NUS National University of Singapore | Sustainable and Green Finance Institute

Understanding Net Zero Commitments by Singaporean Firms

SGFIN Whitepaper Series #12

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Foreword

Since the landmark Paris Agreement in 2016, a global shift has occurred, altering the trajectory and level of alignment in the climate ambition of countries from across the globe. There has been a collective tightening of ambitions, including in Singapore, and a convergence towards a shared target of net zero greenhouse gas emissions by 2050.

It is crucial to understand whether firms are confident in their ability to align with the national commitments. Such information is useful to investors and businesses seeking to engage with firms that are proactively addressing and managing their long-term climate impacts and ambitions. It is also useful to policymakers in gauging which industrial sectors face challenges in making commitments so that effective policy options can be explored.

Through annual or sustainability reports, firms are declaring their own commitments, and in a number of cases, these are more aggressive than the national ambition. However, there is no consistent or comprehensive registry of net zero commitments, making for a devilishly opaque and incomplete appreciation of whether or not listed companies are ignoring, aligning, or aligned with the national ambition.

This work addresses this information gap and offers a comprehensive assessment of publicly communicated net zero ambitions for Singapore's listed firms. Manual screening of annual and sustainability reports—for 479 Singapore-headquartered firms—verifies the large divide in net zero commitments implied by external data vendors, versus what is actually committed. This permits a unique and arguably the most comprehensive evaluation to date of corporate alignment with national net zero ambitions for Singapore.

A preliminary assessment of performance against emissions targets is given. Those with net zero commitments are generally on track to comply with the national net zero target date of 2050. In contrast, those yet to make a commitment are at greater risk of being unable to align with the national target. Some efforts are made to isolate why, with observations including that external sectoral conditions, and decarbonization-related technologies present important inflection points but may be outside of the sphere of influence of even large listed companies. This helps to position some discussion on where financial and broader economic policy may yet help to build capacity and nurture progress towards net zero.

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January 20, 2026

Executive Summary

Based on the annual reports and sustainability reports collected from 2019 to 2024, we identified 60 out of 479 firms that are publicly listed and headquartered in Singapore, with net zero commitments declared with a precise net zero target date. The 60 committed firms accounted for 12.5% of our sample. After comparing our list of firms with those provided by the external data providers of net zero commitments, we noticed a significant gap by the other data vendors, underestimating the extent of Singapore firms' net zero commitments.

The firms identified with net zero commitments represent approximately 75% of the total market capitalization, yet only around 55% of the Scopes 1 and 2 emissions of the publicly listed firms in our sample. On balance, this is a strong level of commitment, covering a material share of value and total emissions, especially given that the national target date was only announced in 2022. At the same time, it also highlights an important commitment gap yet to be filled.

Several sectors—some of which being emissions intensive or key transition sectors including Energy, Industrials, Materials, Consumer Staples and Health Care—have notable commitment gaps. For example, among 23 firms from the Energy sector in our sample, just one company, China Aviation Oil (Singapore) Corporation Ltd, has disclosed a net zero commitment with a precise target date. None of the 31 firms from the Health Care sector pledged a commitment, and low commitment rates exist in other sectors. This is not a tenable or conducive situation and raises questions—not all of which could be addressed here—concerning firms' access to viable net zero transition pathways and areas where regulation and policy intervention may be explored.

Firms with net zero commitments are generally on course to reach net zero before 2050, at least according to the evidence from a simple but informative statistical assessment of emissions' trajectories. In contrast, firms without net zero commitments appear to need more time to make their transition. This is consistent with the idea that firms with incompatible emissions trajectories are not in a position to commit to net zero by a specific target date.

A variety of different business strategies are employed by firms to achieve their net zero targets. These include eight identified strategy areas, comprising 25 sub-themes, some of which are easier for a firm to influence/control internally than others. Firms from different sectors focus their attention on different aspects of these strategic areas. Moreover, there is some evidence of a difference in the strategies discussed in the annual reports versus the sustainability reports. While intuitive and consistent with the different purposes of each report type, this observation may have implications for the importance of standalone sustainability reporting.

Establishing whether organizations' commitments to net zero are credible or legitimate requires a careful look at the climate impact of firms, and what their ambitions and strategies are for addressing such impacts. Understanding firms' conditions is important for current policy thinking, since there is still a considerable gap in the amount of emissions covered by net zero commitments, and policy efforts and interventions may become necessary if firms do not voluntarily set net zero targets in a timely fashion. Ambition does, though, require balancing against pragmatism, such that realistic targets and levels of emission reductions are set and revised in a timely manner on the basis of actions that can be achieved.

Biographies of Authors

David C. Broadstock was a Senior Research Fellow with SGFIN. David regularly interacts with financial institutions, government agencies, research foundations, policy makers and industry leaders to develop and implement impactful research into the successful deployment of transition finance to support sustainable economic development for Singapore. David places a special research emphasis in the emerging area of 'transition finance', seeking to better appreciate how trust and confidence behind net zero commitments can be fostered and sustained so as to facilitate an organized, timely and scalable flow of capital to achieve national decarbonization ambitions without sacrificing on economic competitiveness.

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Part 1

Introduction

"Moving to net zero carbon emissions by 2050 is probably the biggest challenge the world faces."

(Sembcorp Marine Sustainability Report 2022, Chairman's Foreword)

Singapore has committed to achieving net zero emissions by 2050. There is a need for a drastic change in the way companies conduct their business, and how the financial sector can support such a transition to more sustainable businesses.

Key takeaways:

- Singapore's listed companies have begun developing their own transition plans, and in some cases, making public commitments to support the national ambition and achieve net zero in their own operations;
- However, it is challenging to understand the full extent of these commitments across all listed companies, as there is no existing registry and standardized/comprehensive data source capturing such commitments;
- Such information is necessary to fairly evaluate nation-wide progress towards net zero, or discuss plausible policy options to accelerate progress.

At the global scale there is a consensus agreement among nations that rapid and deep decarbonization of our economic models is critical to avoid irreversible and life-threatening impacts from climate change. This intergovernmental alignment was the foundation of the Paris Agreement, adopted on 12 December 2015 and put into force from 4 November 2016. Among other things, the Paris Agreement saw a commitment–originally signed by 196 parties–to limit global warming to well below 2 degrees Celsius, with an ambition to try and strengthen this commitment even further to a 1.5 degree limit. This has become synonymous with the 'net zero' movement on the understanding that science based evaluations of the effort required to limit temperatures rises to no more than 1.5 degrees Celsius by 2100, relative to pre-industrial levels, parallel closely with the task of reaching net zero global emissions by around 2050 (Intergovernmental Panel on Climate Change, 2023; World Resources Institute, 2023).

To clarify, net zero refers to the condition in which no more carbon is emitted to the atmosphere than is removed from it. Net zero does not require zero emissions, but rather that (i) any

emissions are necessary and strictly unavoidable, i.e., from hard-to-abate critical economic sectors, and (ii) emissions from these sectors are 'managed' either through carbon sequestration or through offset projects, which might, for example, include nature-based decarbonisation solutions. In addition, the 'science of net zero' is positioned around the existence of a total planetary carbon budget, which must be strictly adhered to in order to have a chance of avoiding irreversible climate change. This planetary budget is what helps define the time frame for net zero and helps coordinate a shared global understanding of the extent and timing of climate ambition that is required.

1.1 Climate change and financial institutions

Climate change introduces significant stress and risks to the financial system in various ways. Preceding the COP 26 meetings where the Paris Agreement was introduced, Mark Carney (Former Governor of the Bank of England and Chairman of the Financial Stability Board) delivered a widely cited speech on the topic of "Breaking the tragedy of the horizon - climate change and financial stability" (Carney, 2015). Messages within and arising from this talk include how financial institutions (FIs), the wider economy, and various regulators and agents with prudential oversight of assets, should realise the actual damages from climate change together. That our economic and financial systems are inherently inadequately prepared to predict the future, and that there is an urgency to establish a more concrete and comprehensive understanding of climate change as a financial system risk. Among other things, it was noted that monetary policy considerations often have 2-3 year horizons, and financial stability considerations around a decade, but adequately preparing for climate changes necessitates thinking on a different horizon, otherwise there is a risk that FIs will only start to consider it after it has become a realized risk.

There are macroeconomic impacts that will cascade down to individual companies, and which will aggregate back up into financial institutions' portfolio holdings. Some of the potential sources of risk include:

- **Physical Risks to Assets and Infrastructure:**

  Natural Disasters: Climate change increases the frequency and severity of natural disasters like floods, hurricanes, and wildfires. These events can cause substantial damage to physical assets, including real estate, infrastructure, and industrial facilities. Insurers, banks, and investors holding these assets or providing loans are exposed to potentially significant financial losses. Ouazad and Kahn (2022), for example, explore how climate change is impacting mortgage financing, increasing screening requirements (transaction costs) and decreasing supply towards more affected zones.

- **Operational Disruptions:**

  Businesses and industries reliant on climate-sensitive resources (like agriculture, fishing, and water-dependent sectors) face operational disruptions. These can lead to revenue losses, increased costs, and in extreme cases, businesses needing to shut down operations, which in turn affect the broader financial system. Huynh et al. (2020) argue, for example, that firms located in drought-prone zones face higher costs of capital–implicitly due to the increased risk of business/productivity disruption–and further that firms in these regions might not be able to fully diversify drought-related loss in wealth.

- **Transition Risks Due to Policy and Market Shifts:**

  Regulatory Changes: As governments implement policies to mitigate climate change, such as carbon pricing, emissions regulations, and shifts towards renewable energy,

companies reliant on fossil fuels or high-emission processes may face increased costs and reduced productivity/profitability (Ren et al., 2022). This can lead to asset devaluation, particularly in sectors like energy, transportation, and manufacturing, adversely affecting the financial institutions that are invested in these industries. Bolton and Kacperczyk (2023a) examine a global sample of firms, concluding that there is a relation between a company's stock value and exposure to carbon pricing. Among other things, they conclude that carbon-transition risks reflect a combination of policy—including the translation from ambitions and targets to actionable implementation (Gudde et al., 2021)—and technological uncertainty, and are influenced by the sociopolitical context, which can impact upon the pace and ambition of regulatory change.

- **Shifting behavioral preferences and expectations:**

  Consumer preferences are shifting towards more sustainable products and services, pressuring companies to adapt (Diaz-Rainey et al., 2024). Businesses that fail to transition or do so inadequately may lose market share, leading to reduced profitability and potentially stranded assets. Financial institutions with significant exposure to these companies, in turn, face increased risks.

- **Liability Risks from Legal Actions:**

  Litigation and Liability: As the impacts of climate change become more apparent, there is a growing trend and appetite for legal actions against companies (Sarra and DeMarco, 2021), particularly those in the fossil fuel industry, for their role in contributing to climate change. These lawsuits can result in substantial financial penalties, legal costs, and reputational damage. FIs that have invested in or provided financing to such companies may also face indirect exposure to these liabilities, increasing the overall risk within the financial system.[1] Some investment groups have rolled back on their ESG investing activities due to fears of greenwashing and a lack of consistent guidance on what constitutes genuinely 'green' investment choices.[2]

The above considerations allude to the complex and interconnected landscape of financial risks that require careful management and mitigation by financial institutions, regulators, policymakers, and firms themselves. Moreover, it is imperative that these risks are confronted and managed with a head-on attitude. The financial system cannot simply manage the transition by divesting from climate risks. Although divestment may be one possible solution, the risks arising from climate change (and failing to achieve net zero in a timely manner) are felt universally. There is also a challenge that demand for divestments cannot be matched with a ready supply of 'equivalent' re-investment opportunities. Reinforcing the case for direct and timely engagement with climate risk.

FIs such as commercial banks, investment banks, mutual funds, insurance companies, pension funds, hedge funds, asset managers, asset owners, and other entities that provide financial services do not have the capacity to address climate change alone. Yet they are pivotal in supporting the transition through their coordinating role and influence over the financial sector. Some of the groups with which FIs have regular interaction include: governments, the central bank/financial market regulator, exchanges, development finance institutions, and firms in their capacity as users of the financial system.

[1] On the understanding that an Fis risk is shared by it's customers, hence the connection between it's own risk and system-wide risk.

[2] See for example the thought piece by Julie Anderson discussing this gernal issue at https://kogod.american.edu/news/is-esg-investing-dead.

1.2 Singapore's current decarbonization ambition

Singapore has made numerous public announcements and policy commitments in relation to its decarbonization ambitions, which will be further expanded in the next section. In brief the city-island-state has pledged to achieve net zero emissions by 2050. Doing so is important, as Singapore has developed economically in such a manner that it has one of the highest levels of emissions per capita in the world. In 2021, according to data from Climate Watch, Singapore had the 24th highest rate of emissions per capita, see Figure (1, left panel) at more than 10 tons of CO2e (carbon dioxide equivalent) per capita. Despite Singapore being a small nation, with a modest absolute contribution to global emissions—around 0.14% of global emissions in 2021—Singapore has unequivocally and consistently championed a committed yet pragmatic stance towards the global decarbonization challenge.

What makes decarbonization complex for Singapore is that, as of today, Singapore's economic wealth and activity is heavily dependent on fossil fuels and their value chains (Srivastav et al., 2021). Electricity produced and consumed within Singapore is generated almost entirely from natural gas, at around 95% of the current fuel mix. At the same time, Singapore is 'alternative energy disadvantaged' due to its low-lying conditions, population density, and small size, as noted by Su and Ang (2020), among others. Singapore is a major trade hub, and supporting the shipping sector, it has housed the largest shipping fuel bunkering facility.[3] Meanwhile, Singapore is among the world's top refiners of petroleum products (fifth largest refinery and export hub worldwide) and exporters of petrochemicals (top 10 worldwide), highlighting the importance of hydrocarbons to current-day economic performance for the nation.

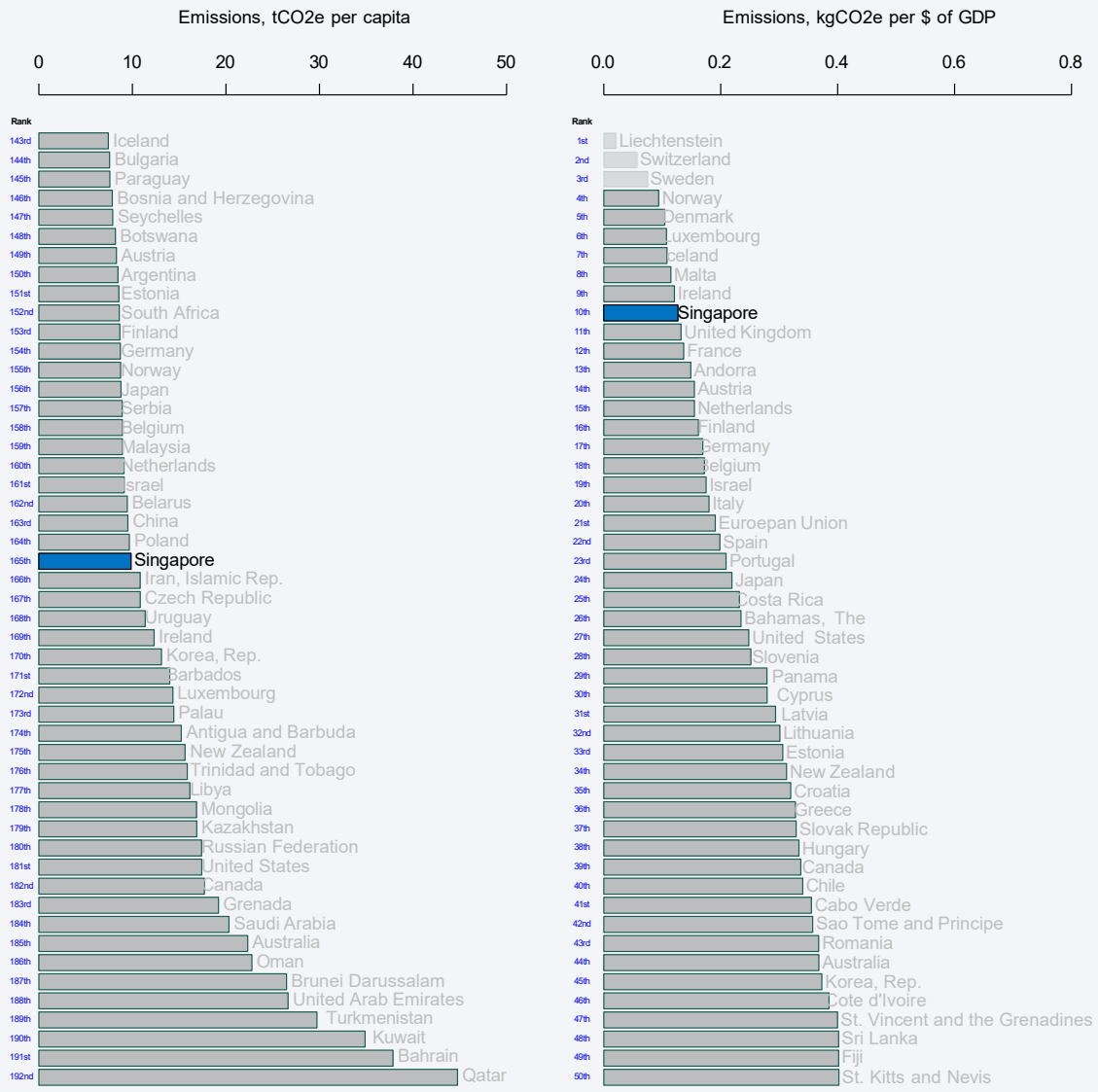
Adding further complexity to things is that, from a certain perspective, Singapore could be considered emissions-efficient. To expand, Figure (1, right panel) points towards the fact that in 2021 Singapore had the 10th lowest level of emissions per unit of gross domestic product (GDP).[4][5] While this should in no way detract from the need for urgent and deep decarbonization, it helps highlight the importance of a pragmatically timed transition to avoid potential economic losses.

[3] See https://www.eia.gov/international/analysis/country/SGP for associated discussion.

[4] This is because Singap0ore is a hub for oil refinery, importing large quantities of oil and emitting carbon when refining the oil before consumption or re-export as a refined product or input into other production processes. This is the main reason why 80% of the national emission is mainly from around 50 facilities.

Figure 1: Singapore's emissions per capita versus other countries.

Singapore's emissions per capita (tCO2e) relative to the 50 most emitting nations in 2021 (left panel); and emissions and per unit of gross domestic product in 2021 (GDP, measured in current US$) relative to the 50 lowest emissions intensive nations (right panel).



Source: The graph was generated by the authors using data available from the 'Climate Watch' website, see https://www.climatewatchdata.org/ for the underlying data.

Taken together the emissions per capita present a compelling case that decarbonisation can be achieved as Singapore is a relatively 'poor' performer in this metric. In contrast, the high performance with regard to emissions per unit of GDP suggests that Singapore has few objective benchmarks on how to maintain economic performance, but with a smaller environmental footprint. In practice, technology will have a large role to play in this transition. As will be further expanded in the next section, major sources of emissions within Singapore include power generation, industrial processes, and transportation. Today's technologies for these energy services within Singapore are not low-emission, with oil and natural gas being the dominant energy sources. With time, and in line with aspirations to decarbonize Singapore's power sector (EMA, 2022), this will change.

1.3 The need for high-integrity and transparent corporate transition plans

The creation of transition plans is one of the frontiers in transition finance today. It is an emerging practice that reflects the international policy context and the extent of national commitments. While many corporates have tracked their environmental impact for a number of years—due among other things to the introduction of mandatory reporting of emissions information in the US to include in the national toxic release inventory in 1986, refer to Davis-Walling and Batterman (1997) for early discussion—and may even have a long record of transparent sustainability reporting, the Paris Agreement created a surge in demand for such information. In response, an ever-increasing number of firms are disclosing, and the number of market observers and data providers is also growing.[5][6]

A recent study by ACRA and SGFIN (2024) looked into the sustainability reporting practices for the 51 largest publicly listed companies on the Singapore Stock Exchange (SGX), examining their preparedness for the pending evolution in the International Sustainability Standards Board (ISSB) requirements for climate-related disclosures, including a high-level overview of net zero targets for the analyzed firms. Establishing whether organizations' commitments to net zero are credible or legitimate requires a careful look at the climate impact of firms, what the ambitions for addressing such impacts are, and whether progress is being made in the 'right direction'. In another recent study looking at the sustainability disclosures of the top 50 firms from each of 14 Asia Pacific countries, including Singapore, PwC and CGS (2024) concluded that 53% of firms have net zero commitments. The insights captured in ACRA and SGFIN (2024) and PwC and CGS (2024) are encouraging, although to reconcile firms' commitments against the national ambition requires an even deeper investigation spanning the wider population of firms, i.e., looking beyond the top 50. There is a spectrum on how Singapore companies have made their net zero pledges, giving rise to several important research questions:

1. What is the extent and nature of net zero commitments made by Singapore's listed and locally headquartered firms?
    - Specifically, this report will focus on the notion of a **'clear commitment'**, the details of which are elaborated in Section (4.1), but in brief requires both (i) a statement of commitment with explicit reference to net zero and (ii) a net zero target year.
2. Are firms' predicted emissions pathways to net zero consistent/aligned with their declared emissions reduction targets, and the national ambition?
3. What can be learned from companies' public sustainability and integrated annual disclosures about the strategies used by firms to achieve net zero?

A lack of clarity in these matters may result in poorly timed and potentially ineffective policy intervention and introduce economy-wide risk to achieve national decarbonization targets. The objective of this whitepaper is therefore to provide answers to the above questions.

The rest of this paper is organized as follows: Section (2) gives an overview of Singapore's net zero journey from a national perspective; Section (3) briefly discusses sustainability disclosure practices from the lens of domestically headquartered companies listed on the Singapore Exchange; Section (4) outlines the work undertaken by SGFIN to build a registry of net zero commitments by Singapore listed companies; Section (5) contains the main findings on net zero commitment practices within Singapore; Section (6) provides an assessment of the strategies highlighted by firms to meet their net zero ambitions;

[5] Although not a central theme of the present study, there are important nuances around the practices and coverage by environmental, social and governance reporters. SGFIN explores these in previous and ongoing research. The interested reader may for example refer to Hendratama et al. (2023).

Section (7) offers a preliminary assessment of Singapore's listed companies decarbonization trajectory and alignment with the national ambition; section (8) concludes and offers policy recommendations.

Part 2

Singapore's Net Zero Journey

In this section, we expand on Singapore's journey toward net zero. Although the nation is relatively young—having gained independence in 1965—it shares common patterns with other economies, where energy demand and industrial structure are closely linked to emissions. Singapore's early development strategies provide the context and constraints for its current decarbonization efforts.

The net zero concept is grounded in the landmark Paris Agreement adopted in 2016, but Singapore did not make a full commitment to achieving net zero until 2022, when it set a specific timeframe.

Key takeaways:

- Being a physically small and import-dependent economy with limited local resources, Singapore took several years (and policy iterations) before making a concrete net zero commitment;
- The national ambition is to reach net zero by 2050, with an interim target of reducing emissions to 60 million tonnes of CO2 (equivalent) by 2030 after peaking earlier in 2028;
- In February 2025, Singapore introduced a second interim target to limit net emissions to 45-50 million tonnes of CO2 (equivalent) by 2035;
- Yet, there is no fixed strategic plan for how this will be done, with some aspiration that key industries, such as the energy sector, will be able to identify and commit to feasible technological solutions and pathways, potentially with strong government guidance and intervention.

2.1 Singapore's early economic development and emissions history

Singapore pursued rapid industrialization following a period of high unemployment, which peaked at 9.1% in 1966 (Huff, 1987). This strategy transformed the country from a low-income trading port in the 1960s into a high-income, industrialized economy by the 1990s. In 1991, the government launched a Strategic Economic Plan, aiming both to strengthen Singapore as a long-term manufacturing base (the 'Manufacturing 2000 Programme') and to position it as a regional business hub (the 'International Business Hub 2000 Programme') (Chia, 2005).

While this economic transformation was successful, it was accompanied by a significant rise in greenhouse gas emissions. Singapore depended heavily on fossil fuels, including oil and natural gas, for both energy generation and its petrochemical sector. Urbanization and increased transportation needs also drove emissions growth. By the 2000s, Singapore had become one of Asia's highest per capita emitters and has retained the status since, prompting a focus on energy efficiency and emissions reduction. See Lee and Rajagopalan (2008) on building energy efficiency, and Olszewski (2007) on Singapore's early transport-sector strategies.

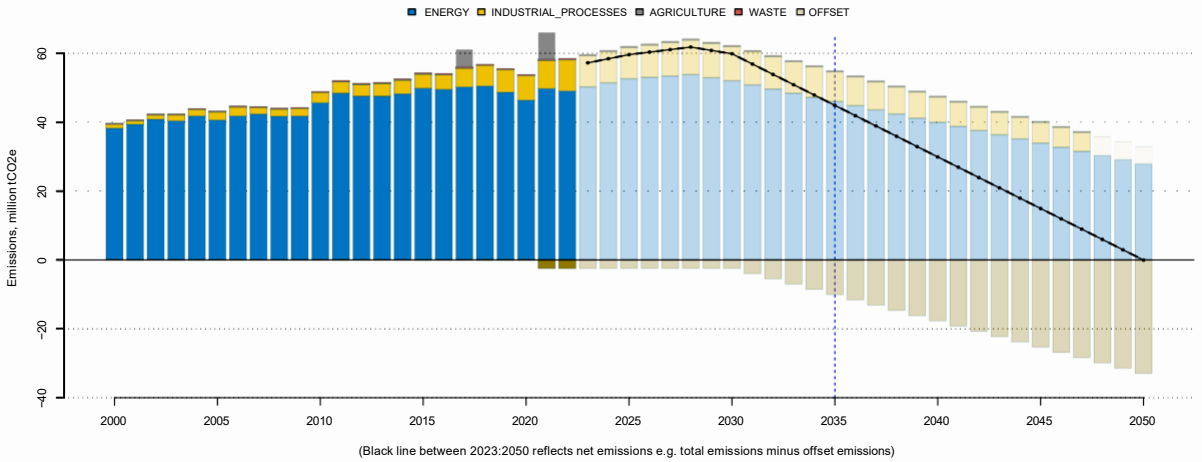
Figure (2) shows Singapore's total emissions between 2000 and 2022. Due to limited land space, emissions from the agriculture sector are negligible and not visually discernible in the figure. Total emissions grew from around 40 million tCO2e in 2000 to nearly 60 million tCO2e in 2022.

In 2022, the largest contributor to emissions in Singapore was the energy sector, which accounted for around 84% of national emissions. This highlights the critical importance of decarbonizing the power sector, which is clearly related to firms' Scope 2 emissions. Transport emissions are included in this energy category as well. Industrial processes, which include a number of hard-to-abate sectors, contributed just over 15% of total national emissions in 2022. It is noteworthy that Singapore has used Internationally Transferred Mitigation Outcomes (ITMOs) since 2021 to offset 2.5 million tCO2e and aims to continue this practice until 2030.

Between 2000 and 2022, emissions growth remained relatively stable, with emissions projected to peak in 2028 at 64.4 million tCO2e. Major economic crises—including the 1997 Asian financial crisis, the 2008 global financial crisis, and the 2020 COVID-19 pandemic—had limited lasting impact on this trend. In 2022, the majority of energy-related emissions came from three areas, namely 'Energy industries' (43.7%), providing services including electricity and heat generation, 'Manufacturing industries and construction' (38.7%), and 'Transportation' (14.3%).

Figure 2: Singapore emissions history, 2000-2022.

Singapore emissions history between 2000-2022 by main source of emissions. Refer to the note to the figure for additional information in relation to projected emissions.



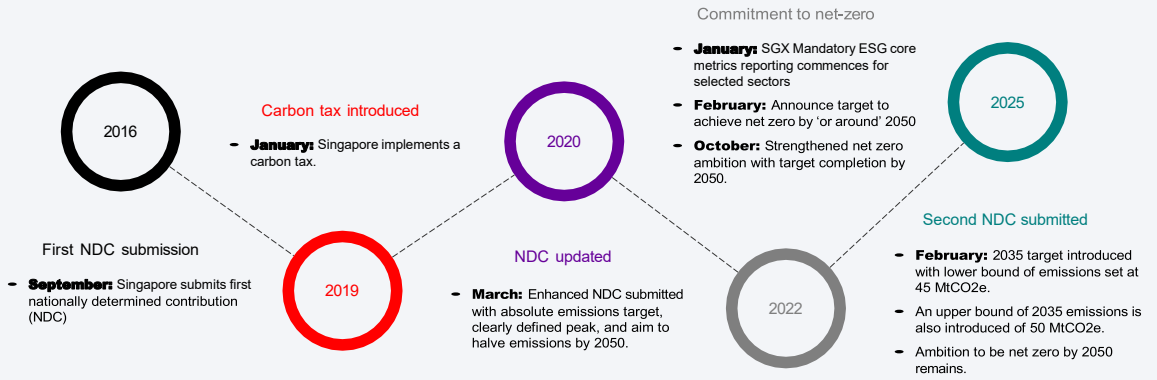
Source: The graph was generated by the authors using data available from Singapore's first Biennial Transparency Report, see https://www.nccs.gov.sg/singapore-s-first-biennial-transparency-report/ for additional details. National emissions for 2050 are set at a total of 33mtCO2e in line with earlier announcements regarding expected 2050 emissions, see https://www.businesstimes.com.sg/international/singapore-commit-net-zero-2050-peak-emissions-2030-dpm-wong. Estimated emissions offsets assume that their use will increase linearly from 2030 to fully offset 2050 emissions and achieve net zero i.e. offsets will remove 33mtCO2e. These assumptions are likely to be inaccurate—not least of all due to the constantly evolving policy context—but nonetheless reflective of the need for increased use of offsets.

2.2 Evolving national decarbonization commitments

Singapore now has a clearly defined climate ambition, though this clarity emerged only after several stages of evolution. The current national targets offer companies a clearer reference point for shaping their own commitments. While executives may remain cautious about the costs and uncertainties of transition, national ambition can provide a pragmatic basis to assess both the challenges of alignment and the feasibility of accelerating beyond national timelines. As such, the existence and credibility of national net zero commitments serve as an important guide for listed companies navigating climate strategy.

Figure 3: Timeline for Singapore's net zero commitment.

Timeline of key phases in Singapore's net zero commitments and supporting policy context.



Source: The graph was generated by the authors.

An outline of Singapore's national decarbonization commitments can be found at the Climate Action Tracker website, elements of which are summarized in Figure (3).[6] Some of the key events and updates in relation to Singapore's publicly committed net zero ambitions include:

- **September 2016**

  Singapore submitted its first Nationally Determined Contribution (NDC) on September 28, 2016. In this initial NDC, Singapore committed to reducing its greenhouse gas emissions intensity (the amount of emissions per unit of GDP) by 36% from 2005 levels by 2030. The country also aimed to stabilize its emissions, with the **goal of peaking emissions around 2030**.

- **March 2020**

  In March 2020, Singapore submitted an enhanced Nationally Determined Contribution and Long-Term Low-Emissions Development Strategy, with an absolute emissions target to peak emissions at 65 million tonnes of carbon dioxide equivalent (mtCO2e) around 2030, and to halve emissions from its peak to 33mtCO2e by 2050, with a view to achieving net zero emissions **as soon as viable in the second half of the century**.

[6] See https://climateactiontracker.org/countries/singapore/targets/ for further information.

- **February 2022**

  The Singapore government announced in February 2022 its plans to raise the country's carbon tax from 2024 onwards, as well as **achieve net zero emissions by or around mid-century**.

- **October 2022**

  A growing number of countries have also set net zero targets, including Singapore, which announced in 2022 (25th October) the country's enhanced target to **achieve net zero emissions by 2050**, with an interim target to reduce 2030 emissions to 60 mtCO2e after peaking emissions earlier.

- **February 2025**

  Singapore submitted its second NDC on February 10, **with a revised target for 2035 setting a lower bound on emissions of 45 mtCO2e, together with an upper bound of 50 mtCO2e** while remaining committed to achieving economy-wide net zero emissions by 2050.[7] The nature of the revised target *"...takes into consideration the reality that as an alternative-energy disadvantaged island state, Singapore's pace of decarbonization depends heavily on developments in nascent mitigation technologies, and international collaboration."*

Singapore's 2022 net zero declaration marked a turning point for the private sector, providing a national anchor for climate-related commitments. With clearer policy direction, companies now have a reference point against which to calibrate their own ambitions. Building on this policy foundation, key public institutions like the Monetary Authority of Singapore (MAS) introduced domain-specific initiatives, such as the Finance for Net Zero (FiNZ) Action Plan, to steer sectoral efforts in line with national goals.

2.3 Singapore's Finance for Net Zero (FiNZ) action plan

Building a climate-resilient financial sector is a stated objective of MAS. Achieving this in an effective and timely manner requires a shared roadmap and concerted efforts in capacity building and local skill development. In April 2023, MAS launched its 'Finance for Net Zero Action Plan' or FiNZ in short (MAS, 2023). FiNZ aims to 'catalyze Asia's net zero transition' by achieving four complementary strategic outcomes with supporting principles:

- **Data, Definitions, Disclosure:**
  - Ensure that climate data are reliable and comparable;
  - Develop and use credible and interoperable taxonomies;
  - Ensure, by mandatory requirement, that sustainability disclosures are ISSB aligned;
  - Promote the use of trusted/trustworthy environmental, social and governance (ESG) labels and ratings to increase users' confidence and reduce greenwashing risk.

[7] See https://www.nccs.gov.sg/singapore-submits-2035-nationally-determined-contribution/ for further details.

- **Climate Resilient Financial Sector:**
  - Promote the proactive adoption of sound environmental risk management practices;
  - Ensure the sector is stress-tested using robust climate scenario analysis.
- **Credible Transition Plans:**
  - Expect the use and communication of science-based transition plans by financial institutions;
  - Observe client engagement to steward real economy transition;
  - Ensure the efforts to align transition plans with regional sectoral decarbonization pathways are visible.
- **Green and Transition Solutions and Markets:**
  - Nurture the use of blended finance to support transition projects;
  - Create a supportive environment for the decarbonization of the carbon-intensive sector that is conducive to a smooth or managed transition (including managed phase out of coal-fired power plants);
  - Cultivate adoption of green and transition financing solutions;
  - Actively support market and platform creation for new transition-related areas, including carbon services and carbon credit markets.

To support these objectives, MAS released a Sustainable Finance Jobs Transformation Map in April 2024 (MAS, 2024) with the expectation that 56% of future financial services-related jobs will be 'highly or moderately augmented' with sustainable finance-related tasks.

Part 3

Sustainability Disclosure Practices in Singapore

Sustainability reporting requirements in Singapore are currently being updated. This is driven by a strong demand among stakeholders to have access to clear and consistently reported environmental and sustainability-related performance of companies.

Key takeaways:

- Sustainability disclosures are an essential pre-cursor to corporate net zero commitments;
- Sustainability reporting can be done either within an annual report, or using a standalone sustainability report - around 43% of firms are issuing standalone sustainability reports;
- While the Singapore Exchange has recommended 27 core ESG metrics for reporting, there is a broad spectrum of reporting practices and depth of information provided by firms.

At the national level, environmental policy is configured around a target date of 2050, though recent revisions to how this commitment is articulated have created some uncertainty about potential future changes. Meanwhile, the policy landscape and enabling environment, especially in relation to the financial sector and requirements for listed companies to support the transition, have not yet stabilized.

Singapore's central bank has assessed financial market conditions and set out strategies and guidance to support the net zero transition in areas where financial institutions and service providers have influence. These efforts help set the tone for the financial and corporate sector, and are positively complemented by the Singapore Exchange's initiatives to mandate sustainability disclosures. Company reporting (disclosures) on environmental and sustainability performance is crucial for tracking and verifying progress against pledges and commitments.

This section provides a brief account of sustainability disclosure practices in Singapore. It is not intended to be comprehensive in describing the quality and scope of such disclosures.[8] Rather, its objective is to highlight that sustainability reporting is still an emerging practice, not yet universal, and is marked by significant variation in reporting styles.

[8] An ASEAN wide assessment of the quality and extent of sustainability disclosures by listed companies undertaken by SGFIN researchers can be found in Rajindran et al. (2024).

3.1 Sustainability disclosure requirements in Singapore

In parallel with the national decarbonisation strategies and targets, the Singapore Exchange (SGX) implemented a public consultation exercise in response to recommendations from the Task Force on Climate-related Financial Disclosures (TCFD).[9] This process, concluded in 2021, laid the groundwork for phased mandatory sustainability reporting in Singapore as follows:

- **For the financial year commencing between 01/01/2022 and 31/12/2022:** Climate reporting is mandatory for all issuers on a 'comply or explain' basis;
- **For the financial year commencing between 01/01/2023 and 31/12/2023:** For the financial, agriculture, food and forest products industry and energy industries, climate reporting is mandatory without a 'comply or explain' option. Issuers from other industries must report on a 'comply or explain' basis;
- **For the financial year commencing between 01/01/2024 and 31/12/2024:** Climate reporting becomes mandatory for the materials and building as well as the transportation industries, in addition to the sectors mentioned above;
- **For the financial year commencing on or after 01/01/2025:** Mandatory climate reporting must align with IFRS Sustainability Disclosures Standards, and sustainability reports must be published within four months of the financial year end (five months if externally audited). Other 'primary components' of the sustainability report are subject to disclosure on a 'comply or explain' basis.

The reporting requirement for Singapore's listed companies begins with 27 Core ESG metrics defined by SGX, although firms are free to go beyond these. Emissions disclosures are structured around three Scopes of emissions:[10] Scope 1 'Direct GHG emissions' from sources that are owned or controlled by the company; Scope 2 'Electricity indirect GHG emissions' relating to the emissions from purchased electricity; and Scope 3 'Other indirect GHG emissions'.[11] The recommendation at the time was that companies separately account for and report on Scopes 1 and 2 emissions as a minimum. The 27 core metrics include variables relating to more than climate-specific/related disclosures, and take a more holistic view on sustainability, including a broader range of social issues, such as gender and age diversity.

It is important to understand a given firm's disclosure requirements and practices as they signal the preparedness of a firm to be able to commit to net zero. To elaborate, some elements of a firm's journey to net zero might involve the following:

- Measure environmental impacts of businesses (e.g., energy use, waste-pollutants);
- Internally report environmental impacts;
- Evaluate internally on emissions reduction possibilities;
- Develop and test emission reduction strategies;
- Initiate external reporting on emissions;
- Gather stakeholder feedback on reported emissions to refine targets;
- Declare decarbonization targets; and
- Implement decarbonization and transition strategies.

[9] See https://www.sgx.com/sustainable-finance/sustainability-reporting for additional detail.

[10] An overview of the greenhouse gas protocol and early corporate accounting and reporting standards for emissions can be found in Bhatia and Ranganathan (2004).

[11] There are 15 sub-categories of Scope 3 emissions which are: Category 1 - Purchased goods and services; Category 2 - Capital goods; Category 3 - Fuel- and energy-related activities; Category 4 - Upstream transportation and distribution; Category 5 - Waste generated in operations; Category 6 - Business travel; Category 7 - Employee commuting; Category 8 - Upstream leased assets; Category 9 - Downstream transportation and distribution; Category 10 - Processing of sold products; Category 11 - Use of sold products; Category 12 - End-of-life treatment ; Category 13 - Downstream leased assets; Category 14 - Franchises; Category 15 - Investments.

Sustainability disclosures are a critical prerequisite for credible net zero commitments. They indicate that a company has assessed its environmental impact and is sufficiently prepared to share strategies and performance with stakeholders.

Table 1: Sustainability Reporting by Sector.

Sustainability reporting using standalone sustainability reports, by Sector, in financial years 2022 and 2023.

		With Sustainability Report: 2022		With Sustainability Report: 2023	
Sector	**# of Firms**	**Count**	**Percentage**	**Count**	**Percentage**
Communication Services	15	7	46.67	7	46.67
Consumer Discretionary	69	36	52.17	33	47.83
Consumer Staples	26	18	69.23	20	76.92
Energy	23	14	60.87	15	65.22
Financials	25	9	36.00	8	32.00
Health Care	31	13	41.94	13	41.94
Industrials	140	71	50.71	70	50.00
Information Technology	36	12	33.33	13	36.11
Materials	24	13	54.17	15	62.50
Real Estate	84	32	38.10	37	44.05
Utilities	6	2	33.33	2	33.33
Grand Total	479	227	47.39%	233	48.64%

Source: The table was generated by the authors using information obtained from sustainability reports available from the Singapore Exchange 'Annual Reports & Related Documents' portal at https://www.sgx.com/securities/annual-reports-related-documents.

In Singapore, the practice of sustainability reporting is still developing and appears in various forms. Only in recent years has the Singapore Exchange started requiring the disclosure of environmental information. Expectations and requirements are changing, with a growing trend toward mandatory reporting. Companies are adapting to these new and evolving standards. Some companies include some sustainability details within their annual reports, while others produce separate sustainability reports, leaving most sustainability information outside the annual reports. Some are comfortable sharing key sustainability data in their annual reports but also produce standalone sustainability reports with more detailed environmental performance evaluations.

The availability of emissions data is of immense importance to tracking and evaluating progress towards net zero. The reported emissions in any given year directly reflect the firm's overall decarbonization progress for that year.

Table (1) indicates the extent of standalone sustainability reporting across the 479 firms used in the main analysis sample for this paper. The sample of firms focuses upon companies that are Singapore-headquartered, defined using the Compustat global fundamentals data, and listed on the Singapore Exchange. In the analysis sample, approximately half of firms (48.6%) issued standalone sustainability reports in 2023. For other companies, sustainability-related information needed to be extracted from their annual reports.

3.2 The type/scope(s) of emissions reported by firms

Table (2) offers an additional view of how Singapore-listed companies report GHG emissions by industry. Nearly three-quarters of the sub-sample disclose a quantified assessment of their emissions for 2023. Most reporting focuses on Scope 2 emissions (73.6%), followed by Scope 1 (68.7%), while coverage of Scope 3 emissions (34.4%) is significantly sparser.

It is noteworthy that reporting of Scope 2 emissions exceeds that of Scope 1 emissions. There are at least two reasons for this: First, many companies may not have material Scope 1 emissions to report, since Scope 1 covers emissions produced directly from sources owned or controlled by the company. Second, Scope 2 emissions are relatively easier for companies to measure (compared to Scope 1 or Scope 3 emissions), as they are often calculated from energy bills and grid emission factors, which in the context of Singapore have remained stable for a number of years.

Table 2: Scope of emissions disclosure by sector.

Scope of emissions disclosure by sector for financial year 2022. For this table the emissions data are taken from S&P Trucost emissions data, and complemented with hand collected data for the firms covered in Rajindran et al. (2024) where Trucost did not provide coverage.

Sector	# of Firms	With Emissions reported (%)			Sector Total Emissions (tCO2e)	
		Scope 1	Scope 2	Scope 3	Scopes 1+2	Scopes 1+2+3
Communication Services	15	40.00	40.00	33.33	613,637	2,458,842
Consumer Discretionary	69	20.29	20.29	15.94	270,955	723,272
Consumer Staples	26	57.69	57.69	53.85	28,664,644	175,524,500
Energy	23	43.48	39.13	34.78	107,967	44,844,108
Financials	25	28.00	32.00	28.00	202,147	30407391
Health Care	31	22.58	29.03	22.58	280,983	405,257
Industrials	140	18.57	18.57	12.86	28,685,555	360,044,202
Information Technology	36	25.00	25.00	22.22	224,781	3,250,673
Materials	24	25.00	20.83	16.67	2,259,630	8,270,962
Real Estate	84	70.24	71.43	65.48	2,372,048	20,769,339
Utilities	6	66.67	66.67	33.33	26,087,250	326,97,712
Grand Total	479	34.03	34.45	29.02	89,769,597	679,396,257

Source: The table was generated by the authors using information obtained from sustainability reports available from the Singapore Exchange 'Annual Reports & Related Documents' portal at https://www.sgx.com/securities/annual-reports-related-documents, as well as S&P Trucost emissions data.

3.3 Reconciling companies' emissions with those covered by NDCs

While Nationally Determined Contributions (NDCs) and corporate net zero commitments both aim to reduce GHG emissions, they differ in scope, purpose, and accountability mechanisms.

NDCs emerged as part of the Paris Agreement and outline country-level plans to reduce national emissions and adapt to the impacts of climate change. These commitments apply to entire nations and cover all sectors of the economy, including energy, transportation, agriculture, and waste management. In contrast, corporate net zero commitments are made by individual companies and typically focus on reducing or offsetting their emissions. This often includes Scope 1 (direct emissions), Scope 2 (indirect emissions from energy use), and sometimes Scope 3 (emissions from the value chain, including suppliers and customers), focusing on their own operations and products.

Reported emissions are provided for different purposes. They contribute to the global objective of limiting global warming to well below 2°C, preferably 1.5°C, as set by the Paris Agreement. NDCs are subject to international climate diplomacy, international review, and have clearly defined update cycles. Under the UN Development Program's 'Climate Promise' initiative, the second round of NDCs was due by 2025. Several, including Singapore's, are already public. Importantly, NDCs are not legally binding. There are no penalties for missing targets. However, countries must demonstrate progress and are held accountable through a global transparency and reporting framework. **A key timing difference exists:** The United Nations Framework Convention on Climate Change (2023) – in their annual update to the NDC Synthesis Report–noted that *"...93 per cent of Parties communicated an NDC implementation period of until 2030, while 7 per cent specified an implementation period of until 2025, 2035, 2040 or 2050."* In other words, there are some important differences in the reference points for climate action between NDCs and broader corporate net zero, which often focus on a 2050 target date and implementation strategy.

Corporate commitments remain voluntary, and are motivated by various factors including consumer demand, investor pressure, regulatory requirements, business strategy, market positioning, risk management, and corporate social responsibility practices. While voluntary, companies face real consequences for missing targets, such as reputational risks, shareholder pressure, regulatory consequences, and financial penalties through sustainability-linked loans that impose higher costs when targets are missed.

On the surface, corporate and national emissions inventories should align well. NDCs cover all locally generated emissions, while corporate Scope 1 and Scope 2 emissions operate on a similar premise of covering internal emissions.

However, several complications arise:

- **Geographic mismatch:** Listed companies often have multinational operations both within and outside Singapore, making it difficult to attribute emissions to specific countries.
- **Limited Scope 3 reporting:** Companies provide much less information about their value chain emissions, which can be substantial.
- **No location-based attribution requirements:** Companies are not required to break down their reported emissions by geographic location, even though they collect this information for internal carbon accounting.

This creates a fundamental challenge in emission allocation. While companies can technically attribute energy consumption and emissions to specific business sites, there is no requirement to report emissions by location. Consequently, efforts to directly connect listed companies' environmental performance with national-level metrics are severely hampered.

In summary, NDCs represent national commitments under international agreements, while corporate net zero commitments are private-sector efforts aligned with company-specific goals that often go beyond regulatory requirements. Both are crucial but operate at different scales within distinct frameworks, creating alignment challenges that complicate comprehensive climate action assessment.

3.4 Guidelines for non-reporting firms.

There remains a reporting gap. Despite improvements, a significant proportion of listed firms still do not consistently report emissions. As shown in Table (2), more than a quarter of the listed companies did not report emissions of any scope in 2023.

Upcoming regulatory changes will significantly impact non-reporting or minimally-reporting firms. As discussed in Section (3.1), upcoming alignment with IFRS Sustainability Disclosure Standards will tighten timelines and expand reporting obligations, including mandatory Scope 3 disclosures for larger firms.

Looking ahead, non-reporting firms will face mounting pressure to disclose a broader range of environmental and sustainability-related metrics. Even where voluntary disclosure exists, reporting expectations are likely to evolve to improve consistency and comparability at domestic, regional, and global levels. This standardization is essential for evaluating the need for additional policy interventions and ensuring effective climate action coordination.

Part 4

Building a Registry of Net Zero Commitments

It is important to consider net zero commitments beyond the emissions data and other sustainability-related metrics disclosed by companies. Achieving net zero is not merely about measuring environmental impact, but about a company's best estimate of when it can operate profitably while also being environmentally sustainable. However, corporate disclosures on net zero commitments are still relatively new and remain sparsely covered by mainstream ESG and sustainability data providers.

To support this study, it was necessary to develop a custom registry of net zero commitments made by exchange-listed companies headquartered in Singapore. This registry acknowledges commitments made through annual and sustainability reports available on the Singapore Exchange online platform, providing a comprehensive record of commitments and pledges.

Key takeaways:

- The registry was populated via a hybrid machine-human screening process using a specially created corpus of machine-readable annual and sustainability reports for Singapore-listed companies;
- The methodology is highly efficient for targeted context searches, and designed to make for easy registry updates;
- Manual data-integrity checks validate the accuracy of the machine search stage of the applied methodology;
- The corpus has the potential to inform many subsequent targeted research applications.

This section describes the process used to evaluate net zero commitments and pledges made by Singapore listed companies. The process requires manual screening of company annual and sustainability reports and creates a machine-readable corpus of these reports as a part of the process. This corpus plays a central role in systematically identifying net zero commitments across all listed entities on the Singapore Exchange and across all years.

As a note for readers, the report refers to both annual and sustainability reports filed with the Singapore Exchange and accessible through its public platform.[12] These reports are referenced in short form. For example, 2022AR refers to the annual report for a given

[12] See: https://www.sgx.com/securities/annual-reports-related-documents.

company for the period ending in 2022, while 2022SR refers to the company's sustainability report for 2022. For brevity, we do not indicate the month of the reporting period.

4.1 Identifying net zero commitments from company reports

This subsection briefly describes the approach used to identify net zero commitments in companies' annual and/or sustainability reports. A more detailed explanation is provided in the Appendix.

Company annual reports (AR) and sustainability reports (SR) were downloaded from the Singapore Exchange's 'Annual Reports & Related Documents' online portal.[13] Although TCFD-based climate reporting is mandatory in Singapore for listed companies, they are not required to publish separate sustainability reports, and in many cases, sustainability information is communicated within the annual report (i.e., as an integrated report).

The sample is limited to Singapore-headquartered companies. This approach ensures that our assessment of corporate commitments can be closely reconciled with the national economy-wide ambition.

The reports are machine-read and screened for references to 'net zero', accounting for variations in case and hyphenation. This approach proves highly accurate because the term net zero is used almost exclusively in the context of climate ambitions. The automated phase efficiently identifies which firms mention net zero and how frequently.[14]

After identifying the relevant reports, a manual screening process was carried out to determine whether net zero is discussed only in the context of recognising national or international decarbonization ambitions, or if it represents a concrete and unambiguous commitment by a company to achieve net zero. A company is classified as having a net zero commitment if the following criteria are met:

(i) The firm uses affirmative wording such as 'commit', 'pledge' or equivalent synonyms permissible like 'goal' or 'target';

(ii) A target date is provided. Without both affirmative wording and a target date, the commitment is not considered concrete;

(iii) The net zero commitment applies to the entire group, as commitments at the subsidiary level are only partial from the group's perspective.

- 'Group' refers to the listed entity and includes all subsidiaries it may have.

This classification scheme involves some subjective interpretation of the wording of commitments or pledges, but in most cases, the wording is well-defined, reducing the risk of misclassification in practice.

[13] See https://www.sgx.com/securities/annual-reports-related-documents for further information.

[14] Independent verification was conducted to ensure that the machine-based classification scheme accurately identified presence of net zero discussion. This included (i) the full sample of reports in which net zero discussion was identified and (ii) random sampling of the much larger quantity of reports in which no mention of net zero was observed.

Figure 4: Discussion of 'Net Zero' in company reports.

Cumulative number of references made to 'net zero' within company's annual and sustainability reports.

Source: This figure was generated by the authors using data extracted from company's annual and sustainability reports for the sample of 479 Singapore-headquartered firms listed on SGX.

Figure (4) provides a simple validity check to confirm that the machine-read corpus of sustainability and annual reports, even in its raw form, can extract meaningful and quantifiable summaries of how often the term 'net zero' appears. Furthermore, the data in the figure highlights the growing mainstream presence of net zero within corporate sustainability narratives.

The first mention of net zero appeared in 2015 in City Development Ltd.'s sustainability report, where they note that *"Since 2009, CDL has also voluntarily reduced our annual carbon emissions to 'net zero' for our Corporate Office operations including our data centre and 11 Tampines Concourse – the first CarbonNeutral® development in Singapore and Asia Pacific. Besides carbon neutralizing the construction phase of 11 Tampines Concourse, we also annually offset emissions from its operations, including that of our tenants."* This reference raises two interesting questions. If a company already operates on a net zero emissions basis, would they feel compelled to state explicitly that they are committed to net zero by a specific date? And, are net zero and carbon neutral equivalent concepts?

Recent years have seen explosive growth in net zero discussions. Around 1,800 unique mentions appeared inside sustainability reports during 2023, with sustained increases over prior years. While this represents a tiny fraction of total length, which typically ranges from tens of thousands to hundreds of thousands of words, it indicates rapid growth in the use of the term. Importantly, these reports are heavily scrutinized due to their importance and the potential reputational or legal ramifications of inaccurate or imprecise information.

If a more stringent definition of "net zero commitment" were applied, such as one that requires full alignment with recognized frameworks like the SBTi Net Zero Standard or the Transition Pathway Initiative, the number of companies identified as committed to net zero would likely decrease across different categories and sectors. For the purpose

of this paper, we continue to follow the existing definition and criteria described above to maintain consistency and comparability across the sample.

4.2 The main net zero data points manually collected

Our manual screening process captures six key data points about each company's net zero commitment:

- **Net zero commitment**: a binary indicator of whether the company explicitly commits to achieving net zero, regardless of whether a target year is mentioned;
- **Net zero scenario assessment**: a binary indicator of whether the company has a scenario assessment.
  - Scenario assessments can be implemented quantitatively or qualitatively.
  - A widely used approach to scenario assessment involves working with the Science Based Targets initiative (SBTi), who *"Lead the way to a net zero economy, boost innovation and drive sustainable growth by setting ambitious, science-based emissions reduction targets."* [15]
- **Target year**: The year by which the company aims to achieve net zero;
- **When the target was announced**: The year in which a company first announced its net zero target;
- **Scope of target**: Information on which Scopes of emissions are covered under the net zero commitment; and
- **Interim milestone information**: Similar information about the interim target year, the interim target level, and the interim target Scopes.

At several points in the following text, reference is made to the notion of a clear commitment. As noted in the introduction, and also elaborated in Section (4.1), a commitment is only considered 'clear' or unambiguous if it includes both (i) a statement of commitment with explicit reference to net zero and (ii) a declaration of a net zero target year.

A company in the early stages of its decarbonization journey may lack the internal resources or expertise to define a concrete target. Companies with limited internal capacity can work with organizations like SBTi to conduct scenario analysis tailored to their specific business conditions. Collaborating with SBTi can help establish realistic commitments, especially plausible target dates, considering current business circumstances. Also, when different companies use SBTi scenario assessments, it improves comparability across their net zero ambitions and strategies.

It is important to note that companies can undertake formal decarbonization scenario assessment,[16] such as an SBTi-based scenario assessment, without committing publicly to net zero, and that not all scenarios are aligned with a 2050 target. It may be justified under certain conditions, such as avoiding unintended negative side effects from poorly defined or communicated sustainability targets (Acuti et al., 2022) or when dealing with critical and possibly skeptical stakeholders (Font et al., 2017).

[15] See https://sciencebasedtargets.org/ and https://sciencebasedtargets.org/resources/files/Net zero-Standard-Criteria.pdf for further detail on SBTi and net zero specific assessments.

[16] There are different sources of information on future scenarios, with some of the more widely referenced including: Science Based Targets initiative (SBTi); the International Energy Agency (IEA); the Intergovernmental Panel on Climate Change (IPCC); and the Network for Greening the Financial Sector (NGFS). This list is not exhaustive, but covers several key providers of scenario information. The total number of mentions across the annual and sustainability reports used for this study is: SBTI = 870; IEA = 767; IPCC = 1,380, NGFS = 422. Given the focus of the present report we do not dwell on the implications of these relative mentions, or of using different scenario benchmarks, though recognise this may be a valuable direction for future research to pursue.

4.2.1 Complementary net zero commitment data sources

Several external data providers also track firm-level net zero commitments. Two widely recognized sources include the Net Zero Tracker and SBTi. These providers rely on voluntarily submitted information from companies. Therefore, unless a company sees explicit value in being recognized within a specific dataset, such as signaling their environmental credentials and the credibility of their commitments, they may choose not to share information with various data providers. Still, many researchers and analysts depend on these datasets to inform their investment decisions or to develop and assess policies aimed at advancing toward net zero.

The importance of considering data coverage in these datasets compared to company reports lies in two main areas: (i) to help validate manual screening of reports and ensure consistency in coverage and/or identify inconsistencies, and (ii) to assess how well these data sources reflect the actual commitments to net zero made by listed companies.[17]

1. **Net Zero Tracker**

   The Net Zero Tracker (NZT) specializes exclusively in net zero commitments. They "...analyze all nations that are parties to the UNFCCC, every region in the largest 25 emitting nations, all cities with more than 500,000 inhabitants, and the world's largest 2,000 publicly listed companies by annual revenue." [18] Examples of research using this data include Schimanski et al. (2023) or Oladapo et al. (2025).

2. **SBTi**

   The SBTi data takes a fundamentally different approach than the Net Zero Tracker. Rather than simply tracking net zero commitments, SBTi focuses on validating the scientific rigor behind companies' targets. Companies listed in SBTi data have undergone a formal validation process where their emissions reduction targets are assessed against climate science and approved as being consistent with limiting global warming to 1.5°C or well-below 2°C. This means SBTi inclusion indicates not just a commitment, but a scientifically credible pathway to achieve it. Their data *"...shows organizations that have had greenhouse gas (GHG) emissions reduction targets validated as science-based by the SBTi. It also shows organizations that have committed to set science-based targets, as well as those that have had their commitments removed in accordance with our Commitment Compliance Policy."* [19] Examples of research using this data include Bolton et al. (2022) or Maia and Garcia (2023).

The next section presents the main findings from applying the screening procedures described in this section.

[17] It is noted that the small number of banks covered in the sample, including DBS, OCBC and UOB are also reflected under the Net Zero Banking Alliance (NZBA), who maintain an online registry of members at https://www.unepfi.org/net-zero-banking/commitment/. Financed emissions are not the primary focus of the present study, hence the limited discussion of NZBA. It is SGFIN's intention to explore the nexus of net zero and financed emissions in a future study.

[18] See https://zerotracker.net/#data-explorer for further information.

[19] See https://sciencebasedtargets.org for further information.

Part 5

Main Findings on Net Zero Commitments

In this section, we present the main findings from systematically screening sustainability and annual reports for net zero commitments using the methodology defined in the previous section.

Out of a total of 2,179 sustainability and 7,341 annual reports between 2014 and 2024:

Key takeaways:

- Among the Singapore-headquartered public firms in the sample, 60 have committed to achieving net zero by 2050 or earlier;
- Only 30% of these are covered by prominent external net zero data providers, highlighting a massive information gap and verifying the importance of direct inspection of company reports;
- Net zero commitments cover around 75% of market capitalization, but only around 55% of observed Scope 1+2 emissions for the firms in sample;
- Several emissions-intensive sectors with a key role in completing a net zero transition, including Energy, Industrials, Materials, Consumer Staples and Health Care, have notable commitment gaps;
- Commitments were communicated in a variety of different ways, with differing levels of information, around timing, Scope of coverage, interim targets, etc.

5.1 Companies with net zero commitments

As of the end of July 2024, 60 Singapore-headquartered public-listed entities have clear net zero commitments that include both (i) a statement of the entity's group-wide commitment with explicit reference to net zero and (ii) a declared net zero target year.[20] Table (3) lists these entities, in alphabetical order, providing information on when they made their commitment, target date, whether they have an interim target date, whether the information is conveyed in the annual and/or sustainability report, and the Global Industrial

[20] We recognize that this may underestimate the true extent of commitments and pledges. For example this method captures public commitments via company reports but does not for instance capture companies that have internal net-zero commitments, with commitments that apply to only a part of their operations e.g. subsidiaries only, imply commitments through alignment with industry bodies or as signatories/memberships of collective groups/alliances etc., or which declare commitments outside of their annual or sustainability reports.

Classification System (GICS) industry classification. The final column of the table indicates whether the identified commitment is reflected by a net zero commitment in the NZT or SBTi databases.

Table 3: Companies with Net Zero pledges.

List of Singapore HQ companies making net zero pledges within their annual or sustainability reports.[21] The final column depicts whether a net zero pledge is reflected in SBTi and/or NZT databases, applying suitable screening criteria e.g. for SBTI data this requires restricting target type to be 'Net-zero'. The fifth column reflects the type of report used to convey the net zero commitment, the report years are not identified and may be from any year since the year of first commitment.

List of Singapore HQ companies making net zero pledges within their annual or sustainability reports.						
Firm	**Year of first commitment**	**Net zero target date**	**Interim target date**	**Commitment in AR or SR**	**GICS sector**	**Covered by SBTi or NZT**
ALPINA HOLDINGS LIMITED	2021	2050		SR	Industrials	
ARA TRUST MANAGEMENT (SUNTEC) LIMITED	2023	2050	2030	SR; AR	Real Estate	
AZTECH GLOBAL LTD.	2021	2040		SR; AR	Information Technology	
CAPITALAND ASCENDAS REIT MANAGEMENT LIMITED	2022	2050	2030	SR; AR	Real Estate	NZT (Capitaland)
CAPITALAND ASCOTT TRUST MANAGEMENT LIMITED	2022	2050	2030	SR; AR	Real Estate	NZT (Capitaland)
CAPITALAND CHINA TRUST MANAGEMENT LIMITED	2022	2050	2030	SR; AR	Real Estate	NZT (Capitaland)
CAPITALAND INDIA TRUST MANAGEMENT PTE. LTD.	2022	2050	2030	AR	Real Estate	NZT (Capitaland)
CAPITALAND INTEGRATED COMMERCIAL TRUST MANAGEMENT LIMITED	2022	2050	2030	SR; AR	Real Estate	NZT (Capitaland)
CAPITALAND INVESTMENT LIMITED	2021	2050	2030	SR; AR	Real Estate	NZT (Capitaland)
CHINA AVIATION OIL (SINGAPORE) CORPORATION LTD	2023	2050	2030	SR; AR	Energy	NZT
CITY DEVELOPMENTS LIMITED	2020	2050	2030	SR; AR	Real Estate	
COMFORTDELGRO CORPORATION LIMITED	2023	2050	2032	SR	Industrials	
DBS GROUP HOLDINGS LTD	2020	2050	2030	SR; AR	Financials	NZT
ELITE COMMERCIAL REIT MANAGEMENT PTE. LTD.	2021	2050		AR	Real Estate	
ENVIRO-HUB HOLDINGS LTD.	2023	2050		SR; AR	Materials	
FEO HOSPITALITY ASSET MANAGEMENT PTE. LTD.	2022	2050		AR	Real Estate	
FRASER AND NEAVE LIMITED.	2022	2040	2025	SR; AR	Consumer Staples	
FRASERS COMMERCIAL ASSET MANAGEMENT LTD	2020	2050	2035	AR	Real Estate	SBTi (expired)
FRASERS HOSPITALITY ASSET MANAGEMENT PTE. LTD.	2020	2050	2024	AR	Real Estate	
FRASERS LOGISTICS & COMMERCIAL ASSET MANAGEMENT PTE. LTD.	2020	2050	2030	AR	Real Estate	SBTi (expired)
FRASERS PROPERTY LIMITED	2020	2050	2030	SR; AR	Real Estate	SBTi
GLOBAL INVACOM GROUP LIMITED	2022	2050		AR	Information Technology	
GOLDEN AGRI-RESOURCES LTD	2023	2050		SR	Consumer Staples	
GREAT EASTERN HOLDINGS LIMITED	2021	2050	2025	SR; AR	Financials	
HO BEE LAND LIMITED	2023	2050	2026	SR; AR	Real Estate	

[21] Some entities, including DBS, declared different ambitions and interim target dates for their operational emissions i.e. Scope 1 and 2, versus broader emissions including Scope 3. In such cases we report the Scope 3 commitment target date for brevity, which is typically set for a later date than Scopes 1 and 2, but recognise this does not fully reflect all nuanced details and targets.

Continuation of Table 3

Firm	Year of first commitment	Net zero target date	Interim target date	Commitment in AR or SR	GICS sector	Covered by SBTi or NZT
HOCK LIAN SENG HOLDINGS LIMITED	2022	2050		SR	Industrials	
HOE LEONG CORPORATION LTD.	2023	2050		AR	Industrials	
IWOW TECHNOLOGY LIMITED	2024	2050	2030	AR	Information Technology	
JAPFA LTD.	2022	2050	2030	SR; AR	Consumer Staples	
KEPPEL LTD.	2021	2050	2030	SR; AR	Industrials	NZT
KORI HOLDINGS LIMITED	2023	2050		SR	Industrials	
LENDLEASE GLOBAL COMMERCIAL TRUST MANAGEMENT PTE. LTD.	2021	2040	2025	AR	Real Estate	
M&C REIT MANAGEMENT LIMITED	2022	2050	2035	AR	Real Estate	
MANUFACTURING INTEGRATION TECHNOLOGY LTD.	2023	2050		AR	Information Technology	
MAPLETREE LOGISTICS TRUST MANAGEMENT LTD.	2024	2050	2030	AR	Real Estate	
METECH INTERNATIONAL LIMITED	2023	2050		AR	Industrials	
MPACT MANAGEMENT LTD.	2023	2050	2030	SR; AR	Real Estate	
NETLINK NBN MANAGEMENT PTE. LTD.	2022	2050	2030	AR	Communication Services	
NEW TOYO INTERNATIONAL HOLDINGS LTD	2023	2050	2030	SR; AR	Materials	
NOONTALK MEDIA LIMITED	2023	2050		AR	Communication Services	
OLAM GROUP LIMITED	2023	2050		AR	Consumer Staples	NZT
OSSIA INTERNATIONAL LIMITED	2024	2050	2030	AR	Consumer Discretionary	
OVERSEA-CHINESE BANKING CORPORATION LIMITED	2021	2050	2030	SR; AR	Financials	NZT
PARKWAY TRUST MANAGEMENT LIMITED	2022	2050		AR	Real Estate	
POLARIS LTD.	2022	2050		SR; AR	Consumer Discretionary	
PSC CORPORATION LTD.	2023	2050		SR	Materials	
SATS LTD.	2024	2050	2030	SR	Industrials	
SBS TRANSIT LTD	2022	2050	2045	SR	Industrials	
SEATRIUM LIMITED	2023	2050	2030	SR; AR	Industrials	
SEMBCORP INDUSTRIES LTD	2021	2050	2030	AR	Utilities	
SIN HENG HEAVY MACHINERY LIMITED	2023	2050	2030	SR	Industrials	
SINARMAS LAND LIMITED	2022	2050	2034	SR	Real Estate	
SINGAPORE AIRLINES LIMITED	2021	2050	2030	SR; AR	Industrials	NZT
SINGAPORE POST LIMITED	2022	2050	2030	SR; AR	Industrials	
SINGAPORE TELECOMMUNICATIONS LIMITED	2020	2045	2025	SR; AR	Communication Services	NZT / SBTi
STARHUB LTD.	2022	2050	2030	AR	Communication Services	SBTi
THE STRAITS TRADING COMPANY LIMITED	2023	2050	2030	AR	Materials	
UNITED OVERSEAS BANK LIMITED	2022	2050	2030	SR; AR	Financials	NZT
VENTURE CORPORATION LIMITED	2023	2050	2030	AR	Information Technology	
YANGZIJIANG FINANCIAL HOLDING LTD.	2023	2050		AR	Financials	

End of list of Singaporean companies making net zero pledges within their annual or sustainability reports.

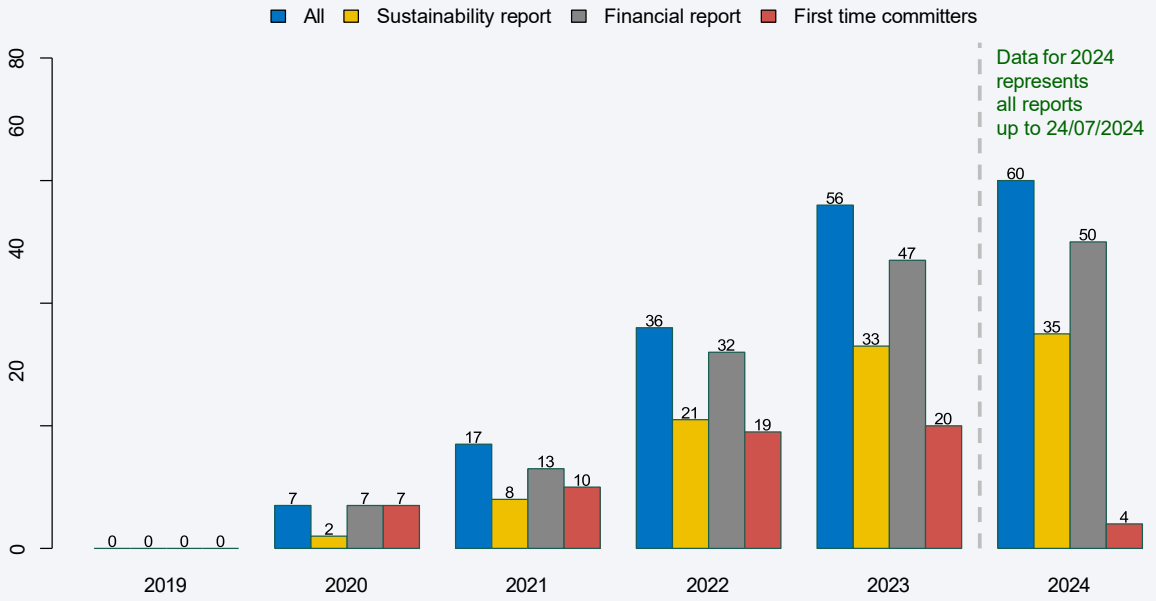
Figure (5) shows the growth of net zero commitments over time, showing both the number of total and newly added commitments each year, as well as decomposition of whether the commitments were disclosed in sustainability reports or annual reports.

We observe a gradual but consistent upward trend in firms making net zero commitments. The first wave of commitments occurred in 2020, with 7 firms declaring net zero ambitions. In 2021, additional 10 firms made commitments, followed by 19 more commitments in 2022. These early adopters—at least within the context of Singapore—can be commended for maintaining a robust stance towards decarbonization and making net zero pledges during the Covid period. In 2023, the number of new commitments remained steady at 20, with the total number of net zero commitments reaching 56. By 2024, the total number of committed firms reached 60.

Given our sample of 479 companies, more than one-tenth of them have 'well-defined' net zero ambitions with clearly defined target years. Moreover, we find that companies tend to communicate their net zero commitments via the annual reports. While sustainability reporting is now mandatory, standalone sustainability reports are not required, so many companies opt to include such disclosures in their annual reports instead.

Figure 5: Cumulative Net Zero commitments by year and source.

Cumulative number of Singapore listed companies with net zero commitments by year and source of commitment.



Source: The graph was generated by the authors using data extracted from company annual and sustainability reports for the sample of 479 Singapore-headquartered firms listed on SGX.

5.1.1 A note on the industry composition of net zero commitments

Table (4) reports the number and percentage of firms with net zero commitments by GICS (global industry classification system) sector, and the share of sectoral information on market capitalization (MCAP) covered by those commitments. Among 25 financial firms in the sample, five committed to net zero, but these include several major financial institutions representing more than 92% of the sectoral market capitalization in the sample. Only the Communication Services sector has a higher rate of MCAP coverage than Financials at over 99%, while the Utilities sector ranks third at 90%.

Several emissions-intensive and critical transition sectors are performing less well, including Energy, Materials, Industrials and Consumer Staples. It is particularly striking how few firms in the Energy sector have made clear net zero commitments.

While this may be understandable given an evolving national energy sector strategy — since there is no concrete national sectoral roadmap for firms to align with — this situation is problematic and may highlight a key risk area for viable net zero transition pathways.

Table 4: The number and market capitalization of Net Zero committed firms, by sector.

The number of committed firms within each sector, and their relative market capitalization (MCAP) to the sectoral market capitalization.

Sector	# of Firms	Percentage of firms with net zero commitment (%)	Share of sector MCAP covered by commitment (%)
Communication Services	15	26.67	99.21
Consumer Discretionary	69	2.90	0.25
Consumer Staples	26	15.38	19.46
Energy	23	4.35	26.43
Financials	25	20.00	92.78
Health Care	31	0	0
Industrials	140	9.29	54.90
Information Technology	36	13.89	63.00
Materials	24	16.67	15.27
Real Estate	84	25.00	66.40
Utilities	6	16.67	90.44
Grand Total	479	12.63%	72.52%

Source: This table was generated by the authors using data extracted from company annual and sustainability reports for the sample of 479 Singapore-headquartered firms listed on SGX, together with stock pricing information taken from the Compustat global database.

Another interesting observation concerns the Health Care sector. Among 31 Health Care firms, none were identified as having a clear net zero commitment. Similarly, the Consumer Staples sector has close to zero coverage, at least in terms of market capitalization. We leave exploration of these gaps to future studies.

5.2 Commitment alignment with national targets

There are varying degrees of net zero commitment observed in the data that can be categorized as follows (see Figure (6)):

- **No mention**

  Companies make no explicit mention of net zero in their sustainability/annual reports.

- **Explicit mention**

  Companies directly referenced the concept of net zero within their reports, but in some cases only to recognize national/international policy agendas and decarbonization targets. There is some evidence that companies began discussing net zero a year or two before making formal commitments. Potentially, this is a strategy to prepare stakeholders and minimize the likelihood of negative market reactions once targets are announced.

- **Committed and aligned with the national ambition**

  Companies made clear commitments to achieving net zero along specific time-frames. For this and the next two classifications, only end-date targets are required, and interim targets are not necessary. Moreover, to be 'aligned', the commitment must target net zero around the same time as the national commitment, i.e., 2050 for Singapore.

- **Ambitious (committed to earlier targets than the national ambition)**

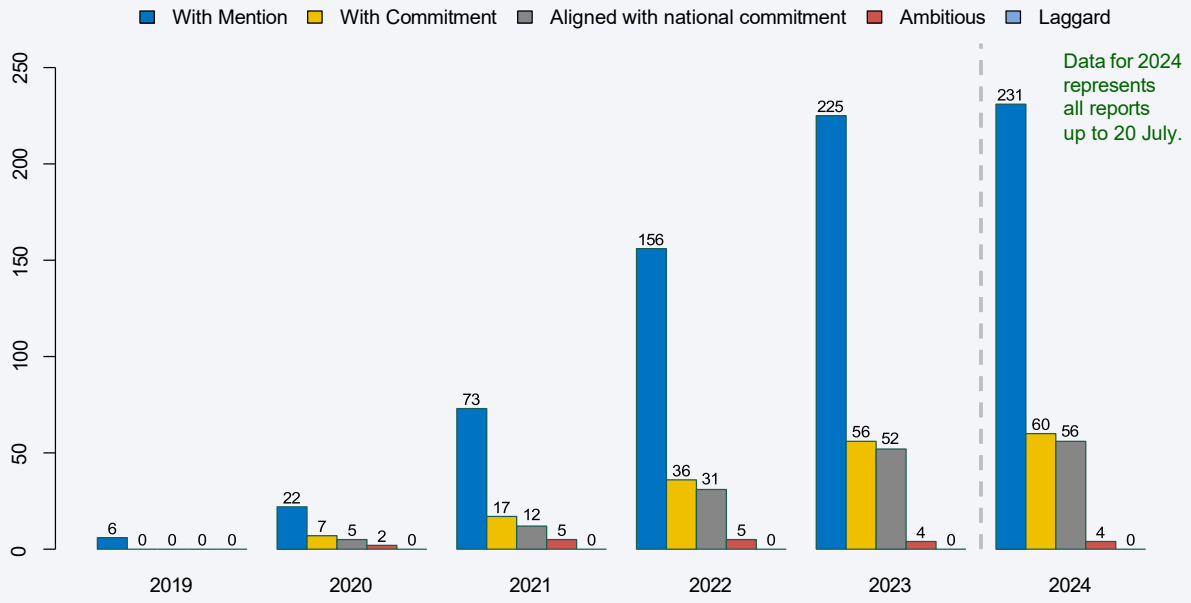
  Companies made clear commitments to net zero, offered with an explicitly stated target date that is earlier than the national target date, i.e., earlier than 2050.

- **Laggard (committed to later targets than the national ambition)**

  Companies made clear commitments to net zero with an explicit target date that is later than the national target date, i.e., after 2050. Laggards are relatively rare; none were observed among our sample.[22]

Figure 6: Net Zero ambition of firms relative to national target.

Net zero ambition relative to the national target by year. 'Ambitious' refers to the case where a firm's target is sooner than the national ambition, and 'Laggard' indicates vice versa.



Source: The graph was generated by the authors using data extracted from company annual and sustainability reports for the sample of 479 Singapore-headquartered firms listed on SGX.

In Singapore, all net zero committed firms were either aligned with or declared more ambitious targets than required along the national decarbonization target, see Figure (6). Moreover, there existed various caveats surrounding the Scope of emissions coverage, geographical attribution of emissions, and subsidiaries, etc. Overall, there is a clear and positive trend that more entities were moving in the same direction as national commitments would require.

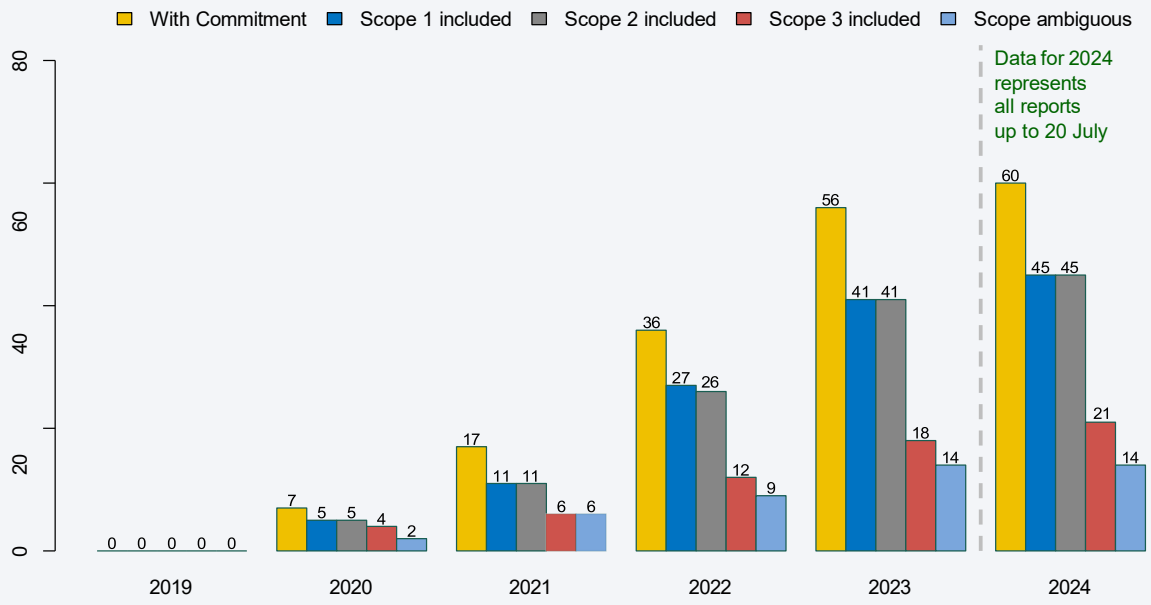
[22] A broader scan of the commitment dates of listed firms within SBTi and Net Zero Tracker data, revealed evidence of a number of 'laggards' across different country contexts. Understanding the intensive and extensive margins of such cautious target setting may be a valuable avenue for future research.

If we consider the number of firms with any mentions of net zero as a leading indicator of future commitment, the data indicates that as many as 231 of the 479 firms in our sample are in some stage of evaluating how to support the net zero transition, or at least actively discussing and communicating why they may need to approach this challenge at a cautious pace.

5.3 The scope of emissions covered

Firms have different emissions reporting practices, as mentioned before, and similarly, the commitments to net zero among listed companies show some variation in the Scope of emissions covered. Figure (7) illustrates this variation to the extent that it is observable from available reports. By 2024, out of the 60 firms committed to net zero, 45 included Scope 1 emissions, 45 included Scope 2 emissions, and 21 included Scope 3.

Figure 7:
Scope of emissions covered by net zero commitments by year.



Source: The graph was generated by the authors using data extracted from company annual and sustainability reports for the sample of 479 Singapore-headquartered firms listed on SGX.

The choice of which Scopes of emissions to include in a net zero commitment often runs parallel to the degree of control companies have over managing those emissions. This is highlighted, for example, by Global Invacom Group Ltd., which noted:

- *"With its continued use of electricity,* ***the Group is dependent on the availability of carbon-free electricity in order to achieve net zero. The Group does not currently consider it feasible to generate its own carbon-free electricity, and so will continue its dependence on electricity consumption from the electricity supply grids*** *in the various places in which it operates. Therefore,* ***the Group is primarily dependent on government policy in the various countries in which it operates for achieving net zero*** *in respect of the Group's Scope 2 GHG emissions."* (Global Invacom Group Limited 2023AR)

- *"The Group recognizes, that **along with many other companies, it will be dependent on third parties to achieve net zero for most of its Scope 3 emissions,** and that **the Group has little or no influence, primarily on account of its size,** in getting these third parties to deliver carbon-neutral goods and services. Challenges are faced with the supply of carbon-neutral steel, electronic components, shipping and aviation."* (Global Invacom Group Limited 2023AR)

These comments emphasize the challenges faced by firms in taking full control over their decarbonization journeys.

5.4 Comparison with external data providers

Table (3) includes a column that highlights the extent of net zero commitments reflected in existing external data sources. One of the most valuable insights from the review of company reports concerns the gap between net zero commitments captured by external data providers versus those freely available in company reports.

A comparison of coverage across several leading net zero data sources shows the following:

- **Our sample:** 60 firms with net zero commitments identified from annual or sustainability reports
- **SBTi coverage:** 5 companies matched with SBTi data, including two 'removed' or expired commitments. While we include these, it is unclear whether companies themselves removed commitments or whether this reflects the changes in the SBTi methodology.
- **Net Zero Tracker coverage:** 14 companies matched with NZT data, though 6 of these come from various listed entities under the CapitaLand group. In effect, 9 unique entities in NZT map to 14 firms in our sample.
- **Combined coverage:** In total, just 18 of our 60 identified firms (30%) appear in either NZT or SBTi databases. This means 70% of public commitments were not captured by these widely used sources.

In other words, current datasets used by analysts and scholars to evaluate net zero alignment, including, for example, Bolton and Kacperczyk (2023b), might only accurately identify up to 30% of firms with declared net zero commitments. This is not intended as a critique of the data providers or specific datasets, nor the research generated from them. Nonetheless, the scale of the gap raises legitimate concerns, especially since public disclosures likely understate true commitments where some firms make commitments but choose not to disclose publicly.

It is important to note that the datasets mentioned above included several other firms not in our sample or potentially classified differently because of the (arguably) more stringent criteria we used. Some examples include:

- **Flex Ltd.:** Flex is identified as a Singapore company with a commitment to reach net zero by 2040. Flex was incorporated in Singapore in 1990, but is headquartered in the United States and is listed on the NASDAQ stock exchange.[23] Their annual

[23] See page 12 of the 2024 Annual Report available at: https://s202.q4cdn.com/732614612/files/doc_financials/2024/ar/2024-annual-report.pdf.

report lists the countries that constitute 5% or more of 2024 net sales (page 41), among which Singapore is not explicitly mentioned, but instead subsumed into an 'other' category. The Malaysian market contributed around 5% of net sales, while in terms of net property and equipment, the Malaysian market represented 6% of the global base, and China, the only other Asia country mentioned here, represents 14%. Furthermore, Flex Ltd. is not included in the Compustat global fundamentals sample, and hence does not feature in the final analysis sample.

- **Wilmar International:** Whilst tagged as a firm with a net-zero commitment, the group only committed to 'Achieve net-zero GHG emissions for Goodman Fielder operations by 2040'. Since this is not a group-wide commitment, Wilmar is not considered a net-zero committed firm under the definition we use.
- **ST Engineering:** While the data entry indicated the company as having a net-zero target, it is noted that no target date is provided; hence, this does not qualify as a clear net zero commitment under the definition we apply.

The cases above are indicative but sufficient to highlight the need for diligent analysis when working with the different net zero datasets. These cases further re-emphasize the nuances involved in benchmarking net zero commitments. They also serve as a reminder that the geographic structure of firms is complex. While we focus on Singapore-headquartered firms, there are firms that may be incorporated but not headquartered in Singapore whose net zero commitments are not covered in this study by our sample selection choice.[24] More importantly, there is an incomplete understanding of the country-specific operations and asset base of companies. There is no obvious way to bridge this information gap using existing data with confidence, and a different reporting basis may be substantiated or at least deserving of consideration, with clearer attribution of financial and sustainability data on a country-by-country basis.

5.5 Market capitalization covered by net zero commitments

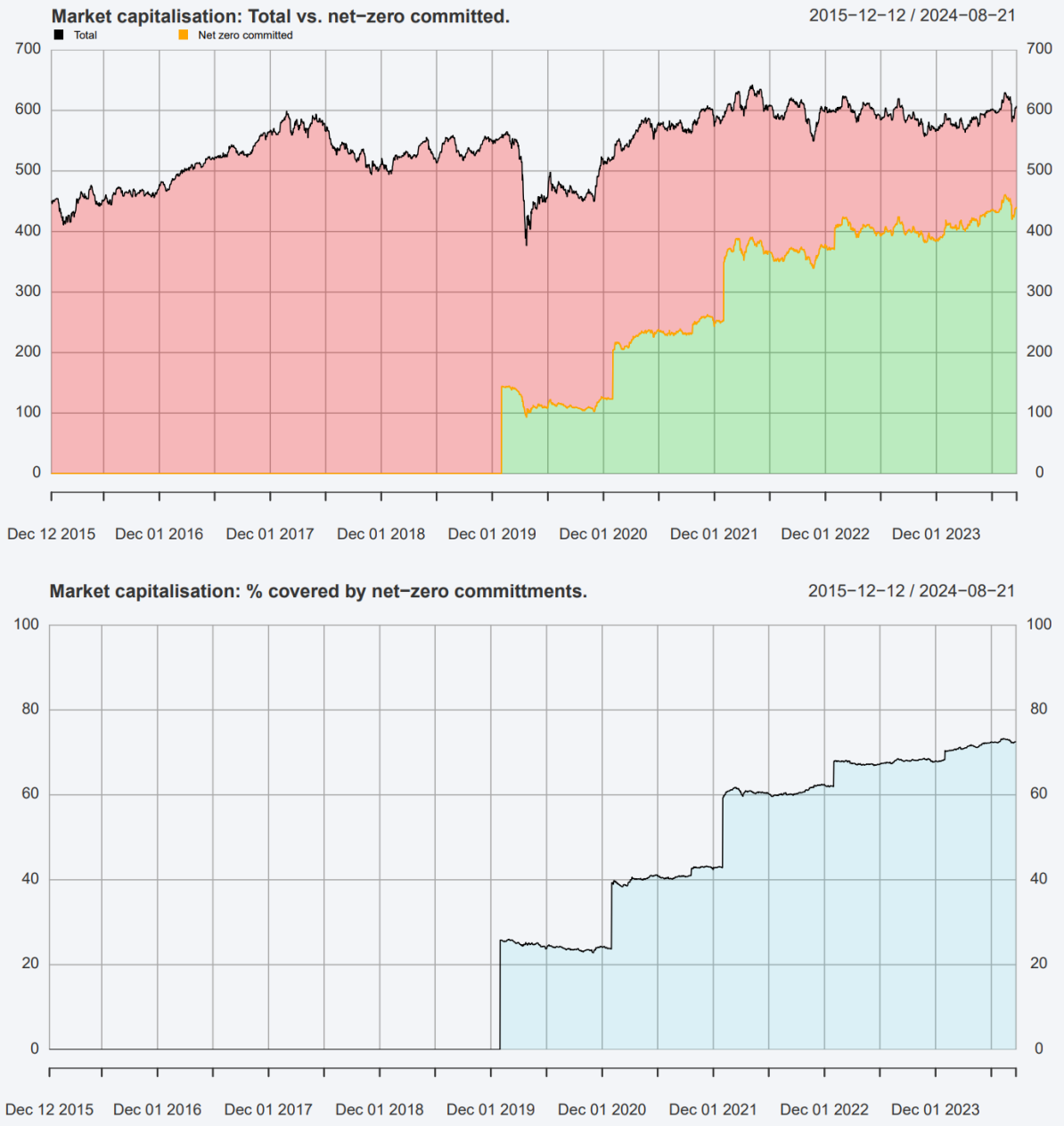
One way to assess the net zero commitment gap is through comparing the total market capitalization of firms with commitments relative to the overall market capitalization of all firms in the sample. This is presented for the sample of Singapore's listed companies in the top part of Figure (8).

As of August 21st 2024, the total market capitalization of the 479 Singapore-headquartered listed companies in our sample amounted to approximately SG$606 billion, based on outstanding shares and closing share prices. This compares with around SG$448 billion for the firms with net zero commitments. The lower panel of Figure (8) shows that 72.7% of Singapore's market capitalization for domestically headquartered companies is covered by a clear net zero commitment which is either aligned with, or more ambitious than the national net zero ambition.

[24] It is possible for firms to be incorporated in a country different from that where their operations are headquartered, albeit uncommon. For the analysis sample, all firms are both headquartered and incorporated in Singapore. For the broader Compustat global data, including all Singapore firms, there is an overlap of greater than 93% of firm-years where the country of incorporation and headquarters are both Singapore.

Figure 8: Market capitalization covered by Net Zero commitments over time.

Aggregate market capitalization in billion $ for (i) all firms in sample and (ii) net zero committed firms, starting from the first day in which their commitment was made.



Source: The graph was generated by the authors using data extracted from company annual and sustainability reports for the sample of 479 Singapore-headquartered firms listed on SGX.

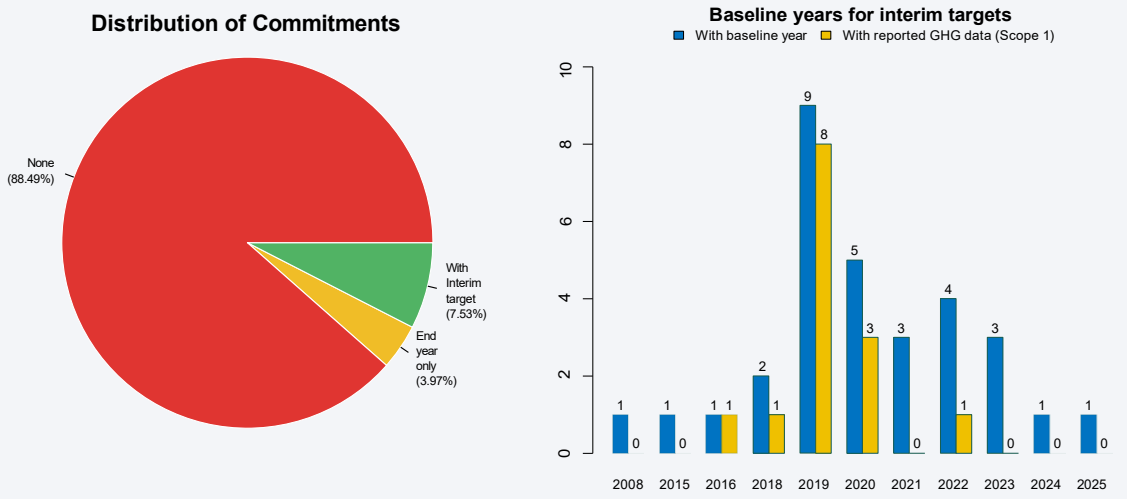
5.6 Interim target base year and GHG data availability

The right panel of Figure (9) shows the range of baseline years used for interim targets. The most common base year is 2019, likely chosen because it reflects pre-pandemic operations, and this is a more stable emissions reference point.

The figures also show how many of those firms had (Scope 1) emissions data available. There are two interesting observations: (i) some firms set baselines without publicly available emissions data for comparison, which has implications for accountability, and (ii) some firms may be setting baseline years without fully evaluating their emissions baselines, for example, firms with 2024 or 2025 baseline years. It should be noted that not all firms with an interim target indicated baseline years.

Referring to the left pane of Figure (9), across the 479 firms in the sample, about 12.5% had a commitment in place; 4.0% just declared a single target date for net zero, and the remaining 7.5% of firms set interim or multi-year targets, suggesting a more sophisticated trajectory planning.

Figure 9: Complexity of net zero commitments active in 2023.



Source: The graph was generated by the authors using data extracted from company annual and sustainability reports for the sample of 479 Singapore-headquartered firms listed on SGX.

There is a clear empirical challenge in evaluating interim trajectories for firms with net zero commitments. Interim targets were considerably less transparent and not always set against an absolute emissions reduction objective. This is most common among financial institutions in relation to their targets and ambitions for decarbonizing financed emissions, and we will discuss them in detail later.

5.6.1 Net zero commitments and key financial ratios

Examining key corporate attributes of committed versus uncommitted firms can provide valuable insights into potential determinants and, more importantly, barriers to commitment. For this purpose, Table (5) tabulates a summary of selected financial ratios:

- **Liquidity ratios:** reflect the financial nimbleness of firms through their short-term access to cash or cash equivalents;
- **Leverage ratios:** describe firms' debt dependence;
- **Efficiency ratios:** reflect either how efficiently a company uses its assets to generate revenue, or how efficiently it sells or replaces its inventories;
- **Profitability ratios:** give a sense of core profitability and business performance;
- **Market valuation:** these measures are provided in absolute terms i.e. not ratios, and provide a sense of the overall scale of a firm and its operations;
- **Emissions intensity relative to sales revenue or total assets:** conveying the relative (scale-independent) environmental impact associated with firms;
- **Ratio of Scope 1+2 emissions to Scope 1+2+3:** reflects the balance of control over emissions generated along the value chain.

Each of the ratios is evaluated for FY2023, along four groupings, including all firms, and then the sub-groups of firms that have no commitment or mention, those that have a mention but no commitment, and those that have a clear net zero commitment. Hence, the second through fourth columns of Table (5) reflect increasing commitment strength. With this in mind, perhaps the most interesting rows are where ratios are systematically increasing (or decreasing) with regard to the level of commitment. For example, under the efficiency ratios, the asset turnover ratio is systematically increasing with higher levels of commitment (from 1.3 to 1.5), while the inventory turnover ratio increases (from 6.4 to 9.3). Tests were conducted comparing the median value of a given indicator for the sample of firms with net-zero commitments, versus all firms without commitments, using bootstrap techniques. The final column of Table (5) provided the (bootstrap) difference in medians across the two groups, while asterisks next to each value indicated the statistical significance of this difference. For example, the observed difference in asset turnover is not economically or statistically significant, but the gross margin is significantly lower for the committed firms.

Table 5: Emissions and financial ratios by level of Net Zero commitment.

Median values of selected corporate fundamentals by economic sector and net zero commitment status, for 2023. Note that data are winsorised to reduce the influence of potential outliers.

Ratio	All firms	No commitment or mention	Mention but no commitment	NZ committed	Difference in medians
Panel (A): Financial ratios					
Liquidity					
Current ratio	1.73	1.79	1.65	1.82	0.06
Cash ratio	0.65	0.66	0.57	0.60	-0.01
Leverage					
Debt ratio	0.44	0.43	0.46	0.43	-0.01
Debt equity ratio	0.72	0.62	0.79	0.75	0.05
Interest coverage ratio	3.59	3.27	3.85	3.66	0.04
Efficiency					
Asset turnover ratio	1.32	1.26	1.40	1.45	0.18
Inventory turnover ratio	6.86	6.42	7.44	9.26	2.74
Profitability					
Gross margin	0.31	0.32	0.32	0.24	-0.08***
Operating margin	0.08	0.07	0.09	0.10	0.03
Return on assets	0.01	0.01	0.02	0.03	0.01
Return on equity	0.04	0.02	0.05	0.05	0.01
Market value (levels)					
Book value (SGD, millions)	98.65	60.71	189.68	2,416.77	2,402.70***
Earnings (SGD, millions)	2.62	0.98	5.95	103.21	110.64***
Panel (B): Emissions ratios					
Emissions intensity relative to sales revenue					
Scope 1	5.67	3.72	12.71	3.60	-2.16
Scope 2	14.81	15.45	16.79	14.77	-1.31
Scope 3	9.89	1.60	38.63	137.71	215.83**
Scope 1+2	36.43	27.20	48.09	20.46	-19.04*
Scope 1+2+3	105.52	57.88	326.85	358.61	247.96
Emissions intensity relative to total assets					
Scope 1	1.30	1.68	2.10	0.29	-1.43**
Scope 2	4.89	5.88	4.81	2.60	-1.81
Scope 3	4.78	1.86	7.53	10.72	6.48
Scope 1+2	10.36	12.64	10.07	4.94	-6.57**
Scope 1+2+3	21.55	18.85	28.93	16.14	-7.42
Scope 1+2 emissions ratio to Scope 3 emissions					
Scope 1+2 versus 1+2+3	0.41	0.89	0.37	0.34	0.19

*Note: The difference in median tests reported in the final column compare the median value for the sample of firms with net-zero commitments, versus all firms without commitments. The test is implemented using a bootstrap approach, with empirical significance levels indicated as follows: * = 10%, ** = 5% and *** = 1% when the upper and lower bounds of the confidence interval given the applied significance level are of the same sign. The null hypothesis is mean equivalence, therefore values with stars indicate a statistical difference between groups of firms with and without net zero commitments.*

Source: The table was generated by the authors using information obtained from sustainability reports for the sample of 479 Singapore-headquartered firms listed on SGX, together with corporate fundamentals data from Cumpustat Global annual data.

Concerning the profitability, the gross margin (gross profit over net sales) is significantly lower among firms with commitments (0.2) compared to those without (0.3). Additional context is provided by the value measures, which are in dollar terms, that broadly pointed towards larger firms in terms of book value (from $60.71 to $2,416.7 million) or firms with higher earnings (from $0.98 to $103.2 million). These illustrated a strong pattern of association between company size and net zero commitments.

Beyond the financial ratios, Table (5) also reports several emissions intensity ratios. While the numbers allude to some potential patterns, there were a limited number of statistically significant differences in values between firms with net zero commitments and those without. Relative to sales, firms with net zero commitments showed modest evidence, at the 10% significance level, of having lower Scope 1+2 emissions, and at the same time, slightly stronger evidence, at the 5% level of significance, of having higher Scope 3 emissions. Relative to assets, there was modest evidence, at the 5% significance level, that firms with commitments had lower Scope 1+2 emissions, with the other test results implying these came from lower Scope 1 emissions predominantly. As more data becomes available on firms' effective transition, it may be interesting to examine more deeply how firms reduce or reorganize emissions between the different Scopes along their commitment journey.

In summary, the observations on net zero commitment versus key financial and emissions ratios displayed patterns alluding to the potential firm-specific conditions that might align with the degree of firm commitment to decarbonization. T-tests provided preliminary evidence that at least some of these patterns were significant. However, more statistical investigation is needed with more data to place greater confidence in the observed significance or to test for potential causality.

5.7 Target setting for financed emissions

For FIs, one of the most critical categories of Scope 3 emissions is Category 15: investment emissions, commonly referred to as 'financed' emissions. These are classified as downstream emissions because capital allocation and financing activities are considered services provided by the reporting company to its clients.

Setting net zero targets for financed emissions is of critical systemic importance, particularly for commercial banks, as their capital flows influence the emissions trajectories of the broader economy. Through their lending and investment decisions, FIs indirectly shape the pace and direction of decarbonization across sectors.

In Singapore, several FIs have taken steps to disclose and manage their "investments" emissions (Scope 3 Category 15). These institutions can be broadly grouped into two types: (i) banks that provide financial services to businesses; (ii) asset owners or managers, such as insurance companies, that manage their own investment funds. We focus on the banks and their strategies for identifying, assessing, and engaging with emission-intensive clients. Among the sample, DBS, UOB, and OCBC have each articulated distinct strategies for managing investment emissions.

5.7.1 DBS

DBS has been a pioneer in driving the sustainable finance agenda and is deeply committed to supporting the sustainability transition within Singapore. This is evidenced through a variety of initiatives, including their support for Climate Impact X, the creation of personal carbon calculator tools for retail customers, and sustained engagement with business customers to understand their sustainability needs and journeys.

In their 2023 Sustainability report, DBS detailed the broad nature of their net zero strategy. With regard to investment emissions, they identify nine priority sectors, engaging with the top 10 emitters within each. The priority sectors and their summary targets were:

- **Power:** Scopes 1 and 3 (equipment) covered with a 2050 target of 100% reduction versus the 2021 baseline.
- **Oil & Gas:** Scopes 1, 2, and 3 covered with a 2050 target of 92% reduction versus the 2021 baseline.
- **Automotive:** Scope 3 (tailpipe emissions of passenger vehicles) covered with a 2050 target of 100% reduction versus the 2021 baseline.
- **Steel:** Scopes 1 and 2 covered with a 2050 target of 93% reduction versus the 2021 baseline
- **Aviation:** Scopes 1 (for airlines and secured aircraft financing) and 3 (for aircraft leasing companies) covered with a 2050 target of 100% reduction versus the 2021 baseline.
- **Real Estate:** Scopes 1 and 2 (operating emissions) covered with a 2050 target of 95% reduction versus the 2021 baseline. This is consistent with a net zero alignment delta of ≤ 0%.
- **Shipping:** Scope 1 covered with a 2050 target of 71% reduction versus the 2021 baseline. This is consistent with a net zero alignment delta of ≤ 0%.
- **Food & Agribusiness:** Current target reflects an objective to improve data coverage.
- **Chemicals:** Current target reflects an objective to improve data coverage.

5.7.2 UOB

> *"The six [target] sectors are among the most important for decarbonisation. In particular, oil, gas and coal, which are the supply of fossil fuels, are responsible for 73 per cent of direct emissions globally. The power, automotive, real estate and steel sectors, through downstream usage of electricity, passenger cars, iron, steel and buildings, account for 67 per cent of emissions arising from fossil fuel combustion. Our targets in these sectors reflect our ambition to facilitate this change end to end."* (United Overseas Bank 2022AR)

UOB has a slightly different configuration of priority sector classifications compared to DBS, identifying six segments, three of which fall under the area of energy, and three under the area of the built environment:

- **[Energy] Power:** Reduce emissions intensity by 64% by 2030 and 98% by 2050, relative to the 2021 baseline.
- **[Energy] Automotive:** Reduce emissions intensity by 58% by 2030 and be net zero by 2050, relative to the 2021 baseline.
- **[Energy] Oil & Gas:** No new project financing for upstream oil and gas projects approved for development after 2022
- **[Built Environment] Real Estate:** Reduce emissions intensity by 36% by 2030 and 97% by 2050, relative to the 2021 baseline.
- **[Built Environment] Construction:** Reduce emissions intensity by 31% by 2030 and 85% by 2050, relative to the 2021 baseline.
- **[Built Environment] Steel:** Reduce emissions intensity by 20% by 2030 and 92% by 2050, relative to the 2021 baseline.

One notable distinction between DBS and UOB in their communication of priority sectors and targets is in the Scope of emissions covered. DBS were quite explicit on the nature of financed emissions covered, and how the nature of the Scope varies between sectors. In contrast, UOB provided no explicit mention of the Scope of coverage for financed emissions.

Differences in sector coverage and classification may be due to the nature of the customer base as well as UOB's internal approach towards defining sectors/business areas. It is indicated in the 2023 Sustainability report that the above sectors cover approximately 60% of their corporate lending portfolio.

5.7.3 OCBC

Similar to DBS and UOB, OCBC has differentiated decarbonization targets for its financed emissions across different sectors. These include the following:

- **Power:** Scopes 1 (generation) and 3 (equipment manufacturers) covered with a 2040 target of 100% reduction versus the 2021 baseline.
- **Oil & Gas:** Scopes 1, 2, and 3 covered with a 2050 target of 95% reduction versus the 2021 baseline.
- **Real Estate:** Scopes 1, 2, and 3 (tenant / plug load) covered with 2030 target of 100% 'alignment delta', i.e., that real estate owner-operators, financed buildings, and REITs are fully aligned with achieving net zero.
- **Steel:** Scopes 1 and 2 covered with a 2050 target of 94% reduction versus the 2021 baseline.
- **Aviation:** Scopes 1 (operators) and 3 (lessors) covered with a 2050 target of 100% reduction versus the 2021 baseline.
- **Shipping:** Scope 1 covered with 2030 target of 100% 'alignment delta', i.e., that real estate owner-operators, financed buildings, and REITs are fully aligned with achieving net zero.

The discussion on financed emissions offered by each of the three banks related primarily to their engagement with corporate customers. Far less explicit consideration is given to the discussion of engagement with individuals (i.e., driving net zero strategies through personal banking solutions/engagement). This is not to say that this is not a focus of the banks, and for example, DBS is known to offer tools for retail customers to benchmark and even offset the carbon emissions arising from their personal consumption.

5.8 Summary

As of the end of July 2024, 60 companies had made explicit commitments to achieving net zero, representing over 10% of the firms in the sample. All of these companies were either aligned with or more ambitious than Singapore's national target of net zero by 2050.

We find some variations in the scope coverage, especially for Scope 3. Some of these are due to the nature of the listed entities' business operations, most notably FIs such as banks that are implementing strategies to decarbonize their finance emissions, or trusts and funds looking to manage the carbon content of their investment portfolios. While the total market capitalization of firms with net zero commitments is around 75% by mid-2024, the analysis suggested that this only reflected around 55% of emissions among the companies in sample. The emission intensities of non-committed firms are (significantly) higher than for net zero committed firms.

Strategies related to the adoption of net zero commitments were not very well coordinated across firms, although this is intuitive given the relative maturity in addressing net zero ambitions. Notwithstanding this, there are some observations which include that sectoral ambition matters, as in the built environment and financial sectors, where there is a global drive towards sustainability, and in the case of buildings, a potential value premium. Other sectors, like shipping or energy, are subject to constraints driven by national policies and technology. This can render individual firms incapacitated to a degree in driving change. This is most evident in relation to key energy choices to facilitate the energy transition, which are unclear in the context of Singapore as well as most other nations.

There is some evidence that the decision to commit to net zero emissions is correlated with several financial ratios, and the balance of emissions between those within the operational control of a firm (Scopes 1 and 2), and those contingent on their broader value/supply chain (Scope 3). This may have implications for financial policy design to grow the number of firms with commitments.

Reflecting on the issue of net zero commitments in relation to financed emissions, we identify some gaps in the commitments. This is an important topic that warrants deeper investigation. Banks and FIs are custodians of considerable assets and have direct engagement with firms that create emissions. It is essential that these institutions are able to develop and enforce net zero targets and implementation strategies without risking losing customers. Contrasting with strategies for financed emissions in other countries is likely to be of considerable value and an avenue for future research.

Part 6

Decarbonization Strategies to Achieve Net Zero

Building on the analysis of net zero commitments, this part explores the strategies firms are adopting to achieve their commitments. Based on disclosures in annual and sustainability reports, it highlights the key approaches companies are using to move from target-setting to implementation.

Key takeaways:

- There are 8 identified strategy areas, comprising 25 sub-themes, spanning a range of internal and external domains of influence.
- There is some difference in the strategies discussed in annual versus sustainability reports, which, although intuitive and consistent with the different purposes of each report, may have implications for the importance of standalone sustainability reporting.
- Different sectors prioritize various strategy areas—for example, the circular economy is important for real estate and industrial sectors, but receives little attention from energy or information technology. However, the most notable aspect is the complete lack of discussion about net zero within the healthcare sector, despite this sector having more firms and reports on the topic than others

6.1 Identified strategy areas

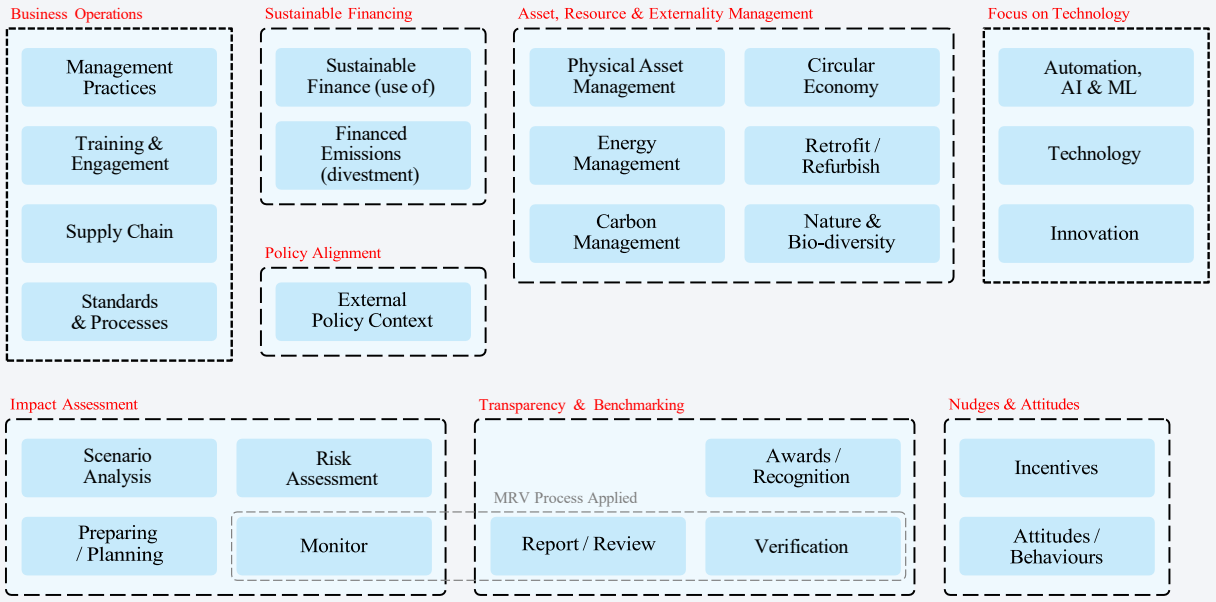
We manually inspected the texts discussed in and around the mention of net zero and identified over 300 separate key terms that appeared with noticeable frequency.[25]

These were further re-classified into 25 sub-themes and then grouped into eight broader strategic areas. These were manually cross-validated for relevance or omissions against the SBTI (2022) monitoring report and related data, which contain more than 1,400 descriptions of plans in place to achieve decarbonization targets. The identified strategy areas are presented in Figure (10) below.

[25] Specifically, for this part of the study the words (collocates) within ±30 words of the key-term 'net zero'—accounting for hyphenation, case etc.—were obtained and reviewed. It is worth noting that the corpus is 'raw' and uncleaned, and given the formatting of sustainability and annual reports, does not always sequence the text as expected, but was deemed sufficiently useful for the type of bag-of-words classification done for this section of the study.

Figure 10: Net Zero strategy areas.

Overview of identified net zero strategy areas their and sub-themes.



Source: The graph was generated by the authors using data extracted from company annual and sustainability reports for the sample of 479 Singapore-headquartered firms listed on SGX.

There is room for subjectivity in this process, but for the most part, the mapping from keywords to sub-themes and strategy areas is relatively straightforward and unobjectionable. Moreover, they correlate quite closely with the World Economic Forum (2023) that discussed various strategies organizations can take towards a net zero ready sustainability plan. As an example:

- **Strategy Area:** Impact Assessment.
- **Strategy sub-themes:** Scenario Analysis, Risk Assessment, Preparing / Planning, Monitor.
- **Example keywords or terms for the Scenario Analysis sub-theme:** 'SBTI', 'scenario assessment', 'interim targets', 'medium term', 'pathway', 'science based', 'long term', 'midpoint target', 'temperature change scenario'.

The area of impact assessment is included in the first step identified by the World Economic Forum (2023), which focuses on integrating sustainability into the core of business strategy. Other areas of overlap include energy use, leveraging technology, improving environmental management processes, tracking and adapting to regulations and policies, and monitoring across the supply chain, etc.

Searching for the relevant keywords or terms requires a careful approach. Some terms appear in the text with or without pluralization, e.g., a firm may have one or many 'interim targets'; therefore, words were stemmed prior to searching (both in the key term and the target text) to account for this. Terms like 'long term' will appear exactly in sequence, but for example 'science based' could be used in different orders and not necessarily in immediate sequence, e.g., 'based [on] science'. These terms were manually tagged, and the words within the term are permitted to appear within ±5 words of each other.

6.2 Strategy areas focused on by net zero committed firms

Figure (11) provides an overview of the different strategy areas discussed in relation to net zero. We identified the net zero strategy areas in the following steps:

- For each report containing one or more mentions of net zero, each ±30 word collocate was generated. Some reports had a handful of mentions, some had dozens.
- Screening was conducted for each of the 302 identified keywords within every collocate.
- The frequency of mentions was aggregated to the level of strategy areas and across different collocates for each firm. For example, under energy, there might be a discussion of 'wind' and 'solar' appearing once each in two different parts (collocates) from the company report. This would result in two points being added to the 'Asset, Resource & Externality Management' strategy area for that firm.
- Firms were then categorized based on their level of attention, using the following scoring: 'NONE' when there were no mentions of a strategy area near net zero; 'LOW' when a single mention was made; 'MODERATE' when between 2-5 mentions were made; and 'HIGH' when more than 5 mentions were made.

Since there were few firms with net zero commitments, mostly made in recent years, the results were combined across different years to improve the accuracy of the classification method. As more commitments are made over time, it will be possible to more carefully assess how firms' strategies change over time.

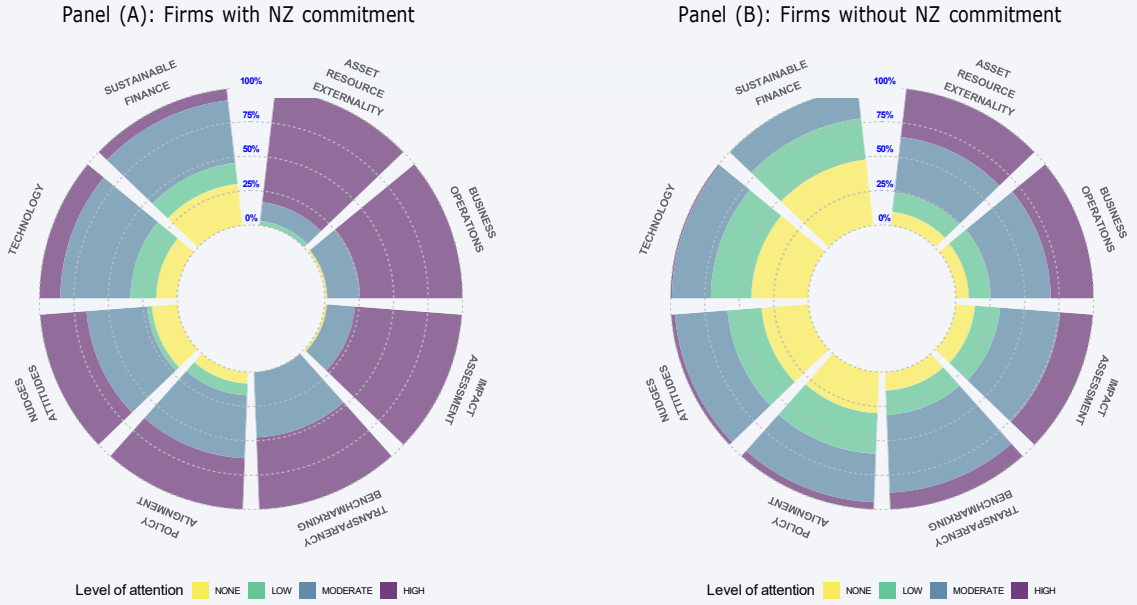
There is a clear difference in the level of attention paid to various strategy areas between firms with net zero commitments and those without, as shown in Figure (11). This makes sense, firms that have net zero commitments were more likely to have well-defined and actionable strategies in place, whereas those without commitments are likely still in the process of developing theirs.

Take 'Asset, Resource & Externality (Management)' as an example. Among firms with net zero commitments, approximately 85% gave this area a high level of attention, and a further 10% gave it moderate attention. In contrast, only about 35% of firms without net zero commitments gave this area a high level of attention, with around 40% assigning it a moderate level of focus. Roughly 10% did not mention it at all in the context of net zero.

At the other end of the spectrum is the Sustainable Finance strategy area. Among firms with net zero commitments, just under 10% gave this a high level of attention, while around 45% gave it moderate attention. In contrast, around half of the firms without commitments made no mention of sustainable finance in relation to net zero at all.

Figure 11: Relative attention by firms to Net Zero strategy areas.

Stacked (circular) barplot indicating the relative attention paid to net zero strategy areas among firms with/without net zero commitments, aggregated across all years.



Tabular format indicating the percentage of observations within each category

Strategy area	No mention	Low attention	Moderate attention	High attention	t-test of group mean equivalence
Firms with net zero commitments					
Asset/resource externality	0	3.39	13.56	83.05	
Business operations	1.69	0	23.73	74.58	
Impact assessment	1.69	0	20.34	77.97	
Transparency/benchmarking	0	0	47.46	52.54	
Policy alignment	8.47	8.47	45.76	37.29	
Nudges/attitudes	18.64	3.39	44.07	33.90	
Technology	15.25	18.64	50.85	15.25	
Sustainable finance	30.51	15.25	45.76	8.47	
Firms without net zero commitments					
Asset/resource externality	10.00	14.12	40.59	35.29	0.00***
Business operations	9.41	15.88	43.53	31.18	0.00***
Impact assessment	14.12	18.24	43.53	24.12	0.00***
Transparency/benchmarking	13.53	17.65	56.47	12.35	0.00***
Policy alignment	30.00	29.41	35.29	5.29	0.00***
Nudges/attitudes	34.12	24.71	38.24	2.94	0.00***
Technology	41.18	29.41	28.24	1.18	0.00***
Sustainable finance	48.24	30.00	21.76	0	0.00***

*Note: The reported t-tests are based on a constructed dummy variable taking the value 1 if a firm gives a specific strategy area either high or moderate attention. The test then evaluates whether the mean of this new variable is the same for groups with net zero commitments, versus without. P-values are reported with the following significance levels: *** = 1%, **= 5% and * = 10%. The null hypothesis is mean equivalence, therefore values with stars indicate no statistical difference between groups of firms with and without net zero commitments.*

Source: The graphs and table above was generated by the authors using data extracted from company annual and sustainability reports for the sample of 479 Singapore-headquartered firms listed on SGX.

Both panels of Figure (11) are ordered in decreasing attention based on the full sample of firms. Each group emphasized the strategies in a similar way, suggesting a possible hierarchy of importance as follows:

1. Asset, Resource & Externality (Management);
2. Business Operations;
3. Impact Assessment;
4. Transparency & Benchmarking;
5. Policy Alignment;
6. (Behavioral) Nudges & Attitudes;
7. Technology;
8. Sustainable Finance.

Elements 1 to 4 in the strategy list fall largely within a firm's internal control, which likely explains why they rank higher in strategy scoring. In contrast, Elements 5 to 8 are influenced to varying degrees by external factors. For instance, policy alignment depends on the broader national and sectoral policy landscape, which firms can respond to but have limited power to shape directly. Similarly, using behavioral nudges to encourage sustainable practices among employees, management, customers, supply chain partners, and other stakeholders is widely recognized as important but is also difficult to implement effectively, often yielding only short-term results.

The technology strategy area spans both the internal deployment of tools, such as artificial intelligence to streamline operations, and the adoption or support of emerging innovations. The latter is often tied to national development strategies and funding priorities, especially in sectors like energy and infrastructure. Finally, while sustainable finance ranks lowest among the strategy areas, this should not be over-interpreted. Around 70% of firms with net zero commitments, and 50% of firms without, still give this area low to moderate levels of attention, indicating that it remains a relevant part of firms' broader net zero approaches.

6.3 Strategy coverage differences in sustainability versus annual reports

There are some differences in the purpose and role between annual and sustainability reports. Intuitively, this could influence how the discussion of net zero and related strategies for achieving net zero varies across these different report types. Figure (12) presents four panels showing differences in strategy focus across two dimensions: (i) between firms with commitments (top Panels A and B) and without (bottom Panels C and D); and (ii) captured in sustainability reports (left panels A and C) and annual reports (right panels B and D).

There are several points of distinction to note:

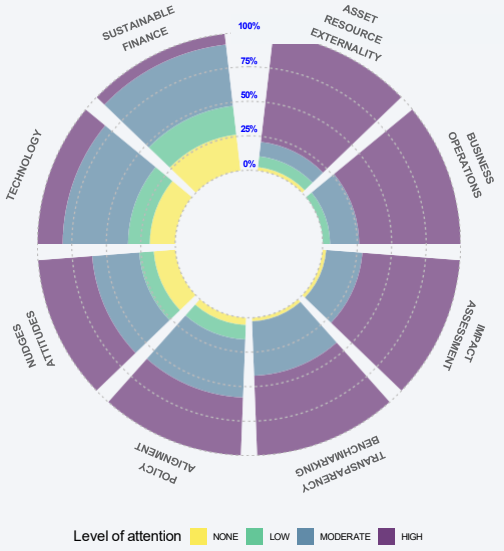
- As expected, sustainability reports included more extensive discussions of net zero topics, and consequently, a generally higher number of strategy areas that attracted a high level of focus.
- Across all panels, firms focused more on strategies that fall within their immediate operational control, such as resource management and internal operations, while placing less emphasis on areas influenced by external factors, such as policy alignment, behavioral change, and technology adoption.

- In annual reports, there was less discussion on certain strategy areas, particularly in areas beyond the direct control of the firm, such as policy alignment and technology. However, it is worth noting that this observation might partly reflect that annual reports need to be concentrated on matters of material financial importance, with stricter reporting criteria to adhere to.

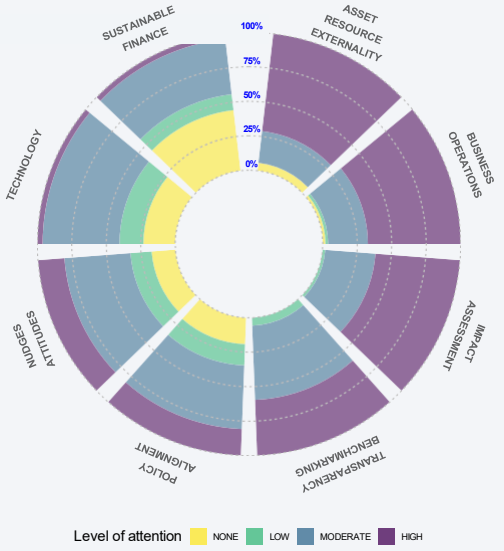
Figure 12: Attention to Net Zero strategy areas by commitment status and report type.

Stacked (circular) barplot indicating the differences in attention paid to net zero strategy areas across sustainability versus annual reports.

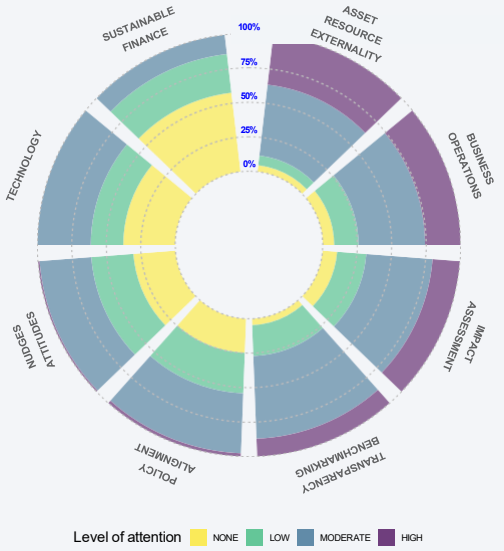
Panel (A): Sustainability report - firms with commitment



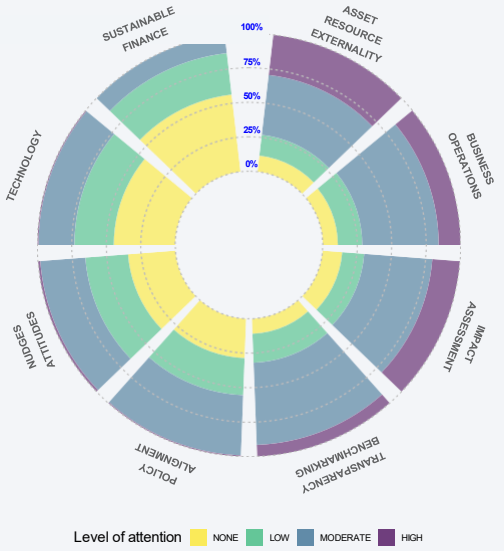
Panel (B): Annual report - firms with commitment



Panel (C): Sustainability report - firms without commitment



Panel (D): Annual report - firms without commitment



Source: The graph was generated by the authors using data extracted from company annual and sustainability reports for the sample of 479 Singapore-headquartered firms listed on SGX.

6.4 Sectoral attention to strategy areas and sub-themes

There is value in assessing whether the strategic focus of decarbonization varies across sectors. This is relevant because different sectors adopt different technologies and solutions in response to climate challenges.

Table (6) presents the strategy areas and specific sub-themes in different industrial sectors, based on the Global Industrial Classification System (GICS). The cells in the table indicate the level of attention paid by the sector (aggregated from firms in that sector) to different strategy sub-themes.

Table 6: Strategy areas and sub-themes by sector.

Indicator	Energy	Materials	Industrials	Consumer Discretionary	Consumer Staples	Health Care	Financials	Information Technology	Communication Services	Utilities	Real Estate	standard deviation
Asset, Resource & Externality (Management)												
Circular Economy	✓	✓✓	✓✓	✓✓	✓	✓	✓✓	✓✓	✓✓	✓	✓✓✓	0.65
Energy	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	0.40
Carbon Management	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	0.30
Nature Biodiversity	✓✓	✓✓	✓✓	✓	✓✓	✗	✓✓	✗	✓	✗	✓✓	0.90
Retrofit Refurbish	✓✓	✓✓	✓✓✓	✓✓	✗	✗	✓✓	✓✓	✓	✗	✓✓✓	1.13
Physical Asset Management	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	0.50
Mean	2.33	2.50	2.67	2.17	1.83	1.17	2.50	2.17	2.17	1.33	2.83	
Business Operations												
Supply Chain	✓✓	✓✓	✓✓✓	✓✓	✓✓	✗	✓✓✓	✓✓	✓✓✓	✗	✓✓✓	1.10
Standards Processes	✓✓✓	✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓	✓✓	✓	✓✓✓	0.65
Training Engagement	✓✓✓	✓✓	✓✓✓	✓	✓✓	✓	✓✓✓	✓✓	✓✓✓	✓✓	✓✓✓	0.79
Management Practices	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	0.30
Mean	2.75	2.25	3.00	2.00	2.25	1.25	3.00	2.25	2.75	1.50	3.00	
Impact Assessment												
Scenario Analysis	✓✓	✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓	✓✓✓	0.47
Risk Assessment	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓	✓✓✓	0.47
Monitor	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	0.47
Preparing	✓✓	✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓✓	0.40
Mean	2.25	2.25	3.00	2.50	2.50	2.25	2.50	2.25	2.75	2.00	3.00	
Transparency & Benchmarking												
Awards Recognition	✓✓	✓✓	✓✓✓	✓✓✓	✓✓	✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓✓	0.50
Reporting	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓	✓✓✓	✓✓	✓✓✓	✓✓	✓✓✓	0.67
Verification	✓✓	✓	✓✓	✓✓	✓✓	✗	✓✓	✓✓	✓✓	✗	✓✓	0.82
Mean	2.33	2.00	2.67	2.67	2.33	1.00	2.67	2.00	2.33	1.33	2.67	
Policy alignment												
External Policy	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	0.40
Mean	3.00	3.00	3.00	3.00	3.00	2.00	3.00	3.00	3.00	2.00	3.00	
(Behavioural) Nudges & Attitudes												
Incentives	✗	✓	✗	✗	✗	✗	✓	✗	✓	✓	✓✓	0.69
Attitudes Behaviours	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	0.40
Mean	1.50	2.00	1.50	1.50	1.50	1.00	2.00	1.50	2.00	1.50	2.50	
Technology												
Automation Ai Ml	✓	✓	✓✓	✓✓	✓✓	✗	✓✓	✗	✓	✗	✓✓	0.87
Innovation Technology	✓✓	✓✓	✓✓✓	✓✓✓	✓✓	✓✓	✓✓✓	✓✓	✓✓✓	✓✓	✓✓✓	0.52
Mean	1.50	1.50	2.50	2.50	2.00	1.00	2.50	1.00	2.00	1.00	2.50	
Sustainable Finance												
Sustainable Finance	✓✓	✓✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓✓	0.50
Divest Financed Emissions	✗	✓	✓✓	✓	✓	✗	✓✓	✗	✗	✗	✓✓	0.87
Mean	1.00	2.00	2.50	1.50	1.50	1.00	2.50	1.00	1.00	1.00	2.50	
Firms	23	24	140	69	26	31	25	36	15	6	84	
Reports	284	308	1,648	805	341	310	239	376	141	66	874	
Words (millions)	11.30	11.91	65.42	29.81	14.26	10.61	12.90	16.29	6.32	3.42	47.06	
Collocates	73	82	602	126	114	15	1,076	74	133	37	1,273	

Key: ✓✓✓= HIGH attention; ✓✓= MODERATE attention; ✓= LOW attention; ✗= NONE.

Source: The table was generated by the authors using a custom scoring system applied to a range of metrics and indicators sources from different databases listed in the main text and references.

The most apparent observation relates to the health care sector, which shows very few mentions of net zero across the 310 annual and sustainability reports of firms within this sector. As a result, there is limited discussion of any of the strategy areas within the sector. It is worth considering why the health care sector pays such limited attention to net zero. One argument is that the sector prioritizes human health over environmental concerns, notwithstanding the fact that these two may be closely linked over the long term.

Other sectors generally show more plausible and structured engagement with key strategy areas. For example, 'carbon management' practices received consistent attention across all sectors. While 'nature and biodiversity' received more focus from real estate, industrials, and consumer staples, the use of 'incentives and nudges' to achieve change got mixed attention across different industrial sectors. Incentives were rarely discussed except in real estate and, to a lesser extent, in communication services, utilities, materials and financials. Meanwhile, there was quite a high level of attention paid to the encouragement of pro-sustainability attitudes and behaviors.

6.5 Summary

Overall, there are a variety of different strategies discussed by firms in relation to their net zero strategies. These span different areas that share some discernible alignment with industrial sectors. Notwithstanding this, sector-specific strategies are relatively difficult to assess within the context of Singapore due to the relatively low levels of overall discussion and commitment to achieving net zero. An extended analysis covering more firms in the Southeast or wider-Asia region would be one way to improve confidence in the different strategies employed by different sectors.

The observed strategies reflected a broad distinction between discussion of strategy areas that were within the scope of influence of individual firms, versus discussion of strategy areas and potential strategy barriers that were not within the immediate influence of firms.

Part 7

Main Findings for Firm-Level Emissions and Progress

This section addresses whether firms' historical emissions trajectories and stated net zero commitments are 'aligned'. That is, based on recent emissions data and a simplified estimation approach, we assess whether firms appear to be on a path consistent with net zero emissions around 2050. This analysis helps benchmark the credibility of firms' net zero targets.

Key takeaways:

- Firms with net zero commitments, by and large, have an emission trajectory consistent with reaching net zero by or before 2050.
- Those firms that have not made net zero commitments or pledges include a mix of firms, with some more likely to be able to achieve net zero in line with a 2050 target, and others that may take much longer without intervention.
- The balance across all firms in the sample is more positive than negative, suggesting that aggregate emissions will track towards the zero level at a median date of around 2038, albeit with some risk of not reaching net zero until around 2060 if non-committed firms are left on their current trajectory.
- Taken together, the results are consistent with firms making net zero commitments having credible plans and positive early progress in working towards their ambitions.

7.1 Objectives for quantitatively assessing progress

This section aims to assess whether listed firms that have set net zero targets are on track to meet them. To do this, we use a simplified yet consistent framework to evaluate the direction and shape of each firm's emissions trajectory. The goal is to identify whether a firm's recent emissions trend appears broadly aligned with achieving net zero by its target year or by the national 2050 goal.

It is important to note that this is not a formal prediction exercise. The short time series available for most firms makes accurate long-term prediction impossible. Instead, this should be understood as a technical benchmarking exercise—one that helps gauge whether firms are heading in the right direction, based on the data available.

Due to the limited availability and uneven quality of historical emissions data, the methodology had to remain simple. Still, there is significant value in applying a standardized approach across firms, so that progress can be compared on a consistent basis. To that end, we apply a set of basic, non-theoretical statistical models to estimate each firm's emissions trajectory and provide a measurable indicator of alignment with net zero goals.

7.2 Methodology

To evaluate firms' emissions trajectories, we apply a regression model based on a simple, data-driven (a-theoretic) approach. The underlying assumption is that each firm's emissions follow a broad trend over time, and our goal is to assess whether this trend shows signs of slowing down, peaking, and eventually declining toward net zero.

We model firm-level emissions using a flexible polynomial function of time:

$$GHG_{i,t} = \alpha_i + \beta_{1,i} TIME_t + \beta_{2,i} TIME^2{}_t + \varepsilon_{i,t} \quad s.t.\ \beta_{1,i} \geq 0;\ \beta_{2,i} \leq 0 \qquad (1)$$

This specification allows emissions to initially increase (if $\beta_{1,i} \geq 0$) and later decline (if $\beta_{2,i} \leq 0$), reflecting the typical decarbonization trajectory expected under net zero targets. The time variable is known with certainty, making this a useful framework for assessing the direction and curvature of emissions over time.

The model is designed to capture the idea that firms will eventually be required to decarbonise. It does so by allowing emissions to initially rise over time (represented by a positive $\beta_{1,i}$) before eventually declining (driven by a negative $\beta_{2,i}$).26 This sign-restricted structure was intentionally chosen as a pragmatic way to ensure reasonable 'regularity' in the results, while avoiding overly rigid assumptions. While we assume that firms will ultimately align with national or international net zero ambitions, the model does not impose any assumptions about the timing of the emissions peak or the achievement of net zero itself.

Given the relatively small number of data points available for most firms, we estimate Eq. (1) using a residual-based bootstrap procedure with 99,999 replications. This approach is appropriate for small-sample settings and also allows us to construct confidence intervals that reflect the uncertainty in each firm's emissions trajectory (Efron and Tibshirani, 1994).

The choice is also taken to have the estimated polynomial function envelope the observed data (from above) such that the fitted curve can be interpreted as an upper bound on expected emissions under a business-as-usual trajectory. This is done using the 'corrected ordinary least squares' (COLS) discussed in Fried et al. (2008) and originally attributed to Winsten (1957) where, after estimating the model, we shift the intercept upward by the largest positive residual ($\max(\hat{\varepsilon}_{i,t})$) so that the fitted curve envelopes all observed data points from above: $\hat{\alpha}^* = \hat{\alpha}_i + \max(\hat{\varepsilon}_{i,t})$. This adjustment produces a fitted trajectory that serves as a conservative upper bound on future emissions, reflecting a business-as-usual pathway and reducing the risk of underestimating a firm's likely emissions.[27] These are contrasted with estimates using approaches similar to the EU ETS linear reduction factors (LRFs), which were calculated in the spirit of the EU factors as described in Life ETX (2021).

[26] The model allows either coefficient to equal zero, which accommodates a wide range of trajectories, including constant growth (if $\hat{\beta}_{2,i} = 0$) or immediate decline (if $\hat{\beta}_{1,i} = 0$), thus preserving flexibility.

[27] This effectively shifted the timing of a firm reaching net zero out to the right. Specifically the adjustment moved the results such that they (on aggregate) crossed the zero intercept roughly 3-4 years later, depending on the firms' net zero commitment status, than the original OLS results, thus the main results were qualitatively invariant to this step.

Specifically, the linear reduction target rate of the EU ETS was expressed as a percentage of the 2013 total emissions and applied to each year from 2021. Note that for the EU, 2013 emissions were higher than 2021.[28]

In our analysis, we also compare against linear reduction factors as considered for the EU-ETS (Life ETX, 2021), including a 2.2% reduction, consistent with current legislation, a 4.2% reduction consistent with a more ambitious decarbonization ambition proposed by the European Commission in 2021, and an even more aspirational 5.4% reduction, proposed by Climate Action Network Europe (CAN).

To ensure consistency with firm-level trends and avoid distortions from COVID-era anomalies, we apply these LRFs from 2021 onward, using 2019 emissions levels as the baseline, the most representative pre-pandemic benchmark. The LRF trajectories were then generated separately for each of the three firm groups in our sample: (1) Firms with net zero commitments, (2) Firms without such commitments, and (3) All firms combined.

7.3 Pre-treatment of emissions data for analysis

A minimum of five years of emissions data is required for each to estimate the model specified in Eq. (1). We use data up to 2022, as data for 2023 were limited at the time the dataset was constructed. This results in a final sample of 117 firms, of which 38 are firms with net zero commitments, and the remaining 79 firms without. Given the bootstrap estimation approach, the analysis involves a total of 11.7 million regressions, which form the basis for the results discussed in this section.

The primary source of emissions data was manual extraction from firms' sustainability reports. These disclosures provide detailed and firm-specific information but are often limited in historical coverage. To address data gaps and extend time series coverage, we merged these manually collected data with emissions estimates from S&P Trucost, focusing on Scope 1 and location-based Scope 2 emissions.[29]

The Trucost dataset includes both reported values and estimated emissions derived through its proprietary methodologies. While our preference is to rely solely on disclosed figures, incorporating estimated data was a necessary compromise to mitigate the more significant issue of small sample sizes. Additionally, we explored the use of data imputation to build a more balanced dataset. The results of this alternative approach are presented in the appendix. Although some quantitative differences emerged, the main results and qualitative conclusions remain consistent, providing confidence in the robustness of the findings.

7.3.1 Firm-level OLS regressions aggregated to the national level

Figure (13) presents the main findings across three panels. Panel (a) is the sum of estimated emissions for all firms with net zero commitments. Panel (B) shows the same for firms that do not have net zero commitments. Panel (C) combines all firms to provide an economy-wide perspective.

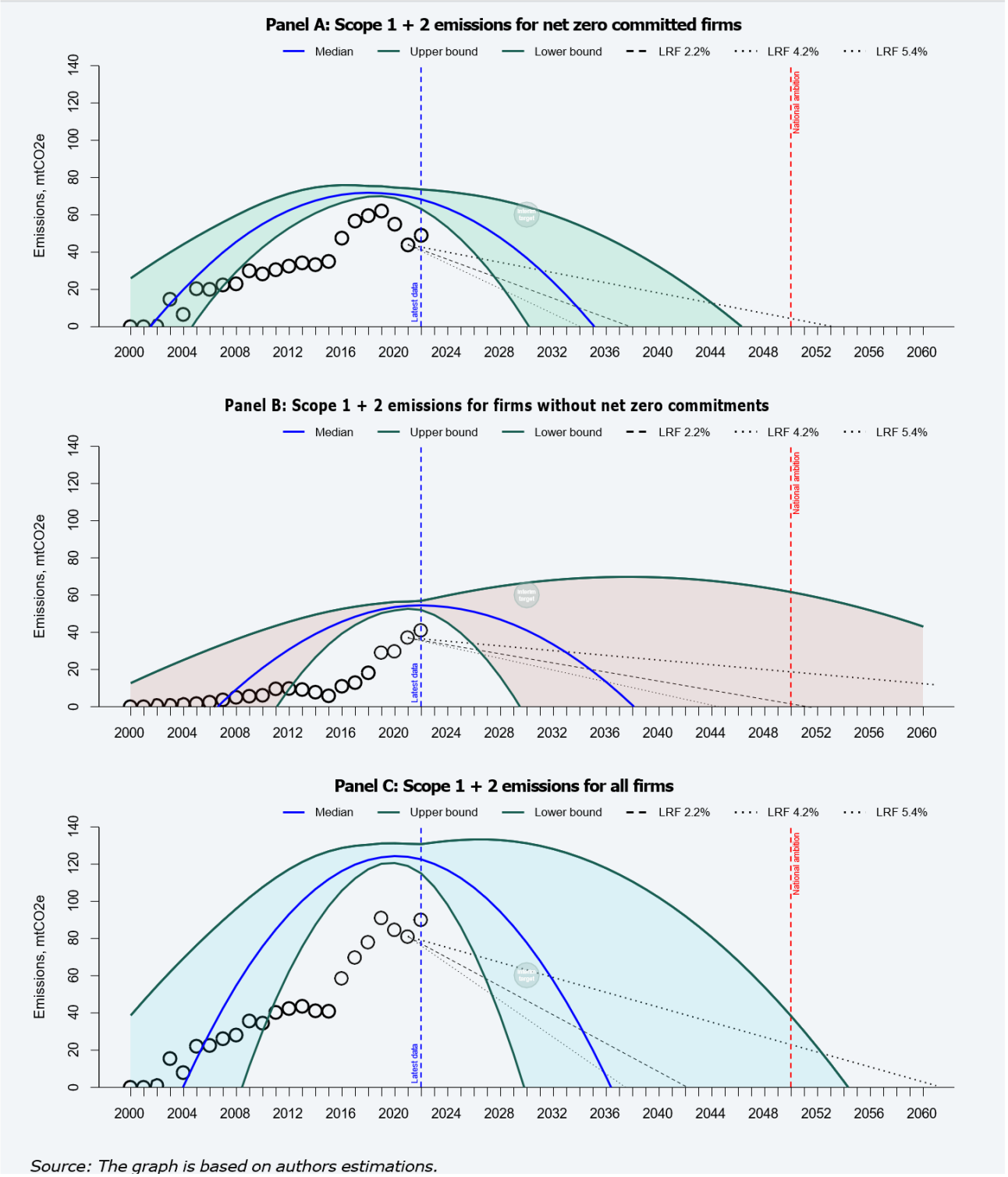
[28] For Singapore official emissions inventories are reported on a bi-annual basis, and net emissions data for 2014 were 47,571.92 gigagrams—or 47.571 million tonnes—of CO2 equivalents as reported by Singapore's National Environment Agency (NEA, 2022).

[29] See https://www.spglobal.com/esg/trucost for further information on this data.

The axes on each panel were kept the same to aid comparison. Each panel contained the sum of the 'median model fits',[30] together with a shaded region and upper and lower bounds.

Figure 13: Estimated emissions trajectories and the Net Zero 2050 target.

Aggregate assessment of emissions trends relative to national ambition for Singapore's domestically headquartered listed companies: All versus net zero committed.



Source: The graph is based on authors estimations.

[30] Recalling that for each firm there are 100,000 sets of results obtained from the bootstrap estimation procedure, one for the original regression and the remainder for the B = 99, 999 bootstrap replications.

These bounds should be interpreted carefully. The upper bound represents the sum of all firms' upper 90% bootstrap confidence interval, while the lower bound reflects the sum of all firms' lower 10% bootstrap confidence interval. These are highly conservative bounds since, in reality, not all firms will simultaneously perform well (towards the lower bound) or poorly (towards the upper bound). Rather, some would be closer to the median, while others fall near the extremes. Although it is possible to construct alternative intervals reflecting such conditions, it is unclear whether doing so would result in providing material benefits for interpreting the results.

For firms with net zero commitments: The estimation results support the view that these firms would be able to achieve net zero within a time frame consistent with their stated targets and the national ambition. The median line suggests that a target date of around 2036 may be possible. The upper bound crosses the zero line before 2049, which can be interpreted as evidence that net zero committed firms will meet their decarbonization targets with more than a 90% level of confidence, or alternatively that we have a 90% level of confidence that firms with net zero commitments may achieve their ambitions by 2048.[31] With reference to the LRF factors, should the median estimate transpire, and net zero be achievable for these firms by around 2036, this would be consistent with a pathway lying somewhere between the European Commission LRF (4.2%), and the Climate Action Network LRF (5.5%), both of which are considerably more ambitious than the current ETS benchmark LRF (2.2%)

For firms without net zero commitments: The median estimate and lower bound suggest that many firms have the potential to reach net zero before the 2050 target date, with the median crossing the zero line at around 2040. While this might seem encouraging, it is important to recognize two things. First, the upper bound lies far beyond 2050, so far that it is not even feasible to adjust the x-axis to display the point at which it crosses zero. To offer some context, 49.3% of the firms without commitments have an upper bound that crosses the zero line after 2050. This makes the likelihood of predicting whether a firm without a net zero commitment will decarbonize in line with the national ambition almost equivalent to the toss of a coin. It is also worth noting that the obtained model results do not, visually at least, appear to be very consistent with the underlying data, which implies more linear upward growth in emissions.

At this point, it is worth recalling that such linear growth can be captured in the regression model when $\hat{\beta}_{2,i} = 0$, and that the aggregate results showing a curved relation with time arise because this, in general, provides a better fit for the firm-level data.

Taking all firms together: The results provide a generally positive indication that net zero is achievable within the national 2050 target, but may require careful monitoring of firms that currently lack precise targets or commitments, which could hinder overall national progress. Under current conditions, net zero is achievable by the firms in the sample by around 2060 with a 90% degree of confidence. Although encouraging, the confidence level is not particularly high, and 2060 is a decade later than the national target date.

Perhaps more importantly, the underlying data used in this exercise do not represent the full population of domestically listed firms; in fact, they span less than half of the entities considered in this study. The insights obtained from this statistical exercise should therefore be viewed as indicative, not definitive, and warrant ongoing tracking in the coming years as more data becomes available.

[31] As all estimates up to and including part of the upper 10% bound imply net zero before 2040, including all of those in the lower 10% region.

7.4 Summary

This section presented an analysis of firms' Scope 1 and Scope 2 emissions profiles, based on available historical data. Given the data limitations, a simple but appropriate regression framework was employed to assess emissions trajectories. This approach allowed us to estimate whether and when a firm's emissions are likely to peak and potentially turn towards net zero.

The analysis provided a measure to evaluate the credibility of firms' performance against their stated decarbonization commitments. While it would be too bold to claim the results as definitive because of the various data limitations discussed throughout this section, the findings nonetheless provide some evidence that firms with net zero commitments generally exhibit emissions trajectories consistent with reaching net zero by or before 2050.

In contrast, those firms without formal net zero commitments are mixed. Some appear to be on track to align with a 2050 target, while others may require substantial intervention to avoid a significantly delayed path to decarbonization.

Overall, the results are more encouraging than not. The median projection suggests that aggregate emissions could reach net zero around 2038, though it is important to note that the analysis makes no assumptions about the use of carbon offsets in achieving this outcome. However, due to the slower pace of progress among firms without commitments, the 90% confidence interval for the national aggregate suggests that achieving economy-wide net zero may not be possible until around 2060, in the absence of targeted intervention and a broader adoption of decarbonization commitments.

Part 8

Summary and Policy Recommendations

A significant portion of Singapore's domestically headquartered listed companies appear to be aligned with the national net zero ambition, in terms of commitment timing, the market value of committed firms, or their share of reported emissions.

However, notable gaps remain in both the coverage and quality of net zero commitments. These include inconsistencies in scope, credibility, and disclosure standards. Financial sector policy may play a critical role in accelerating progress by enhancing the comparability, transparency, and standardization of corporate net zero commitments. Such efforts could also help reconcile firm-level emissions data with national inventories, improving alignment between corporate and national decarbonization pathways.

This paper has presented a comprehensive assessment of net zero commitments made by domestically headquartered Singapore-listed companies. Although the national net zero commitment was only formally established in 2022, our findings show that a substantial number of Singapore's listed companies have openly committed to supporting the national ambition. The analysis was developed around the following primary research questions:

1. What is the extent and nature of net zero commitments made by Singapore's domestically headquartered listed firms?
2. Are firms predicted emissions pathways to net zero consistent/aligned with their declared emissions reduction targets, and the national ambition?
3. What can be learned from firms' public sustainability and integrated financial disclosures about the strategies used to achieve net zero?

To answer these questions, it was essential to build a registry of commitments directly from firms' publicly available sustainability and integrated financial disclosures, since few external data providers systematically capture and report firm-level net zero commitments. Our review revealed that external data providers significantly understated the number and extent of commitments made by Singaporean firms. Specifically, only 30% of commitments observed in our hand-collected registry were reflected in the external data sources reviewed. While differences in coverage are to be expected and we do not critique the efforts of external data providers, it is clear that Singapore would benefit from maintaining its own registry to bridge this substantial information gap.

From our hand-collected data, we identified that 60 out of 479 Singapore-headquartered listed companies in our sample have clear net zero commitments. Moreover, these firms are all aligned with the national ambition to be net zero by or before 2050. They represent

approximately 75% of the market capitalisation of the sample firms, but only around 55% of the emissions reported by the sample. On balance, this indicates a strong level of commitment, covering a significant share of market capitlisation and emissions, especially considering that the national net zero target was only introduced in 2022.

To address the second research question, we used a regression-based framework to assess whether firms' emissions trajectories are consistent with achieving net zero by 2050. Although data limitations posed challenges throughout, the results were broadly plausible and aligned with expectations. Firms with commitments are generally on course to reach net zero before 2050. In contrast, firms without net zero commitments display more uncertainty, with many emissions trajectories not clearly aligned with the national target. This is consistent with the expectation that firms lacking credible plans are less likely to commit to net zero within a specific target date.

To complement the answers to the first two questions we also examined the strategies firms focus on in their net zero journey. While various strategies were adopted, some key observations highlight the importance of energy and carbon resource management, which is not always within firms' control, such as companies whose energy emissions are regulated by the national power grid. Understanding these strategy areas more deeply and how they vary across sectors and jurisdictions will be a fruitful area for further research.

Based on our findings, we propose the following policy directions to enhance alignment between firm-level commitments and Singapore's national net zero objectives:

8.1 Recommendation #1: Minimize the information gap by maintaining a consistent registry of net zero commitments

One of the main challenges encountered in this study was the absence of a reliable external dataset on firm-level net zero commitments. Accurate and up-to-date data are essential for tracking firms' performance against their stated targets. This is particularly important now, as a large portion of emissions falls outside the scope of any net zero commitments. If firms do not voluntarily set credible targets in a timely manner, policy intervention may become necessary to drive broader alignment.

Our findings confirm that existing data sources substantially underestimate the actual number of commitments made by Singapore's listed and domestically headquartered companies. Relying only on such data risks presenting an incomplete and potentially misleading picture of net zero commitments, ambitions, strategies, and progress in their decarbonization journeys.

8.2 Recommendation #2: Enhance comparability of the nature and quality of commitments through standardized disclosure of net zero commitments

The way net zero commitments are communicated varies considerably across firms and sectors. While in some cases—such as financial institutions—complexity is unavoidable due to the nature of financed emissions, there remains scope for more standardized reporting of basic commitment features. For example:

- Clear declaration of commitment target year (including acknowledgement if one has not yet been set);

- Clear communication on the Scope of emissions covered under the commitment e.g., which of Scopes 1, 2 and/or, 3, and the gases covered under CO2 equivalent measurement;
- Supporting details on interim target(s);
- Clear declaration of the baseline year emissions used for interim targets;
- A brief statement outlined key strategies and actions in place to support the net zero transition.

These elements, if disclosed more consistently, would greatly improve comparability and transparency across firms and sectors.

8.3 Recommendation #3: Encourage geography-based emissions disclosures where overseas operations are material

Making a clearer bridge between listed companies' emissions profiles and the national emissions inventory requires clearer attribution of emissions to geographic locations. National inventories, by definition, account for emissions generated within national borders. In contrast, firms typically report emissions that aggregate domestic and international operations, making it difficult to map reported figures onto national accounting frameworks.

For example, a company may have physical assets and business operations in more than one country, such as Singapore and Malaysia. In practice, firms often track emissions from each jurisdiction separately for internal purposes or for compliance with local requirements, but report them as an aggregated group-level figure in public disclosures. This suggests that disaggregating emissions by geography would not introduce significant new reporting burdens.

Geography-based emissions disclosures would improve transparency, support alignment between firm-level reporting and national inventories and enhance policymakers' ability to assess how listed companies contribute to domestic emissions trends, particularly for firms with significant overseas operations.

8.4 Summary

Assessing the credibility of net zero commitments requires a careful evaluation of firms' climate impacts, ambition levels, and strategy implementation. While ambition is critical, it must be balanced with pragmatism—targets should be realistic, time-bound, and anchored in actionable strategies.

The expansion of sustainability reporting requirements is already helping to close the information gap. At the same time, efforts to develop clearer taxonomies and standards are making it easier to identify which commitments are in scope and comparable. Continued progress in these areas will be key to ensuring that firm-level action supports the broader national transition to net zero.

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(Note: All resources were accessed/accessible between October 2024 and February 2025.)

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Appendices

This appendix contains the following items:

Contents:

- Additional detail on the text processing framework for identifying net zero commitments from company reports;
- Additional regression output using imputed emissions data.

A framework for identifying net zero commitments from company reports

We started by collecting the annual reports (AR) and sustainability reports (SR) available online from the Singapore Exchange's 'Annual Reports & Related Documents' portal.35 The reports are available in principle for all listed entities and typically come in the form of machine readable PDF (portable document format) files, predominantly written in English, though in dual-language in some instances. While there is a mandatory requirement for sustainability reporting, it is not required that this be in the form of a separate sustainability report, and in several cases, the sustainability information is communicated within the annual report (i.e., as part of an integrated report).

The pipeline for working with these documents to create a registry of net zero commitments is as follows:

1. **Download the annual and sustainability reports**

   A custom non-intrusive[36] web-scraping algorithm was developed to gather annual and sustainability reports and associated meta-data including company name, report end-date, and ISIN, which is essential information for being able to connect with other data such as emissions data or financial databases. There is some imprecision in this process owing largely to selected entities having multiple ISIN's, and therefore a manual screening is conducted to ensure the correct ISIN is used, cross-referencing both the original metadata for each report and the Compustat global data.

2. **Machine-read the reports**

   To maximize the data capture, this was done using both R and Python, which each utilize different packages for machine reading of pdf files. Within R, the pdf files are directly read and stored into a data frame as a (long) character string matched against the firm metadata. In parallel, Python is used to create raw text files from the pdf reports. A number of reports (several dozen or so) are not directly readable, but in almost all cases become readable following use of Adobe Acrobat Professional's built-in optical character recognition (OCR) functionality. The Python-generated text files are used where R was unable to machine-read a document.

3. **Machine screen reports for reference(s) to net zero**

   The machine-read reports are used to identify references to net zero. Given that the raw corpus is not 'cleaned' in a corpus-linguistic sense, this is done in a rudimentary yet highly accurate way. The term net zero is used almost uniquely in the context of climate ambitions[37] and so searching for instances of the term quickly and accurately isolates which firms (reports) are discussing the concept, and with what frequency.

   In practice, this is achieved by collapsing each report into a single string item by removing all spaces and hyphenation and sending to upper case, such that 'net zero', or 'net-zero', each becomes 'NETZERO'. The frequency of occurrence of this term within each report is then captured. During the subsequent manual screening, it was evident that this process has a high degree of accuracy in identifying the correct frequency of references to net zero.

[35] See https://www.sgx.com/securities/annual-reports-related-documents for further information.

[36] By this it is meant that a 'friendly' algorithm is implemented with in-built rest periods to avoid server congestion.

[37] There are a handful of exceptions referring to water or waste etc., though these are extremely rare within the corpus.

4. **Screen out firms that are not headquartered in Singapore.**
   The sample is constrained to Singapore-headquartered companies. This is helpful for ensuring that the assessment of corporate commitments can be most closely reconciled against national economy-wide ambition.

5. **Manually screen reports identified as having at least one reference to net zero.**

   With the relevant reports identified, a process of manual screening is required to verify the nature of the usage. Specifically, to assess whether it is used simply in recognising the national or international ambitions to achieve net zero, or whether it is part of a concrete and unambiguous commitment by a firm to achieving net zero.

   As a guiding principle, the notion of net zero commitment is attributed to a company under two core conditions: (i) that the firm uses affirmative wording, ideally 'commit*' or 'pledge' with equivalent synonyms permissible, e.g., 'goal' or 'target*';[38] and (ii) that a target date is provided. Absent from both, the commitment is not concretely articulated.

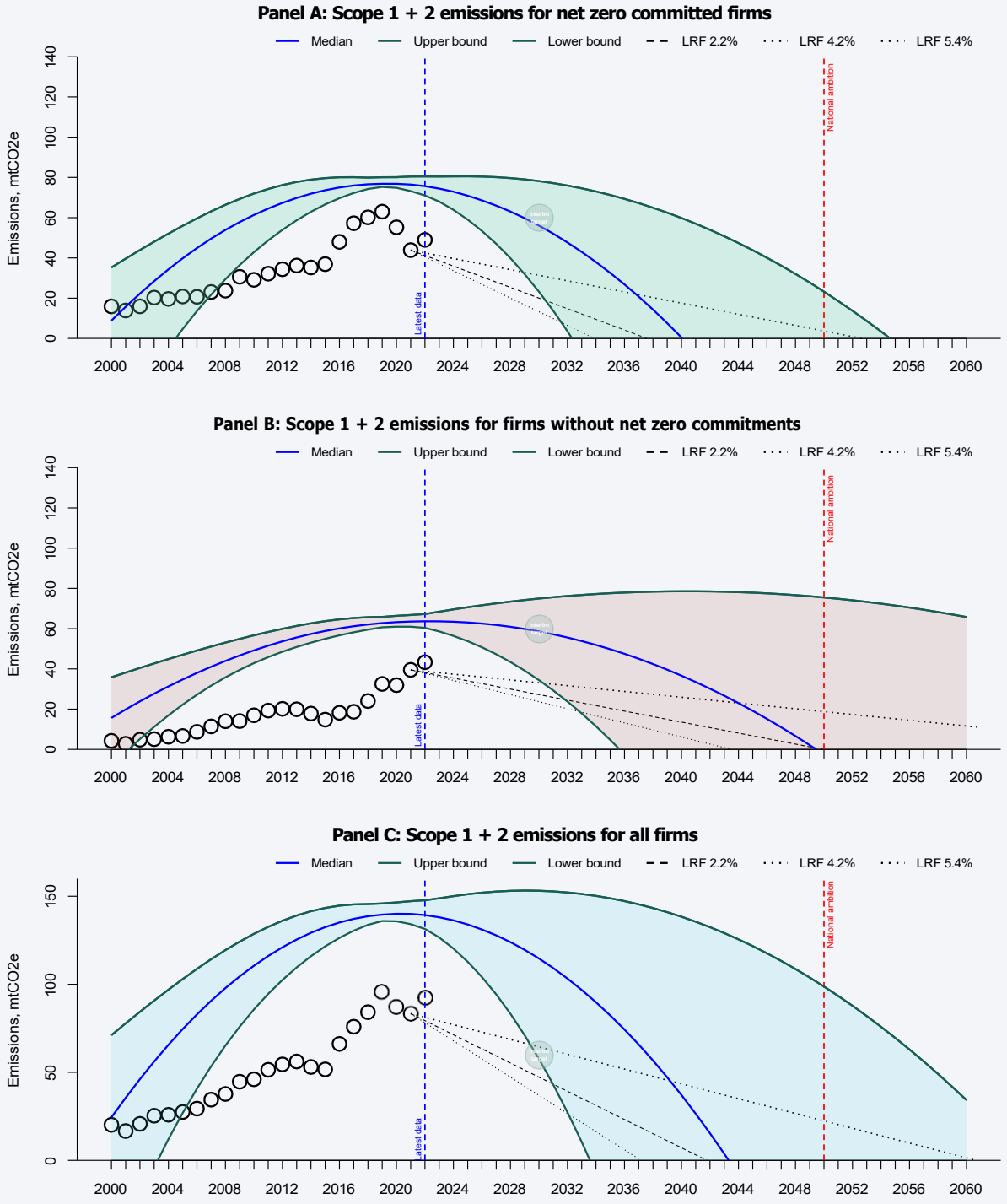
The above steps produce a 'raw' corpus, which over time can be maintained, updated, and refined to track updates on net zero commitments, and to support subsequent alternative research projects.

[38] It is conceded that this classification approach can be potentially subjective, yet we feel that in most cases the wording is sufficiently well defined to limit the risk of mis-classification in practice. Furthermore, the requirement for a coupling of affirmative commitment together with a clearly articulated target date also increases confidence in accurate classification of net zero commitment.

Additional regression analysis with imputed data

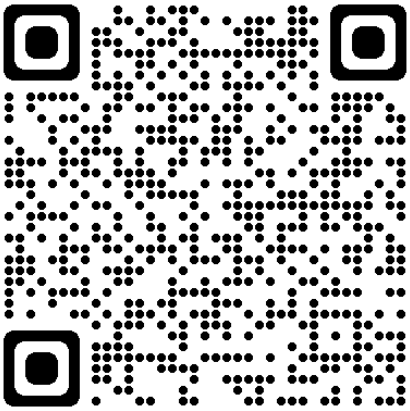
Appendix Figure 1:
Alternative estimates of emissions trends relative to the national ambition.

Alternative estimates of emissions trends for companies listed and domestically headquartered in Singapore, relative to the national ambition.



Source: The graph is based on authors estimations.

An additional layer of data imputation was applied to try to obtain more balanced sample properties. This was done by calculating firm-specific emissions-intensity metrics in relation to net sales, EBITDA, and costs of goods sold. The choice of these variables was to ensure imputed values could be obtained for a broad coverage of firms. The median ratio is taken across all years of data available for a firm, and this is then used as the factor for years where no emissions data are available. This process produces between one and three imputed values for a given firm-year, depending on data availability, and the final imputed emissions value is recovered as their average; hence, the approach can be considered a multiple-imputation framework. In a small number of cases, some imputed values were wildly inaccurate and were manually removed from the sample.



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