental or annual reports due to variations in disclosure. Figure 4.13 shows the steps followed for each company, and for each year between 2015 and 2019.

CDP was the preferred source, if available, since information is presented in a standardized way, with similar metrics across companies and years and improving levels of quality (Matisoff et al., 2013). For each year available an HTML file was downloaded from the CDP website, containing all the information disclosed by the company including: emissions, energy use and low-carbon energy market-based purchases, providing a detailed look into a company's energy related metrics. Data from these files was retrieved using a self-developed python HTML parsing script.

Questionnaires were not always available, however. In some cases companies skipped a year of reporting, made some of their CDP responses private or never submitted responses at all. In such cases, annual reports were used. At minimum, companies had to submit enough data to complete scope 1 and 2 emissions, and energy data. If energy data was given in non-energy units (i.e. liters of gasoline used), conversion values from Blok et al. (2021) were used if applicable.

All companies that left data gaps that could not be solved using CDP questionnaires or annual reports were removed from this step of the analysis. These were nine companies in total, with most being removed due to lack of CDP responses and obscure reporting practices[2].

Generally, CDP information is not without faults. Evaluations of the initiative's effectiveness have highlighted year-by-year variations in the questionnaire's sections as a key source of problems (Matisoff et al., 2013; Kolk et al., 2008). In fact, the initiative modified at least one of the sections gathered in this study every single year, and overhauled the entire questionnaire from 2017 onwards (CDP, 2020c; CDP, 2019b; CDP, 2018; CDP, 2017; CDP, 2016). This was a major source of issues, and necessitated assumptions when grouping the data.

[2] Please consult table E.1 to see which these companies were, and why they could not be included.

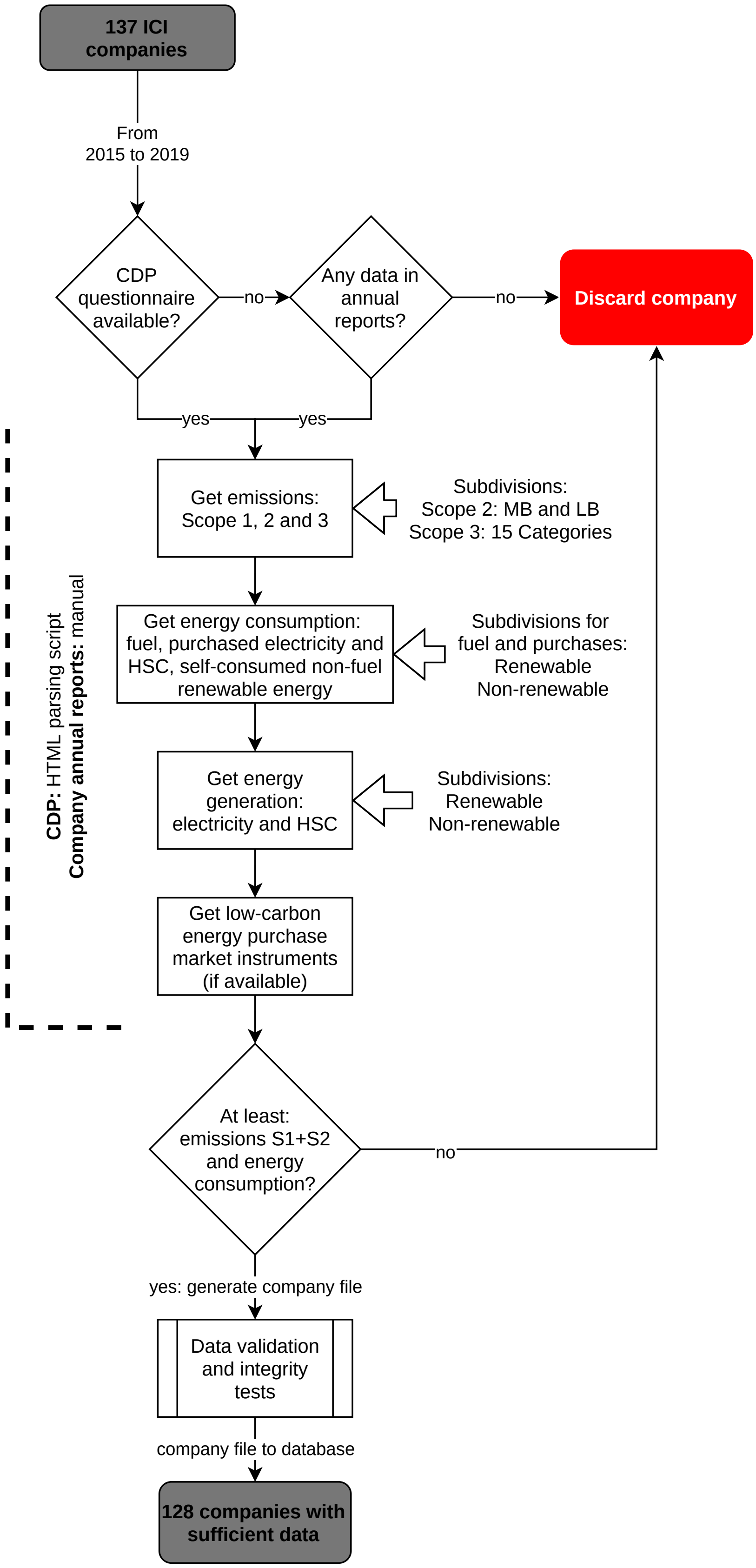


Figure 4.13: Methodology followed to gather environmental data such as emissions, energy used/generated, and market-based energy purchases.

Among the collected sections, only emissions remained without any significant updates. CDP bases their GHG emission methodology on the GHG Protocol, which had its most significant amendment in 2015 in relation to scope 2 emissions (Sotos, 2015). All the CDP questionnaires scanned for this study included this amendment, making collection straight forward.

Unfortunately, the same cannot be said for the energy section. Older versions of the questionnaire did not allow companies to disclose renewable energy without specifying market instruments or specific fuel sources, and featured a reduced section for energy generation. This was updated for 2017 data onwards (CDP, 2018), allowing companies to disclose renewable and non-renewable energy separately for fuels, purchased and generated electricity and Heat, Steam and Cooling (HSC) in the form of a table. Most data was still obtainable in the older versions (although it was presented in a less organized manner), with the exception of HSC renewable data, which was not included anywhere.

This had two implications. First: for 2015 and 2016, renewable HSC data had to be obtained from company reports or be assumed to be zero in cases where no renewables where used for HSC between 2017–2019. Second: for renewable electricity and HSC purchases between 2017–2019, the renewable value given by the company could exceed the market-based low-carbon purchases disclosed. These values were kept unless there was clear evidence that the company made a mistake (e.g., using other non-renewable low-carbon technologies, like nuclear energy, as renewables).

Market-based low-carbon energy purchases was, by far, the section with the most changes out of those collected. Every year the initiative changed at least one of the names used, removed categories, added extra columns, etc. For example, older questionnaires (2015–2016) did not allow companies to disclose the source of the low-carbon of the energy purchased meaning that it was impossible to differentiate between nuclear and renewable sources.

Another issue was that the initiative changed the names used for market instruments constantly. This even confused the responding companies, with some of them disregarding the changes and using older ones, an issue seen in other studies (Kolk et al., 2008).

Sometimes even the categories included violated GHG Protocol standards, which this section is supposed to follow: for two of the five years featured in this study the initiative allowed companies to include grid mix renewable electricity in the section, which would lead to double counting according to scope 2 guidelines (Sotos, 2015). CDP themselves even acknowledged that reporting grid mix renewables was not best-practice in their guidance (CDP, 2018, page 133), and later removed the category entirely. Earlier years also included ambiguous categories that enabled some companies to report self-generation under purchases (although this was a common occurrence even in later years after this issue was corrected). In other cases companies used non-standard, self-written questionnaire options to disclose invalid categories as valid purchases. For example, one company reported recovered heat as a renewable source, which is not purchased energy, and may even come from a fossil-fueled process.

Another issue was that, for unknown reasons, CDP did not allow financial companies to disclose market-based purchases in their newest version of the questionnaire (CDP, 2020c). This means that the amount of renewables in the energy section was all the information that could be collected for many companies in those years.

This necessitated three fixes. First: all low carbon-purchases for 2015–2016 were considered to be renewable in nature. Second: non-renewable energy sources, self-generated renewables and grid mix renewables will be removed if seen in 2017–2019 questionnaires since they are not within scope 2 Market-Based guidelines. Third: a common naming convention of all instruments was developed to identify purchasing methods and isolate issues more easily[3].

4.5.4 Environmental data validation

Once data was obtained for most values, it was subjected to a series of validation tests to ensure its quality due to two issues: yearly errors and longitudinal errors (i.e. mistakes affecting several consecutive years). Yearly errors were mostly caused by the fact that CDP does not subject their own questionnaires to any validation tests or edits, leaving the possibility of human error open. Reasons for longitudinal

[3]Please refer to table D.1 for more information.

errors are harder to assess: they went from simple confusion to outright resistance to updated guidelines.

The following is a list, which is by no means comprehensive, of the most common issues seen in both CDP and annual report data:

- Yearly errors
  - Magnitude errors: e.g. submitting energy in kWh instead of the requested MWh to CDP, or a company's own annual reports.
  - Conversion errors: e.g. not converting energy from TJ to MWh or vice-versa.
  - Typing mistakes: e.g. adding an extra digit to energy use or emissions, increasing them at least ten-fold.
  - Category errors: e.g. flipping renewable and non-renewable energy values, or location-based and market-based scope 2 emissions.
  - Empty categories: e.g. disclosing renewable fuel and non-renewable fuel, but leaving the total fuel value empty.
  - Equality errors: e.g. total energy not being equal to the sum of total renewable energy and total non-renewable energy in the CDP questionnaire.

- Longitudinal errors (year-by-year):
  - Inconsistent accounting boundaries: e.g. arbitrarily removing or including subsidiaries within the reporting boundary.
  - Pervasive methodology mistakes: e.g. conversion mistakes that remained uncorrected for several years.
  - Inconsistent ownership of on-site generation and direct line consumption: e.g. reporting solar panels as self-owned and then suddenly accounting them as a direct line PPA for the next year.
  - Resistance to CDP updates: companies who opted to submit information using older CDP guidelines, leading to invalid data.

Testing methods had to be developed to remove or minimize the effect of these mistakes for each company, done in three steps: validating energy values, validating emissions and validating market-based renewable energy purchases (fig. 4.14). These steps fed back into each other if necessary.

Energy validation

Energy was the only data that could be subjected to automated equality and inequality tests. To do so, energy data was subdivided in four categories based on the most recent CDP questionnaire (CDP, 2020c). These were: energy consumption, electricity generation, HSC generation and market-based

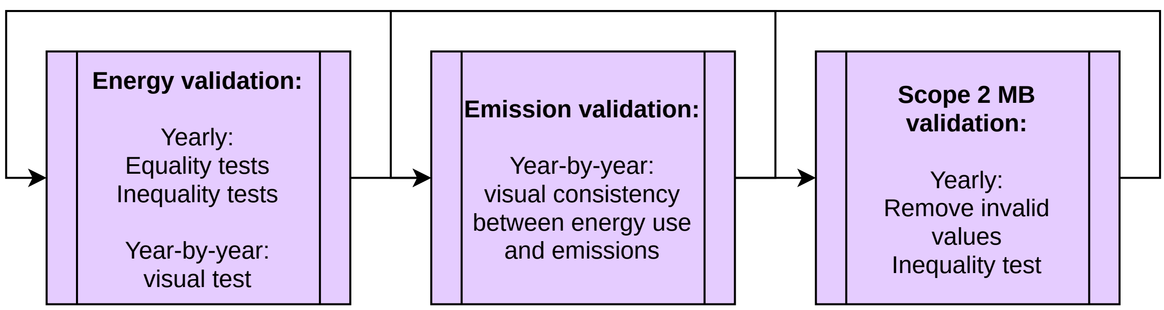


Figure 4.14: Validation methodology followed to correct mistakes in reporting, in three steps.

Table 4.3: Energy values obtained from CDP questionnaires or annual reports for each company (c), and sampled year (i) subdivided in four different categories. The period analysed was 2015–2019.

Energy consumption		**Electricity generation**	
Name	**Symbol**	**Name**	**Symbol**
Renewable Fuel	$Fuel_{REc,i}$	Gross Generated Electricity	$GGElec_{Tc,i}$
Non-renewable Fuel	$Fuel_{NREc,i}$	Self-consumed Electricity	$SCElec_{Tc,i}$
Total Fuel	$Fuel_{Tc,i}$	Gross Generated Renewable Elec.	$GGElec_{REc,i}$
Purchased Renewable Elec.	$PElec_{REc,i}$	Self-consumed Renewable Elec.	$SCElec_{REc,i}$
Purchased Non-renewable Elec.	$PElec_{NREc,i}$	**HSC generation**	
Total Purchased Electricity	$PElec_{Tc,i}$	**Name**	**Symbol**
Purchased Renewable HSC	$PHSC_{REc,i}$	Gross Generated HSC	$GGHSC_{Tc,i}$
Purchased Non-renewable HSC	$PHSC_{NREc,i}$	Self-consumed HSC	$SCHSC_{Tc,i}$
Total Purchased HSC	$PHSC_{Tc,i}$	Gross Generated Renewable HSC	$GGHSC_{REc,i}$
Self-consumed non-fuel renew.	$SCNF_{REc,i}$	Self-consumed Renewable HSC	$SCHSC_{REc,i}$
Total Renewable Energy	$Energy_{REc,i}$	**Market-based energy purchases**	
Total Non-Renewable Energy	$Energy_{NREc,i}$	**Name**	**Symbol**
Total Energy	$Energy_{Tc,i}$	Scope 2 MB purchased renewable	$S2MB_{REc,i}$

energy purchases (table 4.3). Any errors detected were looked into and corrected by using either comments given by the company itself in the questionnaire, annual reports or simple logic.

Energy consumption was the most detailed category, breaking down total, renewable and non-renewable energy into fuels, purchased electricity, purchased HSC and self-consumed non-fuel renewable energy. This last category is necessary because self-generated electricity from biomass would already be included into renewable fuels. A series of equality tests were applied on a per-company basis, ensuring that total energy and renewable/non-renewable totals were consistent (Eq. 4.1), and that the renewable (Eq. 4.2) and non-renewable (Eq. 4.3) subcategories added up to their respective totals.

$$Energy_{Tc,i} = Energy_{NREc,i} + Energy_{REc,i} \quad \text{(Eq. 4.1)}$$
$$Energy_{REc,i} = Fuel_{REi} + PElec_{REc,i} + PHSC_{REc,i} + SCNonFuel_{REc,i} \quad \text{(Eq. 4.2)}$$
$$Energy_{NREc,i} = Fuel_{NREc,i} + PElec_{NREc,i} + PHSC_{NREc,i} \quad \text{(Eq. 4.3)}$$

A similar test was applied to the fuels (Eq. 4.4), purchased electricity (Eq. 4.5) and purchased HSC (Eq. 4.6):

$$Fuel_{Tc,i} = Fuel_{NREc,i} + Fuel_{REc,i} \quad \text{(Eq. 4.4)}$$
$$PElec_{Tc,i} = PElec_{NREc,i} + PElec_{REc,i} \quad \text{(Eq. 4.5)}$$
$$PHSC_{Tc,i} = PHSC_{NREc,i} + PHSC_{REc,i} \quad \text{(Eq. 4.6)}$$

For electricity and HSC generation inequality tests were applied instead. Generally, gross values could not be smaller than self-consumption values for both renewable and total generation. Similarly, renewables could only be equal or smaller than total values. In the case of HSC generation, only data for 2017–2019 could be gathered, since old CDP questionnaires omitted it.

$$GGElec_{Tc,i} \geq GGElec_{REc,i} \qquad GGHSC_{Tc,i} \geq GGHSC_{REc,i} \quad \text{(Eq. 4.7)}$$
$$GGElec_{Tc,i} \geq SCElec_{Tc,i} \qquad GGHSC_{Tc,i} \geq SCHSC_{Tc,i} \quad \text{(Eq. 4.8)}$$
$$GGElec_{REc,i} \geq SCElec_{REc,i} \qquad GGHSC_{REc,i} \geq SCHSC_{REc,i} \quad \text{(Eq. 4.9)}$$

Emissions validation

It was not possible to apply automated tests for emissions: the sectorial heterogeneity in the group of companies analysed, and the lack of knowledge on the company-specific emission factors used for all scopes made it too difficult. Instead, it was decided to realize a simple visual check-up of emissions vs energy use trends. Once mistakes in energy reporting were corrected, it became easy to visually verify year-by-year emission trends by comparing them to energy use in different categories: fuel consumption to scope 1 emissions, and scope 2 emissions to purchased electricity/hsc. Scope 3 emissions were taken as-is, since these come from external partners and are unrelated to the company's energy usage for the most part.

If an inconsistency was identified, annual reports were used to try to understand its cause and correct it if possible. In a few cases where a mistake was apparent, but the correct emissions could not be retrieved, they were estimated by calculating generalized emission factors ($FS1_{c,i}, FS2LB_{c,i}, FS2MB_{c,i}$) for the adjacent years using the following equations:

$$FS1_{c,i} = \frac{S1_{c,i}}{Fuel_{Tc,i}} \quad \text{(Eq. 4.10)}$$

$$FS2LB_{c,i} = \frac{S2LB_{c,i}}{PElec_{Tc,i} + PHSC_{Tc,i}} \quad \text{(Eq. 4.11)}$$

$$FS2MB_{c,i} = \frac{S2MB_{c,i}}{PElec_{NREc,i} + PHSC_{NREc,i}} \quad \text{(Eq. 4.12)}$$

Scope 2 market based validation

Finally, for market-based energy purchases another inequality test was done, this time using the total sum of disclosed purchased renewables (i.e. the sum of all the different market instruments used to source renewable energy) against total renewable purchases (Eq. 4.13). This necessitated manually removing any non-renewable low-carbon purchases and any wrongly reported values such as grid-mix renewables and self-generation to avoid double counting (see section 4.5.3). An inequality test was used because for some companies it was not possible to gather yearly market-based data: some only gave values for purchased renewables ($PElec_{REi}, PHSC_{REi}$) but left the market-based section empty or were not allowed to submit it (as was the case for financials in 2019). In cases where annual reports were used, market-based data was rare to find.

$$PElec_{Tc,i} + PHSC_{Tc,i} \geq PS2MB_{Tc,i} \quad \text{(Eq. 4.13)}$$

If, after pruning the data for errors, the market based value ($PS2MB_{Tc,i}$) exceeded renewable energy purchases ($PElec_{REc,i}$, $PHSC_{REc,i}$), these last two were substituted in such a way that their sum was equal to the market based value. In order to keep the equality condition (Eq. 4.5, Eq. 4.6), total non-renewables were reduced.

4.6. Describing the evaluation methodology

In order to produce results this study employs the logical framework for climate action developed by Hale et al. (2020), and adapts it in order to evaluate progress in the SBTi and RE100 individually. This section is dedicated to explaining what a logical framework is, the template used for this study, and how it was altered to analyse the initiatives.

4.6.1 The Logical framework for climate action

The Logical Framework (also known as a "log frame") is a project design tool first developed by the U.S. Agency of International Development (USAID). It is used to concisely summarize the goals, purposes, outputs and inputs of a project; detailing key indicators, data sources and main assumptions for each (USAID, 2019). Although the primary reason for their creation was project design, log

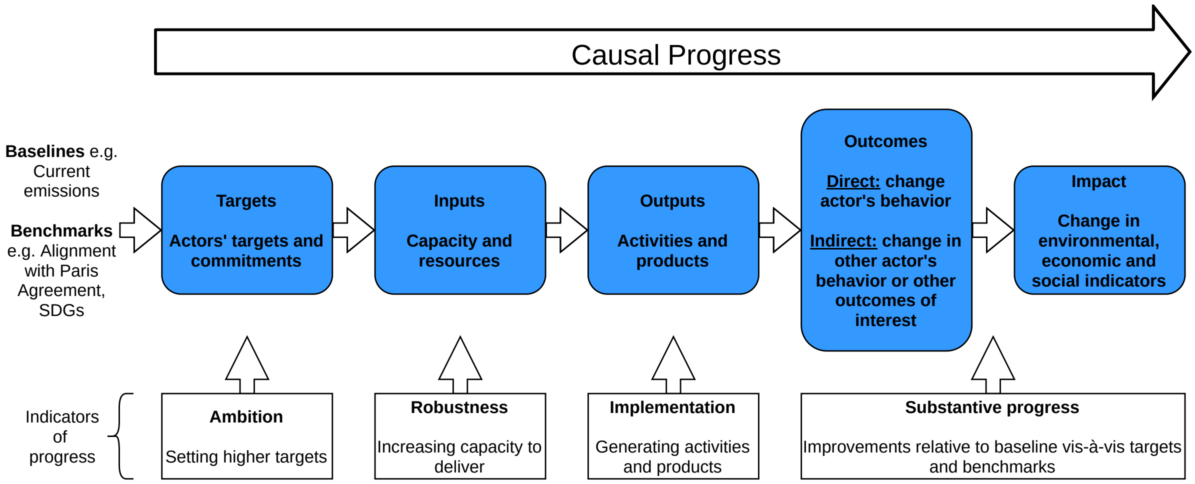


Figure 4.15: Log frame model developed to assess climate actions in terms of ambition, robustness, implementation and progress (Source: adapted from Hale et al. (2020)).

frames are also useful for identifying improvements, monitoring progress and doing ex-post evaluation; their conciseness makes them useful for summarizing outcomes to stakeholders in an easily digestible way (Sartorius, 1991).

This study will make use of log frames as a way of showing and evaluating progress in each of the two selected ICIs. Results will be shown for all the companies that joined them in a collective manner, either by grouping all of them together, or in separating them by the sectors described in section 4.2.4. Specifically, it will make use of the adapted log frame designed by Hale et al. (2020) for assessing climate action by NSAs (displayed in fig. 4.15).

This log frame is composed of five different types of progress indicator. **Ambition** is primarily defined by the actor's own targets, such as having a certain percentage share of renewables in electricity consumption at a given target year. **Robustness** relates to the actor's ability to achieve established goals: it is primarily influenced by the amount of resources given to achieve the target. **Implementation** relates to the activities the actor produced to achieve the objective (such as investing in renewables or switching to electric vehicles). Finally, **substantive progress** is how the outcomes of the actor's activities managed to have direct or indirect impacts on the targeted environmental indicators.

Each progress indicator is evaluated by comparing its evolution against a **baseline** and a **benchmark**. Baselines define the starting point. For example: in order to track increments of renewable energy share in electricity, the bare minimum is knowing that rate on the year the target was set (i.e. knowing the RE share in electricity baseline).

Benchmarks tie the actor's targeted goals to a desired global narrative. As an illustration, when analysing emission mitigation targets they can be compared against global emission pathways to ensure they are ambitious enough (e.g. using a 1.5°C scenario as benchmark).

Each type of progress can be tracked in different ways, meaning that it can be subdivided into different **key indicators**. For example: the GHG emission mitigation robustness of a company can be measured by evaluating their investments, the number of employees assigned to such projects, the periodicity and quality of third-party verification, etc.

4.6.2 Logical Framework for analysing the Science Based Targets initiative

Acquiring data on targets and emissions for SBTi members was only possible through the use of CDP questionnaires and company reports. As such, these sources only provide a limited view into the internal processes of companies, meaning that the analysis will have a black-box nature to it. To account for this, this study applies several modifications to the log frame developed by Hale et al. (2020). Since only absolute targets could be linearized, the log frame can only be applied in its entirety to companies that set that specific type of target. Companies with intensity targets could only be evaluated for some, but not all, of the progress indicators[4].

To evaluate this initiative, Hale's framework had to be modified to account for the black box nature of the information submitted to CDP . It will only be applied in its entirety to members with an absolute scope 1+2 targets, since data for intensity targets was not collected as explained in , meaning ambition could not be evaluated for them.

However, it was possible to do at least some level of evaluation in other progress indicators for these companies. Table 4.4 showcases the benchmarks, baselines and key indicators used for each type of progress. Most types of progress will be evaluated for the period of 2015–2019, except ambition which will be evaluated until 2030. If a company set a target after 2019, it will be present in the evaluation of ambition, and excluded from all other progress indicators.

Ambition was assessed by extending the absolute targets set by companies: i.e., keeping baseline emissions constant for years prior to the start year of the target, and doing the same after the end year using the targeted reduction. The resulting trend is compared against scenarios from the latest Emissions Gap Report (UNEP, 2020). Three scenarios will be used: a descriptive scenario for Current National Policies (CNP), and two normative scenarios for 2°C and 1.5°C compatible pathways. These are the same pathways shown in fig. 2.1 at a global level.

All scenarios are normalized at the sum total targeted emissions of all companies for 2019 to better match current data for global emissions, and because most scenarios assume reductions begin after 2020. The lower and upper bound for 2019 emissions taken were 53.6 and 56.7 $GtCO_2e$. They represent the median emissions projected by integrated assessment models, and the median of the historical estimate for 2019 respectively (UNEP, 2020, Box 3.1). The 2°C scenario corresponds to a higher pathway of the IPCC (2018a), while the 1.5°C scenario relates to pathways with no or limited overshoot. These are cost-optimal scenarios where emissions are reduced in each country to the extent that the marginal costs of further reductions are the same across all countries. It should be noted that the analysis only compares targets against global trends, and does not differentiate between companies located in industrialized nations or developing ones. This may benefit developed nations heavily, since ignoring

Table 4.4: Log frame model used to evaluate progress in the Science Based Targets initiative.

Type of progress	Benchmarks and baselines	Key indicators	Period
Ambition	- Extended company targets - UNEP CNP scenario - UNEP 2°C scenario - UNEP 1.5°C scenario	- GHG mitigation ambition	2015–2030
Robustness	- Third-party verification for each scope	- Total verified companies - Type of assurance	2015–2019
Implementation	- Energy use (consumers) - Net generation (utilities)	- Increase in renewables - Decrease in fossil fuels	2015–2019
Substantive (direct)	**Initiative:** - Active targeted GHGs - Actual GHGs of members with active targets **Sample:** - Extended company targets - Actual GHGs	**Initiative:** - Total covered GHGs - Level of achievement **Sample:** - GHG mitigation	2015–2019
Causal impact	- Overall effectiveness	- All the above	Ex-post review

[4]See section 4.3.1 to understand the issues seen in intensity targets.

historical emissions gives this group larger carbon budgets than approaches that account for them (van den Berg et al., 2020).

It should be noted that companies might have achieved emission reductions before the baseline year. At this time, the initiative does not disclose older targets, or the year when a company first achieved the "Targets Set" status. Since many members within the sample submitted a target recently (see fig. 5.2b), it is very likely several of these targets are updates and not first submissions. This was confirmed during the data gathering stage, as several differences were seen, usually a lower targeted reductions or an older baseline. CDP questionnaires are not a direct source, and tend to have mistakes. Only using targets directly stated by the SBTi avoids making false statements of ambition as much as possible.

Robustness is a difficult metric to assess due to the fragmented picture offered by CDP questionnaires and company reports. A company can improve their capacity to deliver results in a plethora of ways, from creating a sustainability board, to giving internal incentives for achieving results. However, these kinds of managerial actions might not always result in actual robustness improvements, and can be only symbolical in nature (Haque et al., 2018).

Instead, this study proposes that a requirement for a robust emission accounting scheme is an appropriate level of external assurance, as it can increase the level of confidence in the sustainability reporting practices of a company. It has been observed that people tend to distrust reports stating positive environmental results if they have not been subjected to third-party assurance (Sheldon et al., 2020), and assurance at a reasonable or high level of confidence has also been shown to relate to positive reactions among financial analysts (Rivière-Giordano et al., 2018). The benchmarks are twofold: every member must be externally assured at minimum, and this assurance should ideally be of high quality.

Compounding assurance statements is not simple: although the amount of companies engaging in sustainability reporting has steadily increased in the past decade (KPMG, 2020), there is a lack of convergence in assurance standards and their requirements. For example, even though European nations have some of the highest levels of sustainability reporting, there are no mandatory guidelines for the group (European Commission, 2021). This has resulted in a wide variety of national and international standards, complicating comparisons.

To combat this lack of consistency, CDP has limited the standards they accept as valid, and provides different classifications for the level obtained: none, limited, moderate, reasonable and high (CDP, 2021b; CDP, 2018). Generally, the type of assurance can be distinguished as those with a positive or negative statement. Positive statements are reserved for assurance at a high or reasonable level, and as the name implies, are framed affirmatively (e.g., "data of company X complies in all material aspects with the Y standard"), while negative statements are present in moderate or limited assurance and use a more reserved phrasing (e.g., "after review of report X, nothing came to our attention that contradicts standard Y") (IAASB, 2013; Rivière-Giordano et al., 2018).

In short: limited and moderate statements can only provide certainty to a *plausible* level because even if information has been collected it is not enough to reduce the possibility of misstatements to a low enough level (WBCSD et al., 2019). For example, a limited assurance might collect enough data to validate 27% of the emissions disclosed by the organization. High and reasonable assurance are enough to evaluate if the data *conforms* to the criteria evaluated, and is extensive. It is similar to the assurance required for financial statements (WBCSD et al., 2019).

Implementation is another complicated aspect to track because of how varied the group of companies in the SBTi is. However, it is undeniable that a vast majority of emissions come from the use of energy. CO_2 emissions from fossil fuels and industrial processes account for 65% of total GHG emissions with most of it related to power plants or other fuel use (Victor et al., 2014), and recent estimates state that energy makes up almost three quarters of global GHG emissions (Ritchie et al., 2020). Looking into this particular aspect of implementation should give good insights into how companies are tackling their targets.

Energy trends of each sector will be analysed in order to identify evidence of behavioral change in this crucial aspect of mitigation. Emissions from energy can be divided into direct and indirect (Victor et al., 2014), which coincides with how the GHG protocol manages them. To account actions clearly, energy users have been separated from energy producers. Users will be evaluated by looking into their energy use within their operational boundary (self-generation, fossil fuel and renewable fuel), and their purchased energy (the sum of electricity and purchases of heat, steam and cooling); these relate to scope

1 and scope 2 emissions respectively. In the case of utility companies net energy generated will be used instead, dividing it in fossil-based, nuclear and renewable energy; this only relates to scope 1, and it should cover the vast majority of the emissions from utilities.

Hale et al. (2020) state that in order to track implementation of GHG reductions the benchmark and baselines should be the "realized outputs versus planned outputs", and the "fit between outputs and targets". It was not possible to assess the reduction plans of each member, and even if that was the case it would be complicated to analyse them at an aggregated level. This means that there is no benchmark for comparison for this type of progress. The energy profile of the group should still provide useful information, but this study is still limited in regard to how these companies are implementing changes.

Direct **substantive impact** will make use of the same targets analysed in the ambition section, similarly keeping baseline emissions constant for years prior to when the target was set. These will be compared against the emissions disclosed in CDP questionnaires. These emissions will be subdivided into scope 1 and 2 in order to make comparisons to the implementation section easier.

4.6.3 Logical Framework for analysing the RE100 initiative

Here the logical framework used to evaluate RE100 is given. All the indicators used to assess impact are summarized in table 4.5. Similar to SBTi's log frame, types of progress related to target trends (i.e. ambition) will include the results of all companies with targets. However, all other progress indicators will include only members who joined this initiative between 2014–2019. This is due to the fact that this initiative does disclose joining year, contrary to SBTi's lack of transparency in that subject.

Ambition will be assessed by comparing RE100 targets to the expected renewable share in the the total electricity of OECD nations as given by different Integrated Assessment Models (IAMs) used in the IPCC 1.5°C report. Specifically, scenarios based on two Shared Socioeconomic Pathways (SSPs) developed by O'Neill et al. (2017). Results for OECD countries were preferred since most RE100 members are located in those countries, and no distinctions were made between nations in terms of where they are located (i.e. all companies will be compared against the OECD scenarios). Growth in

Table 4.5: Log frame model used to evaluate progress in companies who have joined the RE100 initiative.

Type of progress	Benchmarks and baselines	Key indicators	Period
Ambition	- Company targets - SSP1-1.5°C OECD scenarios - SSP2-Base OECD scenarios	- Target year for 100% - Total covered electricity	2014–2050
Robustness	- Claimed renewable energy purchases (Elec. + HSC) - Renewable purchases with visible market instruments	- % of visible purchases	2015–2019
Implementation	- Renewable energy used by market instrument	- Preference for PPAs and self-generation	2015–2019
Substantive (direct)	**Initiative:** - Total covered electricity - Targeted renewable use - Achieved renewable use	**Initiative:** - Increase in coverage - Level of achievement	2015–2019
	Sample: - Collective electricity use - Extended collective targets - Collective renewable use - Scope 2 GHGs	**Sample:** - Growth in share of renewable electricity - Reduction in GHGs emitted	2015–2019
Causal impact	- Overall effectiveness	- All the above	Ex-post review

electricity demand will not be accounted for since RE100's targets only use the renewable ratio as their metric.

The baseline will be based on descriptive "middle-of-the-road" scenarios (SSP2-Base). They are characterized by medium population growth, and medium and uneven trends in economic growth, human development and technological advances (O'Neill et al., 2017). Normative "sustainable development" scenarios (SSP1-1.5°C) will be used as a reference for progress towards a 1.5°C outcome. This is a best-case pathway with low population growth, and high economic, technological and human development with converging livings standards (IPCC, 2018a).

All scenarios were taken from the IPCC 1.5°C scenario explorer hosted by the International Institute for Applied Systems Analysis (Huppmann et al., 2018). To increase relevancy, any scenarios produced by models assuming decreasing global emissions between 2015–2020 were removed since such reduction did not occur (UNEP, 2020). After filtering, only the scenarios produced by the following three IAMs were left: AIM/CGE 2.0, GCAM 4.2 and WITCH-GLOBIOM 3.1. It should be noted that the IPCC used a cost-optimal approach when generating their scenarios, which according to van den Berg et al. (2020) leads to larger carbon budgets for developed nations than approaches that account for historical emissions. For specific information of the RE share in electricity for each scenario, please consult table J.1 in the appendix.

Robustness will look into the degree of visibility allowed into how these companies are sourcing their energy. Third-party verification is not a good metric for this initiative since in most cases the energy purchasing methods are not even featured in assurance statements. It was not possible to separate electricity from purchases of heat, steam and cooling (HSC) in many cases, so this indicator will use a combination of both. The share of HSC is expected to be relatively small in comparison to that of electricity, but it is still important to keep this in mind when interpreting this indicator as it does not fully match the scope of the initiative.

Visibility for year i and for company c is defined as the sum of renewable energy obtained through Power Purchase Agreements (PPA), unbundled EACs ($UEAC$) and utility green products ($UtilityGP$) in all companies (Nc), divided by the sum of all 'claimed' renewable purchases by all companies:

$$Visibility_i = \frac{\sum_c^{Nc} PPA_{c,i} + UEAC_{ci} + UtilityGP_{c,i}}{\sum_c^{Nc} PElc_{REc,i} + PHSC_{REc,i}} \quad \text{(Eq. 4.14)}$$

Essentially, it is the percentage of purchased renewable energy whose market instrument can be known from outside company and the initiative, either through public reports or CDP questionnaires, which RE100 suggests using (RE100, 2020c). It allows better interpretation of subsequent progress indicators, and gives a view on whether changes in disclosure platforms such as CDP benefit or harm the initiative's standing in terms of transparency. Sustainability processes should be measurable in order to make sense of goals and understand if they are being met properly (Özdemir et al., 2011). Considering that sourcing methods are at the core of the initiative's objectives, a high visibility into them should be expected.

Implementation was evaluated by subdividing transparently sourced energy into four different categories ordered by their degree of additionality: self-generation, PPAs, green utility products and unbundled EACs (see section 4.2.3). Determining the degree of additionality of a specific instrument is not a simple process, as it is highly situational. Even self-generation might not be additional in cases where companies received public support to install it (IRENA, 2018). Still, presenting these different instruments in a separate, qualitative manner can still give useful information on the development of each instrument and any shifts in the sourcing preferences of these companies.

Substantive impact will compare the targets set by these companies against their actual delivery by combining all the data obtained from CDP questionnaires and public sustainability reports. This will answer the simple question of whether the combined contribution of these actors has managed to exceed the collective targeted renewables at a given year. This initiative has been posed as one with a possibly high contribution towards global climate mitigation (Lui et al., 2020; We Mean Business, 2016), so the collective GHG emissions in the sample will also be evaluated in the discussion section of this study.

Results deal with the total electricity consumption in the case of ambition and substantive impact, and energy purchases for robustness and implementation. The total electricity ($Elec_T$) consumed for a specific company (c) and year (i) is defined as the sum of all purchased electricity ($PElec_T$) and consumed self-generated electricity ($SGElec_T$). The total renewable electricity ($Elec_{RE}$) is similar, but only relates to renewable purchases or self-generation ($PElec_{REc}$ and $SGElec_{RE}$, respectively).

$$Elec_{Tc,i} = PElec_{Tc,i} + SGElec_{Tc,i} \quad \text{(Eq. 4.15)}$$

$$Elec_{REc,i} = PElec_{REc,i} + SGElec_{REc,i} \quad \text{(Eq. 4.16)}$$

In turn, total purchased energy ($PEnergy_T$) and total purchased renewable energy ($PEnergy_{RE}$) are simply the sum of either all purchased electricity ($PElec_T$) and heat, steam and cooling ($PHSC_T$), or just their renewable portions ($PElec_{RE}$, $PHSC_{RE}$):

$$PEnergy_{Tc,i} = PElec_{Tc,i} + PHSC_{Tc,i} \quad \text{(Eq. 4.17)}$$

$$PEnergy_{REc,i} = PElec_{REc,i} + PHSC_{REc,i} \quad \text{(Eq. 4.18)}$$

5. G500 participation in the SBTi and RE100 initiatives

An essential step in our analysis consists of obtaining data on the Global 500, and identifying which companies in this group are participating in the SBTi and RE100. The aim of the chapter is to answer the following question:

SQ1: *What is the degree and distribution of participation of G500 companies in the SBTi and RE100 initiatives?*

Identifying, classifying and validating this information will give more transparency on the characteristics of this group of companies, as well as ensuring reduced errors during further analyses. Companies will be assessed in three different dimensions: geographical, economical sector and energy use categories.

The chapter will be structured as follows: First, section 5.1 will summarize the results of the analysis from a general perspective. Details on the evolution of membership across the years will also be given. After it, section 5.2 will explain how these companies are distributed across the globe, and the degree of participation of each country in particular. Section 5.3 does the same but from a sector perspective, detailing the distribution of participation in each initiative in terms of economical sectors and energy use sectors. After this, section 5.4 will end the chapter by summarizing the information and giving conclusions[1].

[1] In case the reader wishes to understand the procedure used to identify members, it can be found in section 4.5.1.

5.1. Overall ICI participation in the G500

This section analyses ICI membership in the G500 from a general perspective in order to understand how participation is distributed at three different levels: geographical distribution, economical sectors and energy sectors. A general overview of ICI participation along with the overlaps between members of the SBTi and RE100 can be seen in fig. 5.1. Over a quarter of these companies have joined at least one of these two initiatives. The SBTi has accrued the largest portion of members, a total of 116 companies (23.2%). Despite its smaller share, the number of RE100 participants is still significant with 69 companies (13.6%). However, there is a significant overlap between SBTi and RE100: 35% of ICI members have joined both initiatives, leaving SBTi and RE100 with only 68 and 21 exclusive members, respectively.

It is also important to know the level of coverage of the total membership of each initiative. The sample of 137 ICI members covers 9.6% and 23.9% of all the members of the SBTi and RE100 as of 23rd February 2021, respectively. This means that this study will only deal with a small sample of businesses for each initiative. Coverage percentages similar to that of the SBTi (i.e. close to 10%) are found in other ex-post studies dealing with NSA result evaluation (Hsu et al., 2020c).

This may not be an issue, since a potential advantage of the G500 subset is materiality. The sample is likely to include high emitting companies due to their sizes. A recent paper by Schröder et al. (2020) found no evidence of economic growth decoupling from emissions at neither the production nor consumption levels up to 2015. It would be fair to expect this to apply to businesses with large revenues to some degree. A similar effect was seen in the report by de Jong (2011): the top 5% companies by revenue covered 22% of total emissions, in a sample of 2000. In short: although the subset of 137 companies may be small compared to overall membership, it should encompass a significant portion of the total scope 1+2 emissions and energy used by members in these initiatives.

5.1.1 SBTi participation

The 116 companies in the SBTi appear to be a particularly active subset of the initiative's members, as shown in fig. 5.2. When compared to the SBTi's overall membership several differences are easily identified. The G500 subset has an above average level of approved targets (fig. 5.2a); almost two thirds of the companies instead of the 50/50 split seen in the initiative overall (fig. 3.2b).

When it comes to the distribution of target categories (1.5°C, well-below 2°C or 2°C pathway compatible), the G500 subset is quite similar to the level of ambition seen in the rest of the initiative: 1.5°C remains the most popular category edging just above a half of the members with approved targets (52.8%), essentially the same percentage seen in the initiative overall (which was 51.6%). Well-below

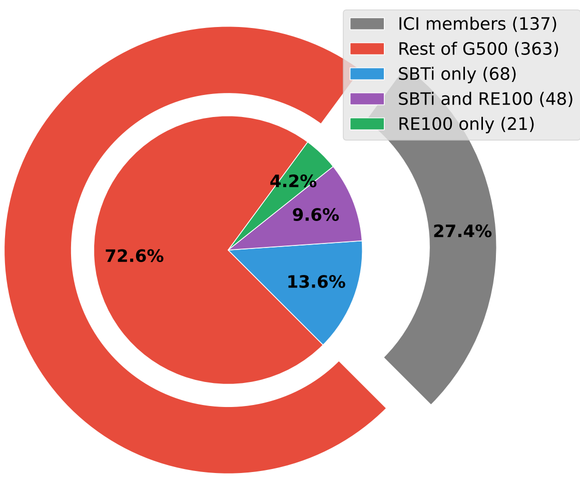
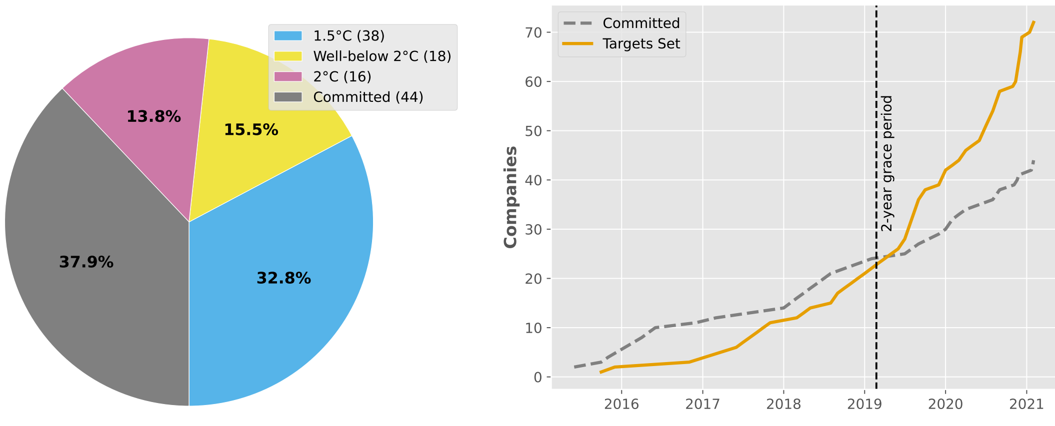


Figure 5.1: Participation in the SBTi and RE100 in the Fortune Global 500 as of 23rd February 2021.



(a) Distribution of SBTi categories among G500 members (Source: (SBTi, 2021b); own figure).

(b) Cumulative status update dates of committed and approved G500 members (Source: (SBTi, 2021b); own figure).

Figure 5.2: Details on SBTi members in the G500 as of 23/Feb/2021. Dates of in fig. 5.2b should not be interpreted as the first time a company's targets were approved.

2°C and 2°C also follow this pattern with 25% and 22.2% respectively, essentially the same numbers seen in the larger sample. Since the 2°C category has been depreciated (Giesekam et al., 2021), this preference for 1.5°C is an unexpected but welcomed trend, and may indicate that the initiative's recent campaigns like the Business Ambition for 1.5°C (SBTi, 2021a) are bearing fruit.

A cumulative progression of the update dates of the companies' statuses is shown in fig. 5.2b. It accurately displays the times at which committed companies joined, but in the case of those with targets it may not display joining times with precision. This is because these companies may have updated a previously approved target recently due to various reasons (e.g., changes to a company's boundaries or setting more ambitious goals to achieve a better target category). Regrettably, it was not possible to ascertain the specific dates when each company's targets were first approved by the SBTi. This information was not available in the initiative's website, databases or reports in a disaggregated way, and the initiative itself did not provide it when requested.

Still, some conclusions can be drawn: there appears to be an increasing level of activity in regard to target approval/updates in recent years, which started around mid-2019 and continues to this day. This acceleration is barely seen in committed members, however; as most of these companies appear to be lagging behind. Figure 5.2b includes a vertical dotted line at exactly two years before the sample used in this study was taken (23rd February 2019), marking the date at which the initiative's own waiting time for target approval should have passed. Twenty-four companies are lagging behind, of which a majority of fourteen are financials. Giesekam et al. (2021) identified a similar trend in their study, and theorized that they might be waiting for the initiative to develop a specific target methodology for their sector.

5.1.2 RE100 participation

This initiative has 69 G500 companies among its members and does not disaggregate them into subcategories, simplifying analysis. Since RE100 does not disclose any information regarding when companies joined in their website, the initiative's annual reports (RE100, 2018a; RE100, 2020a) were used to determine them. If a company was not mentioned in any report (which only applied to the most recent members), the initiative's own website and social media platforms of either the initiative or the company in question where used to determine it.

Figure 5.3 shows how the number of G500 companies in RE100 has grown steadily over the years, with no signs of slowing down. If 2014 and 2021 are ignored, an average of ten top companies join the initiative each year. Also, the three companies that joined in 2014 are all both founding members and Fortune G500 rankers: BT Group, Nestlé and Swiss Re (RE100, 2014)

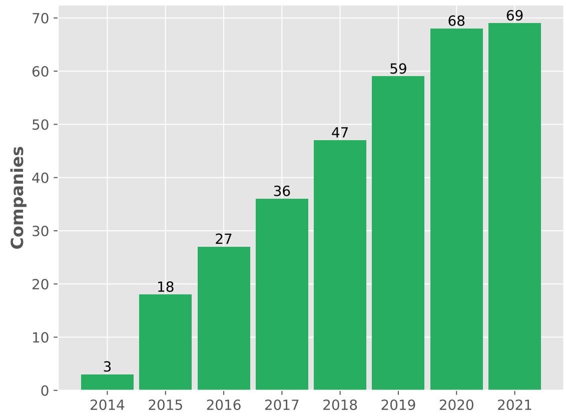
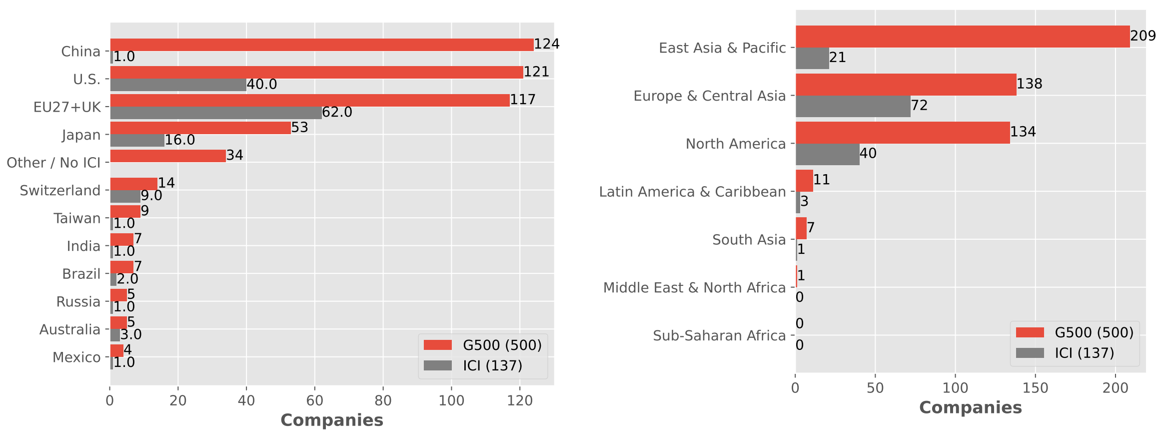


Figure 5.3: Cumulative membership of G500 companies in RE100.

5.2. Geographical distribution

Unfortunately high revenue companies are not distributed equally around the world, which makes any study on them skew towards a few privileged regions with high economic activity. G500 companies have their headquarters in 32 different countries[2]. However, almost three quarters of them are concentrated in three large groups: China, the United States and a combination of the EU27 and the United Kingdom (fig. 5.4a). Japan, which comes in fourth place, is the third nation with most companies in the ranking with 53 (no individual European nation has more than 31). A regional overview of these companies, seen in fig. 5.4b, is even more disparate: Africa, Latin America, the Middle East and South Asia are significantly underrepresented in the G500 index, and thus are also missing in the ICI sample.

Overall participation in the initiatives shows several key differences. For starters, the East Asia & Pacific region has considerably fewer SBTi and RE100 participants than companies in the G500 ranking. This is the most concentrated region in the G500 with over 200 companies, but only a tenth of them are members in the ICIs (most of them Japanese). In fact, only Europe crosses the 50% mark when it comes to participation.



(a) Total companies per country or in the EU27+U.K.

(b) Total companies per geographic region, as defined by the World Bank.

Figure 5.4: Geographical distribution of companies in this study, and ICI (RE100, SBTi) members.

[2]Please see table F.1 in the appendix for a more detailed overview of country distribution of G500 companies.

The per-country ratio between G500 companies, and those in ICIs is shown in fig. 5.5[3]. Clearly, this type of graph heavily benefits or penalizes countries with few companies (e.g., Nordic countries all have either 100% or 0% since all of them only have a single company in the ranking). Despite these details such a graph is a useful guide for identifying trends and highlighting irregularities.

European countries are generally top performers when it comes to membership; the U.K., Ireland and Switzerland are the three non-single company countries with the most participation, and France, Germany and Spain all achieve more than 50%. The Netherlands and Italy are the biggest outliers in the subcontinent, having both less participation than 20% and at least 6 companies in the ranking.

ICI participation falls significantly outside of Europe: only Australia had more than 50%. Interestingly, Japan and the Americas showed similar percentages (with one significant exception), forming a second group in terms of commitments. Asian nations, aside from Japan, tended to have significantly less level of engagement: China, India, Singapore, South Korea and Taiwan all scored less than 20% and all have more than one company in the G500 list.

Two nations with very low levels of participation stand out. China, the nation with the largest number of companies in the sample, had only a single company participating in either the SBTi or RE100 (technology giant Lenovo). Canada is the other oddity: not a single company participated in either initiative, despite eleven companies from this country featuring the G500 listing. No easily identifiable reason was found to explain this lack of engagement. The SBTi is based in its neighboring country and RE100 has several Canadian members outside the ranking (RE100, 2020a), and many of the Canadian businesses in the G500 are financials, the largest sector in the RE100 group (see section 5.3)

Overall results seem to corroborate findings in the literature stating that NSA action tends to flourish in developed countries and nations with strong civil liberties (Andonova et al., 2017; Hsueh, 2017). There are some dichotomies though: some nations (mainly Canada, China, India and Italy) have been shown to have significantly more ICI participation than in the 137 ICI sample. A possible

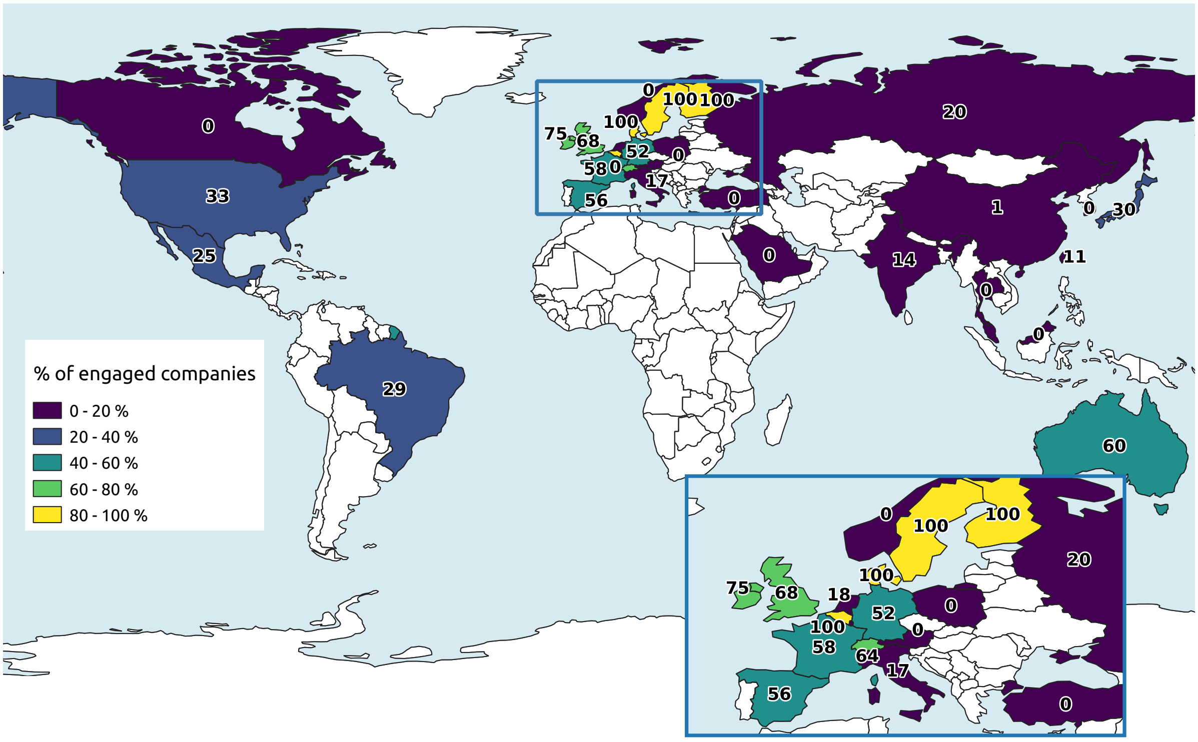


Figure 5.5: Percentage of country participation in the SBTi and RE100 per total G500 companies in that country.

[3]Please refer to fig. F.1 for a disaggregated overview of G500 and ICI totals per country.

explanation is the business focus of this study: these countries might focus on other types of actors, such as subnational entities, instead of large companies.

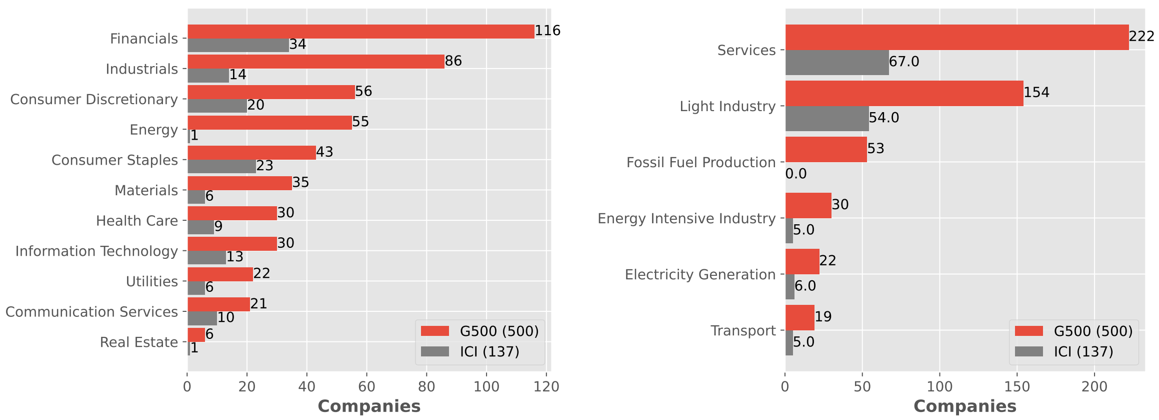
Another interesting detail is that high participation ratios in these initiatives are more concentrated in countries that do not explicitly mention NSAs in their Paris NDCs, most of them being developed nations. Hsu et al. (2020b) theorized that developed nations might have omitted referring to NSA actions as a way to appease concerns from developing ones, who argued that their mention could potentially distract from broader commitments.

5.3. Sectorial participation

Economic and energy sectors are dimensions that must be explored in order to get a proper picture of our sample of companies. Most of them are multinationals meaning that their influence spans across different countries and regions; exclusively analysing the geographical dimension would be imprecise. Sector classifications may aid in alleviating the plurality of our sample. Well-developed sectorial classifications can produce groupings with high homogeneity in the metrics they were designed for (Hrazdil et al., 2014). For this study, two sectorial classifications were used: the market-focused Global Industry Classification Standard (GICS) and a self-made energy use sector classification developed using literature studies[4].

Figure 5.6 categorizes all the G500 and the ICI members subset using the classifications stated above. Both show a general trend towards Financial and Service companies, who share majority in either grouping. These businesses are not expected to have high energy consumption, and thus may not be responsible for as many emissions as other sectors. Industrial manufacturers make up the second biggest group, which includes both Energy Intensive Industry (EII) and Light Industry. This group is obscured in the GICS classification since it is separated many categories such as Industrials, Materials and Consumer Discretionary; which may also include service suppliers. These three categories have differing degrees of ICI participation, with each varying between 20 to 50% ICI participants.

Companies that deal with energy production or distribution make up another large portion of the G500 sample. These include GICS sectors such as Energy and Utilities, and the energy sectors Fossil Fuel Production and Electricity Generation. An important exception in participation is the Fossil Fuel Production energy sector. None of these companies joined either the SBTi or RE100, opting to form their own initiative instead: the Oil and Gas Climate Initiative (OGCI, 2021). This initiative has had mostly a discursive role so far, but some argue that it may be able to have large impacts due to the size and capacity of its members (Bach, 2019). The economic Energy category in the GICS is for these types of companies too, but it includes equipment and service companies. This explains the single ICI

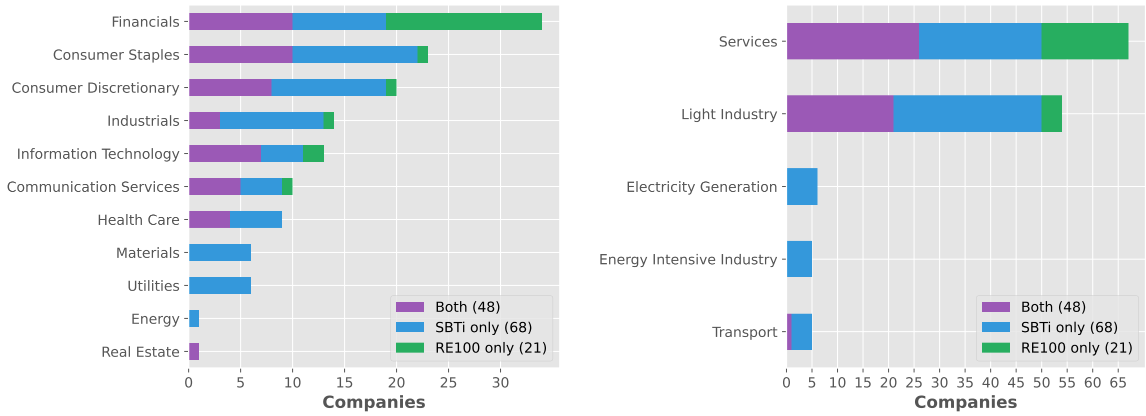


(a) GICS economic sectors.

(b) Energy sectors.

Figure 5.6: Sectorial distributions of the G500 and ICI participants.

[4] Please see section 4.2.4 in the methodology chapter for more information on how these were applied



(a) GICS economic sectors.

(b) Energy use sectors.

Figure 5.7: Sectorial overlaps between both initiatives.

participant in this group: Schlumberger, a manufacturing company that makes drilling equipment used in fossil fuel extraction who committed to the SBTi.

If fossil companies are ignored, other high emitting sectors become a small portion: Energy Intensive Industry (closely related to the Materials economic sector), and Electricity Generation (essentially the same as Utilities in the GICS) combined account for around 10% of the G500, and also account for around 10% of ICI members. Both of them, along with the Transport energy sector, have similar ratios of membership: between 21 and 27%.

The high degree of overlap between the initiatives (fig. 5.1) necessitates a dive into which types of companies decide to join them. Figure 5.7 disaggregates each sector classification into single and mixed members (i.e. single SBTi and RE100 members, and those in both).

RE100 is easily identifiable in the Financial sector, overwhelming the other two groups. Exclusivity in this initiative is relatively sparse otherwise: IT companies, the second largest group of single RE100 members, are only a fifth of single member Financials. All the other economic sectors with single RE100 members (Consumer Discretionary, Consumer Staples and Materials) have only one.

SBTi single members are more heterogeneous in their distribution: most sectors feature at least four exclusive members, with some exceeding ten. Accounting for this, Consumer Staples (food companies, supermarkets and cosmetics companies) actually make up the largest economic sector in the SBTi. This initiative takes up all the high emitting sectors too: all the Utilities and all Energy Intensive companies are SBTi members exclusively. Transport is a similar story, with just one company (French logistics company La Poste) joining both initiatives.

Mixed members are also distributed heterogeneously when it comes to economic sectors, with the exceptions stated above. However, it can be easily identified that most of them are either Service or Light Industry companies. This leaves SBTi as the initiative with not only the majority of members, but potentially the largest share of covered emissions in the G500.

5.4. Summarizing G500 participation in the SBTi and RE100

This chapter set out to answer the following question:

SQ1: *What is the degree and distribution of participation of G500 companies in the SBTi and RE100 initiatives?*

To do so, several algorithms and manual checks were employed to detect the companies in the G500 that have become members, identifying those who have enrolled in both. In total 137 companies have joined the SBTi and RE100, with 48 of affiliating with both. Individual members are mostly concentrated in the SBTi with 68 exclusive joiners, leaving the RE100 initiative with just 21.

This subgroup of 137 ICI members was contrasted against the G500 total at three different levels: geographical, energy sectors and economic sectors. This was done to enrich further analysis of the initiative's effectiveness.

Geographic distribution showed that G500 companies are concentrated in three groups: China, the U.S. and the EU27+U.K. However, only the last two had a significant amount of ICI participants, since only one Chinese company in the G500 joined either initiative. In fact, more than half of all participants are concentrated in Europe alone.

Energy sector involvement is mostly composed of service and light industry companies, the first being the bulk of RE100 participants, and the second the greater part of the SBTi. This last initiative is the only one with a few members in high emitting sectors such as Energy Intensive Industry and Electricity Generation. No fossil fuel producers in the G500 have joined.

Lastly, economic sectors showed a heterogeneous distribution of participants for both initiatives. However, in the case of exclusive members RE100 had a large concentration in Financials, and very few in any other. SBTi contrasted this with its sole joiners spanning across most economic sectors.

6. Evaluating the performance of the Science Based Targets initiative

This chapter assesses the Science Based Targets initiative in order to answer the following questions:

- ***SQ2:*** *Are these companies setting appropriate targets and what impact can be expected of them?*
- ***SQ3:*** *Through which methods are these companies improving their capacity to deliver on their targets?*
- ***SQ4:*** *To what level has the collective work of these companies lead to substantive climate mitigation?*

To achieve this, a descriptive analysis of the combined action of G500 companies who are members in the SBTi was carried out using the four types of progress in the logical framework developed by Hale et al. (2020). These types of progress are: ambition, robustness, implementation and substantive impact. Analysis is limited to scope 1 and 2 since they are either within the boundary of the company or under direct control of their energy purchasing decisions, and do not rely on inaccurate supplier data[1].

The first question will be answered by looking into the targets set by these companies, assessing their collective ambition against global scenarios. Improvements on the capacity to deliver will be measured on two levels: by the robustness of the assurance procedures employed by each company to validate their climate metrics, and by the collective trends in energy use. Finally, overall GHG emissions produced by the group will be reviewed. All aspects will be brought together in order to judge the causal impact of the joint actions of these companies in order to provide conclusions.

The chapter is ordered as follows. First, section 6.1 contextualizes the different sample groups that will be evaluated. Second, section 6.2 assesses members with absolute targets on the four types of progress, subdividing them by energy sector. Then, section 6.3 evaluates companies with either intensity targets or only committed to setting them. Section 6.4 provides a causal assessment of the impact that these companies have had. Finally, section 6.5 ends the chapter by summarizing it and giving conclusions.

[1] Methodologies specific to how target trends were created for members in this initiative and how the log frame model used in this chapter was developed can be found on section 4.3 and section 4.6.2, respectively.

6.1. Sample of companies in the analysis

It is crucial to clarify the different groups of companies that will be analysed. A total of 116 companies in the G500 have joined the SBTi in some capacity, but not all of them can be examined with the same level of thoroughness. Figure 6.1 summarizes all the different groupings of member companies: excluded members with missing information, committed companies, and those with absolute or intensity targets.

First, it was not possible to collect and verify data for all members: a total of seven companies had to be excluded because of this. These companies did not disclose environmental data with enough consistency to complete the five-year period of this study. They were: French container shipping company CMA CGM, North-American online retailer Amazon (who, in fact, has actively avoided disclosing their energy consumption for quite some time according to Bryce (2021)), Mexican telecom company América Móvil, Swedish manufacturer Volvo, the Russian X5 Retail Group, U.K. based insurer Phoenix Group and the Japanese Fubon Financial Holding (see appendix E for more information). Of these companies only América Móvil had set targets, all the rest are committed members.

Of those companies whose information could be collected, 38 are committed members. Members with targets have been divided in two sub-groups: those with at least one absolute scope 1+2 target, with a total of 64 companies, and those who are using intensity based metrics for scope 1+2 or have no targets for those scopes at all, which add up to seven members. Only American software company Microsoft fell into the "other" group, as they only have a renewable electricity target for scope 2 and lack any emission targets for scopes 1+2. Six other companies had renewable electricity targets on top of GHG emission ones: Nestlé, Deutsche Telekom, Bosch, Anheuser-Busch InBev, Vodafone and Schneider Electric. These renewable targets will not be evaluated as they fall within the boundary of scope 1+2 emission targets, and every company with these except for Bosch is also a RE100 member.

All absolute targets for scope 1 and scope 2 were combined ones (i.e. the target baseline is the sum of both scopes), with the majority of them using market-based energy purchases as their method of tracking progress for scope 2 (fig. 6.1, right side). SBTi does not disclose whether the scope 2 portion of the target is market or locations-based, so this information had to be acquired from CDP responses[2].

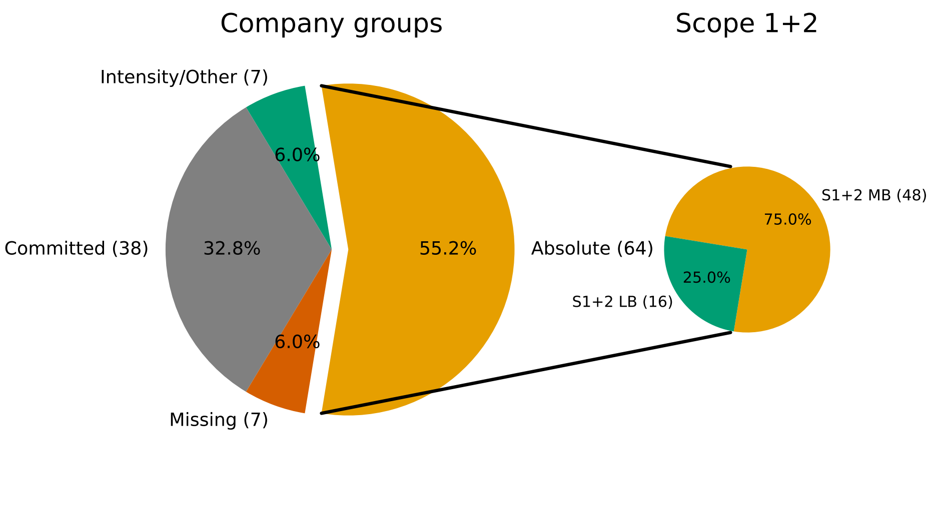


Figure 6.1: Distribution of G500 companies participating in the SBTi. Only scope 1, scope 2 or a combination of both were considered for the absolute and intensity/other groupings.

[2]See section 4.5.2 for more information on the target gathering procedure.

Intensity targets suffer from increased information issues (Giesekam et al., 2021). So much so that even the most recent SBTi progress report was unable to track progress for some companies, including some within the sample of this study like Microsoft, ENGIE and Renault (SBTi, 2021e). Companies with this type of target will not be explored as thoroughly due to these limitations.

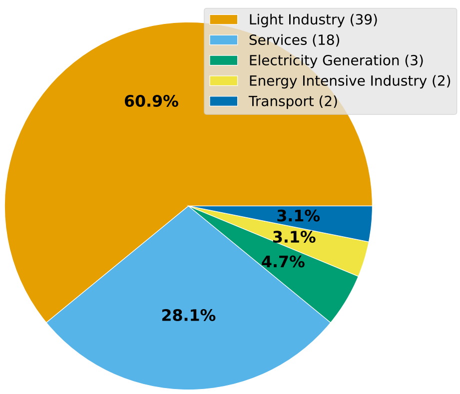
6.2. Performance of companies with absolute scope 1+2 targets

Here the results of the log frame analysis for companies with absolute scope 1+2 targets are given. These targets only cover emissions generated within a company's organizational boundary, and the emissions generated by their energy purchases (World Resources Institute, 2011). For simplicity, it is assumed that there are **no overlaps** between member commitments.

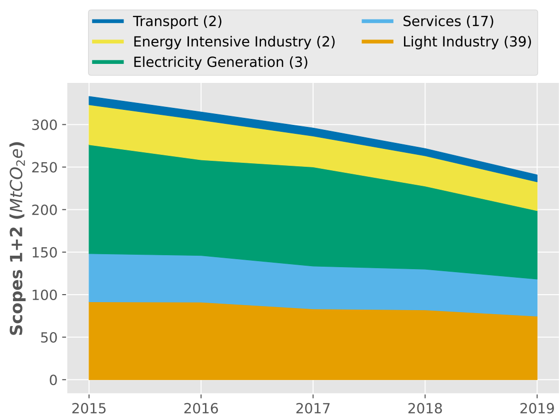
During the analysis, the total companies with active targets (i.e. within the base and end year period) will be specified for each year as n in figures. This does not mean that the data for that year is *only* for those members with active targets. In many cases the data is for all applicable members, and n is there just to show how many of them had an active target in that year. The goal of n is to aid the reader in visualizing the progression of coverage within the scope of the current targets disclosed by the SBTi. This approach was deemed preferable since it avoids excluding old members who updated goals recently, and to present information in a holistic manner.

Figures are presented in either the total collective sample or in disaggregated energy sectors as this classification was deemed more useful for the analysis. Economic sector data was useful for more specific inquiries, and it can be found in appendix K. Other disaggregations, such as the qualifications used by the initiative, are also found in that appendix.

Analysis only corresponds to 64 companies in the case ambition (fig. 6.2a). For all other progress indicators it will correspond to 63 since one member (telecommunication service company Vodafone Group) set their target baseline at 2020, which is outside the analysis period of 2015–2019 (fig. 6.2b). Although it was observed that members with targets have a tendency to engage in emission reductions before baseline years, this company was still omitted to maintain consistency.



(a) Distribution of 64 members with absolute scope 1+2 targets by energy sector.



(b) Evolution of emissions of 63 companies within the sample period.

Figure 6.2: Emission trends and energy sector distribution of companies who only set absolute targets for scopes 1, 2 or both.

6.2.1 Ambition

Figure 6.3 shows how the combined ambition of all 64 companies in the sample is consistent with a lower 2°C pathway. Approximately 300 $MtCO_2e$ are covered in 2015 by the extended targets, which should be reduced to 171 $MtCO_2e$ by 2030 if all companies achieve their goals, representing a reduction of 43%, and differing from the Current National Policies (CNP) scenario by 133 $MtCO_2e$. This is in line with how the SBTi qualifies ambition, since the majority of these companies were classified as 1.5°C (34) or well-below 2°C (15) compatible.

In fact, when separating the sample for each of the three qualifications of the initiative, overall results showed them to be within the expected trend (see fig. H.2). Essentially, the initiative's own qualifications appear to be good indicators of collective ambition when compared against global IPCC scenarios. More than two thirds of covered $MtCO_2e$ are also concentrated in the 1.5°C and well-below 2°C qualifications. This should improve as members update their targets away from the depreciated 2°C category.

Trends in energy sectors also give interesting results. Most importantly, there are significant differences in the emissions covered by each sector, with most of them concentrated in a handful of companies (fig. 6.4). Although only three electric utilities are in the sample, they represent a third of the emissions covered. If the two energy intensive companies are added to them, this concentrates half of all emissions covered in just five companies, less than 8% the members in the sample. For energy consumers, ambition appears to decrease the more intensive the sector: service companies are confidently inside the 1.5°C pathway, while light industry falls just outside it. The number of companies in other sectors is too small to be used for overarching statements; still, none of them are as ambitious, with EII being the least ambitious sector overall.

A surprising outcome of economic sector analysis was a trend for short-term targets in IT companies (fig. H.1). This sector is often touted as a front-runner in climate mitigation, making this lack of ambition a surprise. However, this might be due to the already low emissions in the sector (the lowest per-member of all economic sectors). The sectors with the highest overall ambition were industrials and communication services. The first is mostly made up of manufacturers of electrical equipment, but also includes two transportation companies (which did not fare that well as seen in fig. 6.4d).

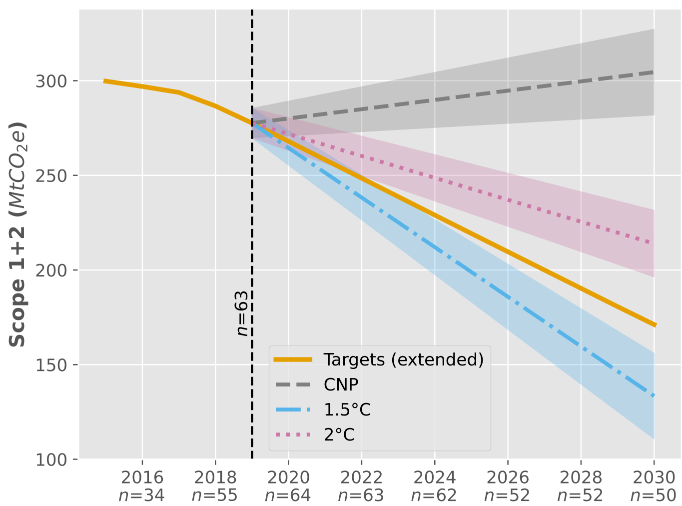
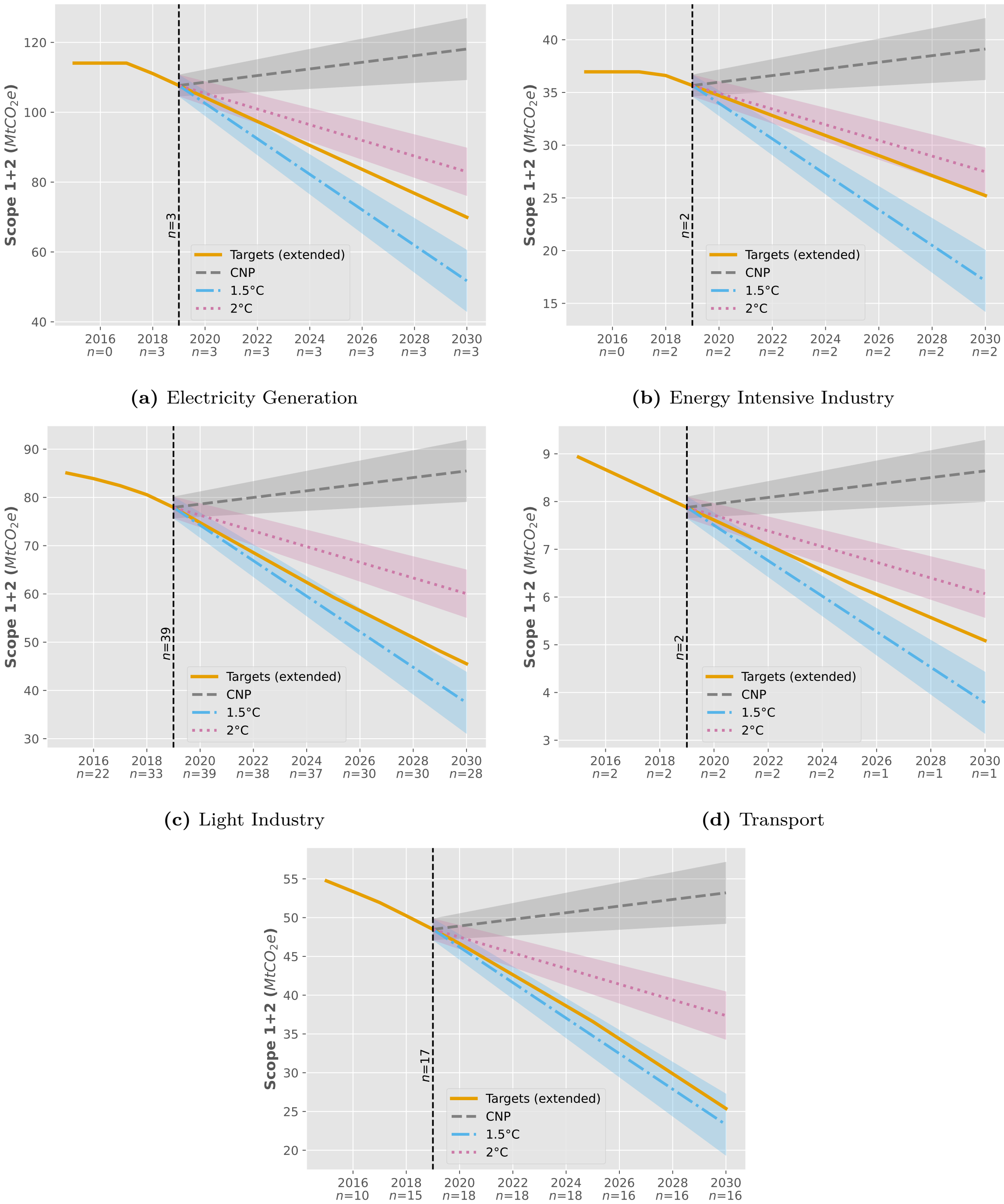


Figure 6.3: Emission mitigation ambition of 64 G500 companies with absolute targets for scopes 1+2, compared against normalized scenarios from UNEP (2020).



(a) Electricity Generation

(b) Energy Intensive Industry

(c) Light Industry

(d) Transport

(e) Services

Figure 6.4: Ambition of G500 companies in the SBTi who have set absolute targets for scopes 1+2, subdivided by energy use sectors. Notice that y-axis scaling differs between figures.

6.2.2 Robustness

The presence and level of yearly third-party assurance for each scope is shown in fig. 6.5. A progressive decrease in the number of companies without any type of third-party verification can be easily identified. By 2019, only one company had never engaged in any kind of external verification (American meat company Tyson Foods). The robustness profiles of scope 1 and scope 2 are largely the same, indicating that companies tend to verify both scopes in tandem. The only exception was an electric utility, Électricité de France, which assures scope 1 at a reasonable level, and scope 2 at a limited level.

Despite the high percentage of assured companies, most of them only do so at a limited level, and there is little evidence of any improvement in the type of verification sought: assurance at a high or reasonable level has remained essentially the same in the past five years (fig. 6.5). This might indicate that once an emissions accounting scheme has been put in place and minimal external assurance is obtained, there is little incentive to improve upon it. This is in line with public consultations suggesting that businesses are generally against stricter assurance requirements (European Commission, 2020).

This lack of high quality verification generally applies to all energy sectors with a large enough sample size (fig. 6.6). The similarities between the light industry and services sectors came as a surprise, as it seemed logical that the second would seek lower levels of assurance. In the case of high emitting sectors such as utilities and EIIs, no overarching statements can be made due to the small sample size. Still, it is worrying to see that assurance of at least a reasonable level is not a standard practice in neither of them considering the large amount of emissions concentrated in these five companies. The assurance level is still better than the one seen in other studies of large emitters, but given the unreliability of CDP disclosures it is still a reason for concern (Stanny, 2018; Liesen et al., 2015).

Economic sectors allow better visibility into how these companies engage in assurance (fig. H.3). One company alternated between high and limited levels of assurance every two years (British pharmaceutical GlaxoSmithKline), most likely as a way to minimize the costs associated with it. No other member showed this behavior. Companies without assurance tend to obtain limited assurance as a first step, as expected. Most sectors had at least one member switching to a reasonable level of assurance, but these improvements were counteracted by a similar decrease in others (particularly in the Consumer Staples and Real Estate sectors).

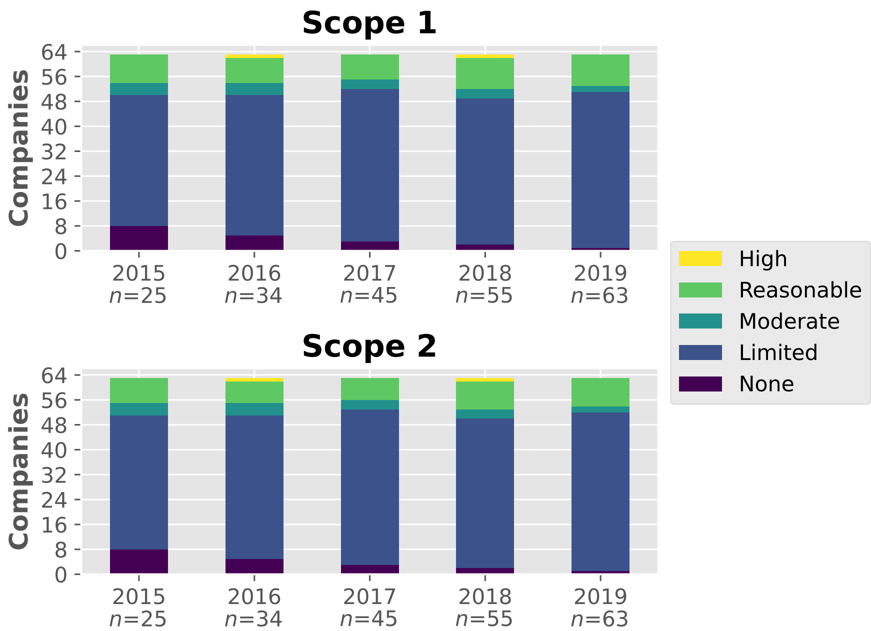
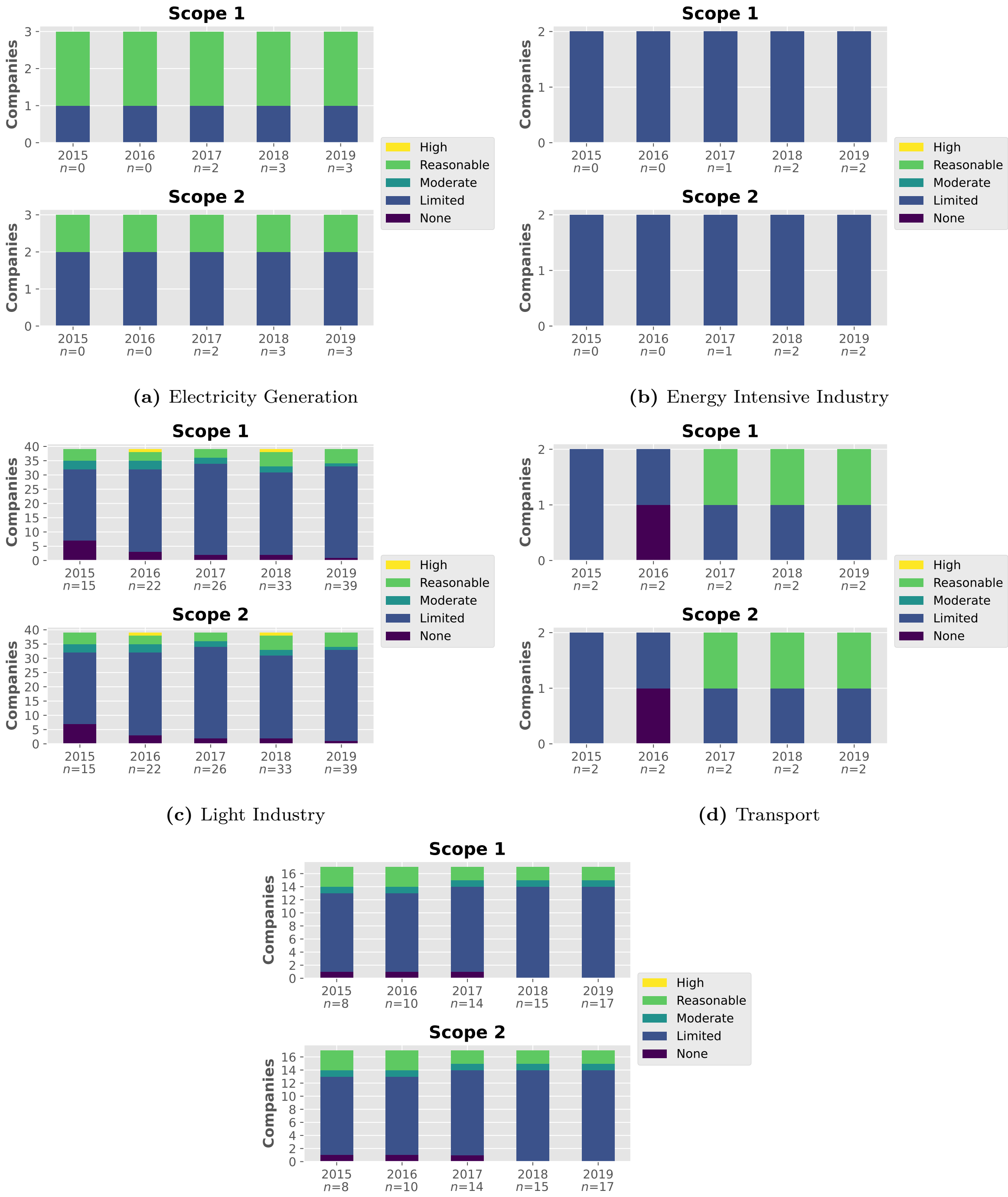


Figure 6.5: Degree of third-party assurance and verification for scopes 1 and 2 in all 63 companies with absolute scope 1+2 targets, between 2015 and 2019.



(a) Electricity Generation

(b) Energy Intensive Industry

(c) Light Industry

(d) Transport

(e) Services

Figure 6.6: Robustness of G500 companies in the SBTi who have set absolute targets for scopes 1+2, subdivided by energy use sectors. Notice that y-axis scaling differs between figures.

6.2.3 Implementation

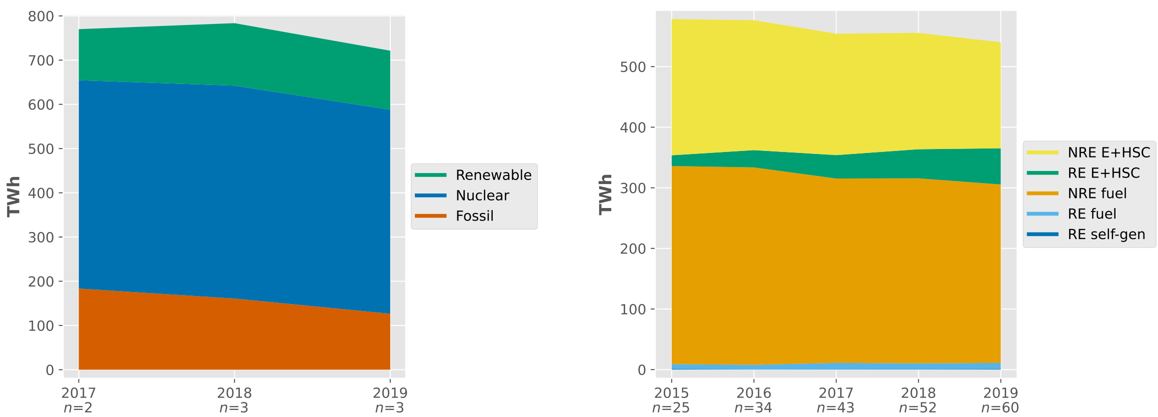
Implementation is evaluated by looking into the energy profiles of these companies. Energy consumers are separated from energy producers in order to show progression in a more logical way. Overall results can be seen in fig. 6.7. Generally, energy generation companies appear to be tackling mitigation by generating more renewable energy, and reducing fossil use in their portfolio. In the case of end-users, most sectors appear to be using renewable energy purchases as their primary mitigation strategy; with reduction of fossil fuel use playing a secondary role. There is little evidence of increased adoption of alternative fuels or increased use of self-generated non-fuel renewable energy.

Figure 6.7a displays net-energy generated (i.e., subtracting self-consumption) by the three utility companies in the sample: nuclear giant Électricité de France (EDF), French multi-utility Veolia Environnement and Spanish electric utility Iberdrola. Only three years can be shown as older version of the CDP questionnaire did not collect this kind of data, and annual reports of utilities also did not disclose the necessary data. Still, this time range fits within the target boundary of all companies.

Energy trends of these companies generally show that they already rely significantly on low carbon energy sources, with nuclear being the biggest energy source by far. EDF is the main cause of this, generating over 430 TWh of nuclear electricity every year. Iberdrola only generates around 23 TWh, while Veolia has no nuclear generation. The percentage of nuclear generation in this group of companies has increased slightly over the years: 61% in 2017 to 64% in 2019. Renewable generation has increased moderately (15% to 18.5%), while fossil fuels show the most drastic change (24% to 17.5%). Individually, all members increased their use of renewables, but the smaller companies displayed the largest increases: Veolia went from 17 to 24%, and Iberdrola went from 36.8 to 51.8%.

The energy profile of these companies gives a bitter-sweet message: while it is good to see how they collectively produce a lot of clean energy, it also means that joining the SBTi did not imply a drastic change in behavior. Only the company with the least generation had less than 50% low-carbon generation in 2017 (Veolia, with 17.2%). Targets from these three companies already cover a significant portion of the emissions in the sample. Other utilities with less ideal profiles would make invaluable additions to the SBTi's membership.

Changes in the energy profile of end-use companies are shown in fig. 6.7b, and an energy sector disaggregations can be seen in fig. 6.8. It is made up of five energy categories. Renewable non-fuel self-generation (RE self-gen), renewable fuel (RE fuel) and non-renewable fuel (NRE fuel) are shown in the lower portion of the graphs, and relate to scope 1 emissions. Purchases of electricity and HSC (RE E+HSC, NRE E+HSC) both relate to scope 2 emissions.



(a) Net electricity produced by utility companies.

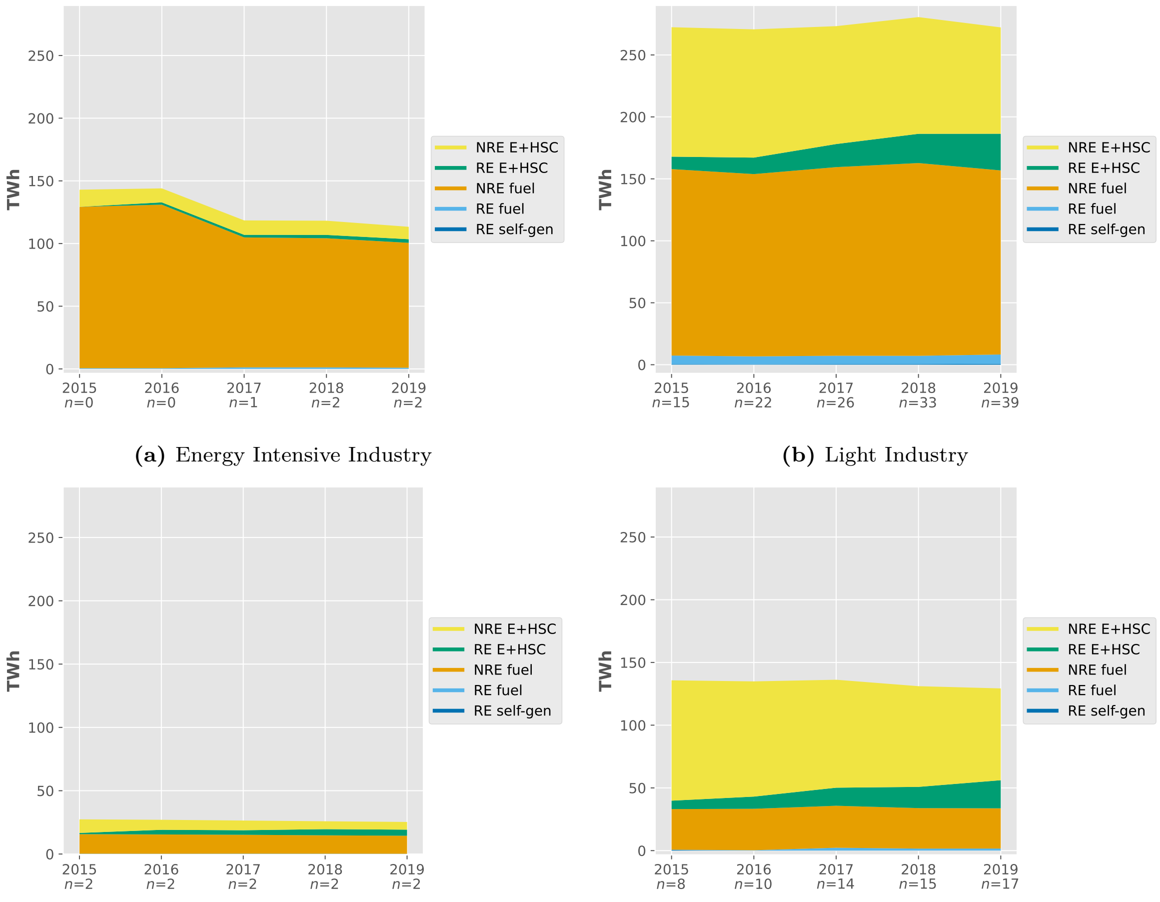
(b) Energy consumed by all end-use companies.

Figure 6.7: Implementation of different energy measures in 63 companies who have set absolute targets for scopes 1+2.

Overall energy demand has fallen relatively steadily between 2015 and 2019 ($R^2 = 0.9$). This in itself is not surprising due to the high participation of European and Japanese companies. According to the IEA current policies are enough to continue reductions in demand in these countries, which have had a downward trend since the mid-2000s (International Energy Agency, 2018).

Most of this reduction in energy demand stems from within the operational boundary of these companies (scope 1) due to a reduction in fossil fuel consumption: by 2019 consumption fell by 32.5 TWh, with EII and transport sectors being the prime contributors in the sample. It should be noted that most of these reductions come for a single company (German steel manufacturer ThyssenKrupp), who showed a drastic decrease in energy use between 2016 and 2017. Energy sectors with larger samples did not show this reduction: both light industry and service companies have kept fuel usage stable throughout the five years analysed.

Aside from this fuel use reduction, consumption of renewable energy within the company's boundary remains low. Non-fuel renewable generation never exceeds a collective 0.2% and is barely present in any sector at all. This does not mean that these companies do not have renewable sources such as solar or wind on-site, but if they do it is through leases or contracts such as PPAs. Renewable fuel usage appears to be heavily influenced by economic sectors instead of energy ones: consumer staples are its main user, with health care being a distant second. Both sectors are related to agriculture: food companies are self-evident, and pharmaceuticals make use of crops to obtain some therapeutic substances (S. Li et al., 2010).



(a) Energy Intensive Industry

(b) Light Industry

(c) Transport

(d) Services

Figure 6.8: Implementation of different energy sources in G500 companies in the SBTi who have set absolute targets for scopes 1+2, subdivided by energy use sectors.

Energy purchases (scope 2) exhibit the largest change in behavior in most energy-use sectors. Although the use of purchased energy only shows a modest steady increase, from 42% to 43.4% of total energy, renewable purchases have increased from just 3% to 11% of that total. Renewable electricity is the main contributor, accounting for 10.8% of total energy consumption 2015 (58.3 TWh). This trend is seen in almost every sector, with IT and communication services being the ones with the largest share at the end of 2019. Also, not all sectors increased energy use. Service companies have experienced a modest decrease in overall purchased energy: from 102.6 to 95.6 TWh.

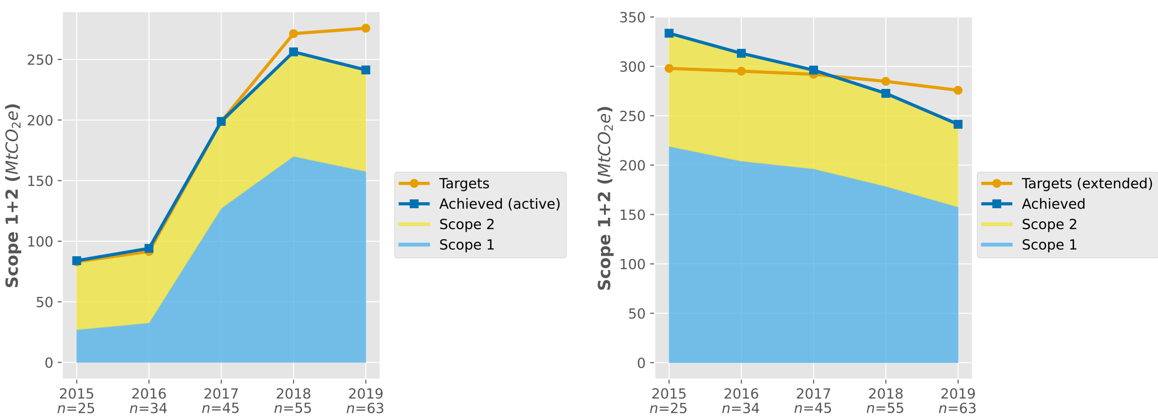
These results suggest that currently the primary driver for GHG mitigation in energy consumers is indirect in nature. Although increased sourcing of renewables is definitely welcomed, more than half of the consumed energy is inside the operational boundary of the group, and renewable purchases do not necessarily guarantee displacement of fossil fuel usage on a global scale, or added installed capacity (IRENA, 2018, page 60). Industry and services (named "buildings" in other studies) are "hard-to-abate" when compared to electric utilities (Fekete et al., 2021), which might explain the general lack of change within their respective operational boundaries.

6.2.4 Direct substantive impact

Here the evolution of emissions of the 63 companies with target boundaries within 2015–2019 is evaluated. Figure 6.9 depicts progress in two ways: the trend of emissions within the scope of "active" targets (i.e., between baseline year and target year), and for all 63 members regardless of whether they had set a target or not. The evolution of coverage within targets (fig. 6.9a) aids in understanding that even if membership within the sample has grown at a relatively steady pace, the emissions covered per year have not. It should not surprise that the largest increases in coverage happened in 2017 and 2018, when the five companies in the sectors with the biggest energy use per company (Electricity Generation and EII) set their baselines. This also coincides with scope 1 emissions surpassing scope 2. Another useful detail is how the group has begun to outpace their collective goals, achieving emissions 34 $MtCO_2e$ below targets in 2019.

Figure 6.9b enables a better view of overall mitigation by extending targets and presenting the evolution of emissions in all companies. With it a clear conclusion can be drawn: mitigation in this group of companies goes beyond what their current targets might imply. Between 2015–2019 the group has collectively reduced their carbon footprint by 93 $MtCO_2e$, while the target trend only implies a reduction of 22 $MtCO_2e$. Actual reductions are 27.6% below 2015 values with average annual rate of -7.74%, which is within the annual reduction needed for a 1.5°C pathway (Höhne et al., 2020a).

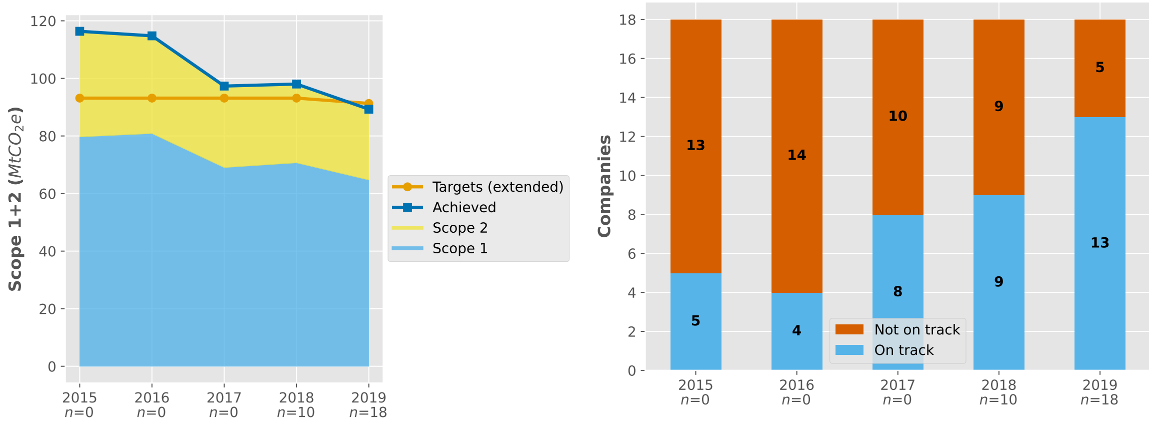
The majority of the difference between targets and achieved emissions comes from companies with recent baselines. Figure 6.10 presents substantive progress in the 18 companies who set their baseline



(a) Evolution of emissions within active targets, excluding companies that had not set them.

(b) Evolution of the sample, keeping baseline emissions constant before a target's start year.

Figure 6.9: Direct substantive impact of who have set absolute targets for scopes 1+2.



(a) Evolution of emissions.

(b) Companies whose emissions are above or below the extended target.

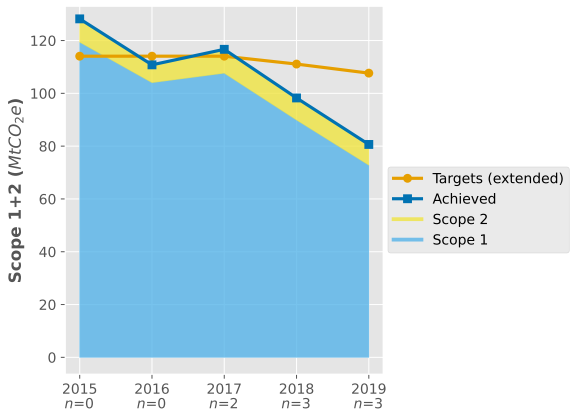
Figure 6.10: Trends of companies with a recent target baseline (2018–2019) for scopes 1+2.

at either 2018 or 2019. The difference in results is about 24 $MtCO_2e$, two-thirds of the difference in the full sample. There are several explanations for it: some of these companies could be early members who have already reached their target and submitted a new one, or maybe they updated it when the initiative disallowed the 2°C qualification in 2019. It is also possible that they began engaging in mitigation action when they committed to the initiative. Another reason could be that the initiative tends to attract businesses who where already engaging heavily in sustainability actions, which would restrict combined potential. Since the SBTi does not disclose exact membership dates, or even older targets, it was not possible to assess which one is the case.

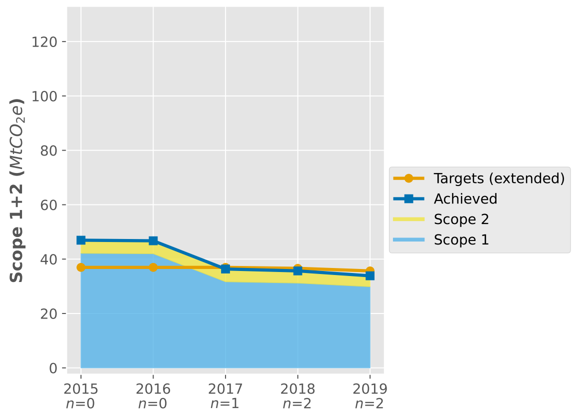
Most energy sectors also show 2015 emissions above the target baseline and overachieved collective targets, but *where* these reductions happened varies significantly between them (fig. 6.11). By 2019 the only sector with emissions above the objective was the transport sector which has only two companies, both with baseline years before 2015, and the lowest share of emissions in the sample. Light industry and service companies do not show strong evidence of a decrease within their operational boundary (scope 1), most emission reductions are tied to their indirect emissions (scope 2). Although the average emissions per-member in these sectors is low, combined they represent almost half of covered emissions. Utilities and EIIs are the inverse: these five companies are responsible for the vast majority of direct emission mitigation. In fact, utilities are also responsible for most of the target over-achievement in recent years (fig. 6.11a). Some ex-ante studies have stated that this sector is the least ambitious overall among NSAs (NewClimate Institute et al., 2019). This success could be used as an incentive for other utilities to increase their ambition. However, national climate policies tend to relate to utilities direct (Kuramochi et al., 2020). Whether this achievement is due to internal ambition, or external political influence remains an open question.

6.3. Performance of other groups for scopes 1+2

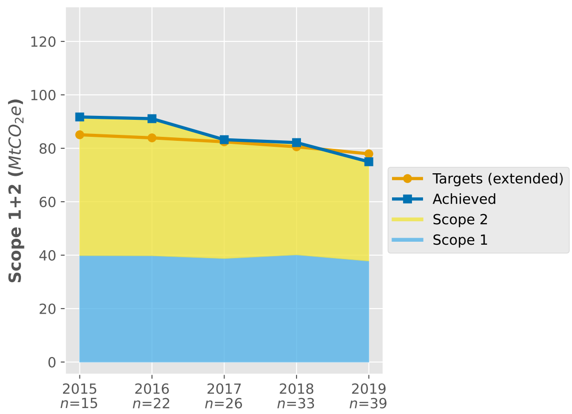
This section will briefly evaluate how other groups of companies in the SBTi have performed. Specifically, it will analyse progress for companies with intensity targets and committed members. The complete log frame methodology will not be applied since it was not possible to construct target trends for either group, meaning ambition and substantive progress could not be evaluated adequately. Robustness was also omitted for committed members, as verification data was not collected and pruned for companies without targets. Instead, the energy trends of utility companies and other big polluters will be displayed, and the emission trends in the past five years for these groups will be shown in order to identify if they have progressed. This should help in contextualizing behavior in the SBTi as a whole.



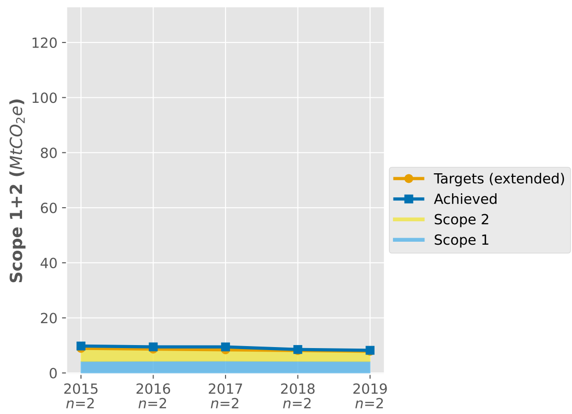
(a) Electricity Generation



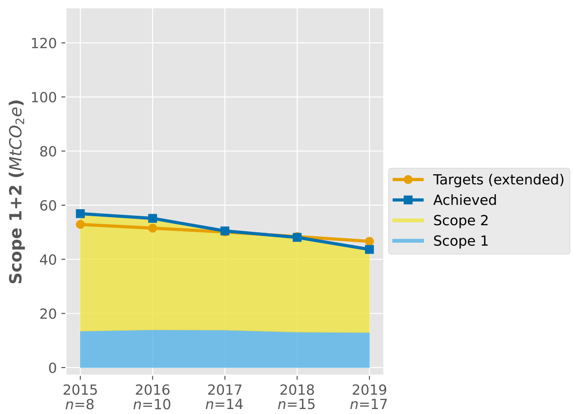
(b) Energy Intensive Industry



(c) Light Industry



(d) Transport



(e) Services

Figure 6.11: Direct substantive impact of G500 companies in the SBTi who have set absolute targets for scopes 1+2, subdivided by energy sectors.

6.3.1 Performance of members with intensity targets for scopes 1+2

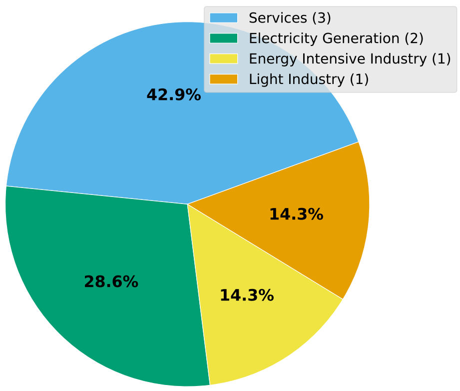
Here the companies with only intensity targets for scopes 1, 2 or both are addressed. They are seven in total, all of them with baselines within the scope of the analysis. Although few, they cover an impressive amount of emissions. Figure 6.12 indicates that, once again, emissions are concentrated utilities and EII. These are the electric utility multinationals Enel (Italian) and Engie (French), and cement manufacturer LafargeHolcim (Swiss). This time the difference of emissions between sectors is exacerbated due to the few services and light industry companies in this sample, and the size of the three large emitters. As fig. 6.12b shows, these companies alone cover more emissions than the entire sample of section 6.2. By 2015 this sample covered 441.71 $MtCO_2e$, 1.32 times that of the absolute sample of 63 companies.

Mitigation in this group has been very effective, with an average annual reduction of -12.7%. This is once again mostly due to the contribution of utility companies, who have halved their emissions from 257.6 to 128.8 $MtCO_2e$ at an impressive AAGR of -15.8%. The cement company's progress is not as drastic, but still remarkable: from 180.5 to 128.3 $MtCO_2e$ (AAGR of -8.14%).

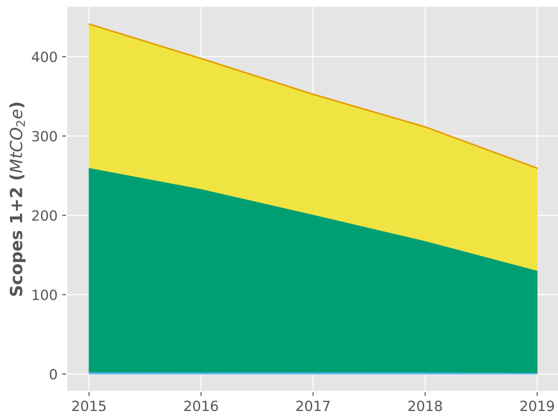
Although target tendencies are not something this section considers, there is an interesting similarity between these three large emitters, and the trends of companies with recent baselines seen in the previous section: baseline years not being an accurate indicator of when emission reductions began taking place. Both utilities set their baseline year in 2017, and the EII did so for 2018. Yet, as fig. 6.12b displays, emission reductions have been taking at least since 2015 (assuming they were constant before that).

The level of verification sought by these companies shows trends that are somewhat similar to those of the absolute sample. Specifically, they are similar in the lack of reasonable verification in big emitters. Although fig. 6.13 displays three companies with at least reasonable levels of assurance, only one of the three large emitters achieved the reasonable status (Engie). The other two only did so at a limited level. Interestingly, this makes it so that the only utility companies with good assurance are all French: Engie, EDF and Veolia Environnement. This is to be expected, as French requirements on ESG reporting are more stringent than other European nations (Aureli et al., 2018).

The energy trends of the three large emitters are given in fig. 6.14 in order to compare their characteristics to those seen in their equivalents with absolute targets (fig. 6.7a, fig. 6.8a). Once again, low-carbon energy appears to be a significant portion of the energy portfolio of the utility companies in the initiative. However, it only surpassed fossil fuels collectively in 2019. The EII profile is very similar



(a) Distribution members with only intensity targets by energy sector.



(b) Evolution of emissions in the sample period. S2 MB data preferred if available.

Figure 6.12: Emission trends and energy sector distribution of companies who only set intensity targets targets for scopes 1, 2 or both.

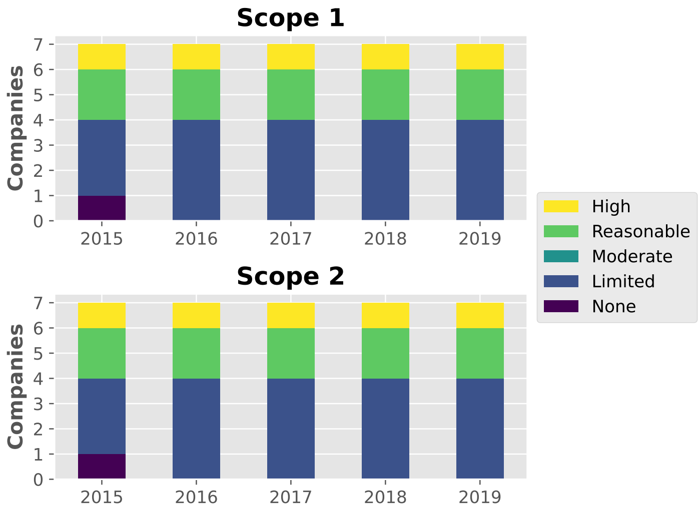
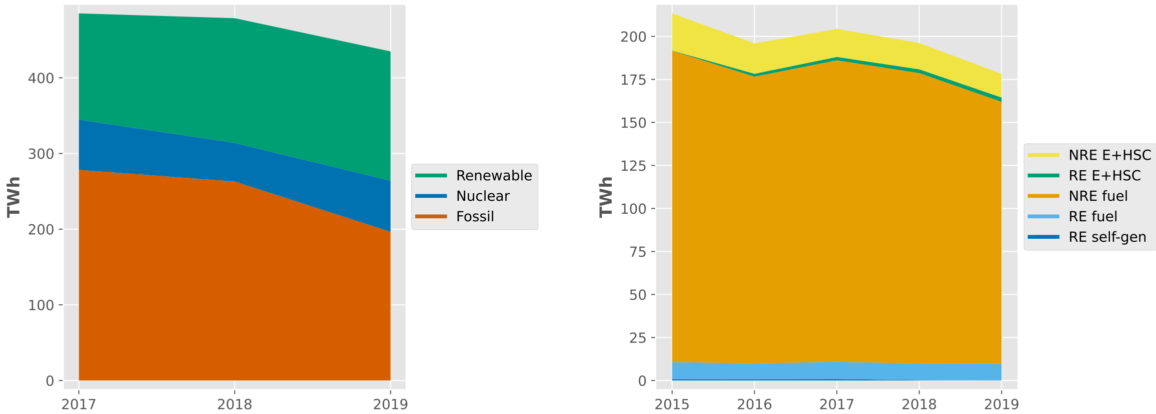


Figure 6.13: Degree of third-party assurance and verification for scopes 1 and 2 in all seven companies with intensity targets for scopes 1, 2 or both between 2015 and 2019.



(a) Net electricity produced by two utility companies.

(b) Energy consumption profile of LafargeHolcim.

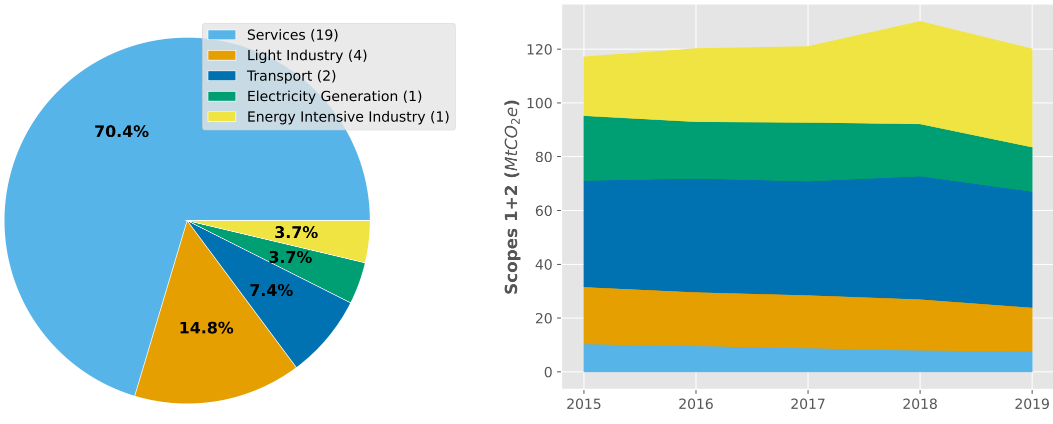
Figure 6.14: Implementation of different energy measures in three large emitters with intensity targets for scopes 1, 2 or both.

to the one seen in companies with absolute targets: most of the change in energy use appears related to reduction within the operational boundary of the company. Renewable energy is a small part of energy purchases and fuel use, but only the former appears to be increasing.

6.3.2 Performance of committed members for scopes 1+2

In total 44 companies in the G500 committed to the SBTi at the time of this study. However, their number is reduced to 27 after removing members with missing information, and those who had not become members within the period of this study. The group is distributed unevenly (fig. 6.15); more than two thirds are service companies, with light industry being a distant second. Unsurprisingly, these two sectors are also just a small portion of total emissions.

Mitigation progress in this sample is mixed: emissions have increased overall (from 117.11 to 120 $MtCO_2e$), but this is heavily influenced by a few poor performing companies concentrated in specific sectors. Services, light industry and one small utility company are responsible for most emission reductions, but these are counteracted by increments in transport and EII. Companies in these sec-



(a) Distribution committed members by energy sector.

(b) Evolution of emissions in the sample period. S2 MB data preferred if available.

Figure 6.15: Emission trends and energy sector distribution of companies who are only committed members.

tors with poor performance are just three: parcel company DHL (German), shipping company Maersk (Danish), and construction materials manufacturer CRH (Irish). They committed in 2017, 2019 and 2018 in the same order, and all of them have increased their emissions when comparing 2015 to 2019. Removing these three companies gives a good trend: emissions decrease from 55.75 to 40.49 $MtCO_2e$, with an AAGR of -7.58% ($R^2 = 0.94$). But this cannot be considered an impartial assessment since it handpicks members. If only members who committed between 2015–2016 are selected, only the utility company and a handful of service companies, all of them financials with collective emissions of less than 1.8 $MtCO_2e$, are left. This completely removes the light industry sector, which also achieved reductions.

As such, it can be safely stated that these 27 companies have not reduced their carbon footprint collectively. Emissions are once again concentrated in a few companies who determine the trend of the group, although the transport sector is the largest this time instead of utilities or EII. Services and light industry continue being the sectors with the most membership, but also those with the least collective emissions.

6.4. Causal impact

As seen in the previous sections, companies with absolute and intensity targets have been collectively successful in achieving emission reductions. Here, the implementation and substantive impact of all 70 companies with either absolute or intensity targets will be contrasted in order to illustrate clear distinctions between energy sectors in how emission reductions are achieved.

The prime difference is the scope targeted. As seen in table 6.1, EIIs and electric utilities contribute via *internal* behavioral change: scope 1 emissions of these eight companies outweigh all the rest combined, with utility companies being the main contributors. Scope 1 emissions in these companies are being reduced at a pace consistent with 1.5°C pathways (Höhne et al., 2020a), making up most of the mitigation achieved. Indirect scope 2 emissions of either to these two sectors do not appear to fit a linear downwards trend, however ($R^2 < 0.9$).

Sectors with lower energy requirements (light industry, services, transport) prefer to reduce through *external* means, with increasing purchases of renewable energy appearing to be the main the reason behind the reduction of scope 2 emissions. Internal change is sparse, with none of these three sectors giving plausible evidence of a decrease in their accumulated use of fossil fuel. Although increases in the renewable energy bought are certainly welcomed, this kind of contribution towards emission reductions is harder to track and quantify, and depends on the type of market instrument employed to source it (IRENA, 2018). Unless it is either generated with new installed renewable sources, or the fossil power plants that generate the energy that is no longer purchased by these members are taken out of commission, other entities may make use of it meaning emissions are just shifted to less ambitious

Table 6.1: Results of the sum of emissions per scope of companies with scope 1 or 2 targets, divided by energy sectors. R^2 corresponds to the coefficient of determination of a simple linear regression applied to the five data points resulting summing the emissions of each group of companies for each year.

			Sum ($MtCO_2e$)			
Sector	**Companies**	**Scope**	**2015**	**2019**	**AAGR**	R^2
Light Industry	40	S1	40.501	38.441	-1.24%	0.381
		S2	52.446	37.733	-7.79%	0.957
Services	20	S1	14.544	13.725	-1.39%	0.581
		S2	44.762	31.694	-8.20%	0.981
Electricity Generation	5	S1	371.639	196.736	-14.55%	0.987
		S2	14.169	12.655	-1.70%	0.008
EII	3	S1	206.594	150.672	-7.55%	0.981
		S2	20.807	11.533	-13.39%	0.872
Transport	2	S1	4.175	4.149	-0.14%	0.083
		S2	5.603	4.066	-7.53%	0.93
Total	70	S1	637.453	403.722	-10.75%	0.995
		S2	137.787	97.681	-8.22%	0.99
		S1+2	775.24	501.403	-10.29%	0.996

entities. Whether this is occurring is still unknown, however, meaning it is pure speculation. Regardless, more focus on direct emission mitigation should become a key focus area for these businesses, specially for light industry, where scope 1 is now the collective majority[3].

6.5. Summarizing the results of the SBTi

This chapter set out to answer three questions in relation to the SBTi:

- ***SQ2:*** *Are these companies setting appropriate targets and what impact can be expected of them?*
- ***SQ3:*** *Through which methods are these companies improving their capacity to deliver on their targets?*
- ***SQ4:*** *To what level has the collective work of these companies lead to substantive climate mitigation?*

The central focus of these questions is to determine the fitness of actions taken by members in SBTi towards climate mitigation on a descriptive manner. Four types of progress indicators were used in order to evaluate them: ambition, robustness, implementation and substantive impact. It should be noted that for the last three types progress the results of companies with absolute and intensity targets will be combined, giving a total of 70 companies.

Ambition was evaluated on 64 companies with absolute targets, comparing linearized targets against three different global scenarios: a descriptive Current National Policies scenario, and two normative scenarios for 2°C and 1.5°C . It was found that the initiative's target qualifications are a good indicator of ambition (i.e. the aggregated emission trends of companies with 1.5°C are consistent with a 1.5°C pathway).

Collective ambition in these 64 companies was consistent with a well-below 2°C pathway, with is within the guidelines of the Paris accord but above the recommendations of the special report by the IPCC . However, this ambition differs significantly by energy sector, declining the more emission intensive it is. Service companies where the only ones collectively consistent with a sub 1.5°C pathway, with light industry falling just outside of it. Electric Utilities do not conform with a 1.5°C pathway, and Energy Intensive Industry is the least ambitious sector by far. This is a reason for concern since

[3]Descriptive statistics of all energy sectors can be found in table I.1 in the appendix

emissions are heavily concentrated in these two sectors. The five companies in them control 50% of emissions under absolute scope 1+2 targets.

An interesting detail is that targets do not appear to be a precise indicator of emission reductions in the sample. Most energy sectors demonstrated GHG mitigation occurring prior to the baseline year selected by members. At this point in time it is exceedingly difficult to interpret if this is because companies with already good performance tend to join the initiative, or if they are old members who updated a target. Better disclosure of membership dates and target updates could aid in alleviating this problem. The initiative generally suffers from a lack of transparency since this kind of information, and other crucial data such as baseline emissions, can only be obtained from secondary sources like CDP .

Robustness evaluations where done for 70 members with absolute and intensity targets. Results showed that there has been a progressive improvement on the use of third-party assurance, and that there are little differences between the level of assurance sought for scope 1 and 2. In 2015 only nine companies avoided third-party assurance, which fell down to one by 2019 demonstrating a level of improvement.

However, the type of assurance done is overwhelmingly of a limited capacity. There are no signs of an increase towards reasonable or high assurance, the only levels equivalent to financial audits (WBCSD et al., 2019). This is made worse by the fact that reasonable assurance is not standard in large emitting sectors: only three utilities achieved this grade of confidence (all of them from France, where assurance of non-financial data is required by law for some industries). All the EIIs with targets only verify using limited assurance, which is the least stringent type of third-party verification. The low level of assurance is also reflected in light industries and service businesses, with no distinctions between the two.

Given these limitations, and the already large amounts of errors seen in CDP questionnaires, results presented in this study and by these companies in general should be taken with caution. This lack of robust data validation and its lackluster improvements should be considered a prime barrier to the believability of the progress of these actors, and the ICI as a whole.

Implementation was evaluated by separating six electricity producers from 64 electricity users. Electric utilities have reduced their use of fossil fuels regardless of whether they set absolute or intensity targets, and have also increased their renewable generation, but there is a net decrease in the total energy produced by the five utilities with targets. Another detail is how, collectively, most of these utility companies already had a good generation profile, with a high amount of renewables and nuclear generation, mostly due to the fact that most of them are French companies.

Energy users showed stark contrasts in their preferred way to reduce emissions depending on the energy sector they were located in. The three EIIs showed most progress by reducing their consumption of fossil fuel internally, and showed a modest increase in the use of purchased renewable energy. Every other energy sector, by contrast, did not show tangible evidence of reductions in the internal use of fossil fuels. Instead, targets are being met by purchasing more renewable energy, which in the case of companies with absolute targets is now 11% of all the energy consumed by end-use companies (including EIIs).

Substantive impact largely reflects implementation. Only two energy sectors showed evidence of scope 1 emission reductions: electricity generation and Energy Intensive Industry. In all the rest, the change was seen in scope 2 emissions. Essentially, this means that large emitters focus on *internal* change, while companies with lower emissions achieve reductions through *external means*. Although scope 1 emissions in large emitters makes up most of the emission in the sample (around 577 $MtCO_2e$, or 75% of the total), the preference for external action in other companies makes their progress more difficult to track properly, as it is harder to prove whether such emissions have been displaced or not.

Overall, the SBTi appears well posed for climate mitigation when compared against the lackluster delivery at a global scale, but in the case of most sectors (specially for those with lower emissions per-member) only when such evaluation is constrained to the targets and emissions stated by these companies. Even if the carbon footprint of these companies has been reduced, at least according to the GHG protocol, the chance that these changes might not reflect outside them is still open for the sectors with the most membership. The lack of reasonable assurance, the complications in tracking some intensity targets, and the lack of consistency in the disclosure of information indicates that there is much work to be done. Without proper, transparent and veritable data, valid questions on legitimacy will continue to be raised.

Total emissions covered by the initiative may be heavily skewed towards a reduced number of companies and sectors. Overarching statements seen in other reports such as average yearly reduction per-member, or increases in the total membership of this ICI, should be taken with care as they ignore whether the change is internal or external, and the actual size of each member's contribution. If the growing membership is coupled with a focus on internal change and transparency, the SBTi could truly become a shining example of not only ambition, but on how mitigation can be implemented effectively.

7. Evaluating the performance of the RE100 initiative

This chapter assesses the RE100 initiative in order to answer the following questions:

- ***SQ2:*** *Are these companies setting appropriate targets and what impact can be expected of them?*
- ***SQ3:*** *Through which methods are these companies improving their capacity to deliver on their targets?*
- ***SQ4:*** *To what level has the collective work of these companies lead to substantive climate mitigation?*

Descriptive analysis of the action by G500 companies who have enrolled in this ICI will be presented using the logical framework from Hale et al. (2020) using four indicators of progress: ambition, robustness, implementation and substantive impact. Analysis mostly relates to the use of electricity and the increase of the share of renewable sources in it. Where electricity purchases could not be fully separated from HSC ones, general energy purchases will be presented instead.

The question related to ambition will be answered by comparing the collective target trends of RE100 members in the G500 against electricity scenarios for OECD nations developed by the IPCC . The second question will be answered at two levels: first by analysing robustness in terms of the degree of visibility into renewable energy sourcing methods allowed by disclosure platforms, and then by disaggregating these visible purchases into different market instruments and ordering them by their perceived additionality. Finally, overall collective targets will be compared against the achieved renewable use in order to evaluate substantive progress. All of these aspects will be combined to judge the actual causal impact of this group of companies, and what it says about RE100 as a whole [1].

The chapter is ordered as follows: section 7.1 contextualizes the sample of companies in the analysis. Results for each progress indicator are presented in section 7.2, and a causal evaluation of impact in GHG emissions is given in section 7.3. The chapter ends with section 7.4 by providing summary of the assessment of the impact of these members of the initiative.

[1]Explanations related to how RE100 sets targets, how they were interpreted, and the reasoning behind the logical framework used in this chapter can be found in section 4.4 and section 4.6.3 in the methodology chapter.

7.1. Sample of companies in the analysis

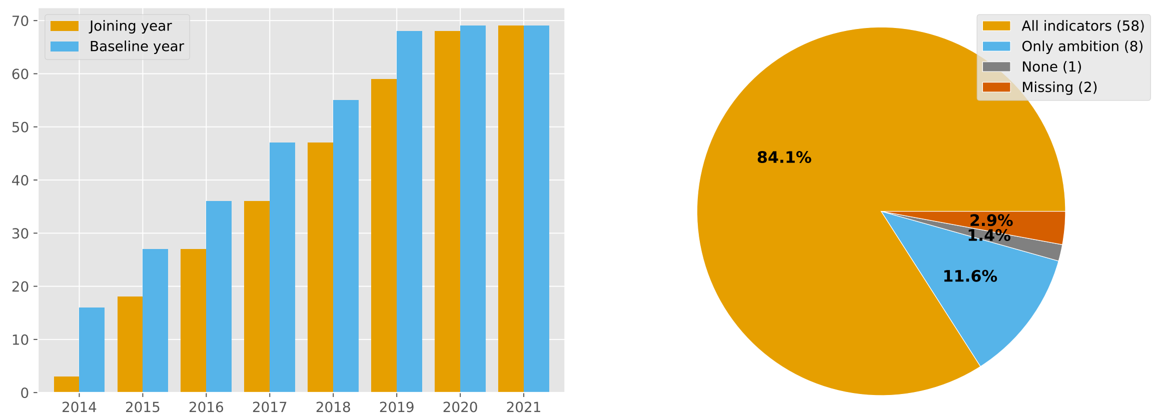
This section clarifies some key aspects of how the initiative was evaluated, particularly the sample of companies in the analysis, as well as why some members had to be excluded. With it, the reader should have a clear idea of the number of companies evaluated in each type of progress indicator.

There are several crucial distinctions between the analysis of this initiative and that of SBTi in terms of sample composition. First, RE100 does not give any qualifications to its members, nor does it require them to pass a thorough evaluation process in order to approve their targets (choosing to focus on evaluation instead). There are no sub-groups such as members with "approved targets" or just "committed", making analysis straight forward.

Second is that this initiative does disclose the joining year of each individual member in their annual progress reports, and that they do not specify when their target was approved or modified (RE100, 2020a). This is an important difference because it allows the analysis to be more selective by ensuring that members who had not joined in a specific year can be removed. In the case of this study, this gains importance for the evaluation of robustness, implementation and substantive impact. However, it introduces the need to differentiate between *baseline* years and *joining* years when discussing the sample. Most companies in the RE100 have their baseline set at the year before they joined the initiative, with a few exceptions. As fig. 7.1a shows, the number of companies "active" for a year can vary widely depending on which of the two criteria is chosen. Joining years were preferred as they might reflect the influence of the initiative on its members better.

Figure 7.1 exhibits how this initiative will be analysed. Although a total of 69 companies in the G500 have become members, it was not possible to collect information for all of them. Two had missing data: Japanese convenience store company Seven & I Holdings, and the financial corporation M&G (see appendix E for more information). The German industrial Siemens did submit enough data to CDP, but since it joined in 2021 it was not possible to generate a baseline for it because no data for either 2020 or 2021 was collected.

This leaves us with 58 companies who joined up to 2019, and can be analysed on all types of progress indicators. In the case of ambition (i.e. target trends) eight additional companies whose baselines could be determined were included in its analysis, meaning 66 in total leaving only the three companies with no target data were left out.



(a) Cumulative differences between active target baseline years and joining years.

(b) Members grouped by the type of log frame analysis possible.

Figure 7.1: Division of all 69 G500 companies in RE100 in different groupings. The 58 companies where a full analysis was possible are those who joined between 2014–2019. Members who joined in 2020, but whose previous year baseline was obtainable were included when analysing ambition.

7.2. Performance of companies participating in the RE100 initiative

In this section RE100 members are evaluated using the log frame methodology described in section 4.6.3. There are no electric utilities among these companies, and it is assumed that they do not sell energy between each other.

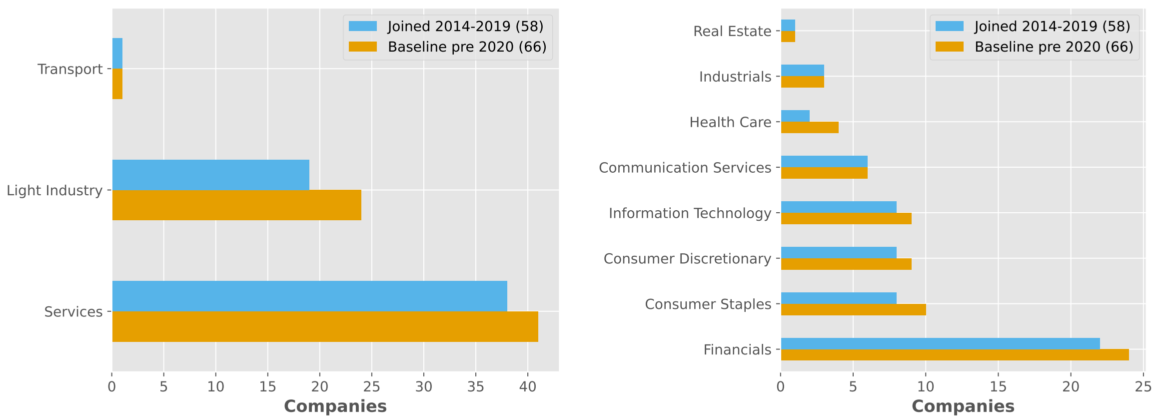
Similar to chapter 6, n will be included in most figures as a way to represent the total companies with active targets in that year. A target is considered active from the baseline year until 2050, since members are expected to maintain 100% renewable electricity once they reach it. Care should be taken to avoid confusing n with the year that a company *joined* the initiative: RE100 members tend to set their baseline one year before they became members and n will represent that year in most cases. This approach was taken to keep the nomenclature between chapters consistent, and because some companies may already display important behavioral changes between their baseline and joining years.

Another important thing to keep in mind is the particularly low level of variety in terms of energy sectors, and the large amount of financial companies (see chapter 5 for more information). As fig. 7.2 shows, excluding the single transport company, more than half of the members in the sample belong to the service sector, and the rest are light industries. This applies to both sample groups: the 58 companies who joined between 2014–2019 and those with a baseline set at or before 2019. In both, only one transport company is present, and the rest are always either service or light industry companies. The large number of financials will gain importance during evaluation of some progress indicators, robustness and implementation in particular, as CDP questionnaire changes have negatively affected this sector by disallowing them to disclose how they purchase the renewable energy they use.

The structure is as follows: section 7.2.1 looks into the ambition of the 66 companies where baselines could be established in order to produce target trends. Section 7.2.2 follows it by reviewing the robustness of the renewable energy claims of 58 companies who joined between 2014–2019. In order to evaluate implementation of the initiative's goals, section 7.2.3 disaggregates energy use in these 58 companies into different sourcing instruments. Afterwards, section 7.2.4 compares the progress made against the targets in order to see how successful the initiative has been at covering more electricity usage, and how these 58 members stack up against collective goals.

7.2.1 Ambition in the RE100 initiative

Ambition in the 66 companies whose baselines could be established is consistent with the required share of renewable energy to stay within 1.5°C by the end of the century. Figure 7.3 presents individual



(a) Distribution of sample groups by energy sector. **(b)** Distribution of sample groups by economic sector.

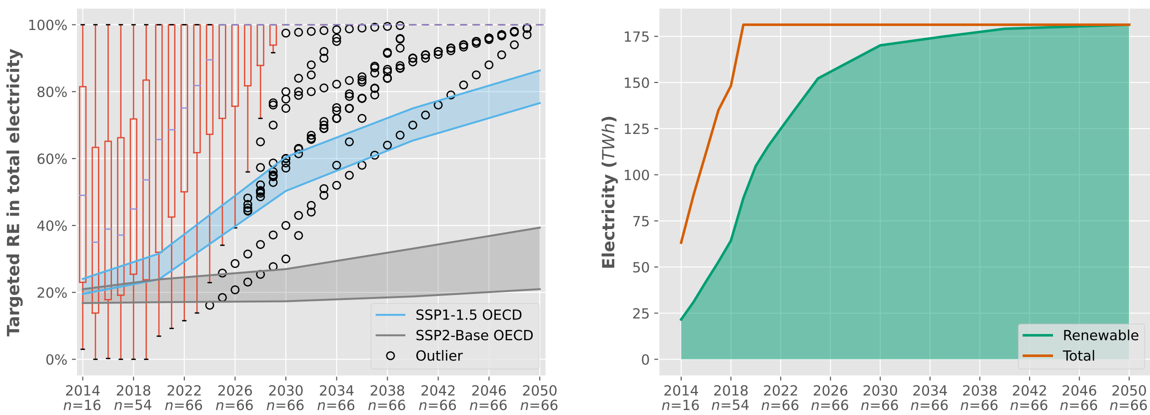
Figure 7.2: Sectorial composition of the two sample groups used to evaluate the RE100 initiative.

targets in the form of a box plot, which are way of showcasing multiple data by grouping it and showing the minimum, 25 and 75th percentiles, and maximums, along with a median and outliers (Galarnyk, 2020). At the individual level most members already exceeded the OECD share of 23.8–31.6% when they set their target, with the 25th percentile rarely dropping below the SSP-1.5 range (fig. 7.3a). Their target year for achieving 100% renewable electricity also significantly exceeds the scenarios: by 2025 the median is already at 100%, and by 2030 everyone but some outlier companies have full renewable usage. However, some members are less ambitious, as seen in the outliers of earlier years, where several members who do not follow the initiative's supposed minimum criteria can be spotted.

However, individual ratio metrics are not an adequate way of assessing collective goals since electricity needs can vary significantly depending on firm size and sector. Figure 7.3b displays how the share of renewable electricity in this sample might evolve if companies match their goals, and keep their electricity consumption constant from their baseline year onwards (2015 data had to be used instead of 2014 baselines since no data was collected for that year). Goals remain short-term, with the share of renewable electricity exceeding 90% in 2030, meaning that the least ambitious companies, although present, play a minor role.

By 2019 a total of 181 TWh are covered, just below Thailand which is the 24th nation in terms of electricity generation (IEA, 2021a, 2018 data). This is a large portion of the total electricity covered by the initiative, which was approximately 278 TWh in 2019 (RE100, 2020a). Although the two numbers are not directly comparable since the sample includes a few new members, it still means that this study covers more than half of the total energy consumption within the initiative: if only the 58 members who joined between 2014–2019 are selected, in turn losing some 2020 joiners who are also in the report, the number comes down to 158 TWh which is still more than half coverage.

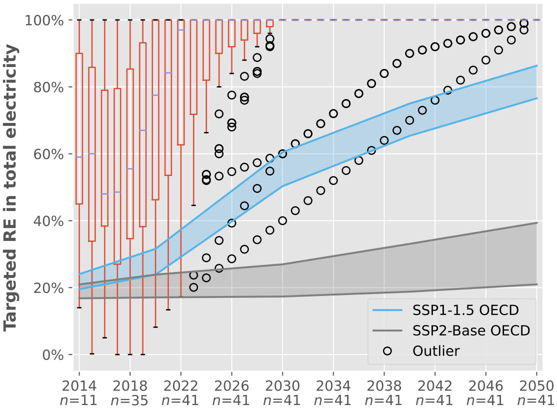
Services and light industry show some interesting differences (fig. 7.4). The first is the majority in both membership and total electricity, and has the most ambitious targets exceeding a 90% share by 2025. By contrast, the second achieves a similar ratio almost a decade later (2034). The only transport company (French parcel company La Poste) only contributes slightly. Economic sectors are more disaggregated (see fig. K.1 in the appendix). Financials, who make up more than a third of the sample, contribute less than 9% of total electricity use. Most coverage actually comes from consumer staples, telecommunications and consumer discretionary; last one being the least ambitious sector ignoring sectors with single members.



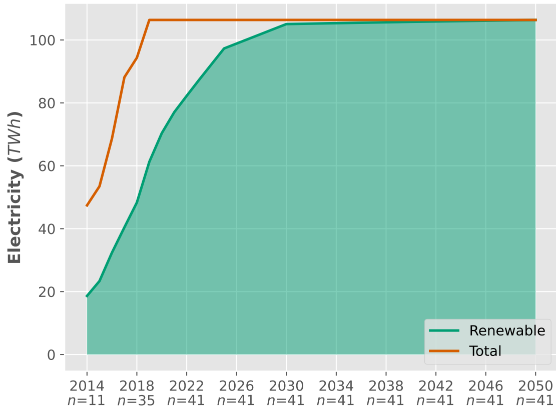
(a) Box plot of individual company compared against IPCC OECD scenarios from Huppmann et al. (2018).

(b) Targeted renewable share in total electricity assuming electricity consumption remains constant.

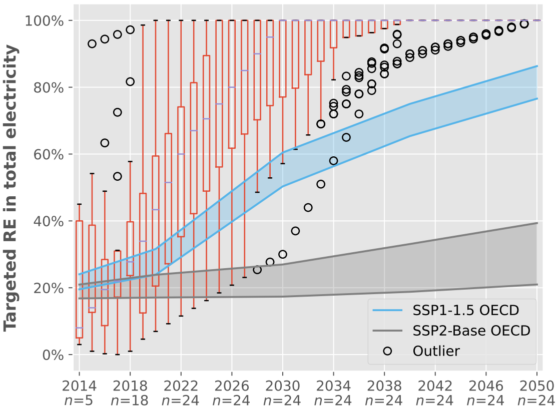
Figure 7.3: Ambition of 66 RE100 members in the G500. Left shows the statistical distribution of individual goals, and right the added total covered electricity and how renewable energy should increase if targets are met. n accurately represents the number of targets shown in each year.



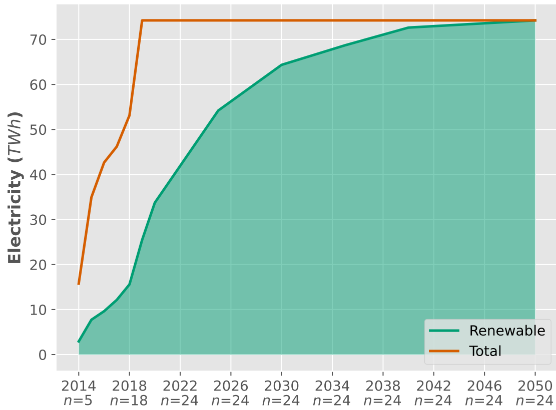
(a) Services targets



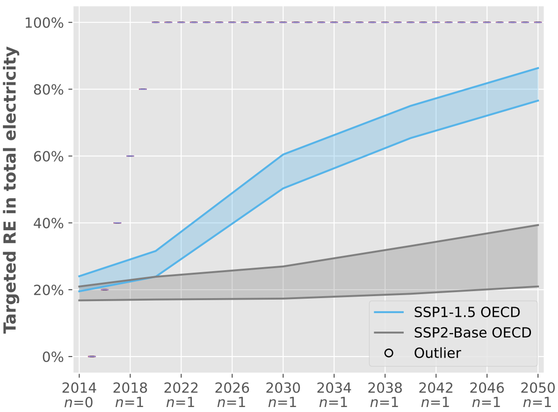
(b) Services total electricity



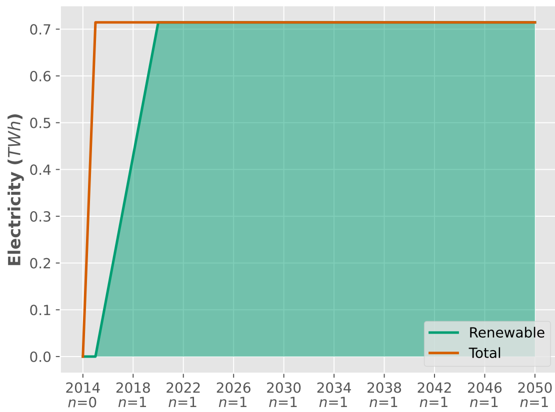
(c) Light Industry targets



(d) Light Industry total electricity



(e) Transport targets



(f) Transport total electricity

Figure 7.4: Ambition of G500 companies in the RE100 initiative whose target baseline could be created, subdivided by energy sector. Notice that y-axis scaling differs between electricity figures.

7.2.2 Robustness in terms of visible purchasing methods

As discussed in section 4.2.3, not all renewable energy purchases are equal in terms of additionality. But before looking into market instruments, it is essential to see how much of the renewable energy that these companies claim to purchase can actually be subdivided into different sourcing methods.

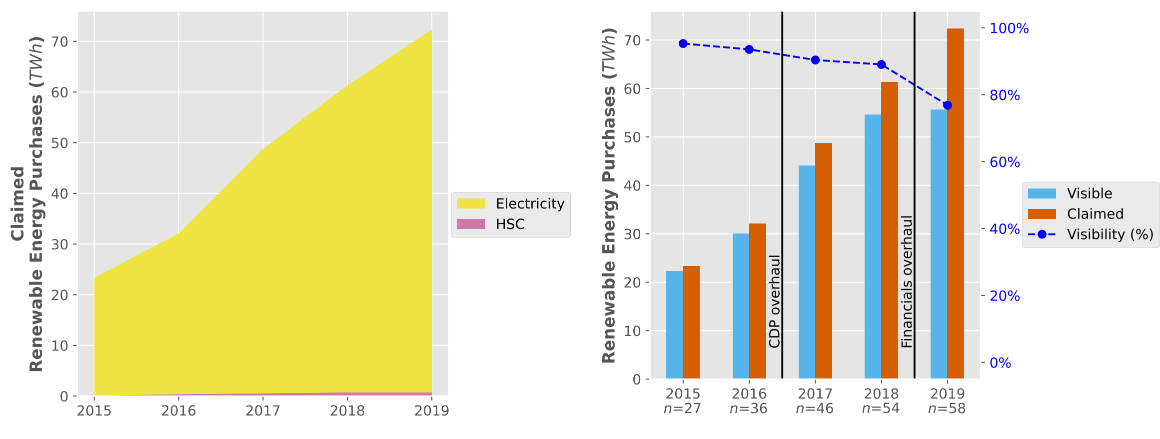
Figure 7.5 presents whether energy purchases have become more visible between 2015–2019 for the 58 companies who joined at or before 2019. First, the vast majority of renewable energy purchased is electric (fig. 7.5a), an unsurprising result given how most companies in this initiative are in the service sector. This increases the trustworthiness of the visibility metric in relation to RE100 results, since HSC's small contribution does not affect it significantly.

Results show that visibility has not improved overall. Contrary to what one would hope, the transparency of energy purchases allowed by the CDP responses has been steadily decreasing along the years: from approximately 95% to just below 77%. This is due to two primary reasons, both marked in the figure: a change in the questionnaire that allowed companies to submit a number for their purchased renewables without disclosing pruchase method from 2017 onwards, and a more recent change that completely disallowed financials from disclosing how they purchase their energy.

Another secondary reason could be how some CDP responders tend to wrongly submit grid-mix renewables as scope 2 market-based purchases, which were removed from the "visible" metric but not the "claimed" one as the second is most likely what is used to calculate emissions or disclosed in company reports. Such instances of accounting errors were not tracked during the gathering process, so it is difficult to say how much of it affects RE100's numbers.

This does not necessarily mean that RE100 does not know how these companies are purchasing energy. They have their own spreadsheet and verification methods to do so (RE100, 2021b). Decreases in visibility do not imply that the initiative's capacity has been hampered, as long as a company is willing to fill in extra documents and submits them to the initiative in time and form. Instead, decreasing visibility signifies a lack convergence in how RE100, CDP and companies disclose information to one another. The more processes converge, the more transparent, comparable and coordinated they become (Matisoff et al., 2013).

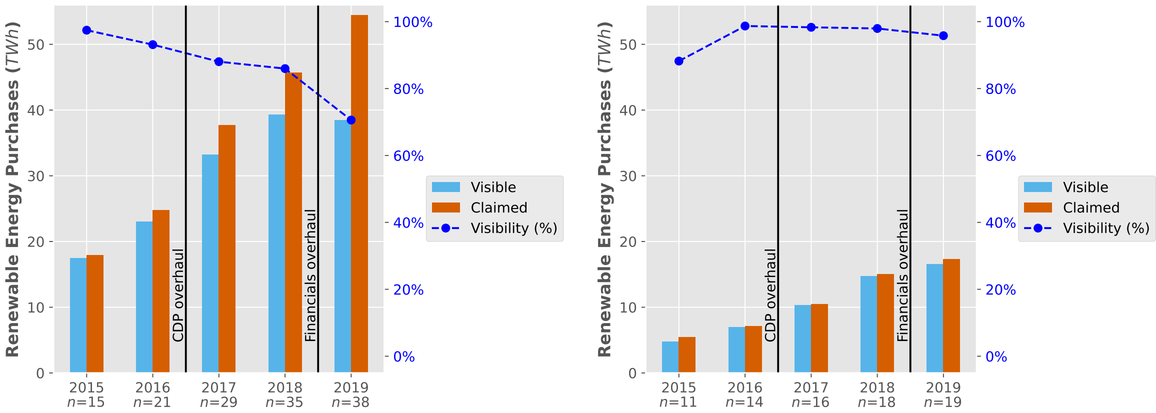
When disaggregating for energy sectors (fig. 7.6), CDP changes become more apparent, with services having the least visibility and light industry remaining comparatively high. This is a troubling development since the services sector has seen the largest increase in purchased renewable energy, as displayed in fig. 7.6a. The change for financials is stark in economic disaggregations (see fig. K.3), with visibility petering out to just above 21% for this sector, with visible data coming from a separate report of one company (Wells Fargo). Other economic sectors, such as communication services and consumer



(a) Evolution of claimed purchases divided by electricity and HSC purchased.

(b) Relation between claimed renewable purchases and visible market instruments.

Figure 7.5: Robustness of 58 G500 companies in the RE100 initiative that joined between 2014–2019. Only renewable energy purchases included, no self-generation.



(a) Services **(b)** Light Industry

Figure 7.6: Robustness of 58 G500 companies in the RE100 initiative that joined between 2014–2019, subdivided by energy sector. The transport sector is not presented due to its low contribution and single membership.

discretionary, owe their decreasing visibility to either members choosing to omit the data in the CDP report, or faults in properly applying the GHG protocol.

7.2.3 Implementation through different sourcing methods

Accounting for the robustness in the renewable energy claimed by these actors, we can now look into implementation by dividing it into the market instruments used to source it. Overall results are shown in fig. 7.7, where a clear increase in claimed renewable energy can be observed: from 24 to 74 TWh, meaning it has more than tripled in the span of five years. Assuming compatibility, this is 65% of the 113 TWh of total renewable electricity covered by the initiative in 2019 (RE100, 2020a). This indicates that the approach taken by this study was effective in isolating a portion of members with high consumption, since these 58 companies are only 22% of the total members included in the report that featured that number. Not all of that energy has a known sourcing method though: visible purchases have only increased from 23 to 58 TWh, reducing total coverage to 51% which is still a large portion.

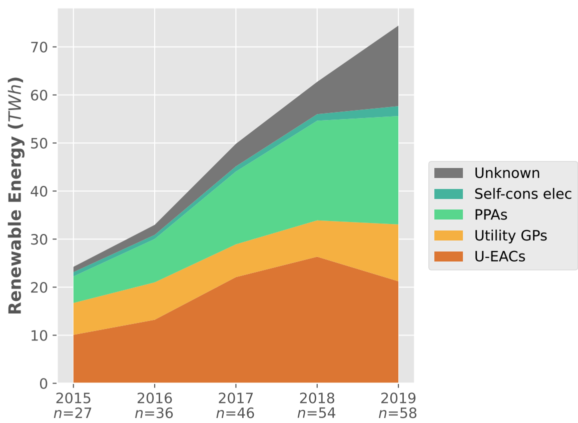


Figure 7.7: Market instrument use in 58 members of RE100, subdivided into unbundled certificates (U-EACs), utility green products (utility GPs), power purchase agreements (PPAs) and self-consumed electricity. Unknown represents claimed consumption with no market instrument disclosed.

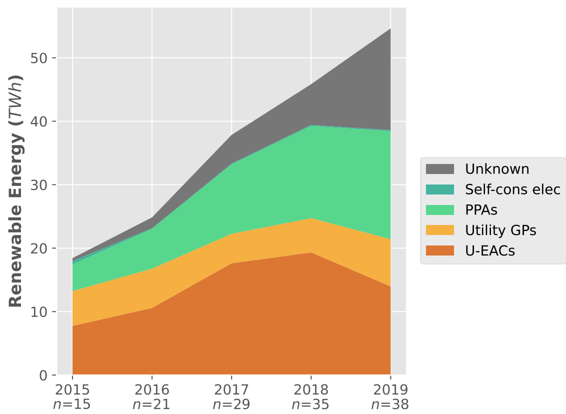
Despite the uncertainties previously mentioned, there are some clear collective trends in this group of companies. First, there was a shift in preference from utility green products towards PPAs (fig. 7.7), and they even appear to have overtaken unbundled EACs in 2019, making up 29% of total claimed renewable energy. The reason for this apparent uptake, however, is the increasing lack of visibility of purchases in finance and consumer discretionary businesses (see fig. K.4 in the appendix).

Second is that unbundled EACs were the main sourcing method of purchased energy in all years except 2019, and even in this year it is very likely that they are still the main source of renewables assuming several of the low visibility sectors did not have significant behavioral shifts in this last year. In fact, instruments associated with low additionality such as unbundled EACs and utility green products still made up almost 57% of visible purchases in 2019. Conversely, the highest method in terms of additionality, gross self-generation of electricity, remains fairly low at 2.5 TWh (3.3%).

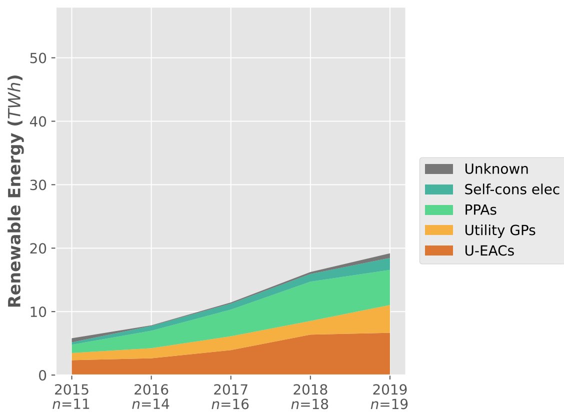
Energy sector behavior (fig. 7.8) shows how most self-generation is concentrated in light industries, an important detail to keep in mind as it will contextualize its use in economic sectors. Another aspect, this time in service companies, is how most of the unknown energy purchased is condensed in it. This was already identified in the robustness section, but here we see that they are now the second largest category, possibly due to a significant drop in reported unbundled EACs. A commonality between these two sectors with high membership is how unbundled EACs and PPAs have become the premier purchase methods, with the second vastly overtaking utility green products since early years. The only transport company, included here for the sake of completeness, does not betray the preference for unbundled certificates.

Economic sectors show even more distinct differences in sourcing preferences (fig. K.4), but the small sample size means their results should be considered with care. Three sectors stand out due to a distinctive preference for unbundled EACs: financials, information technology and consumer discretionary. Conversely, PPA usage is densely concentrated in communication service companies, edging over 12 TWh and exceeding any other single market instrument in all economic sectors. This instrument also sees much use in consumer staples, health healthcare and industrials.

Finally, gross-self generation is also mostly used in information technology companies. Since light industry envelops most of this sourcing category, it can be concluded that, by the measure of this data, it is hardware technology and not software companies the ones that prefer self-generation.



(a) Services



(b) Light Industry

Figure 7.8: Implementation through different market instruments in 57 G500 companies in the RE100 initiative subdivided by energy sector. The transport sector is not presented due to its low contribution and single membership.

7.2.4 Substantive impact through increasing renewable electricity use

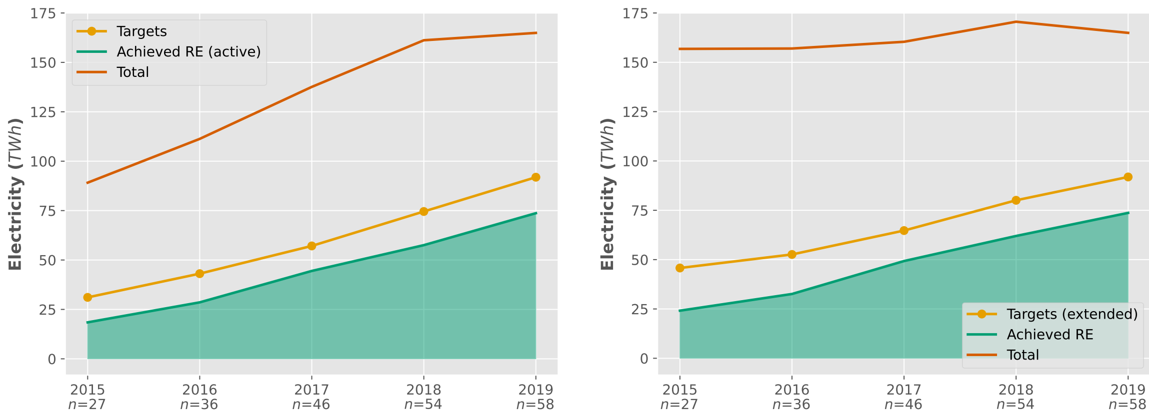
Keeping in mind the general preference towards instruments with low additionality, we will turn to comparing overall total claimed renewable electricity use against the constructed target trends. Figure 7.9 compares these in two ways: by only presenting energy within covered targets (fig. 7.9a), thus displaying how target coverage has evolved throughout these five years, and by extending the target baseline while keeping the ratio of renewable electricity constant (fig. 7.9b), which instead shows how much renewable electricity these 58 companies sourced regardless if they had set targets or not. Three things stand out: the increase in total covered electricity by active targets, an apparent offset error between targets and claimed achieved renewable usage, and the similarities between the renewable electricity areas of both figures.

Total covered electricity has almost doubled in this sample of companies, from 88 to 164 TWh which is more than the entire electric generation of Sweden (IEA, 2021a, 2018 data). Overall energy consumption in the group has also increased slightly, from 156.8 to 164.9 TWh in 2019 (2018 saw the largest consumption at 170.6 TWh). In terms of energy sectors (fig. 7.10), service companies are the ones who have increased their electricity use, with light industries maintaining it at a constant rate, ignoring the 2018 spike.

The offset between targets and actual renewable use stems from differences in the claimed renewable electricity used by early members in RE100 reports and their renewable consumption data disclosed through CDP documents. As a matter of fact, most of it stems from a single member: U.S. retailer Walmart. RE100 documents state that this company consumed 26% renewable electricity in 2014 and aims to achieve 100% renewable use by 2025, which after target linearization would equate to a targeted 32.7% in 2015 which is around 10.2 TWh. CDP data only indicates 2.1 TWh however, which is significantly lower. Removing this company decreases the offset between targets and active achieved renewables from 12.5 to 4.4 TWh.

A possible explanation for this is a change in the reporting boundary that Walmart was disclosing to RE100. This is supported by a drop in the reported renewable use to 9% in recent years as seen in official RE100 documents (RE100, 2020a). Even if this is just an assumption, it still serves as an example of the issues created by a lack of convergence in the tools used to track climate metrics in these initiatives.

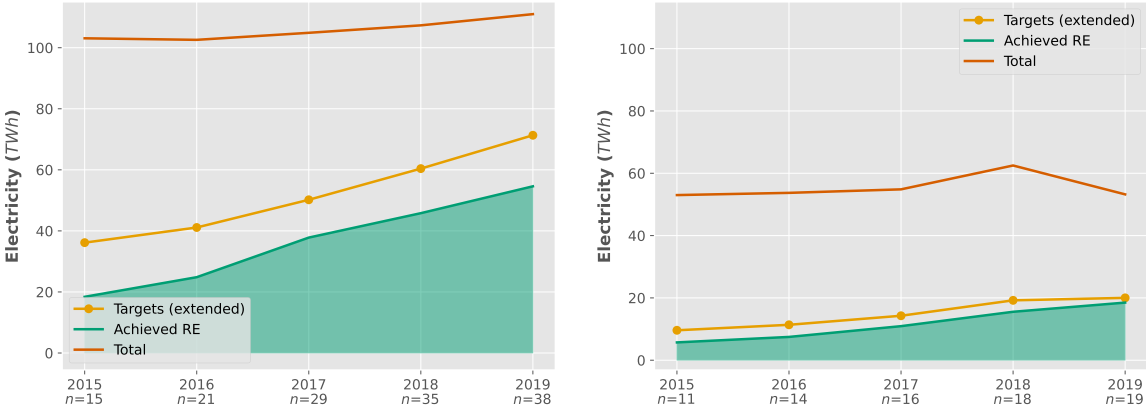
The similar profiles of achieved renewable electricity in fig. 7.9a and fig. 7.9b implies that most of the increase in renewable usage was achieved after a company joined RE100 (i.e. within the target scope).



(a) Evolution of renewable electricity use within active targets, excluding companies that had not set them.

(b) Evolution of the sample, keeping the renewable percentage constant for years prior to the start year.

Figure 7.9: Substantive impact in terms of renewable electricity use for 58 G500 companies who joined RE100 between 2014–2019.



(a) Services **(b)** Light Industry

Figure 7.10: Substantive progress through renewable energy use in 58 G500 companies in the RE100 initiative that joined between 2014–2019, subdivided by energy sector. The transport sector is not presented due to its low contribution and single membership. Targets are extended by keeping the renewable ratio constant for years prior to the start year of a target.

The difference between active and actual renewable use in 2015 is just 5.71 TWh (18.54 to 24.25 TWh). It is good evidence of the initiative actively changing the behavior of these actors. As seen in most economic sectors (see fig. K.5 in the appendix), by 2019 most groupings sit close to their intended targets.

7.3. Causal impact

A key question in regard to the impact of RE100 is actual GHG emission reductions. Although it is not directly stated in their goals, this initiative has been referred to as one with a large potential impact on future GHG emissions (Lui et al., 2020; We Mean Business, 2016). Is this the case?

Table 7.1 summarizes the evolution of collective scope 1+2 emissions in the sample of 58 members evaluated for most of this chapter. Accounting both scope 1 and 2 emissions, these companies emitted around 95.75 $MtCO_2e$ in 2015, much less than the combined 775.24 $MtCO_2e$ of the 70 members with absolute and intensity targets in SBTi (see table 6.1). This stark difference is due to a lack of emission-intensive industries and utilities in RE100, and the high number of financial service companies which have low consumption in comparison.

Similar to the results seen for light industry and services in the SBTi, scope 1 emissions do not see significant reductions. In the case of RE100 it is to be expected, since most of the emissions that fall within the scope of its targets are indirect.

Scope 2 has seen emission reductions at a significant pace (-9.44% AAGR), but they were only 65.2 $MtCO_2e$ in 2015, very small in comparison to the coverage of SBTi. Even if only scope 2 emissions of 62 SBTi members in the services, light industry and transport energy sectors are accounted, they come up to 102.81 $MtCO_2e$.

Considering that the sample of 58 RE100 companies envelops over half of the electricity covered by the initiative as a whole in 2019 (RE100, 2020a), the slow growth in membership (fig. 3.4a), and how around two thirds of the energy sourced in the 58 sample (fig. 7.7) and the initiative as a whole (fig. 3.5b) are currently on the low additionality side, it is hard to see RE100 reaching the potential impact stated by ex-ante studies with its current trends.

Table 7.1: Linear regression results of the sum of emissions per scope of all 58 G500 companies who joined the RE100 initiative between 2014–2019. The *p*-value corresponds to an alternative hypothesis of the slope of the regression line being less than zero.

			Sum ($MtCO_2e$)			
Sector	**Companies**	**Scope**	**2015**	**2019**	**AAGR**	R^2
Services	38	S1	10.965	11.169	0.54%	0.022
		S2	40.097	25.469	-10.68%	0.98
Light Industry	19	S1	19.158	18.537	-0.76%	0.014
		S2	25.035	18.34	-7.45%	0.984
Transport	1	S1	0.402	0.37	-2.03%	0.896
		S2	0.095	0.004	-37.12%	0.81
Total	58	S1	30.525	30.077	-0.36%	0.076
		S2	65.227	43.813	-9.44%	0.988
		S1+2	95.751	73.89	-6.26%	0.993

7.4. Summarizing the results of the RE100

The purpose of this chapter was to answer the following three questions in relation to G500 companies in the RE100 initiative:

- ***SQ2:*** *Are these companies setting appropriate targets and what impact can be expected of them?*
- ***SQ3:*** *Through which methods are these companies improving their capacity to deliver on their targets?*
- ***SQ4:*** *To what level has the collective work of these companies lead to substantive climate mitigation?*

This was done in order to understand if this initiative is fit for proper climate mitigation by evaluating its processes and results in a descriptive manner. Four different progress indicators in a log frame methodology were applied to do so. These were: ambition, robustness, implementation and substantive impact.

First, ambition was evaluated by constructing linearized targets of the targeted renewable electricity use for 66 companies, and comparing them against two sets of IPCC scenarios of the share of renewable energy in produced electricity: one compatible with 1.5°C pathways with no or limited overshoot, and another with "middle-of-the-road" outcomes where Paris agreement targets are not met. These scenarios related to OECD nation outcomes, and are based on a cost-optimal effort-sharing approach.

Results showed that these companies generally exceed the level of ambition required for a 1.5°C outcome, collectively aiming for over 90% renewable electricity usage by 2030, with an estimated total consumption of 181 TWh. This is a good portion of the total electricity use covered by the initiative as a whole, which was 278 TWh for all 261 members featured in their most recent 2020 report. It was also seen that several members do not comply with the set of minimal criteria established by the initiative's own documents, but they do not appear to have a significant effect on the level of collective commitment.

Robustness was evaluated for a total of 58 companies who joined the initiative between 2014–2019. To do so, a visibility metric was created to compare the ratio of visible market instruments disclosed by members against the total renewable energy they claimed to have purchased. This was deemed an adequate method since most of the claimed energy purchased by these companies was electric in nature, with HSC playing a minimal role in overall purchases. A high visibility means an increased convergence between CDP and RE100 reporting methods, which should lead to better confidence in the results of these companies.

Overall visibility does not appear to improve over the years, and has instead fallen from over 95% in 2015 to below 77% in 2019. The primary reasons were how CDP has allowed to disclose renewable energy totals separately from sourcing methods in 2017, and the removal of the sourcing section for financial companies in 2019. Although this low visibility does not necessarily imply that RE100 cannot track how these companies are sourcing energy, it does mean that the documentation process of their progress is not converging and is instead becoming less coordinated.

Contrasting implementation and substantive progress in these 58 companies gives a mixed picture of progress. Although there is a clear increase in the share of renewables in the electricity they source, little of it could be said to translate into additional mitigation.

Implementation was evaluated by separating consumed energy into five categories: unbundled EACs, utility green products, PPAs, self-consumed renewable electricity, and unknown. Total claimed renewable use among them increased from 24 to 74 TWh between 2015 to 2019. However, these companies showed a general preference for instruments with low additionality, with 44% of visible purchases coming from unbundled EACs and utility green products in 2019. Unknowingly sourced renewable energy now makes up 22% of all claimed renewable use, and is likely made up of unbundled EACs if some key sectors with low visibility have not changed their habits. Use of PPAs and self-generation has increased, but they are only a third of claimed energy by 2019.

Substantive evaluation of the 58 companies showed how most of the increases in renewable electricity occurred within the scope of the targets set by the companies in the initiative, which speaks positively of the capacity of RE100 to change the behavior of its members. It also demonstrated a visible offset between the renewable usage given in CDP questionnaires and RE100 reports for some early members.

In conclusion, RE100 appears to have a positive influence in the amount of renewable electricity used by its members, and a good level of ambition when pitted against cost-optimal IPCC scenarios developed for OECD nations, where most of its members are located.

However, most of this renewable energy is sourced through methods with low additionality, made worse by an increasing lack of visibility in the tools used to report said purchases. Most of the mitigation achieved will be *external*, and most likely small due to the lack of energy intensive members and the additionality issues already mentioned.

8. Discussion

This chapter rounds up analysis by comparing the progress and impact seen in both initiatives, and addressing other important questions commonly raised about climate action in businesses such as transparency and the geographical balance of the emissions mitigated. By doing so the author hopes to frame the results of this study in a more holistic manner.

It is structured as follows: section 8.1 compares the SBTi and RE100 by first looking into the energy sourcing methods used by the first, and the emissions covered by the second, and then reviewing overlaps in both metrics. Then, section 8.2 addresses some transparency issues seen these initiatives and in corporate disclosure platforms. Section 8.3 gives some data on the possible geographical distribution of these emissions and considers the fairness of comparing emission targets against the required global reduction trends, and the renewable targets against scenarios for OECD nations developed using a cost-optimal approach.

8.1. Contrasting the SBTi and RE100

This section briefly rounds up the analysis done in chapter 6 and chapter 7 by contrasting both initiatives in terms of emissions and energy use in order to answer the following question:

How do SBTi and RE100 contributions overlap, and to what degree can they be considered additional?

Chapter 6 and chapter 7 evaluate the SBTi and RE100 using progress indicators closely related to their underlying objectives, which are emission mitigation and renewable electricity use respectively. These objectives compliment one another, to the point where the energy sectors with most membership in both initiatives appear to be meeting objectives through the same means: increasing renewable energy. Similarly, the ultimate reason why these initiatives have grabbed the attention of scientists and policymakers is their argued potential for mitigation. How do both compare?

8.1.1 Market instruments used by the SBTi

Here the market instruments used by non-utility members with targets set in the SBTi are displayed, showing a collective lower use of high additionality instruments than the RE100. Chapter 6 showed how most energy sectors, barring utilities, have preferred to reduce their emissions by increasing their share of renewable energy purchased. However, the initiative's methodology does not really deal with the market instruments employed to do so. Given how most scope 1+2 targets relate to the market-based method, and even in location-based targets purchase methods still play an important role, this oversight can mislead stakeholders and policymakers.

As fig. 8.1 shows, energy purchases in the 65 non-utility SBTi members with targets set mostly come from instruments associated with low additionality. A lucky coincidence is that the renewable increase of both groups is strikingly similar: from around 25 to 74 TWh. High additionality instruments such as PPAs and self-consumed electricity only make up 21% of claimed energy, while unbounded EACs and utility green products are 66%.

Comparing these results against those of the RE100 (fig. 7.7) exemplifies that the focus on promoting the use of PPAs in that initiative has lead to arguably more additionality than that of the SBTi. Even if SBTi targets cover more emissions than RE100's, and there is evidence of some efficiency improvements in specific sectors (service companies with absolute targets as seen in fig. 6.8d), a strong argument can be made that RE100 has been more effective at producing additional renewables in their sample.

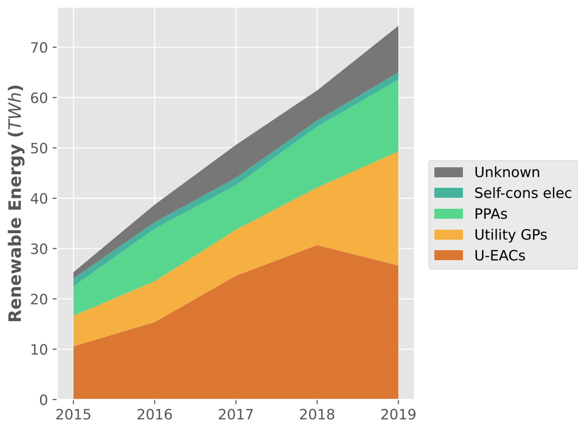


Figure 8.1: Market instrument use among 65 G500 companies in the SBTi with either absolute or intensity targets set. Utility companies have been excluded.

8.1.2 Emission overlap between both initiatives

The final detail between the two initiatives in the context of the G500 is overlaps between members whose progress could be assessed. As chapter 5 described, there is a significant overlap between participants in the G500; which extends even beyond this group as a majority of RE100 members have at least committed to setting targets in the SBTi (fig. 3.4b).

Table 8.1 disaggregates companies with targets into three groups: overlapping members, and those who joined either SBTi or RE100 exclusively. Collectively, emissions have decreased from 802 to 520 $MtCO_2e$. In total, 26 companies with targets were present in both, leaving 44 SBTi exclusive members and 32 only in RE100; a total of 102 companies with targets. It can be seen that exclusive RE100 members had the smallest share of emissions, once again due to the large number of financials, a sector that is absent in SBTi members with set targets. Overlapping members make up the second largest group, and cover more than double the emissions of the previous. Finally, individual SBTi members are the biggest group by far, 7.38 times larger than the sum of the previous two (see fig. 8.2).

The fact is that the individual SBTi members group has the EIIs and utilities in it, which displayed *direct* rather than *indirect* reductions (i.e. scope 1 reductions instead of scope 2). It appears that this initiative will have the larger impact of the two, if both initiatives continue showing their current trends in growth and membership preferences. Ultimately, SBTi targets cover a wider range of scopes, the initiative has gathered a much larger membership, both in the G500 and at large, and appeals to a wider set of sectors.

Table 8.1: Overlap between members with targets in at least one of the two ICIs analysed. Market-based emissions taken for scope 2 when available.

			Sum ($MtCO_2e$)				
Group	**Companies**	**Scope**	**2015**	**2016**	**2017**	**2018**	**2019**
SBTi targets only	44	S1	614.99	563.15	510.87	452.98	381.45
		S2	92.45	85.29	76.38	73	65.22
RE100 targets only	32	S1	8.06	8.32	8.02	8.65	7.81
		S2	20.36	18.62	14.1	12.46	11.86
Overlap	26	S1	22.46	22.43	23.1	22.28	22.27
		S2	44.86	42.17	38.75	35.57	31.95

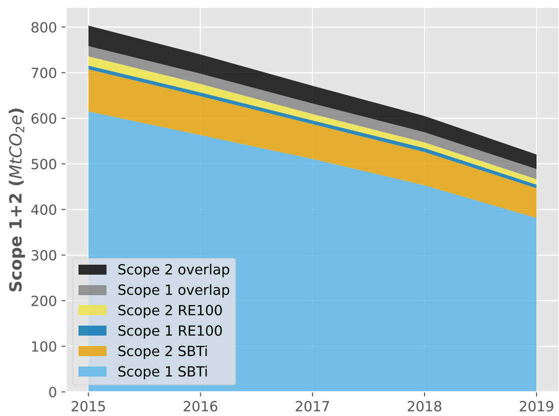


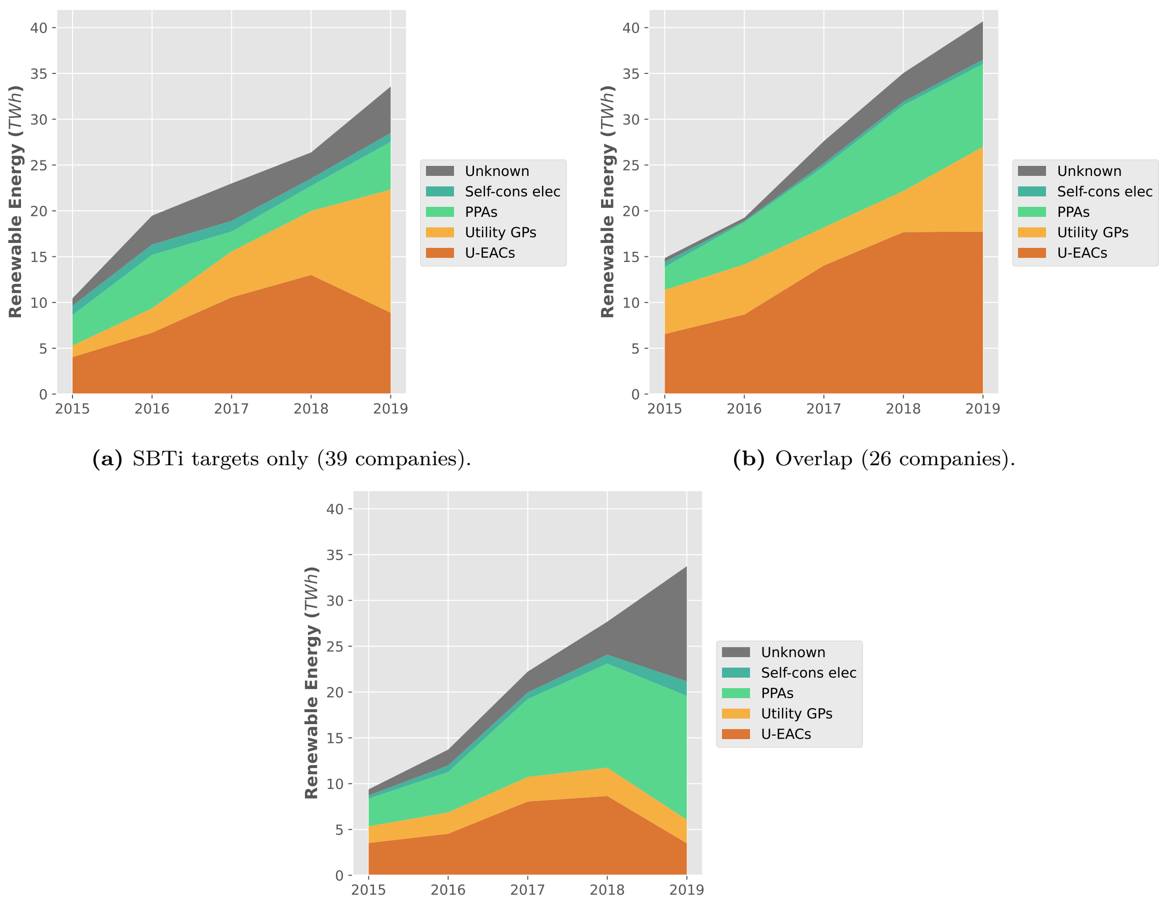
Figure 8.2: Combined emission reductions of both initiatives, including overlaps. Market-based emissions taken whenever possible.

8.1.3 Renewable energy overlap between both initiatives

However, RE100's influence in terms of energy purchases has lead to a larger use of high additionality instruments. As discussed in section 8.1.1, the amount of renewable energy purchased and self-consumed electricity in both groups is similar in volume, but very different in terms of sourcing methods.

If we divide the renewable energy purchased and self-generated electricity into exclusive and overlapping members (fig. 8.3), a relation between RE100 membership and PPA usage is very apparent. This speaks of some level of complementarity between the two initiatives. Although an increasing overlap between the two would mean that potential mitigation is reduced, it could be an effective way of increasing the additionality of scope 2 reductions and give much needed legitimacy to the claims made by the larger portion of members in the SBTi.

It is to be expected that light industries and service companies achieve their reductions through external means, as they are "hard-to-abate" sectors (Fekete et al., 2021), but such reductions should be contextualized. At the very least, SBTi would largely benefit from focusing on increasing the use of PPAs and adapting some RE100 practices such as reporting on the sourcing methods of members in energy consuming sectors. Both initiatives have much work to do in order to legitimise how scope 2 reductions are being implemented, as it would be preferable if members in both moved away from unbundled EACs. Still, it is clear that RE100 has a better case in terms of additionality in renewable generation.



(a) SBTi targets only (39 companies).

(b) Overlap (26 companies).

(c) RE100 targets only (32 companies).

Figure 8.3: Market instruments used by companies featured in this study, exclusive and shared members. Utility companies have been excluded.

8.2. On disclosure quality and transparency at large

Evaluating disclosure platforms such as CDP at large, or analysing the quality of the tracking that each initiative has when making claims about its members were not the goal of this study. Still, information issues posed the largest barrier by far, to the point where the chosen initiatives and group of companies were selected in order to get around the majority of these issues (see section 4.1). However, even though the study would have been impossible without the reports and databases given by the initiatives and the existence of CDP questionnaires, it is very clear that, in the opinion of the author, the underlying system of disclosure is poor and actively hurting the legitimacy of their claims.

First, none of the two initiatives disclose enough information to accurately compare the size and contribution of its members, meaning targets have to be constructed using secondary sources or by making assumptions. SBTi does not publish the baseline emissions of their members in their reports or website, meaning any assessments will need to construct them through the company's own statements which in many cases are also incomplete (Giesekam et al., 2021); intensity targets in some cases were difficult to evaluate even by the initiative itself (SBTi, 2021e, appendix A). RE100's tracking process is better in the sense that they give values for individual progress each year, and contextualize overall progress more thoroughly. However, the electricity consumption of each member is not disclosed making comparisons between them impossible, and no distinction between the additionality of each member's progress is given.

It is possible that some members might reject a thorough approach to target tracking. However, sustainability processes and claims should be measurable (Özdemir et al., 2011) if they are to be taken seriously. Complete, transparent and atomized databases should be a concrete feature of ICIs.

Second is that, although CDP questionnaires have undoubtedly improved along the years, much work remains in order to make them a trustworthy source of information. Key issues are the lack of mathematical consistency in the energy section, where energy totals may not add up and energy consumption and generation can contradict one another, and consistent naming changes that confuse users (this was very apparent in the section for market-based accounting). This initiative sells a corrected version of company targets and emissions, which this study did not make use of. Still, improving the submission data to disallow errors will ultimately benefit CDP, the initiatives and researchers using its data, and policy-makers assessing their results.

8.3. On geographical balance and fairness

Chapter 5 discussed the geographical distribution of companies in terms of headquarter location, but no geographical disaggregation was done when evaluating members with targets. This was because country-specific emission data could not be adequately collected and assessed. Still, geographical imbalances in ICI participation is a feature of many studies discussing their potential and effectiveness (Chan et al., 2018; Andonova et al., 2017; NewClimate Institute et al., 2019).

As seen in table 8.2, the headquarters these companies are mostly located in Europe, and the largest portion of emissions reductions also occurred in that region. North America comes second, but its contribution is an order of magnitude smaller. East Asia & Pacific was third, with a majority of companies located in Japan. Other regions, particularly the global south, are sorely underrepresented.

The targets used in this study are based on either required global trends (emissions) or cost-optimal scenarios for OECD countries (renewable electricity). Both approaches are generous towards industrialized nations, since neither is consistent with effort-sharing approaches that account for historical emissions (van den Berg et al., 2020). Although the emissions of many of these companies might be distributed around the world, a strong argument can be made in that they should adhere to more stern targets given their countries of origin. In the case of SBTi companies this is especially true since projected ambition always matched the required trend at a global level, meaning it is likely that they would not fare as well if region-specific benchmarks were applied instead (see fig. H.2).

Table 8.2: Collective emissions of the 102 companies with targets that could be evaluated completely, subdivided by World Bank region depending on HQ location. Market-based emissions taken whenever possible.

		Emissions ($MtCO_2e$)				
World Bank Region	**Companies**	**2015**	**2016**	**2017**	**2018**	**2019**
Europe & Central Asia	53	700.99	638.55	579.86	515.14	436.01
North America	33	81.85	79.39	69.91	69.54	65.59
East Asia & Pacific	15	19.98	21.65	21.04	19.77	18.64
South Asia	1	0.38	0.39	0.41	0.49	0.33
Latin America & Caribbean	0	0	0	0	0	0
Middle East & North Africa	0	0	0	0	0	0

9. Conclusion

Non-state and Subnational Actors NSAs such as cities, regions and businesses have had an increasing role in climate policy due to an argued capacity to bring climate mitigation that is additional to lack-luster national commitments which, as a whole, are not enough to ensure global warming is kept below 1.5°C, or the Paris-mandated well-below 2°C goal. By the end of 2019 the gap between current national commitments and 1.5°C compatibility was 34 $GtCO_2e$ for 2030, while current NSA commitments and ICI potential goals are estimated to have the capacity of reducing global emissions by 2.3–5.0 and up to 21 $GtCO_2e$ for the same year, respectively.

However, studies showing achievement are scarce due to a plethora of problems such as inadequate tracking platforms, capacity limitations and lack of control over the targeted emissions. Given how these entities have been subjected to scrutiny due to possible greenwashing and effort segmentation, ex-post evaluations are an important missing link. As nations aim to convene once again in Glasgow for the 26th Conference of the Parties, results in the performance of these initiatives can shed light on the way to go forward, as nations should embolden their ambition to ensure we keep global warming below 1.5°C.

This chapter concludes the thesis, wrapping up analysis, offering recommendations and acknowledging its limitations. It is structured as follows: section 9.1 lists the research questions that guided this study, and answers them. Section 9.2 discusses the implications seen in the way this group of companies behaves and performs. Section 9.3 gives policy recommendations that could be useful for the initiatives, companies and policymakers going forward. Finally, section 9.4 reflects on the limitations of the methods taken, and suggests areas of future research.

9.1. Answering the research questions

This study set out to analyse large businesses, specifically the Fortune Global 500 ranking of 2020, and evaluate their participation and performance of in the Science Based Targets initiative (SBTi) and RE100 initiative. Although there are no recent and complete estimates of the emissions attributed to Fortune's G500 listing, and the companies featured in it change every year, estimations of other revenue-rated listings with the same total of companies estimated a collective 5.0 $GtCO_2e$ for scopes 1 and 2 in 2015 (assuming no overlaps).

The SBTi was created in 2015, and works by evaluating company emission targets by a set of criteria, approving and classifying members that fit within different cost-optimal emission mitigation pathways (2°C, well-below 2°C or 1.5°C compatible). Membership has grown at an accelerated pace, with 593 members with approved targets as of 23rd February 2021. The most recent ex-ante studies of their impact in the literature give an estimated potential of 2.7 $GtCO_2e$ of mitigation by 2030.

RE100 is a slightly older initiative, funded in at the 2014 UN Climate Summit. It has the goal of increasing global usage of renewable electricity, with its members targeting 100% renewable use by 2050 at minimum. The initiative has grown at a somewhat linear pace, reaching 289 members by 23rd February 2021. The latest ex-ante estimates attribute a potential reduction of 1.9–4.0 $GtCO_2e$ by 2030 to this initiative.

The three groups featured in this study were brought together in order to answer the following main research question:

To what extent have the SBTi and RE100 cooperative initiatives directly contributed to climate change action and the renewable transition via reductions in emissions and shifts to renewable electricity usage between the Paris agreement and today?

To do so, data collection and validation algorithms were employed to obtain information on the membership of each group, identify overlaps between them and collect target data. Then, disclosure platforms such as CDP and public reports were used to obtain data on the emissions, energy use and energy purchase methods, among others. This information was used in combination with a logical framework to assess progress in four key aspects: ambition, robustness, implementation and substantive impact.

> ***SQ1**. What is the degree and distribution of participation of G500 companies in the SBTi and RE100 initiatives?*

A total of 137 companies in Fortune's Global 500 have joined at least one of these initiatives in some capacity; 68 joined the SBTi exclusively, 21 are only in RE100, and 48 have entered both. In the case of the SBTi, 72 members have approved targets, while the remaining 44 have only committed to setting them in the near future. This last group has lagged behind in setting approved targets, with a total of twenty-four members exceeding the claimed two-year limit established by the initiative's own criteria. By contrast, all 69 companies in the RE100 have targets, as it is a requisite to become a member.

Geographical analysis showed that most of these 137 companies have their headquarters in either Europe, North America, or Japan. There is a heavy skew towards developed nations in the sample analysed, with European companies being the large majority with a total of 72, and North American companies being second with 40. Although Chinese companies are the largest group in the G500 ranking (124), only one of them joined either initiative.

Most companies participating in the ICIs are either in the service or light industry sectors. Among the initiatives, only SBTi has a few firms in sectors associated with large GHG emissions such as Energy Intensive Industrys or Electric Utilities. RE100, by contrast, has 17 financials among its exclusive members.

> ***SQ2**. Are these companies setting appropriate targets and what impact can be expected of them?*

Ambition in the SBTi was evaluated for 64 companies with absolute targets for scopes 1+2 covering 300 $MtCO_2e$ by 2015, showing a collective trend to stay within global pathways for well-below 2°C. This is within the Paris agreement guidelines but above IPCC recommendations. Ambition differs significantly by sector, with only service companies staying within 1.5°C and other sectors showing decreasing ambition the more energy intensive they were. Three electric utilities covered the largest portion of these emissions (114 $MtCO_2e$), collectively matching a well-below 2°C pathway. Targets tend to match IPCC scenarios well, with groupings by the initiative's own qualifications showing to be a good indicator of collective ambition at a global scale. However, most of these companies are located in developed nations, which are generally expected to abate emissions faster than developing ones, especially so if historical emissions are taken into account. Although SBTi targets are definitely ambitious compared to scenarios of Current National Policies, questions remain on whether their targets fit the trends that their respective nations should have.

RE100 ambition was analysed for 66 companies, covering a total of 181 TWh by 2019. Assuming their electric consumption remains constant, they would reach over 90% renewable usage by 2030. Most company targets tend to exceed the ambition required to exceed scenarios for increments in the share of renewable electricity in OECD nations developed by the IPCC, which shows that ambition is generally high among this initiative. However, these IPCC scenarios were developed using a cost-optimal approach to effort-sharing, which tends to be lenient in the carbon budget assigned to industrialized nations.

> ***SQ3***. *Through which methods are these companies improving their capacity to deliver on their targets?*

Evaluation of progress in robustness and implementation was done for 70 SBTi members with approved targets. Robustness showed a general preference towards third-party assurance at a limited level, which is generally cheaper and less thorough than reasonable assurance. This applies to most sectors regardless of how energy intensive they are, with French utilities being the only high emitters that reached reasonable or high levels of assurance. Although a decrease in the number of companies with no third-party assurance was seen, there is no evidence of a collective improvement in the level of assurance sought. Implementation assessed energy producers and users through different energy categorizations. Generally, emission intensive members showed evidence of internal change through reduction in fossil fuel use; while the light industry, services and transport sectors showed little evidence of internal change and instead replaced purchased non-renewable energy with renewable purchases. Sourcing methods with high additionality make up only 21% of the renewable energy that is purchased or self-consumed by members that are not electric utilities.

The renewable energy use of 58 RE100 members was assessed for robustness in the degree of visible purchasing methods disclosed by the companies themselves, and implementation was evaluated by subdividing those visible purchases into different market instruments ordered by their degree of perceived additionality. In the case of robustness, an increasing lack of visibility hinted at a lack of convergence between RE100 and reporting instruments such as CDP, some of which have affected the disclosure of financial service companies in particular. Visible renewable purchases have decreased from 95 to 77% between 2015 and 2019. Low additionality instruments are also popular among RE100 members, with 44% of the renewable energy used in 2019 being obtained through their use. Despite this, Power Purchase Agreements have seen an increased use along the past half-decade, and in 2019 they represented one third of claimed renewable energy use. Self-generated renewable energy, the sourcing method associated with the most additionality, has seen limited use. By 2019 only 2.5 TWh (3.3%) of renewables were self-consumed by this group of companies, most of it coming from light industries in the IT economic sector.

> ***SQ4***. *To what level has the collective work of these companies lead to substantive climate mitigation?*

In terms of emission reductions, a collective of 102 members with targets in either initiative have reduced their scope 1+2 emissions from 802 to 520 $MtCO_2e$ between 2015 and 2019. Among the two initiatives, SBTi covers a significant portion of these emissions, mostly thanks to the Electricity

Generation and Energy Intensive Industry sectors which emitted 613 $MtCO_2e$ in 2015. RE100 has a much smaller share (95 $MtCO_2e$ in 2015), attributable to the lack of companies in the Energy Intensive Industry sector (the initiative disallows utilities to join). Neither of the two sectors with the most members, service companies and light industries, showed evidence of a decrease in scope 1 emissions in either initiative, meaning their reduction in emissions comes through indirect means.

The increases in purchased renewable energy and electricity generation in energy consuming sectors in both initiatives was roughly comparable, with both increasing from around 25 TWh to close to 74 TWh in 2019. In this case, RE100's influence in additionality gives it a better standing, but both groups still vastly prefer instruments with little identifiable impact.

9.2. Implications

In this section, all the other chapters are brought together in order to discern what the results imply for non-state action, international cooperative initiatives focused on business contributions, and the transition towards sustainability as a whole. Although this research is limited in its scope and coverage of corporate focused ICIs, the author believes that there are several key lessons that can be taken from its results and the experience gathered while developing it.

It is clear that companies participating in these initiatives have been successful in improving their environmental performance. Even if comparing their contributions against global and regional trends is difficult, at the very least they can serve as an example to other international businesses in how it is possible to shift towards practices that are consistent with a Paris-aligned world. The results shown by some sectors, in particular the utilities, are very impressive; it is gratifying to see how the average reduction of emissions is above 1.5°C requirements in many cases.

However, there appears to be a disconnect between the approach taken by some of these actors and the problem at large. Removing the few large emitters that make up most of direct emission mitigation (scope 1) seen in this study, most actors focus on attaining reductions through external means that make their contributions hard to discern in terms of additionality. Although indirect emissions reductions (scope 2) are definitely welcomed, the fact remains that most targets in the SBTi mix both scopes and treat progress in either of them as equivalent when this is just not demonstrable with the disclosure methods employed by the initiative so far, nor is it consistent with the purchase preferences of these companies. RE100's approach is more complete, and does appear to successfully promote better energy sourcing practices, but it still mostly targets emissions whose abatement is not directly controlled by the company.

This implies a mixed message of success. These companies do set targets that at the very least are consistent with a 2°C world, which are better than the current trends seen in national policies, and they have been generally successful at achieving them, with different energy sectors exceeding expectations when it comes to the SBTi, as most already showed a pattern of decreasing emissions before they set their current target. In the case of RE100, the target covers a smaller portion of the emissions of these companies, but generally is quite ambitious when compared to OECD scenarios of renewables in electricity and collectively members appear to be on track to reaching them, offset errors caused by reporting problems notwithstanding.

However, most of these companies are located in industrialized nations that were already showcasing a trend of decreasing emissions, with a large portion of them having their headquarters in Europe, which perhaps implies a relation between countries that have already implemented climate policies and non-state action by businesses on these initiatives. This coincides with observations made by previous studies that looked into this type of governance (Andonova et al., 2017). This tendency means that global scenarios are perhaps not the best measure of ambition to these companies as industrialized nations should, in theory, diminish their emissions at rates faster than the global mean.

These initiatives also seem to attract mostly light industries and service companies. Such sectors do not generate as many emissions, meaning that the collective success or failure of the initiative with a few emission intensive members (SBTi) largely depends on these few companies. RE100 does not have such companies, meaning its effects will be smaller, especially considering that this study already covers over half of the electricity consumption covered by the initiative. The rest of the members of the

SBTi, and all of RE100's, do not seem to have achieved collective internal change, focusing instead on sourcing renewable energy, and generally preferring methods which reduce their own carbon footprint, but risk displacing the emissions elsewhere for the time being. Such methods might have effects on the long term, but are closer to what some authors describe as indirect impacts (Chan et al., 2018).

There is also the issue of how information is disclosed, shared and reviewed. While the GHG Protocol acts as a solid foundation on how emissions and energy data should be accounted, and for the guidelines set by the initiatives themselves, the quality in which information is disclosed varies significantly. In many cases company reports and CDP responses did not fully follow the guidelines set by the protocol and presented mistakes that should be easily preventable, if such checks were included as part as the disclosure procedure. There is also little coordination in how companies, RE100, SBTi and CDP disclose information and share data, with the lack of completeness on disclosing target metrics by the initiatives themselves being a major oversight.

Information is not truly widely and easily accessible in ways that enable external parties to assess progress, meaning transparency at the initiative level is generally low. Collecting and verifying information proved to be difficult, likely the reason why there are so few ex-post studies of how such initiatives progress, and a plethora of other issues makes comparing data across years prone to errors, which should be an essential part of how these initiatives track progress. These issues undoubtedly add up, generating a cacophony of problems that harms the legitimacy of the contributions of these actors. Given how progress against targets appears to be good overall, there are strong incentives for these initiatives and companies to improve the ways in which data is made public, as it can only embolden their message towards nations.

9.3. Policy recommendations

As it stands, companies are doing well when it comes to setting adequate targets (at a global scale) and achieving progress that reduces their own carbon footprint, but the interim steps of robustness and implementation have not developed sufficiently. Widerberg et al. (2015) gave two recommendations, among others, that the author believes ring true to the issues seen.

First, *the international community should safeguard the additionality of ICIs.* This implies that initiatives should re-align the disclosure of target metrics and promote behavioral change in their members in ways that acknowledge the difficulties in proving the additionality of their actions at a global level, in particular when it comes to reductions in indirect emissions. Although verifying additionality at 100% certainty is essentially impossible with current disclosure methods, shifting the focus towards different mitigation and reporting practices might aid in producing actions with quicker effects on society at large. This can be done by:

- Encouraging direct mitigation within the boundaries of their members, with a particular focus on light industries and service companies.
- Disclosing progress in scopes 1 and 2 separately per-member in order to identify areas of improvement more easily.
- Promoting the use of high-additionality instruments such as Power Purchase Agreements and self-generation, and using that data to contextualize scope 2 reductions whenever possible.
- Requiring targets in line with UNFCCC principles of common but differentiated responsibility (i.e. companies in developed nations must do more than just match the required global trend).
- Focusing on achieving membership growth in sectors with high emission intensity and in developing nations.

Second, *ICIs should be encouraged to have open and transparent goals, procedures and reporting.* In the case of the SBTi and RE100, the first two steps appear to have received good amounts of attention, as both initiatives provide plenty of information on their members, methodologies and rules. However, there is one oversight that both share in terms of open and transparent goals, which is that target data should be complete per-company and should be disclosed in ways that make the size of each member's contribution differentiable, disclosing the following information at minimum:

- Joining year.
- Baseline year.
- Baseline metrics.
- Target end year.
- Targeted reduction.

It is in the reporting where most of the issues are concentrated, as neither of these initiatives provide open and veritable data on how they are evaluating the progress of their members. They rely instead on CDP disclosures, whose issues on longitudinal consistency reduce the credibility of year-on-year evaluations, and are not truly open since access is limited to a few responses per account and companies can choose to make their responses private. Instead, to increase the credibility of these initiatives and for the benefit of society at large, this study makes the following recommendations when it comes to disclosure of progress in either the initiatives themselves or sustainability disclosure platforms:

- All target data, and all progress metrics, should be open and easily accessible to the public.
- Steps must be taken to ensure that companies report data with longitudinal consistency.
- Emissions and energy data disclosed must relate to the same operational boundaries.
- Databases should strive to improve convergence with one another. This means using similar names for members and striving to use the same boundaries for target tracking.
- Data, and energy data in particular, should be mathematically consistent whenever possible.
- Validation tests must be employed to identify preventable mistakes before submissions.
- Members should be encouraged to ensure that their emission reporting schemes are of high quality.

Previous evaluations of corporate ICIs have commented on the limitations of voluntary initiatives in terms of what they can achieve disclosure-wise (Giesekam et al., 2021). It is very likely that the companies featured in this study are preforming better than the norm in terms of setting ambitious targets and following through with them, and yet it is hardly enough to allow adequate tracking. Understanding how much difference there is between these members and other firms would necessitate a system with stronger incentives for accurate accounting than what the current voluntary approach is offering. Nations should consider a stronger system of emissions reporting by large firms, as it would enable society at large to identify areas of improvement with better clarity.

9.4. Limitations and future research

Although this study aimed to be as thorough and complete as possible, decisions on how and which data would be gathered and presented necessarily impose limits on it. This section aims to explain the reasoning behind such decisions, how they affect results and how future research could improve upon it.

9.4.1 Data methods and assumptions

Most of the data used in this study comes from the companies themselves through CDP questionnaires, which are are not subjected to further validation after submission (i.e. CDP applies no corrections to them). Stanny (2018) showed that utility companies may submit unreliable data to the platform. The high amount of errors, and the lengthy validation process showed that this extended to other members.

CDP does offer revised versions of their data for company targets and GHG emissions through the Clean and Complete Dataset, and the Cleaned Corporate Targets Dataset. These databases are sold at a premium, and this study did not make use of them. Extreme care was taken to ensure that information had the highest level of quality possible, but in many cases it was necessary to assume values by interpolating either emissions or energy (see section 4.5), removing wrongly submitted energy purchases or combining data from company reports and CDP questionnaires.

The values shown in this study are the best estimations possible, and should at least capture the order of magnitude of the emissions of each actor. However, this still means that there is significant room for error. The author believes that the results show the general trends and preferences of these companies well, but caution should be taken when interpreting exact values.

9.4.2 Boundary changes

Another limitation was the assumption that the organizational and operational boundaries of companies did not change significantly during the five years featured in this study. It is important to keep in mind that in some cases reductions may have occurred because a member sold an asset or spun out a branch, i.e. the source of emissions passed onto a different actor. The visibility allowed by the data collection methodology used in this study renders this unknowable, and this assumption had to be made. However, and given the issues seen in the data, this still leaves room for error. Boundary descriptions could have been a valuable resource to not only assess changes in the size of each firm, but also identify accounting errors. Integrating this aspect in to the analysis would allow a better view into the internal dynamics of each company.

9.4.3 Scope 3 emissions

A key limitation of this study is the lack of evaluation of targeted scope 3 reductions in the case of SBTi results (they are outside RE100's goals, by definition). These usually make up the majority of the indirect emissions of a company, and are often the least successful at being reduced (Giesekam et al., 2021). Although this scope was collected for every member, it was not possible to apply a proper logical framework analysis. Obtaining information on whether companies approach these targets seriously, and how they implement change would be incredibly valuable.

During the early stages of the study it was noticed that companies only tend to verify some reported categories. Proper analysis necessitates comparing scope 3 categories with third-party assurance against the total categories disclosed. This is made more important by the fact that there is no other metric that can be used to identify mistakes (such as energy purchased in the case of scope 2). Since it was not possible to collect assurance information in an automated way, these emissions were omitted.

The lack of any kind of scope 3 analysis in this study is a major limitation since they dwarf the other two scopes, and they generally do not show signs that they are being reduced collectively, as seen in fig. 9.1. It is very likely that plenty of these emissions are occurring in developing nations, which makes them invaluable contributions towards a Paris-aligned world since most of the emission increases are expected to occur in those countries.

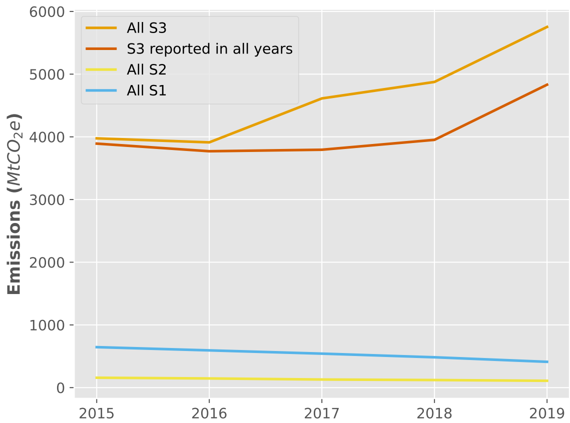


Figure 9.1: Scope 3 emissions reported by 102 companies who set targets in either initiative. In many cases companies began tracking new categories after 2015, so a second line including only categories disclosed every single year was included.

9.4.4 Overlaps

All figures and calculations present in this report do not account for potential overlaps between electric utilities and other members. This was done to keep comparisons simple, and because emission location data in CDP questionnaires could not be properly validated due to time constrains.

Similarly, no overlap analysis between Nationally Determined Contributions and the emission reductions of these actors was done, which is very relevant in the case of utilities. Considering how a large majority of electricity generation companies are located in a single country (France), and how other studies have stated that utility companies and national goals tend to be more closely aligned (NewClimate Institute et al., 2019), it is very possible that the progress in GHG emission mitigation expressed in the SBTi chapter is considerably lower.

9.4.5 Chosen log frame progress indicators

Another limitation are the progress indicators chosen, and how they only provide an incomplete picture of how these companies and initiatives operate. Choosing to compare ambition against generalized benchmarks without adjusting them for specific regions or sectors may already benefit most companies. This is especially true in the case of the SBTi, since global targets are most likely a low bar when compared to the required trend for developed nations.

Robustness indicators are also limited in what they can offer. In both cases, they may relate more to the level of trust-worthiness of the data than inputs and activities done by these actors in order to perform better. For RE100, the metric was even affected by factors outside the control of the initiative or the companies themselves (changes in the CDP questionnaire). Although they were useful to contextualize other progress indicators, future analyses would benefit significantly from identifying other indicators that tie more directly to the activities of the actors.

Implementation also suffers from a lack of specificity. Even if identifying trends in energy use and market instruments is useful, they leave the specific technologies employed unknown. Combining economic and energy sector classifications with an indicator that identifies the use of specific technologies could produce more useful lessons that are immediately adoptable. As they stand, these indicators can only offer a generalized view on trends.

When it comes to substantive impact, the largest limitation is how progress can only be interpreted against the internal boundaries of the companies (i.e. it is not possible to know how progress reflects on a global scale). The study tried to solve this by contextualizing it against implementation, but statements about the possible additionality of improvements in this metric remain speculative.

9.4.6 Initiative coverage

This study limited the companies analysed to the Global 500 in order to reduce the possibility of overlaps and ensure that most members had the capacity of doing adequate emissions accounting. However, this also meant that none of the initiatives would be covered in their entirety, limiting the statements that can be made on the initiatives as a whole. Although results might give useful insights into how these actors are operating, it is unclear if they are an accurate representation of the behavior of an average member in these ICIs.

9.4.7 Collective progress versus individual improvement

During the literature review it was identified that initiatives and other studies tend to show progress in terms of percentage of reduction achieved, or similar dimensionless metrics (RE100, 2020a; SBTi, 2021e; Giesekam et al., 2021). Although this approach allows the reader to compare progress between companies, it obscures size differences.

Instead, this study made a conscious decision to avoid using such metrics when evaluating progress, opting to display collective impact instead in order to properly show differences in GHGs emitted and energy use when comparing between both initiatives, sectors or different qualifications. Figures showing the percentage of reductions achieved against targets were generally avoided, with a few exceptions. However, this also means that best performers were not identified, and it also makes it possible for smaller companies with poor progress to hide behind large, overachieving firms.

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A. Appendix

A. Rejected International Cooperative Initiatives

This section gives a brief explanation on some investigated ICIs were not selected. Table A.1 summarizes the scores given to these initiatives. For a full overview of the documentation reviewed, please see appendix B.

For starters, technically focused industry initiatives such as ETIP PV do not seem to aim at on-the-ground implementation, centering their efforts on furthering technological development instead (ETIP PV, 2017; ETIP PV, 2019). This initiative is featured prominently in ex-ante literature and has been given a potential of 0.2-0.5 $GtCO_2e$ (Lui et al., 2020; Hsu et al., 2020a; NewClimate Institute et al., 2019). However, it is unclear how this potential was calculated since none of the documents disclosed by ETIP PV mention the goal of installing 600 GW of solar PV by 2025 mentioned in these studies. Due to its focus on increasing ambition in research policies and not direct implementation, which makes tracking directs impacts difficult with current methods, it is not possible to assign direct mitigation impacts to the initiative at this moment (Smit et al., 2020).

Another rejected initiative was The Climate Group's EP100 since it focused on intensity metrics (e.g., cars per tCO_2e) instead of absolute ones (EP100, 2020). These types of metrics, while useful for businesses, are hard to track and make comparisons difficult. Some studies have said that intensity approaches may not lead to effective mitigation in some cases (Haque et al., 2018; Doda et al., 2016). The initiative has an expected impact of 0.3-2.4 $GtCO_2e$ (We Mean Business, 2016), but it was discarded for the reasons stated above.

Finally, CA100+ was also rejected. This initiative is compounded of several investors pushing for better targets and oversight on climate activities in companies. According to a report by CDP, there is a general lack of senior oversight in company targets, and most of these companies have not set science based targets (CDP, 2020b). The fact remains that this is an investor-led initiative whose impact will be mostly indirect, making its contributions difficult to track and classify in a quantitative manner (Chan et al., 2018). The initiative is developing a benchmarking framework, but that this moment no results have been relased publically (CA100+, 2020).

Table A.1: Summary of 4BDC scores given to each initiative.

Name	Targets?	Incentives?	Baselines?	MRV?	Score
ETIP PV	No	Yes	No	No	1/4
EP100	Yes	No	Yes	Yes	3/4
CA100+	No	No	No	Yes	1/4

It is important to clarify that not being selected does not imply lack of impacts. Generally, it just means that progress in these initiatives was too hard to quantify, and thus did not match the purpose of this study.

B. Review of ICI documents

Table B.1: Summary of reviewed ICI documentation.

ICI	Scope (companies analysed)	Data disclosed per company	Reference
CDP	Global 500 by market cap (366)	CDP response status, country, industry, market cap	CDP, 2019c
CDP	Hong Kong and SEA (71)	CDP score, country, industry	CDP, 2019d
CDP	Australia and New Zealand (95)	CDP score, sector	CDP, 2019a
CDP	Italy (55)	CDP response status	CDP, 2019e
CDP	India (59)	CDP score, GHG emissions (Scopes 1, 2, 3), sector	CDP, 2020d
CDP	Japan 500 by market cap (319)	CDP score, GHG emissions (Scopes 1 and 2), industry, SBTi membership	CDP, 2020e
CDP	Latin America (90)	None	CDP, 2020f
CDP	Largest fossil fuel producers (100)	Cumulative GHG emissions 1988–2015 (Scopes 1, 3)	CDP et al., 2017
CA100+	Initiative members (160)	CDP response status, industry	CDP, 2020b
CA100+	Initiative members (160)	None	CA100+, 2020
RE100	All members (261)	Country, joining year, target year, % progress 2015–2019	RE100, 2020a
RE100	All members (289)	Target year	RE100, 2021a
EP100	All members (100+)	Baseline year, country, joining year, intensity metrics, sector, target year, % progress	EP100, 2020
SBTi	Members with targets (338)	Absolute metrics, approval year, baseline year, intensity metrics target year, % progress	SBTi, 2021e
SBTi	All members (1205)	Absolute metrics, baseline year, date of last update to targets, intensity metrics, ISIN, target pathway, target year	SBTi, 2021b
ETIP-PV	All members (15)	Signatory name	ETIP PV, 2017

C. Toolset

This section gives a rundown of all the different tools, coding languages and libraries used while developing this study.

- Automated web scrapping
  - Python libraries: Selenium Webdriver, Beautiful Soup
- Approximate string matching (a.k.a., fuzzy searching)
  - Python library: fuzzywuzzy
  - Method used: Partial ratio
  - Minimum score: 90/100
- Database management
  - Python libraries: Pandas, Numpy
- Graphics
  - Diagrams: Drawio
  - Tables: Latex
  - Plotting: Matplotlib
  - Geographic Information: QGIS

D. CDP: market-based low-carbon energy purchases

Table D.1: Low-carbon energy purchases seen in different versions of the CDP questionnaire. Self-owned and Grid mix categories were removed once identified as they violate GHG protocol requirements for scope 2 market based reporting. "Check" was used as a trigger for manual validation, and covers all cases where a company did not follow the categories of that specific version of the questionnaire.

Study	2020	2019–2018	2017–2016
PPA direct line	Power purchase agreement (PPA) with on-site/off-site generator owned by a third party with no grid transfers (direct line)	Off-grid energy consumption from an on-site installation or through a direct line to an off-site generator owned by another company	Off-grid energy consumption from an on-site installation or through a direct line to an off-site generator owned by another company
PPA w/EAC	Power purchase agreement (PPA) with a grid-connected generator with energy attribute certificates	Power Purchase Agreement (PPA) with energy attribute certificates	Direct procurement contract with a grid-connected generator or Power Purchase Agreement (PPA), supported by energy attribute certificates
PPA no EAC	Power purchase agreement (PPA) with a grid-connected generator without energy attribute certificates	Power Purchase Agreement (PPA) without energy attribute certificates	Direct procurement contract with a grid-connected generator or Power Purchase Agreement (PPA), where electricity attribute certificates do not exist or are not required for a usage claim
Green Utility Product w/EAC	Green electricity products (e.g. green tariffs) from an energy supplier, supported by energy attribute certificates	Contract with suppliers or utilities (e.g. green tariff), supported by energy attribute certificates	Contract with suppliers or utilities, supported by energy attribute certificates
Green Utility Product no EAC	Green electricity products (e.g. green tariffs) from an energy supplier, not supported by energy attribute certificates	Contract with suppliers or utilities (e.g. green tariff), not supported by electricity attribute certificates	Contract with suppliers or utilities, with a supplier-specific emission rate, not backed by electricity attribute certificates
Unbundled EAC	Unbundled energy attribute certificates, Guarantees of Origin / Renewable Energy Certificates (RECs) / International REC Standard (I-RECs) / other - please specify	Energy attribute certificates, Guarantees of Origin / Renewable Energy Certificates (RECs) / I-RECs	Energy attribute certificates, Guarantees of Origin / Renewable Energy Certificates (RECs) / I-RECs
HSC agreement	Heat/steam/cooling supply agreement	-	-
Grid mix	-	Grid mix of renewable electricity	-
Self owned	-	-	Grid-connected electricity generation owned, operated or hosted by the company, where electricity attribute certificates do not exist or are not required for a usage claim
			Grid-connected generation owned, operated or hosted by the company, with energy attribute certificates created and retired by company
Check	Other, please specify	Other, please specify	Other (specify in Comment column)
	-	-	Off-grid energy consumption from an onsite installation or through a direct line to an off-site generator

E. Companies omitted

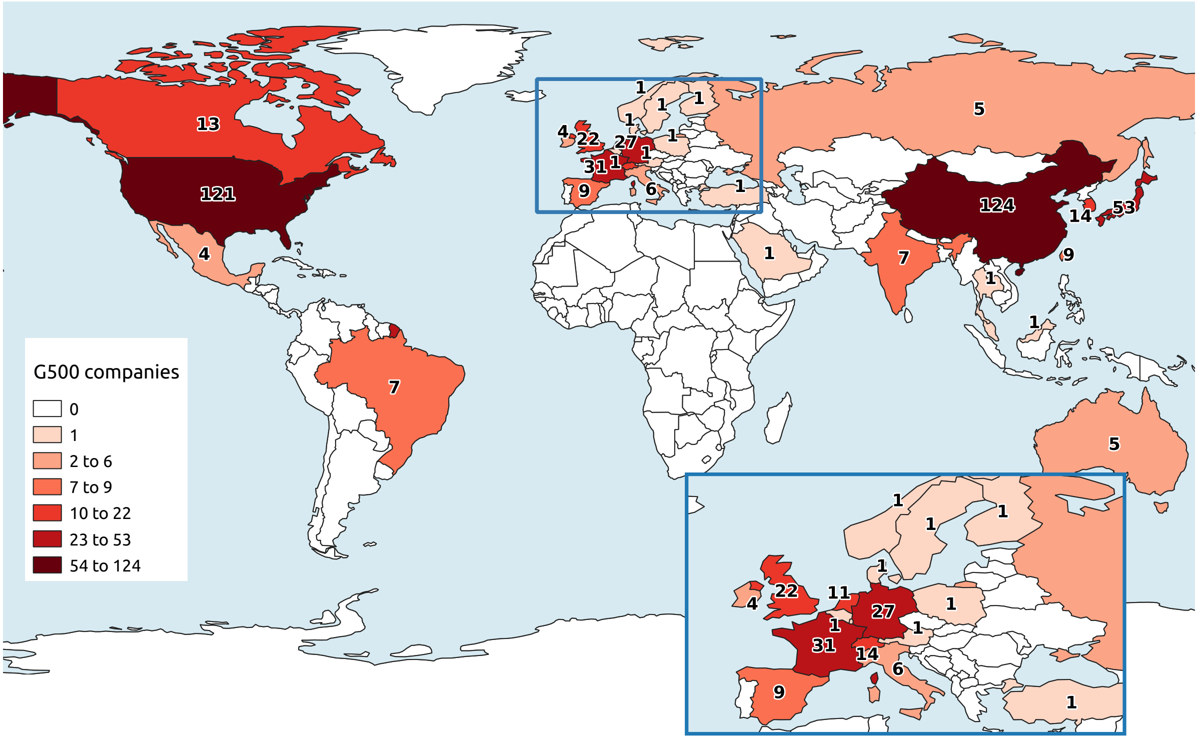
Table E.1: List of companies that did not disclose enough environmental data to be included in the evaluation.

Company	**Reason**
CMA CGM	Only two CDP questionnaires and not enough data in annual reports.
Amazon	No CDP responses. The company does not disclose energy consumption data (Bryce, 2021). Emissions only available for recent years.
Seven & I Holdings	The company submits data that is two years old to CDP, meaning that the 2020 questionnaire had 2018 data. Annual reports were not useful to collect 2019 data.
América Móvil	All CDP responses are private. Annual reports had errors in energy calculations, making longitudinal analysis impossible.
Volvo	No CDP responses. Annual reports were not transparent enough to complete energy section.
X5 Retail Group	Only two CDP questionnaires. No emissions disclosed prior to 2019 in annual reports.
M&G	Spun out from another company in 2019 (Cohn, 2019).
Phoenix Group Holdings	No CDP questionnaires, annual reports do not allow to complete energy data.
Fubon Financial Holding	Only two CDP questionnaires, not enough energy data in annual reports.

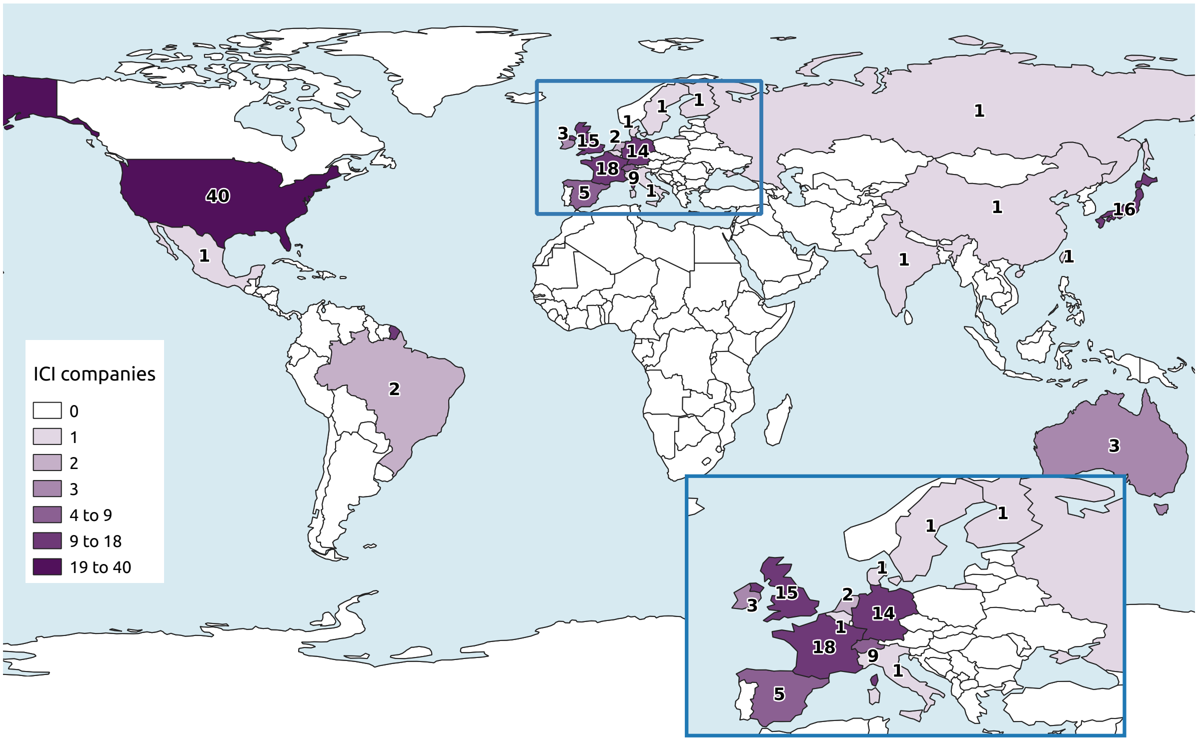
F. Geospatial maps of G500 and ICI membership

Table F.1: Geographical distribution of G500 companies, and the ratio of participation in the SBTi and RE100.

Country/Region	G500	ICI	Participation
China	124	1.0	0.81%
United States	121	40.0	33.06%
Japan	53	15.0	28.3%
France	31	18.0	58.06%
Germany	27	14.0	51.85%
United Kingdom	22	15.0	68.18%
Switzerland	14	9.0	64.29%
South Korea	14	1.0	7.14%
Canada	13	0.0	0.0%
Netherlands	11	2.0	18.18%
Taiwan	9	1.0	11.11%
Spain	9	5.0	55.56%
Brazil	7	2.0	28.57%
India	7	1.0	14.29%
Italy	6	1.0	16.67%
Russia	5	1.0	20.0%
Australia	5	3.0	60.0%
Ireland	4	3.0	75.0%
Mexico	4	1.0	25.0%
Singapore	2	0.0	0.0%
Austria	1	0.0	0.0%
Norway	1	0.0	0.0%
Poland	1	0.0	0.0%
Malaysia	1	0.0	0.0%
Saudi Arabia	1	0.0	0.0%
Luxembourg	1	0.0	0.0%
Sweden	1	1.0	100.0%
Finland	1	1.0	100.0%
Denmark	1	1.0	100.0%
Thailand	1	0.0	0.0%
Turkey	1	0.0	0.0%
Belgium	1	1.0	100.0%



(a) Companies in the Fortune Global 500 ranking of 2020 (Source: data from Fortune (2020); own figure).



(b) 137 companies participating in either SBTi or RE100.

Figure F.1: Geographical distribution of companies in this study.

G. Fortune industries to GICS and energy use sector tables

Companies in the "Energy" industry were reclassified into other existing categories by consulting their classification in other business websites like Forbes or Bloomberg, or by reading company reports. "Mining, Crude-Oil Production" was subdivided into "Mining (Metals)", "Mining (Coal)" and "Crude-Oil Production" by following a similar method. Mining companies with some fossil extraction but otherwise very diversified portfolios were set as "Mining (Metals)".

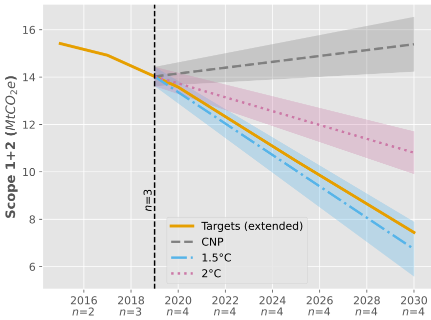
Table G.1: Summary of how Fortune industry classifications were re-classified to GICS sectors, based on S&P's own documentation (S&P, 2018).

GICS sector	**Fortune G500 Industries**
Communication Services	Telecommunications; Entertainment; Interactive Media and Services
Consumer Discretionary	Motor Vehicles & Parts; Specialty Retailers; Apparel; General Merchandisers; Home Equipment, Furnishings; Food Services
Consumer Staples	Food & Drug Stores; Food Production; Consumer Food Products; Beverages; Soaps and Cosmetics; Wholesalers: Food and Grocery; Tobacco
Energy	Petroleum Refining; Pipelines; Oil & Gas; Mining (Coal); Oil & Gas Equipment, Services; Crude-Oil Production
Financials	Banks: Commercial and Savings; Insurance: Life, Health (stock); Diversified Financials; Insurance: Property and Casualty (stock); Megabanks; Insurance: Life, Health; Superregional Banks; Consumer Credit Card and Related Services
Health Care	Pharmaceuticals; Wholesalers: Health Care; Health Care: Insurance and Managed Care; Health Care: Medical Facilities; Medical Products and Equipment; Health care: Pharmacy and Other Services
Industrials	Trading; Aerospace & Defense; Engineering & Construction; Electronics, Electrical Equip.; Industrial Machinery; Airlines; Delivery; Construction and Farm Machinery; Railroads; Diversified Outsourcing Services; Shipping; Mail, Package, and Freight Delivery; Trucking, Transportation, Logistics
Information Technology	Computers; Electronics; Internet Services and Retailing; Computers, Office Equipment; Information Technology Services; Network and Other Communications Equipment; Computer Software; Wholesalers: Electronics and Office Equipment; Semiconductors; Technology Hardware, Storage and Peripherals; Semiconductors and Other Electronic Components
Materials	Metals; Chemicals; Building Materials, Glass; Mining (Metals)
Real Estate	Real Estate
Utilities	Utilities

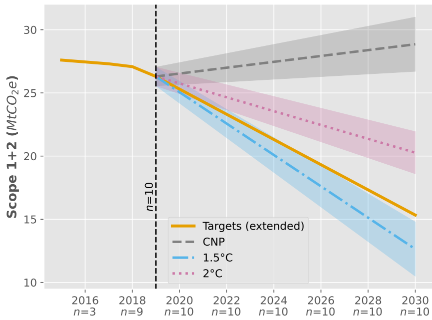
Table G.2: Summary of energy sector classification vs industry classification in the Fortune G500 2020 list. Fortune G500 industries are subdivided by semicolons.

Energy sector	Fortune G500 Industries
Electricity Generation	Utilities
Energy Intensive Industry	Metals; Chemicals; Building Materials, Glass
Fossil Fuel Production	MotorPetroleum Refining; Pipelines; Oil & Gas; Crude-Oil Production; Mining (Coal)
Light Industry	Motor Vehicles & Parts; Aerospace & Defense; Apparel; Engineering & Construction; Pharmaceuticals; Textiles; Electronics, Electrical Equip.; Food Production; Semiconductors; Industrial Machinery; Motor Vehicles; Motor Vehicle Parts; Real estate; Computers; Electronics; Computers, Office Equipment; Consumer Food Products; Construction and Farm Machinery; Network and Other Communications Equipment; Mining (Metals); Soaps and Cosmetics; Medical Products and Equipment; Tobacco; Home Equipment, Furnishings; Oil & Gas Equipment, Services; Technology Hardware, Storage and Peripherals; Beverages; Semiconductors and Other Electronic Components
Services	Banks: Commercial and Savings; Insurance: Life, Health; Food & Drug Stores; Trading; Telecommunications; Specialty Retailers; Diversified Financials; Megabanks; Insurance: Property and Casualty; Food Services; Insurance: Life and Health; Wholesalers: Health Care; Internet Services and Retailing; Entertainment; Health Care: Insurance and Managed Care; Computer Software; Information Technology Services; Diversified Outsourcing Services; Wholesalers: Food and Grocery; General Merchandisers; Health Care: Medical Facilities; Superregional Banks; Consumer Credit Card and Related Services; Wholesalers: Electronics and Office Equipment; Health Care: Pharmacy and Other Services; Interactive Media and Services
Transport	Airlines; Delivery; Railroads; Mail, Package, and Freight Delivery; Shipping; Trucking, Transportation, Logistics

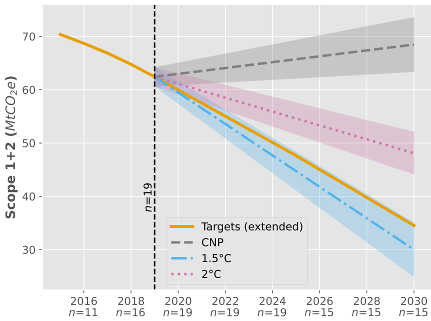
H. RE100 log frame results: economic sectors



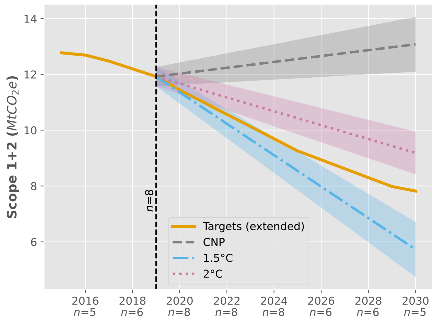
(a) Communication Services



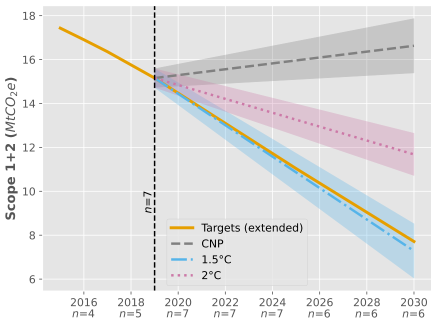
(b) Consumer Discretionary



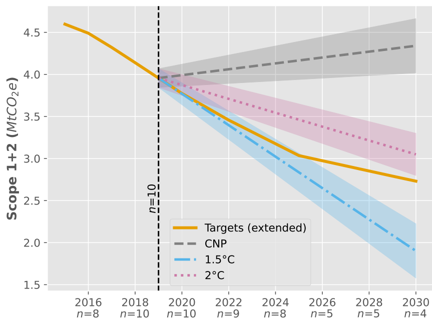
(c) Consumer Staples



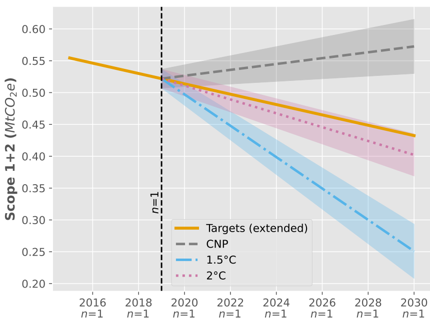
(d) Health Care



(e) Industrials

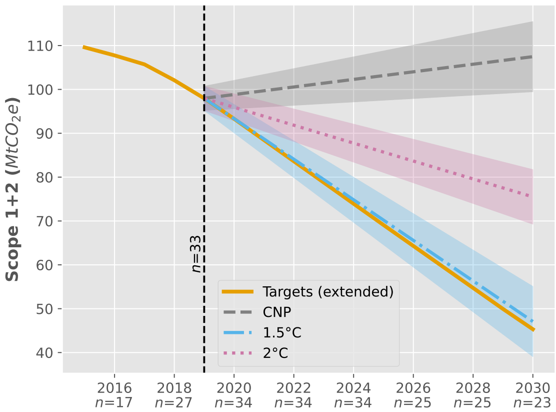


(f) Information Technology

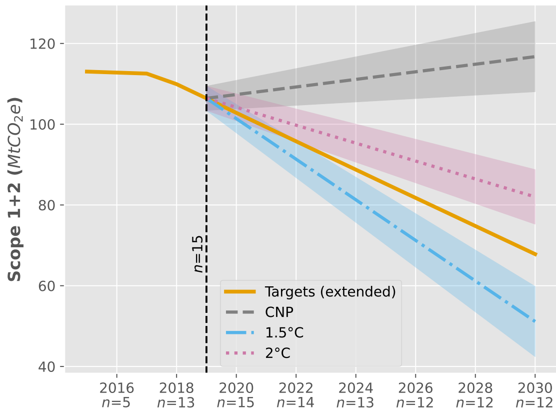


(g) Real Estate

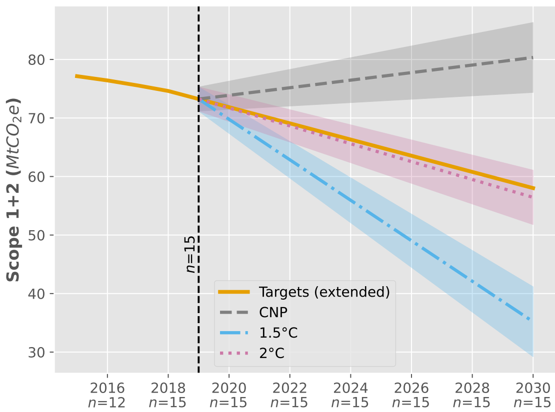
Figure H.1: Ambition of G500 companies in the SBTi who have set absolute targets for scopes 1+2, subdivided by GICS sectors. Materials and Utilities are excluded as they are the same as their energy sector equivalent. Notice that y-axis scaling differs between figures.



(a) 1.5°C qualification

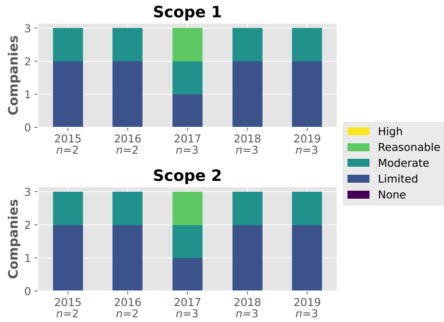


(b) Well-below 2°C qualification



(c) 2°C qualification

Figure H.2: Ambition of G500 companies in the SBTi who have set absolute targets for scopes 1+2, subdivided by ambition qualifications as defined by the initiative. Notice that y-axis scaling differs between figures.



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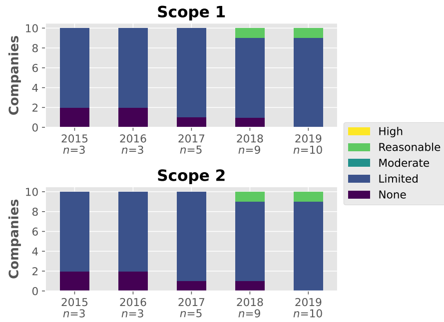
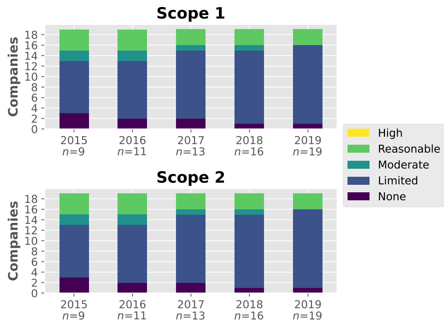
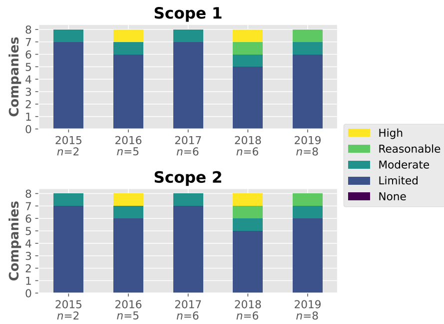


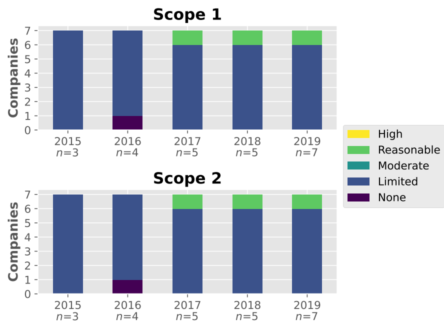
(b) Consumer Discretionary



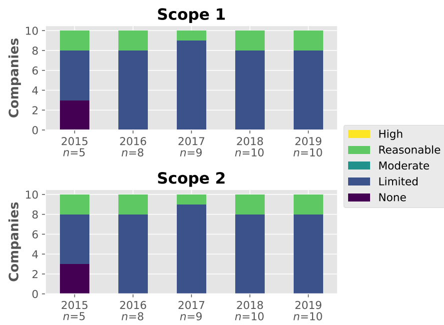
(c) Consumer Staples



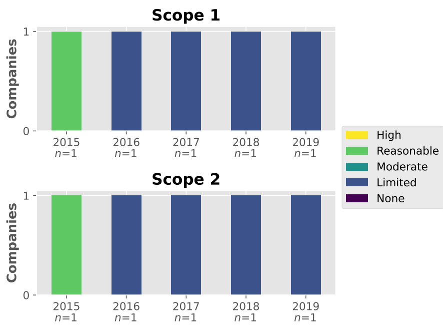
(d) Health Care



(e) Industrials

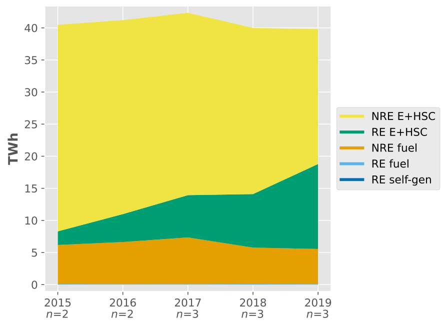


(f) Information Technology

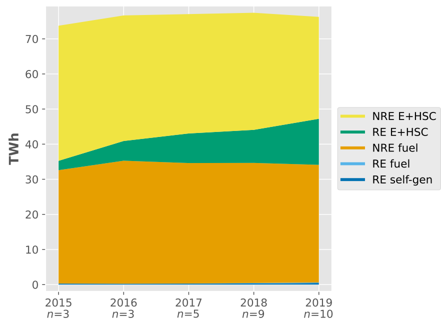


(g) Real Estate

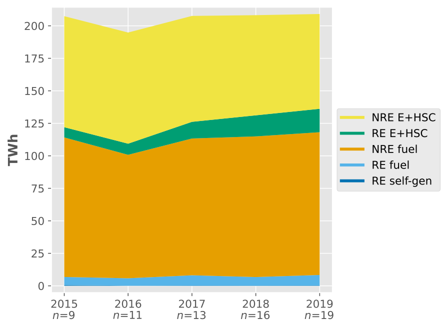
Figure H.3: Robustness of G500 companies in the SBTi who have set absolute targets for scopes 1+2, subdivided by GICS sectors. Materials and Utilities are excluded as they are the same as their energy sector equivalent. Notice that y-axis scaling differs between figures.



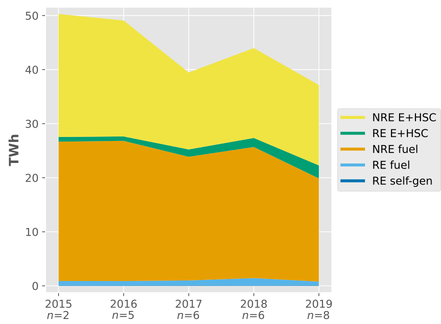
(a) Communication Services



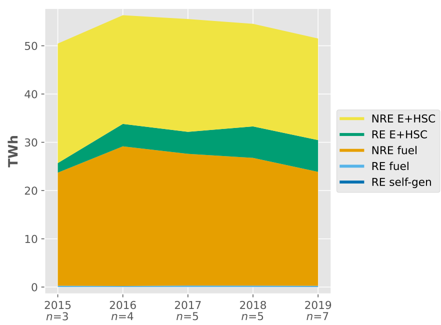
(b) Consumer Discretionary



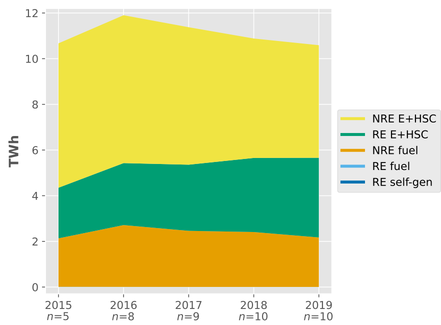
(c) Consumer Staples



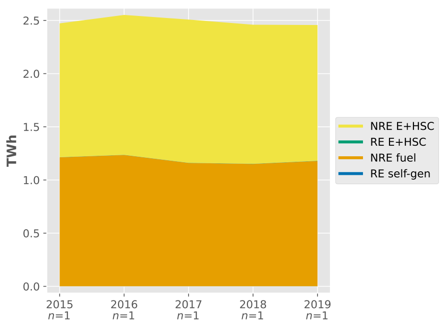
(d) Health Care



(e) Industrials

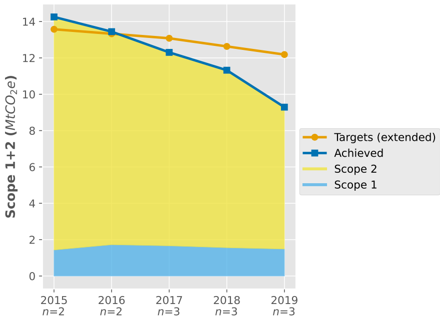


(f) Information Technology

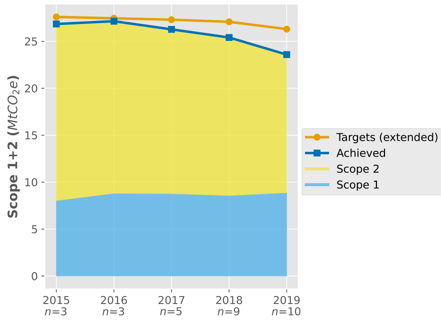


(g) Real Estate

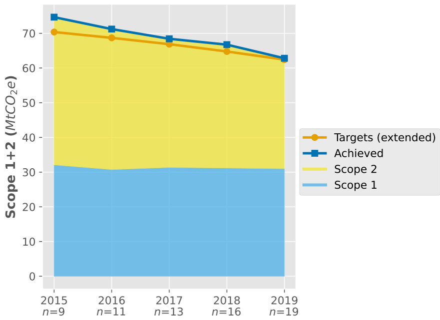
Figure H.4: Implementation of different energy sources in G500 companies in the SBTi who have set absolute targets for scopes 1+2, subdivided by GICS sectors. Materials and Utilities are excluded as they are the same as their energy sector equivalent. Notice that y-axis scaling differs between figures.



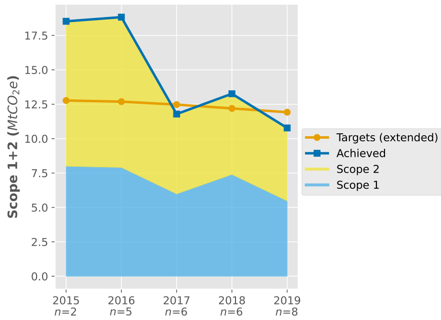
(a) Communication Services



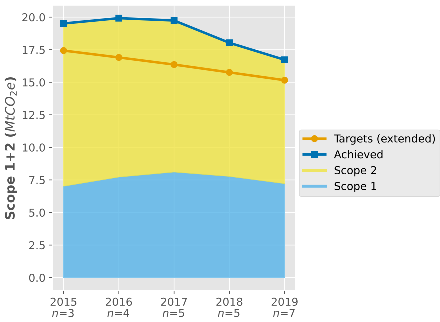
(b) Consumer Discretionary



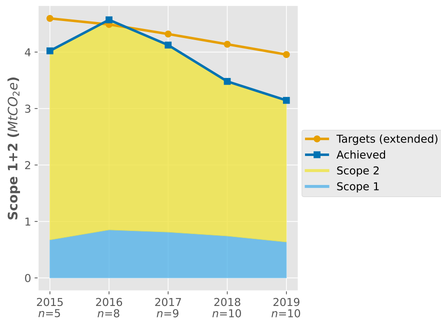
(c) Consumer Staples



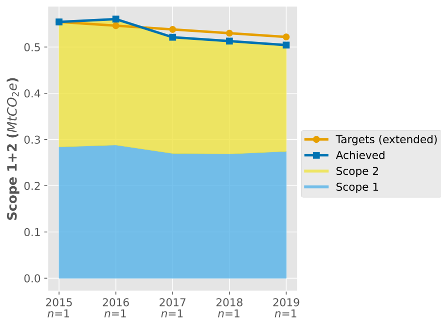
(d) Health Care



(e) Industrials



(f) Information Technology



(g) Real Estate

Figure H.5: Direct substantive impact of G500 companies in the SBTi who have set absolute targets for scopes 1+2, subdivided by GICS sectors. Materials and Utilities are excluded as they are the same as their energy sector equivalent. Notice that y-axis scaling differs between figures.

I. SBTi log frame: statistics

Table I.1: Descriptive statistics of emissions per scope of companies with a scope 1 or 2 target set between 2015–2019, divided by energy sector.

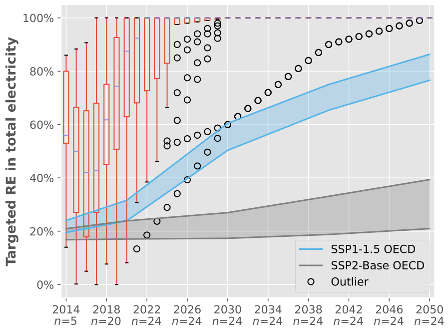
			Emissions 2015 ($MtCO_2e$)				**Emissions 2019** ($MtCO_2e$)			
Sector	**Companies**	**Scope**	**Mean**	**Median**	**Min**	**Max**	**Mean**	**Median**	**Min**	**Max**
Light Industry	40	S1	1.013	0.548	0.007	4.41	0.961	0.522	0.008	4.494
		S2	1.311	0.833	0.081	5.72	0.943	0.552	0.007	3.796
Services	20	S1	0.727	0.23	0.023	6.107	0.686	0.246	0.017	6.485
		S2	2.238	1.268	0.051	14.928	1.585	0.704	0.061	11.079
Electricity Generation	5	S1	74.328	60.205	27.427	132.757	39.347	33.09	13.427	69.982
		S2	2.834	0.971	0.185	7.68	2.531	2.301	0.388	5.367
EII	3	S1	68.865	32.6	9.528	164.466	50.224	21.8	8.052	120.82
		S2	6.936	3.62	1.2	15.988	3.844	2.707	1.3	7.526
Transport	2	S1	2.087	2.087	0.402	3.772	2.074	2.074	0.37	3.778
		S2	2.801	2.801	0.095	5.508	2.033	2.033	0.041	4.025
Total	70	S1	9.106	0.572	0.007	164.466	5.767	0.541	0.008	120.82
		S2	1.968	0.932	0.051	15.988	1.395	0.744	0.007	11.079
		S1+2	11.075	1.654	0.142	180.453	7.163	1.308	0.032	128.346

J. RE100 target benchmarks: IPCC scenarios

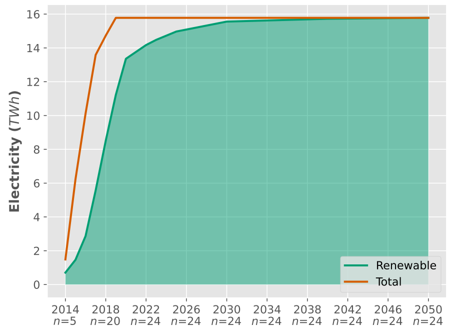
Table J.1: IPCC scenarios used to evaluate ambition in RE100 members. SSP1-19 and SSP2-Baseline correspond to the SSP1-1.5°C and SSP2-Base trends described in other sections, respectively. All SSP1-19 scenarios correspond to pathways resulting in at least 1.5°C with low or no overshoot under IPCC criteria (Source: data from Huppmann et al. (2018)).

			RE share in total electricity				
Scenario	**Region**	**Model**	**2010**	**2020**	**2030**	**2040**	**2050**
SSP1-19	R5OECD90+EU	AIM/CGE 2.0	17.65%	24.26%	56.29%	71.41%	76.58%
		GCAM 4.2	19.00%	31.58%	50.32%	65.37%	77.17%
		WITCH-GLOBIOM 3.1	16.61%	23.89%	60.46%	75.01%	86.32%
		Max	19.00%	31.58%	60.46%	75.01%	86.32%
		Min	16.61%	23.89%	50.32%	65.37%	76.58%
SSP2-Baseline	R5OECD90+EU	AIM/CGE 2.0	17.40%	17.07%	17.34%	18.78%	20.96%
		GCAM 4.2	19.00%	23.88%	26.22%	27.48%	26.32%
		WITCH-GLOBIOM 3.1	16.63%	20.85%	26.96%	33.08%	39.35%
		Max	19.00%	23.88%	26.96%	33.08%	39.35%
		Min	16.63%	17.07%	17.34%	18.78%	20.96%

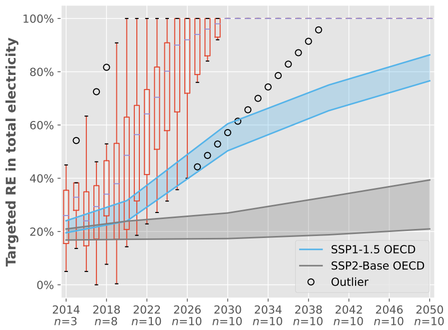
K. RE100 log frame results: economic sectors



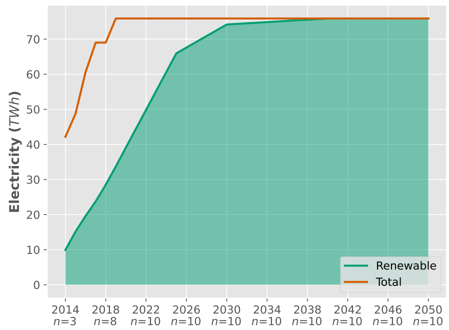
(a) Financials targets



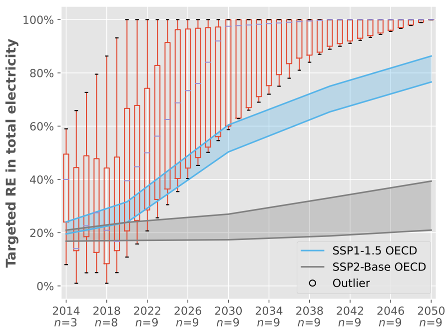
(b) Financials total electricity



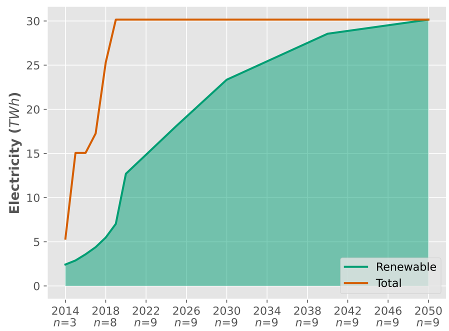
(c) Consumer staples targets



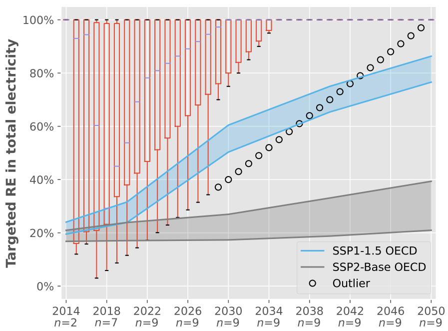
(d) Consumer staples electricity



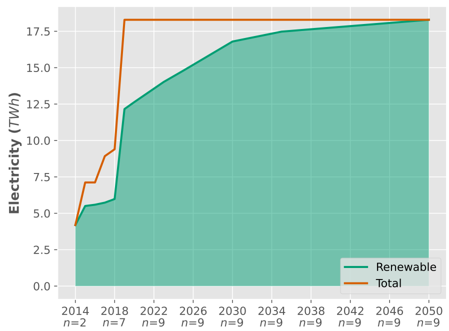
(e) Consumer discretionary targets



(f) Consumer discretionary total electricity

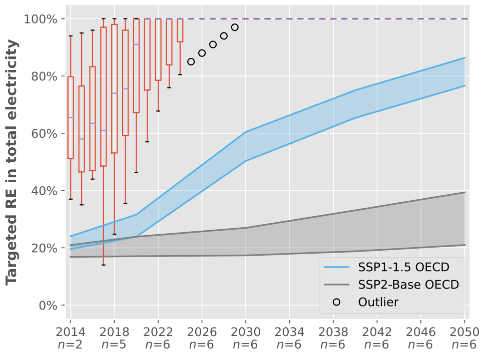


(g) Information technology targets

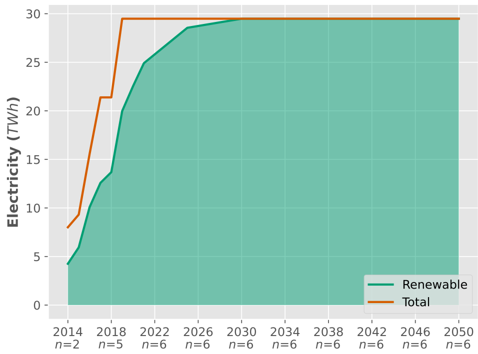


(h) Information technology total electricity

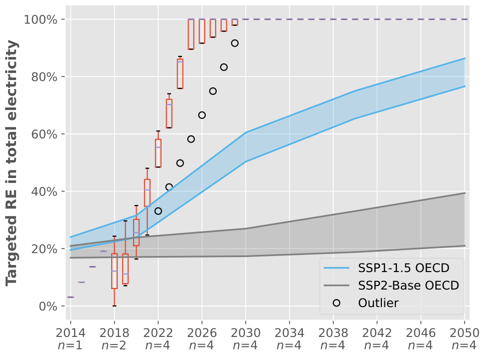
Figure K.1: Ambition of G500 companies in the RE100 initiative whose target baseline could be created, subdivided by GICS sector. Notice that y-axis scaling differs between electricity figures.



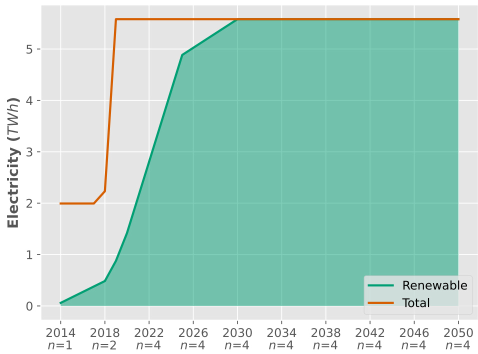
(a) Communication services targets



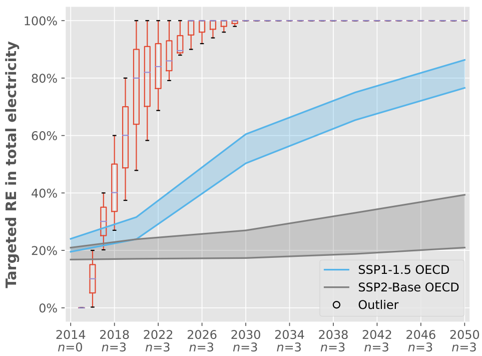
(b) Communication services total electricity



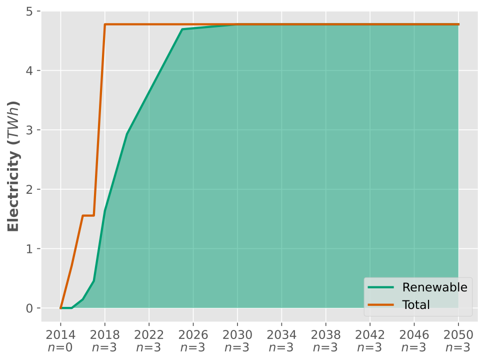
(c) Health care targets



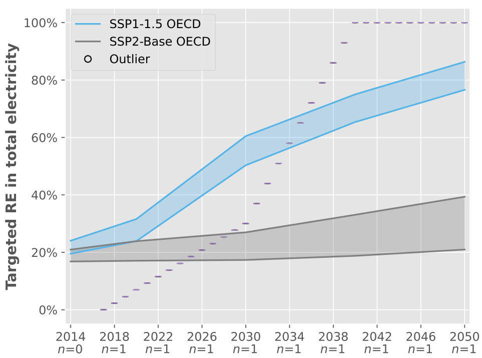
(d) Health care electricity



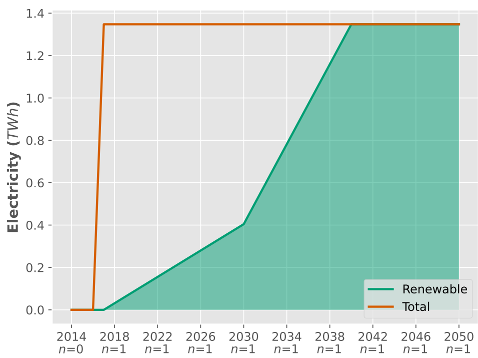
(e) Industrials targets



(f) Industrials total electricity

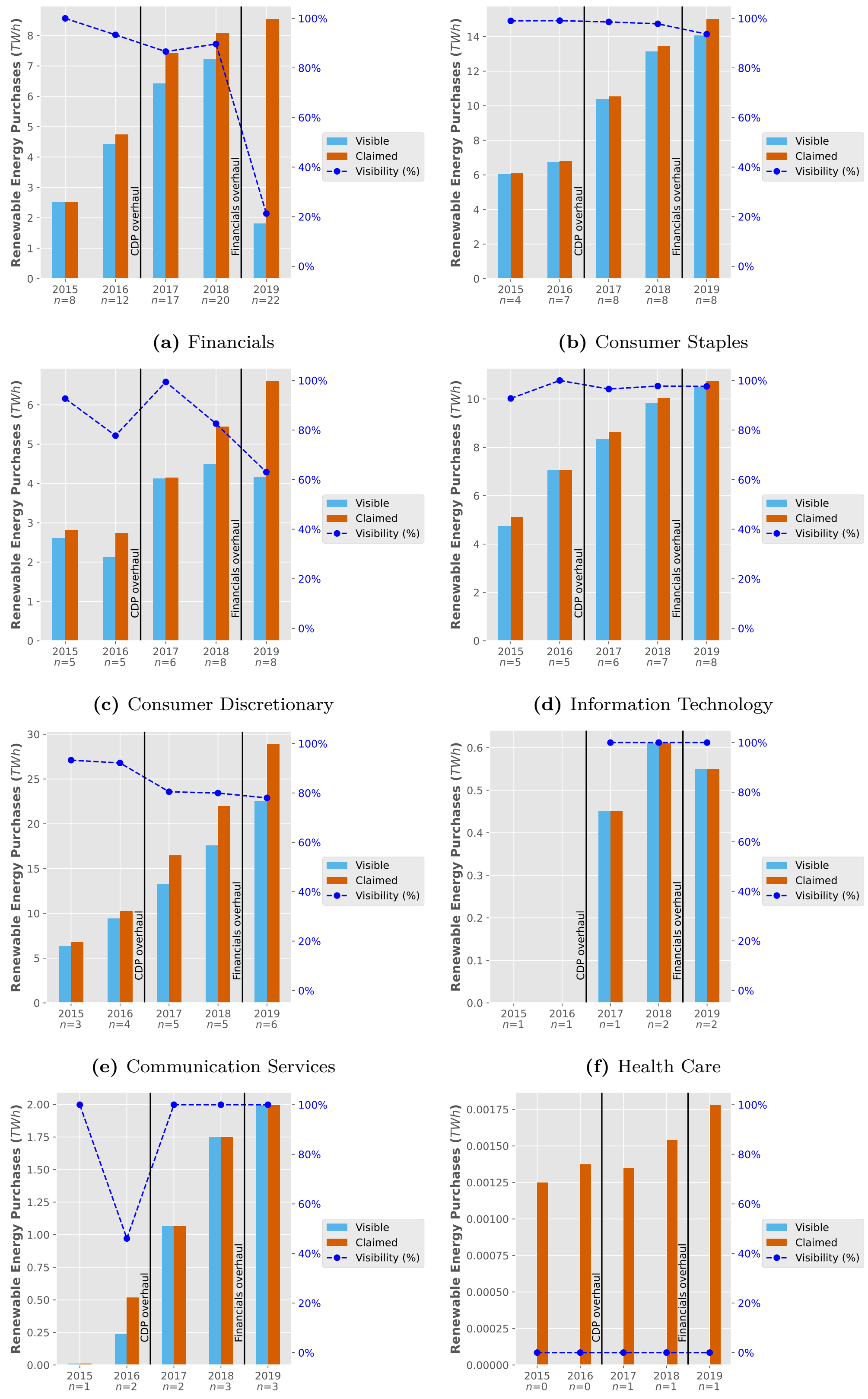


(g) Real estate targets



(h) Real estate total electricity

Figure K.2: Ambition of G500 companies in the RE100 initiative whose target baseline could be created, subdivided by GICS sector. Notice that y-axis scaling differs between electricity figures.



(a) Financials

(b) Consumer Staples

(c) Consumer Discretionary

(d) Information Technology

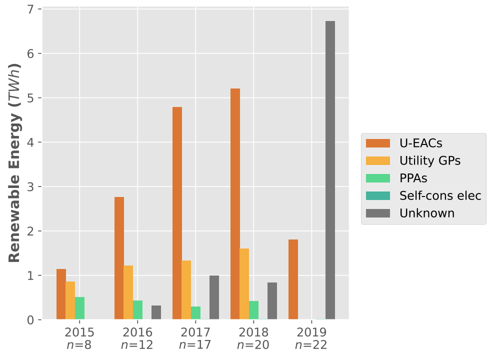
(e) Communication Services

(f) Health Care

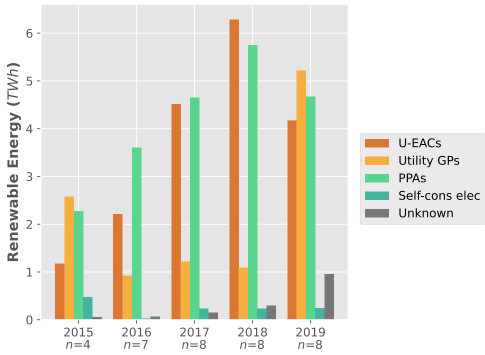
(g) Industrials

(h) Real Estate

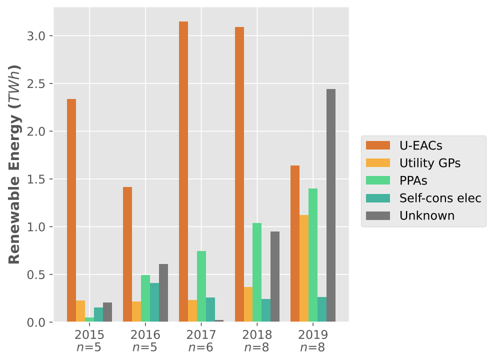
Figure K.3: Robustness of 58 G500 companies in the RE100 initiative that joined between 2014–2019, subdivided by GICS sector. Notice that y-axis scaling differs between figures.



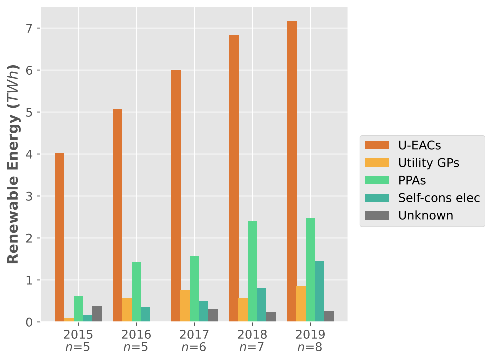
(a) Financials



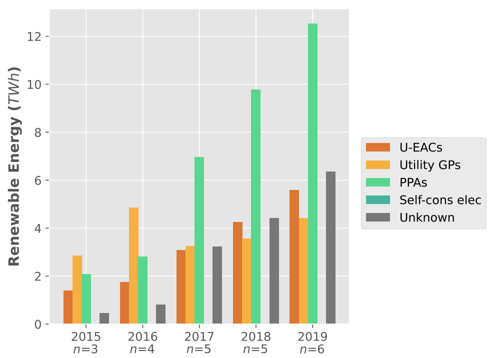
(b) Consumer Staples



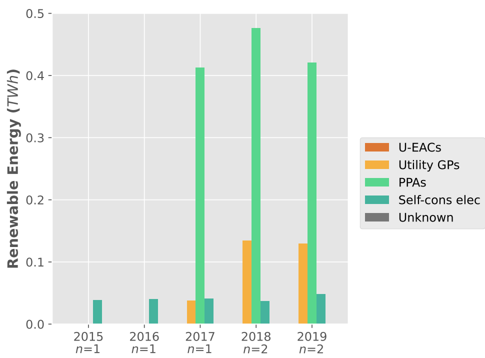
(c) Consumer Discretionary



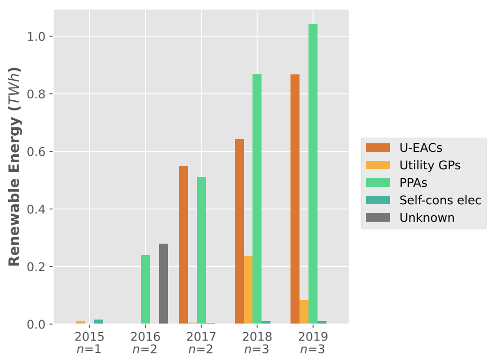
(d) Information Technology



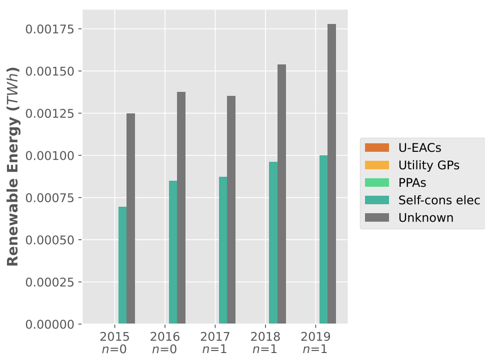
(e) Communication Services



(f) Health Care

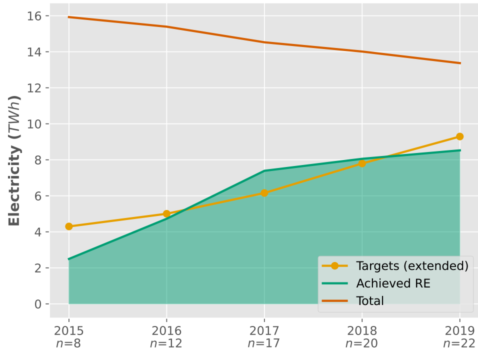


(g) Industrials

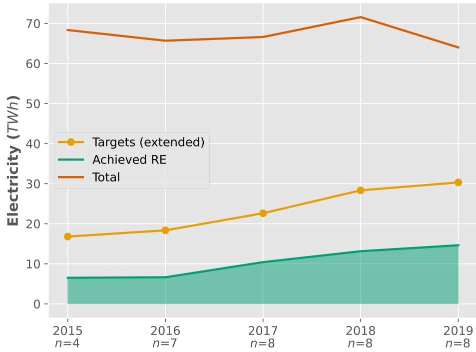


(h) Real Estate

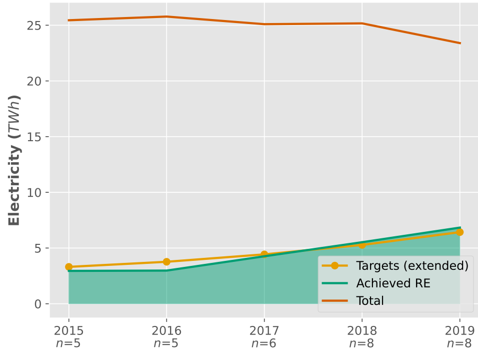
Figure K.4: Implementation through different market instruments in 58 G500 companies in the RE100 initiative who joined between 2014–2019. Unknown represents remaining claimed purchases with no purchasing method. Notice that y-axis scaling differs between figures.



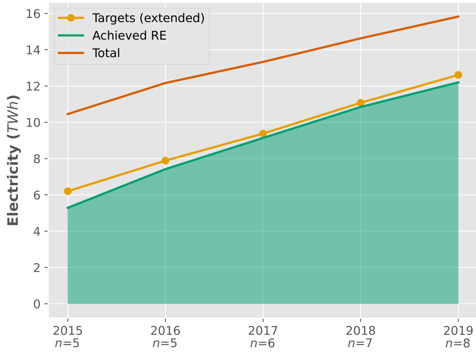
(a) Financials



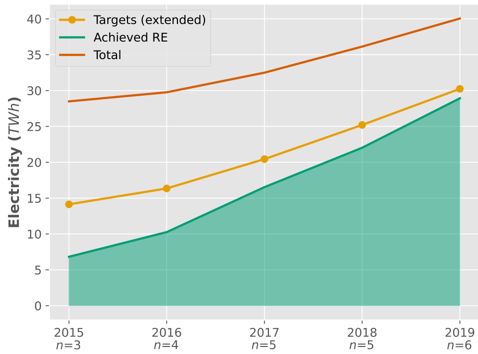
(b) Consumer Staples



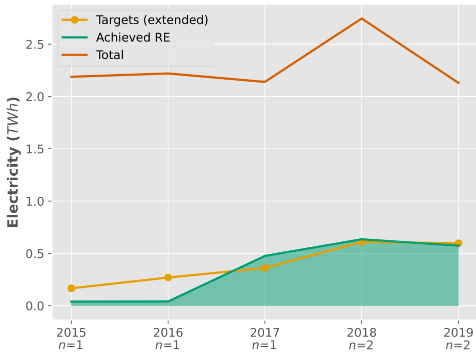
(c) Consumer Discretionary



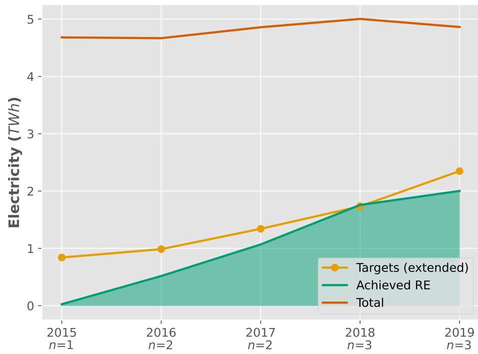
(d) Information Technology



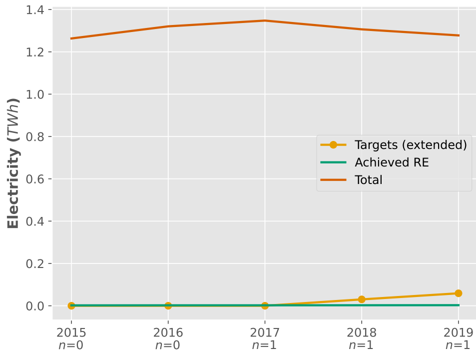
(e) Communication Services



(f) Health Care



(g) Industrials



(h) Real Estate

Figure K.5: Substantive progress through renewable energy use in 58 G500 companies in the RE100 initiative who joined between 2014–2019, subdivided by energy sector. Targets are extended by keeping the renewable ratioconstant for years prior to the start year of a target. Note that y-axis scaling differs between figures.

L. List of companies

Table L.1: List of all G500 companies participating in either the SBTi or RE100 in some capacity.

Company	Country	Energy Sector	GICS Sector	G500	SBTi	RE100
Walmart	U.S.	Services	Consumer Staples	1	Targets Set	yes
Volkswagen	Germany	Light Industry	Consumer Discretionary	7	Targets Set	
Amazon	U.S.	Services	Consumer Discretionary	9	Committed	
Apple	U.S.	Light Industry	Information Technology	12		yes
CVS Health	U.S.	Services	Health Care	13	Targets Set	
AT&T	U.S.	Services	Communication Services	22	Targets Set	
Alphabet	U.S.	Services	Communication Services	29		yes
Ford Motor	U.S.	Light Industry	Consumer Discretionary	31	Committed	
AXA	France	Services	Financials	34	Committed	yes
JPMorgan Chase	U.S.	Services	Financials	38		yes
General Motors	U.S.	Light Industry	Consumer Discretionary	40	Committed	yes
Verizon Communications	U.S.	Services	Communication Services	44	Committed	
Allianz	Germany	Services	Financials	46	Committed	yes
Microsoft	U.S.	Services	Information Technology	47	Targets Set	yes
BMW	Germany	Light Industry	Consumer Discretionary	56	Committed	yes
Bank of America	U.S.	Services	Financials	58		yes
Crédit Agricole	France	Services	Financials	67	Committed	yes
Anthem	U.S.	Services	Health Care	68	Committed	yes
Wells Fargo	U.S.	Services	Financials	69		yes
Citigroup	U.S.	Services	Financials	70		yes
HSBC Holdings	U.K.	Services	Financials	73	Committed	yes
Siemens	Germany	Light Industry	Industrials	74	Targets Set	yes
Dell Technologies	U.S.	Light Industry	Information Technology	81	Targets Set	yes
Nestlé	Switzerland	Light Industry	Consumer Staples	82	Targets Set	yes
Deutsche Telekom	Germany	Services	Communication Services	86	Targets Set	yes
Enel	Italy	Electricity Generation	Utilities	87	Targets Set	
Aviva	U.K.	Services	Financials	88		yes
Bosch	Germany	Light Industry	Consumer Discretionary	95	Targets Set	
Carrefour	France	Services	Consumer Staples	98	Targets Set	
BNP Paribas	France	Services	Financials	99	Committed	
Tesco	U.K.	Services	Consumer Staples	103	Targets Set	yes
Johnson & Johnson	U.S.	Light Industry	Health Care	104	Targets Set	yes

Table L.1: List of all G500 companies participating in either the SBTi or RE100 in some capacity.

Company	Country	Energy Sector	GICS Sector	G500	SBTi	RE100
Hitachi	Japan	Light Industry	Industrials	106	Targets Set	
Electricité de France	France	Electricity Generation	Utilities	110	Targets Set	
AEON	Japan	Services	Consumer Staples	115	Targets Set	yes
Target	U.S.	Services	Consumer Discretionary	117	Targets Set	yes
Sony	Japan	Light Industry	Consumer Discretionary	122	Targets Set	yes
Intel	U.S.	Light Industry	Information Technology	138		yes
Zurich Insurance Group	Switzerland	Services	Financials	139	Committed	yes
Deutsche Post DHL Group	Germany	Transport	Industrials	142	Committed	
Facebook	U.S.	Services	Communication Services	144	Committed	yes
MetLife	U.S.	Services	Financials	149	Committed	
Panasonic	Japan	Light Industry	Consumer Discretionary	153	Targets Set	yes
Procter & Gamble	U.S.	Light Industry	Consumer Staples	156	Targets Set	yes
Engie	France	Electricity Generation	Utilities	159	Targets Set	
PepsiCo	U.S.	Light Industry	Consumer Staples	160	Targets Set	yes
Dai-ichi Life Holdings	Japan	Services	Financials	165		yes
Lloyds Banking Group	U.K.	Services	Financials	170		yes
Renault	France	Light Industry	Consumer Discretionary	175	Targets Set	
Seven & I Holdings	Japan	Services	Consumer Staples	178		yes
HP	U.S.	Light Industry	Information Technology	184	Targets Set	yes
Unilever	U.K.	Light Industry	Consumer Staples	185	Targets Set	yes
Société Générale	France	Services	Financials	192	Committed	
Telefónica	Spain	Services	Communication Services	201	Targets Set	yes
Goldman Sachs Group	U.S.	Services	Financials	202		yes
Morgan Stanley	U.S.	Services	Financials	203		yes
Anheuser-Busch InBev	Belgium	Light Industry	Consumer Staples	205	Targets Set	yes
América Móvil	Mexico	Services	Communication Services	209	Targets Set	
Cisco Systems	U.S.	Light Industry	Information Technology	211	Targets Set	
Bayer	Germany	Light Industry	Health Care	214	Targets Set	
Pfizer	U.S.	Light Industry	Health Care	215	Targets Set	
Lenovo Group	China	Light Industry	Information Technology	224	Targets Set	
Novartis	Switzerland	Light Industry	Health Care	225	Targets Set	
Tokio Marine Holdings	Japan	Services	Financials	226	Committed	
Vodafone Group	U.K.	Services	Communication Services	228	Targets Set	yes
Continental	Germany	Light Industry	Consumer Discretionary	230	Targets Set	yes

Table L.1: List of all G500 companies participating in either the SBTi or RE100 in some capacity.

Company	**Country**	**Energy Sector**	**GICS Sector**	**G500**	**SBTi**	**RE100**
Deutsche Bahn	Germany	Transport	Industrials	232	Targets Set	
Swiss Re	Switzerland	Services	Financials	233	Committed	yes
Saint-Gobain	France	Energy Intensive Industry	Materials	244	Targets Set	
MS&AD Insurance Group Holdings	Japan	Services	Financials	246	Committed	
ThyssenKrupp	Germany	Energy Intensive Industry	Materials	248	Targets Set	
Orange	France	Services	Communication Services	249	Committed	
American Express	U.S.	Services	Financials	251		yes
Banco Bilbao Vizcaya Argentaria	Spain	Services	Financials	254	Committed	yes
Volvo	Sweden	Light Industry	Industrials	259	Committed	
Woolworths Group	Australia	Services	Consumer Staples	260	Targets Set	yes
Best Buy	U.S.	Services	Consumer Discretionary	275	Targets Set	
Accenture	Ireland	Services	Information Technology	279	Targets Set	yes
GlaxoSmithKline	U.K.	Light Industry	Health Care	282	Targets Set	yes
Tyson Foods	U.S.	Light Industry	Consumer Staples	287	Targets Set	
Banco do Brasil	Brazil	Services	Financials	288	Committed	
Sanofi	France	Light Industry	Health Care	289	Targets Set	yes
UBS Group	Switzerland	Services	Financials	293		yes
Metro	Germany	Services	Consumer Staples	294	Targets Set	
M&G	U.K.	Services	Financials	299		yes
Mitsubishi Electric	Japan	Light Industry	Industrials	300	Targets Set	
Iberdrola	Spain	Electricity Generation	Utilities	303	Targets Set	
Daiwa House Industry	Japan	Light Industry	Real Estate	311	Targets Set	yes
Maersk Group	Denmark	Transport	Industrials	320	Committed	
Nike	U.S.	Light Industry	Consumer Discretionary	322	Targets Set	yes
Barclays	U.K.	Services	Financials	327		yes
Vale	Brazil	Light Industry	Materials	333	Committed	
Coca-Cola	U.S.	Light Industry	Consumer Staples	335	Targets Set	
Tata Motors	India	Light Industry	Consumer Discretionary	337		yes
Phoenix Group Holdings	U.K.	Services	Financials	338	Committed	
ABB	Switzerland	Light Industry	Industrials	340	Committed	
ING Group	Netherlands	Services	Financials	342	Committed	yes
J. Sainsbury	U.K.	Services	Consumer Staples	344	Targets Set	
Fujitsu	Japan	Services	Information Technology	356	Targets Set	yes
Credit Suisse Group	Switzerland	Services	Financials	357	Committed	yes

Table L.1: List of all G500 companies participating in either the SBTi or RE100 in some capacity.

Company	Country	Energy Sector	GICS Sector	G500	SBTi	RE100
Sompo Holdings	Japan	Services	Financials	363	Committed	
Capital One Financial	U.S.	Services	Financials	372		yes
L'Oréal	France	Light Industry	Consumer Staples	375	Targets Set	
British American Tobacco	U.K.	Light Industry	Consumer Staples	379	Targets Set	
Schlumberger	U.S.	Light Industry	Energy	382	Committed	
3M	U.S.	Light Industry	Industrials	389		yes
Compass Group	U.K.	Services	Consumer Discretionary	395	Committed	
CRH	Ireland	Energy Intensive Industry	Materials	397	Committed	
Inditex	Spain	Services	Consumer Discretionary	398	Targets Set	
Toshiba	Japan	Light Industry	Industrials	402	Targets Set	
Fubon Financial Holding	Taiwan	Services	Financials	403	Committed	
SAP	Germany	Services	Information Technology	404	Targets Set	yes
Veolia Environnement	France	Electricity Generation	Utilities	412	Targets Set	
Schneider Electric	France	Light Industry	Industrials	413	Targets Set	yes
Takeda Pharmaceutical	Japan	Light Industry	Health Care	414	Targets Set	
CMA CGM	France	Transport	Industrials	415	Committed	
Commonwealth Bank of Australia	Australia	Services	Financials	416		yes
Philip Morris International	U.S.	Light Industry	Consumer Staples	421	Targets Set	
Hewlett Packard Enterprise	U.S.	Light Industry	Information Technology	431	Targets Set	yes
BT Group	U.K.	Services	Communication Services	432	Targets Set	yes
La Poste	France	Transport	Industrials	433	Targets Set	yes
Johnson Controls International	Ireland	Light Industry	Industrials	439	Committed	
Linde	U.K.	Energy Intensive Industry	Materials	444	Committed	
Sumitomo Electric Industries	Japan	Light Industry	Consumer Discretionary	445	Committed	
Migros Group	Switzerland	Services	Consumer Staples	448	Committed	
NEC	Japan	Services	Information Technology	450	Targets Set	
Danone	France	Light Industry	Consumer Staples	453	Targets Set	yes
Michelin	France	Light Industry	Consumer Discretionary	472	Targets Set	
Heineken Holding	Netherlands	Light Industry	Consumer Staples	474	Targets Set	
X5 Retail Group	Russia	Services	Consumer Staples	475	Committed	
LafargeHolcim	Switzerland	Energy Intensive Industry	Materials	476	Targets Set	
Starbucks	U.S.	Services	Consumer Discretionary	478	Committed	yes
Adidas	Germany	Light Industry	Consumer Discretionary	480	Committed	
Nokia	Finland	Light Industry	Information Technology	488	Targets Set	

Table L.1: List of all G500 companies participating in either the SBTi or RE100 in some capacity.

Company	**Country**	**Energy Sector**	**GICS Sector**	**G500**	**SBTi**	**RE100**
Westpac Banking	Australia	Services	Financials	491	Committed	yes
Naturgy Energy Group	Spain	Electricity Generation	Utilities	492	Committed	
Mondelez International	U.S.	Light Industry	Consumer Staples	495	Targets Set	