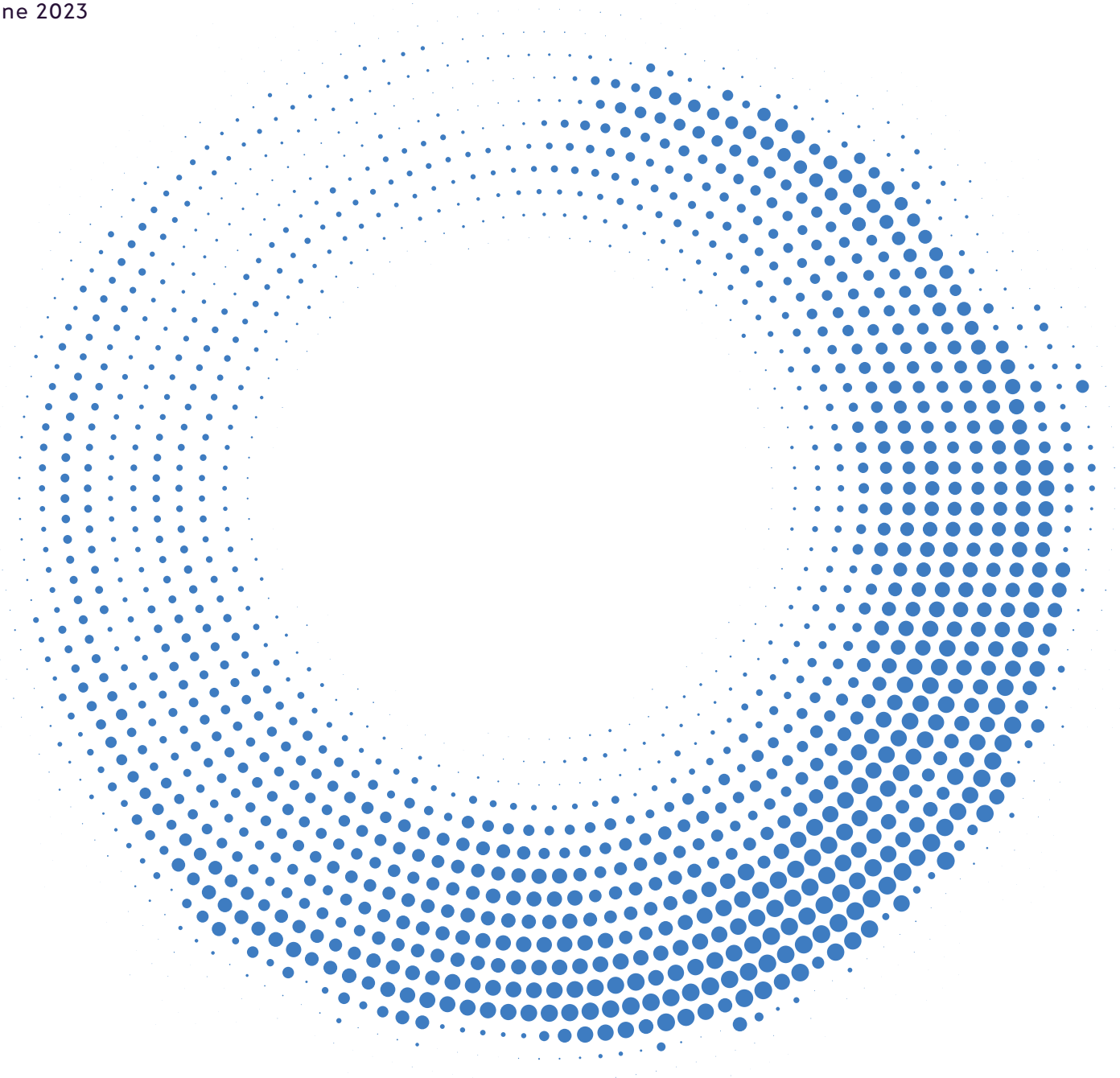
NET ZERO TRACKER

NET ZERO STOCKTAKE 2023

Assessing the status and trends of net zero target setting across countries, sub-national governments and companies

June 2023



A report by:

NewClimate Institute, Oxford Net Zero, Energy & Climate Intelligence Unit and Data-Driven EnviroLab

Authors

Net Zero Tracker (NewClimate Institute, Oxford Net Zero, Energy and Climate Intelligence Unit and Data-Driven EnviroLab).

This report was prepared by (in alphabetical order): Kaya Axelsson, Richard Black, Peter Chalkley, Thomas Hale, Nick Hay, Frederic Hans, Angel Hsu, Camilla Hyslop, Takeshi Kuramochi, John Lang, Natasha Lutz, Alexis McGivern, Silke Mooldijk, Natalie Short, Steve Smith, and Zhi Yi Yeo.

Suggested citation
Net Zero Tracker (2023) Net Zero Stocktake 2023: NewClimate Institute, Oxford Net Zero, Energy and Climate Intelligence Unit and Data-Driven EnviroLab.

Disclaimer

Download

Download the report at www.zerotracker.net/analysis/net-zero-stocktake-2023

Executive summary

- **Growth in the number of national and subnational net zero targets has slowed, but company net zero target-setting momentum continues at speed.**
- **National government net zero targets underpinned by legislation or policy documents increased substantially in the two-and-half years, from less than 10% to 75%.**
- **A significant share of subnational and corporate entities still lack any emission reduction target whatsoever, at the global level and within the G7.**
- **Collectively, there are limited signs of improvement in the robustness of subnational and corporate net zero targets and strategies.**
- **More entities are clarifying their intention to use carbon dioxide removals (CDR) in their value chain.**
- **Despite having net zero pledges, no major producer countries or companies have committed to phasing out fossil fuels.**

Net zero has had to grow up quickly, transforming from scientific principle to global organising principle in just a few years. In June 2019, shortly after the Intergovernmental Panel on Climate Change's (IPCC) Special Report on 1.5°C propelled net zero into the mainstream, one-sixth of global GDP was covered by a net zero target. Two years later when the 2021 UN Climate summit in Glasgow (COP26) closed its doors, 90% of the global economy was on board.

If Phase One of net zero was about accepting the scientific principle of net zero and Phase Two about pledges aiming to get there, the much more consequential Phase Three is about delivery — and as the IPCC has just made clear again, near-term delivery at that. Stopping climate change at safe levels is a timed test to halve emissions in the next decade, achieve net zero carbon dioxide (CO_2) in the next 25 years, and go to net zero greenhouse gas (GHG) emissions thereafter. Entities that have set long-term targets but are doing nothing concrete to meet them are coming under more scrutiny than ever.

For the over 4,000 entities currently in the Net Zero Tracker database, the last year confirms there is nowhere to hide. In November, the UN Secretary-General's High-Level Expert Group on the Net-Zero Emissions Commitments of Non-State Entities (UN Expert Group) set out what 'good net zero' looks like for states & regions, cities, financial institutions and companies. Although its remit did not cover net zero commitments by nation states, many of its 10 recommendations are logically relevant to national governments as well as non-state entities.

At its core, the Net Zero Tracker investigates the scale of net zero target setting globally and lifts the hood on individual targets to assess indicators of how credible they are. This analysis is our third comprehensive

analysis. The first two, Taking Stock 2021 and Net Zero Stocktake 2022, provide valuable reference points against which to judge progress over time in both net zero target-setting (intent) and in adoption of measures of robustness (integrity). These include, for example, whether entities are restricting or even banishing the use of offset credits to meet their targets, whether they are setting near-term interim targets to spur immediate emission cuts, and whether they commit to annual reporting.

Of the 4,000+ entities we currently track, at least **1,475 have a net zero target**, up from 769 in December 2020, and up from 1,180 twelve months ago:

- **149 countries** including the EU and Taiwan, up from 124 in December 2020
- **145 states & regions**, up from 73
- **252 cities**, up from 115
- **929 publicly-listed companies** from the Forbes Global 2000, up from 417

Most large economies and emitters have some variation of a net zero target, including 19 members of the G20. Country-level targets (including the European Union and Taiwan) now represent:

- **92% of global GDP (PPP)**, up from 68% in December 2020
- **88% of global GHG emissions**, up from 61%
- **89% of the global population**, up from 52%

As in previous stocktake editions, we reveal a mixed picture. On intent, growth in the number of national and subnational net zero targets has slowed, but company net zero target-setting continues apace. On measures of integrity, there remain very limited signs of improvement in national, subnational and company net zero strategies.

There has, however, been steady progress in country-level net zero targets accelerating up the governance curve; that is, from 'pledged' to 'in policy document' to 'enshrined in law.' The proportion of net zero targets set in domestic legislation or policy documents has substantially increased from 7% of total greenhouse gas coverage in December 2020 to 75% today. More than 70 countries now have net zero targets either enshrined in legislation or outlined as a goal in policy documents.

Unlike our previous analyses, we place more of a spotlight on those entities without net zero targets. We found, for example, that 41% of states & regions in our database do not have any mitigation target whatsoever, whereas the vast majority of states & regions in G7 countries (80%), the EU (75%) and US (72%) do. For the more than 1,000 companies we track that are headquartered in G7 countries, at least 57% have net zero targets in place. US companies (49%) trail their EU counterparts (79%) by some distance. At the city level, 72% of EU cities have pledged net zero, compared with 60% in the US and 37% across the world. About one-third (37%) of the cities we track have a net zero pledge, and half (49%) have no mitigation target of any kind in place.

Target setting momentum at the company level steadily continues, with company coverage of net zero targets having more than doubled in a little over two years by number, an increase in momentum that has not been matched by other entity groups. As we approach the point where half of the world's largest listed companies have net zero targets, we know that the largest of the largest are moving more quickly than the average: the 929 companies with net zero targets now represent 65% of the total annual revenue of companies (1,986) in our database.

We find that entities are not, overall, implementing measures of integrity as quickly as might be expected. More than 1,000 set their net zero targets over a year ago, and have therefore had time to prepare robust strategies for reducing emissions. Leaning on the Race to Zero's latest version of its 'starting line' criteria — a minimum threshold that is necessary but by no means sufficient — we found that fewer than 5% of net zero targets set by sub-national governments and companies met this procedural bar.

At the sectoral level, we found that the Biotech, Health Care & Pharma (44%), Infrastructure (46%), and Retail (26%) sectors have particularly high percentages of companies without any emission reduction target at all. Unsurprisingly, the same three were among the worst performing sectors on net zero target-setting: less than 40% of companies in these sectors have net zero targets, compared with, for example, Power Generation (71%) and Fossil Fuels (67%).

To further align with the UN Expert Group's recommendations, the Tracker is preparing to introduce a new indicator that assesses whether entities intend to phase out fossil fuels. For this report, we piloted the indicator against the 114 fossil fuel companies we track. We found that none of these companies is making the necessary commitments to fully transition away from fossil fuel extraction or production.

Our series of three reports also allows us to trace evolution in the kaleidoscope of emerging voluntary net zero standards, guidelines and assessment frameworks. We find that there is growing convergence between these initiatives, and note the particular importance of those published within the last 12 months by the UN Expert Group and the International Organization for Standardization (ISO), as well as those of the UN Race to Zero campaign. The last section of our report compares these three voluntary standards with others, showing exactly where there has been high, moderate and low convergence in guiding principles and criteria for their operationalisation. Broadly speaking, guidance strongly converges on higher-level guiding principles across almost all dimensions of net-zero strategies.

As domestic laws and policies emerge to support overarching net zero objectives — including the high-profile Inflation Reduction Act (IRA) in the US, which is leveraging trillions of dollars more private investment than expected, and the EU's Net Zero Industry Act — scrutiny on measures of integrity will not be limited to the domain of voluntary initiatives. As the UN Expert Group's proposed Task Force on Net Zero Regulation and the recently proposed UNFCCC Global Climate Action Recognition and Accountability Framework for non-state entities are operationalised, national-level regulatory frameworks will inevitably

align. As the United Nations climate talks focus this year on taking stock of collective progress towards the Paris Agreement goals, we offer three conclusions from our analysis for reflection:

- **Most global entities have still not set a net zero target consistent with what 195 nations signed up to eight years ago**
- **Most entities that have pledged net zero do not meet minimum requirements for what 'good' net zero looks like, including backing up long-term vision with urgent near-term efforts to halve emissions**
- **The clear consensus on net zero standards and what good looks like can serve as a guiding star for both commitments and implementation.**

The age of implementation is here, but net zero integrity has been slow to catch up. In the year of the UN Global Stocktake, the big question is whether existing net zero targets will acquire the measures of credibility quickly enough to keep the Paris Agreement's temperature goals within reach. We need more entities to sign up, and need those that have pledged to step up.

Acknowledgements

The Net Zero Tracker project is supported by the European Climate Foundation. Responsibility for the information and views set out in this report lie with the authors. The European Climate Foundation cannot be held responsible for any use which may be made of the information contained or expressed herein.

NewClimate Institute also received support from IKEA Foundation.

We thank Thomas Day (NewClimate Institute) for providing constructive feedback on an earlier draft. Thank you to Nayah Thu and Claudia Tam (University of Oxford), who have provided invaluable help behind the scenes managing data collection and validation.

This analysis would not have been possible without the heroic efforts of our numerous volunteers, mostly from the University of Oxford. Thank you Sara Abdelaziz, Duygu Acikalin, Bethan Adams, Da Eun Ahn, Oluwaseun Apenuwa, Amelia Barnes, Anna Beever, Carys Bill, Amy Booth, Barasha Borthakur, Samuel Boyer, Kiyomi Boyes, Sophie Brown, Gabriel Cairns, Annamarie Candler, Max Collett, Alex Collin, Claire Coulthard, Luna Dantas, Ebenezer Dariye, Alexander Dunn, Athena Efthimiou, Marwan El Kilany, Nicole Fan, Lyndsey Fowks, John Bervin Galang, Ben Glanz, Julian Gonzales, Mia Hard Af Segerstad-Smith, Arianwen Harris, Sitara Hooseria, Andy Hu, Amelie Hylton, Molly James, Amba Janiurek, Oscar Jones, Nadya Kamenkovich, Alp Katalan Nasi, Roisin Kennelly, Kyle Kline, Jana Konle, Hayley Kunde, Isobel Laughton, Esmé Layton, Angela Le, Seoyoung Lee, Harry Linehan-Hill, Charlotte Maddinson, Laura Monikowska, Cassandra Murrell, Mitchel Muza, Ella Needham-Hewavisenti, Alexander Newton, Fergus O'Keeffe, Lucia Palacio Sasse, Sze Ann Pang, Rosa Parker, Jocelyn Perry, Nolwen Prince, Shannon Ray, Phoebe Reid, Maddy Robertson, Rita R. Sakari, Caitlin Sarro, Heejung Seo, Richard Shen, Qicheng Shen, Sana Sherif, Kunja Shrestha, Roberto Spacey Martin, Emily Speake, Ann Sun, Claudia Tam, Haroon Taylor, Daulet Teginbayev, Nayah Thu, Mattia Troiano, Irene Trung, Ibrahim Usman, Gabriella Von Alten-Reuss, William Wallock, Hantao Wang, Josephine Ward, Minqi Xia, Jess Zionts and Anna Zhukova.

A particular thank you to Lucy Main.

Contents

Abbreviations

CCRM	Climate Corporate Responsibility Monitor
CDR	Carbon dioxide removal(s)
CO_2	Carbon dioxide
ECIU	Energy & Climate Intelligence Unit
EU27	27 member states of the European Union
FLAG	Forest, land and agriculture sector
GDP PPP	Gross Domestic Product based on Purchasing Power Parity
GGPC	Greenhouse Gas Protocol (Corporate) standard
GHGs	Greenhouse gases
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LUCF	Land-use change and forestry
OECD	Organisation for Economic Co-operation and Development
RtZ	Race to Zero
SBTi	Science Based Targets initiative
UN	United Nations
UN Expert Group (HLEG)	United Nations' High-Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities
UNFCCC	United Nations Framework Convention on Climate Change

1. Setting the scene and scientific underpinning

The world is now firmly in a third phase of net zero target-setting and implementation.

In Phase One, which began around a decade ago and lasted until about 2018, net zero was a principle emerging from science. Progressively, research consolidated the conclusion that halting climate change at any level of warming entails eliminating humanity's net emissions of carbon dioxide into the atmosphere. And the Intergovernmental Panel on Climate Change's (IPCC) seminal Special Report in 2018 set the global target date at 2050 (IPCC, 2018).

Following 2018, Phase Two saw the trickle of net zero targets being set by countries, sub-national governments, cities and companies become a flood.

If Phase One was about principles and Phase Two about pledges, Phase Three is about delivery. It means entities that are serious about getting to net zero must set a target commensurate with a scientifically validated pathway, put in place measures to make the pledge robust (such as interim targets, independent validation and annual reporting), and then implement all elements of the pledge.

Until the end of 2022, it was possible for entities with net zero targets to assert credibility of their plans even if they lacked specific elements because there was no obvious consensus on credibility requirements. A universally-recognised set of standards did not exist, leaving everyone without a common reference point.

The report of UN Secretary-General Antonio Guterres' High-Level Expert Group on net zero commitments of non-state entities (UN Expert Group), released at the 2022 UN climate summit (COP27) in Egypt, marked a notable shift in the global net-zero landscape (UN HLEG, 2022). Entitled 'Integrity Matters,' the report shows what integrity has to mean in the context of a net zero target. Its 10 recommendations make clear, for example, that integrity includes having regular interim targets beginning in 2025, not using offset credits to meet those interim targets, committing to end fossil fuel use and adopt renewable energy, and committing to a socially and ecologically fair transition.

Other sets of standards still exist and this report examines the degree to which they are converging. We also refer, as we have in our previous stocktaking reports in 2021 and 2022, to the criteria used by the UN Champions' Race to Zero campaign (RtZ) as a standard for would-be members. But the crucial aspect about the UN panel is that it is a UN panel: as Mr. Guterres has said, its recommendations will now frame all discussions of net zero within the UN system. The recommendations provide everyone a universal yardstick to assess their own net zero targets and those of others. No company, city or region can any longer claim not to know what a credible target looks like. Neither can any accreditor, scrutiniser or regulator.

The UN Expert Group's remit did not include national government net zero commitments, but many of its recommendations logically should apply. For instance, one guideline that stands out is its statement on fossil fuels. The International Energy Agency's net zero pathway declares that an expansion in fossil fuel supply is not compatible with reaching global net zero CO_2 emissions by 2050 (IEA, 2021). The Synthesis element of the IPCC's Sixth Assessment Report, published in March this year, notes that emissions from current and planned fossil fuel infrastructure are enough to take us past 1.5°C of warming (IPCC, 2023). Against this backdrop, if a 'no new fossil fuel development' commitment applies to non-state entities, it should logically apply to national governments too.

The Carbon Neutrality Coalition, which brings together governments committed to achieving national net zero, unveiled a Framework on Net Zero Climate Action by countries at COP27 (Carbon Neutrality Coalition, 2023). Drafted by referring to best practice across governments, the report includes measures such as embedding targets in law, aligning investment with the net zero pathway, and implementing policies in key sectors such as land use, buildings and energy.

So, in contrast to a year ago, the standards and expectations for net zero target-setting are clear. Governments and regulators are beginning to transform these pledges into requirements, particularly for companies if not yet for other non-state entities. The focus lies in two areas, disclosure and transition planning.

Corporate disclosure of climate-related risks is already mandatory in China and the UK. This year, the EU, India, Switzerland and New Zealand are due to introduce similar measures, with Canada and South Korea following by 2025. These regulatory changes will put almost half of global GDP and global emissions under disclosure rules, rising to two-thirds if similar proposals go through in the US (Corb et al., 2022).

The UK and Spain will also require companies to publish net zero transition plans. At the EU level, talks continue about the strength of the forthcoming Corporate Sustainability Due Diligence Directive. In June 2023, the European Parliament supported inclusion of a provision mandating companies to have transition plans commensurate with a science-based 1.5°C net zero pathway, along with a host of other measures that align with the UN panel's report (European Parliament, 2022).

Meanwhile, advertising regulators in the EU, France, and the UK are cracking down on greenwashing, for example blocking airlines' claims to carbon neutrality. The number of court cases aiming to ban misleading net zero claims also continues to rise. While most concern corporations' statements, a notable exception is in Australia, where plaintiffs say the government's own carbon neutral certification scheme is misleading and deceptive (Hemming, 2023).

In terms of standards, regulation, expectations and enforcement, then, a lot has changed since our last

stocktake report one year ago. This report is an opportunity to determine whether the subjects of those standards and regulation – the entities setting net zero targets – are keeping up.

The Net Zero Tracker is the most comprehensive and up-to-date database of net zero commitments made by nations, states & regions, cities and major companies. It includes:

- all UNFCCC member states and a selected number of territories;
- subnational states & regions in the 25 largest emitting countries;[1]
- all cities around the world with populations over 500,000;
- publicly-traded companies that were listed in the Forbes Global 2000 in 2020.[2]

It only uses information in the public domain, a decision taken in part to encourage entities to be open.

Using a combination of automated web data-scraping and manual searching by volunteer data analysts working in a range of languages, the Tracker gathers and collates data on the status of net zero targets and robustness parameters across these 4,000+ entities. Parameters include the existence of interim targets, intentions regarding offsetting, the existence of a published plan, and what the target covers in terms of greenhouse gases and emission scopes.

For the first time in this stocktake report we examine a small number of particularly important entities for any indication of a commitment to end fossil fuel use, as set out in the UN net zero integrity report.

There is a small degree of natural change and turnover in the entities in the database. An expanding city (for example) will enter the database once its population tops half a million; on the corporate side, mergers and acquisitions will change the mix, while companies may leave or newly enter the Forbes list if they contract or expand. But these changes result in minor considerations. Overall, our approach enables the Tracker not only to make snapshots, but to evaluate how the landscape is changing over time – in particular, whether entities are adding important robustness elements to their pledges, which in turn will increase confidence on delivery.

1. United States, Australia, Canada, India, Russia, Japan, Germany, Iran, Saudi Arabia, South Korea, Mexico, Indonesia, Brazil, South Africa, France, Turkey, Italy, Thailand, Poland, Kazakhstan, United Kingdom, Spain, Taiwan, China, and Malaysia.

2. Broadly speaking, the 2000 biggest publicly-listed companies in the world, by annual revenue. The database tracks slightly fewer than 2000 companies (1986), mainly due to mergers and acquisitions.

2. Summary of data and methods

This report updates and expands the data and analysis presented in the Net Zero Stocktake 2022 report (Net Zero Tracker, 2022). The data used for this report's analysis are drawn from the core Net Zero Tracker database, which is a "living" data resource that is updated regularly (adapted from Hale et al., 2022). The data are freely available for download and use under a Creative Commons licence (CC BY-NC 4.0). The data collection cut-off date for this report was 1 June, 2023, but the underlying dataset on the Net Zero Tracker will continue to be updated. The dataset used for the analysis presented in this report is available on Zenodo (Hyslop et al.).

The assessment framework applied in this report updates that developed by and used in Hale et al. (2021) and updates the Net Zero Stocktake 2022 report. We provide a detailed assessment on the following key components of a robust net zero target recorded in the Net Zero Tracker database: **(i) target year, (ii) target status, (iii) coverage of greenhouse gases, (iv) consideration of offset credits and carbon dioxide removals, (v) emission scope coverage (for companies), (vi) interim target-setting, and (vii) planning documents**. In this report, percentages are weighted by GHG emissions coverage at the country level; population coverage at the states & regions and cities level, and by number (headcount) at the company level. The indicators used for the assessment are consistent with the Race to Zero v3.0 Starting Line criteria, except the 'Persuade' criterion that requires entities to align external policy and engagement with their net zero target, which is not recorded in the Net Zero Tracker database.

As per the previous report, this analysis assesses the prevalence of targets and their robustness, but not implementation and progress. The information presented in the report therefore captures the first stages of the causal chain from targets to implementation to outcomes (Hale, 2021). More details about the data collection process and the assessment of the entities recorded in the Net Zero Tracker database can be found in Appendix I.

3. Analysis: Key findings

Growth in the number of national and subnational net zero targets has slowed, while company net zero target-setting momentum continues at speed

Here we look at the global dissemination of net zero targets since the first Net Zero Stocktake report was published in March 2021 based on December 2020 data (Black et al., 2021). Since December 2020, we observe an overall increase in net zero targets tracked under the Net Zero Tracker database (Figure 1) across all four entity groups. The increase is due to both new target announcements over the course of the last two and a half years as well as enhanced data collection. In total, 1,475 out of 4,075 entities in the Net Zero Tracker database now have a net zero target or similar.[3]

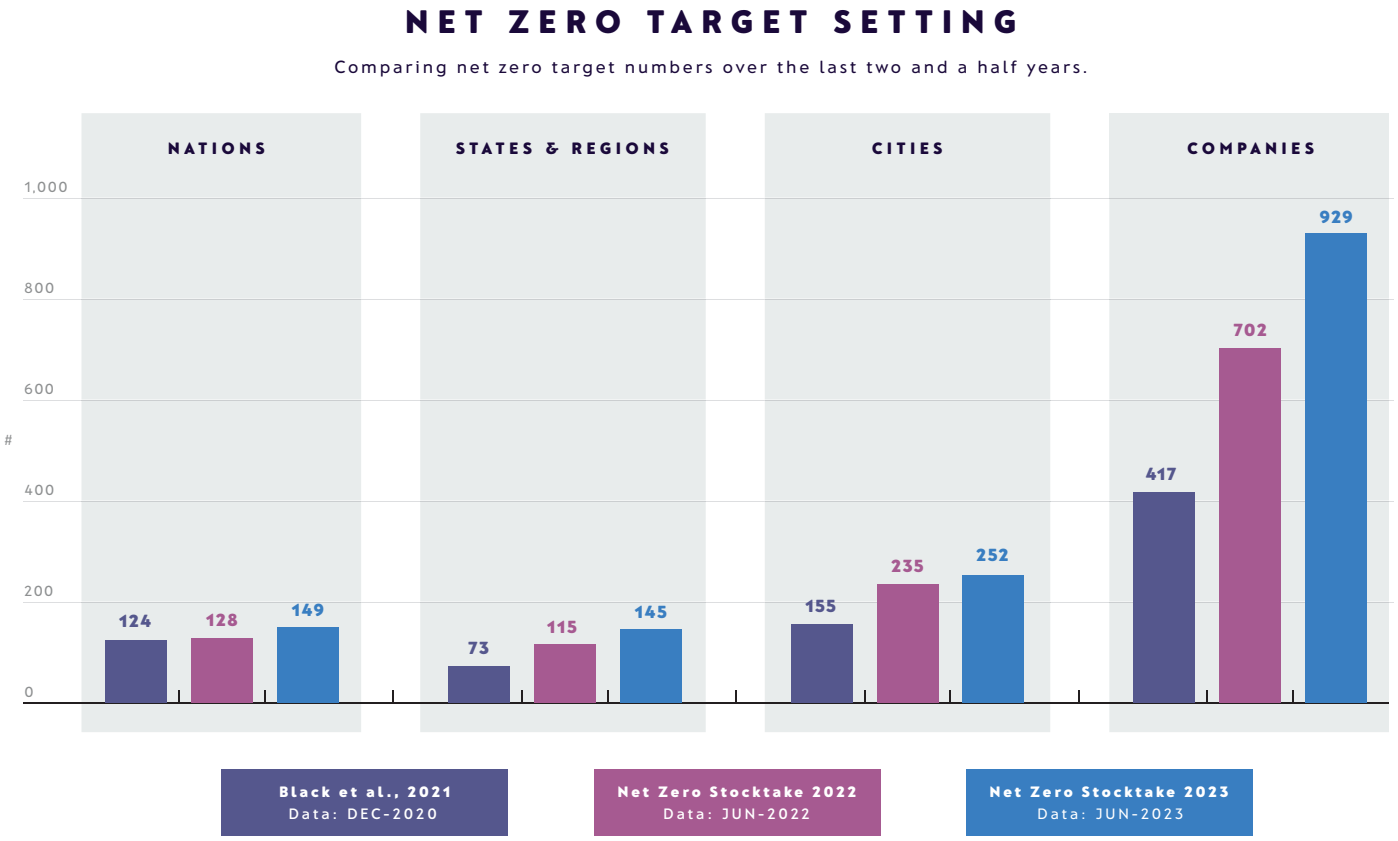


***Figure 1**: Number of NZ pledges per entity group covered by the Net Zero Tracker database.*

The database indicates that the net zero targets set by national governments (including the European Union and Taiwan) represent at least 88% of global GHG emissions (up from 61% in December 2020)[4, 5], 92% of global GDP (up from 68%) and 89% of global population (up from 52%) (see Figure 2).[6]

3. The following target names are considered in scope: net zero, zero emissions, zero carbon, climate neutral, climate positive, carbon neutral(ity), GHG neutral(ity), carbon negative, net negative, 1.5°C target, science-based target.
4. The estimate in Black et al. (2021) based on the December 2020 data did not include international bunkers in the global total
5. Climate Action Tracker (Climate Action Tracker, 2022) reported a slightly higher GHG emissions coverage (88%) due to the GHG emissions data source used; Climate Action Tracker uses PRIMAP data (Gütschow et al., 2021) which excludes land-use emissions, whereas the Net Zero Tracker uses Climate Watch GHG emissions data which includes land use-change emissions. Climate Watch reports a lower 78.9% coverage (Climate Watch, 2023) because they do not count countries that signed up to the 2019 Climate Ambition Alliance but have not followed up domestically.
6. The majority of states and regions with net zero targets reported in the Net Zero Tracker database are in a country with a national net zero target. A few exceptions include regions in Mexico and Poland.

While the number of national net zero targets and their aggregate GHG emission coverage have not significantly increased in the past year, the Net Zero Tracker database suggests that national governments are making steady progress on formalising net zero targets within domestic policy (see next section).

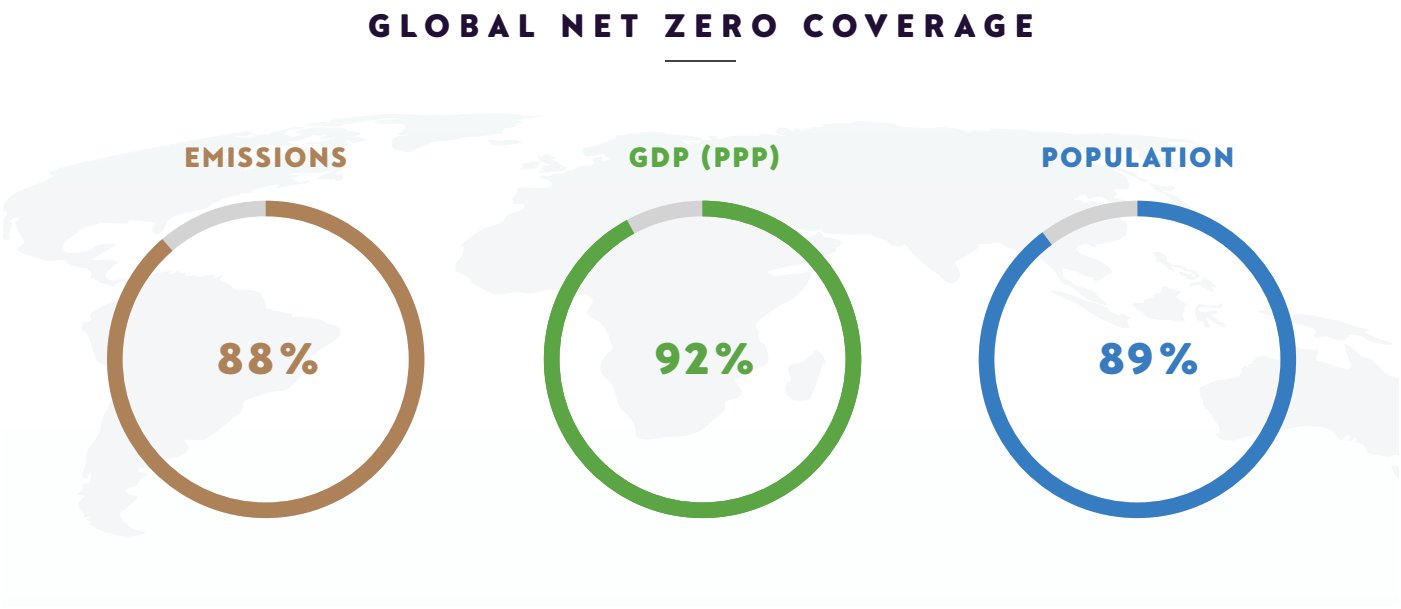


Figure 2: Percentage of greenhouse gas emissions (including land-use change and forestry), GDP (based on purchasing power parity, in 2017 constant international dollar), and population covered by country-level net zero pledges. Coverage includes targets that are proposed, in discussion, in policy document, in law and achieved). Population and GDP figures use 2021 data, GHG emission figures use 2019 data. See Appendix I for data sources.

For subnational and non-state actors:

- **States & regions**: The number of subnational states and regions with net zero targets in the 25 major countries increased gradually in the past two and a half years; today they together cover a population of 1,457 million, compared with 497 million in December 2020. The growth in the past year is in part due to the carbon neutrality targets newly set by 12 Chinese provinces.

- **Cities**: Like states & regions, the number of cities with a population above 500,000 that set net zero targets gradually increased and now covers a total population of 787 million, compared with 640 million in December 2020. Nevertheless, they only represent 21% of all cities tracked in the database.

- **Companies:** 929 companies from the Forbes 2000 list have set net zero targets. The number has more than doubled in the past two and a half years. The aggregate annual revenue covered by net zero targets has increased from $3.8 trillion in December 2020 to $26.4 trillion today. However, it has also become apparent in the past year through several analyses, including the Net Zero Tracker's, that many of the company emission reduction targets are of questionable quality (Bjørn et al., 2022; Net Zero Tracker, 2022; Day et al., 2023b).

National government net zero targets underpinned by legislation or policy documents increased substantially in two-and-half years

Figure 1 shows that the number of net zero targets set by national governments has not increased significantly since December 2020. However, many countries have increased the degree to which these policies are set out in formal documentation. Today we count more than 70 countries with net zero targets either enshrined in legislation or outlined as a goal in policy documents. These countries account for about 75% of total GHG emissions covered by national net zero targets (or two-thirds of global total GHG emissions), a massive increase from less than 10% in December 2020 (Figure 3).

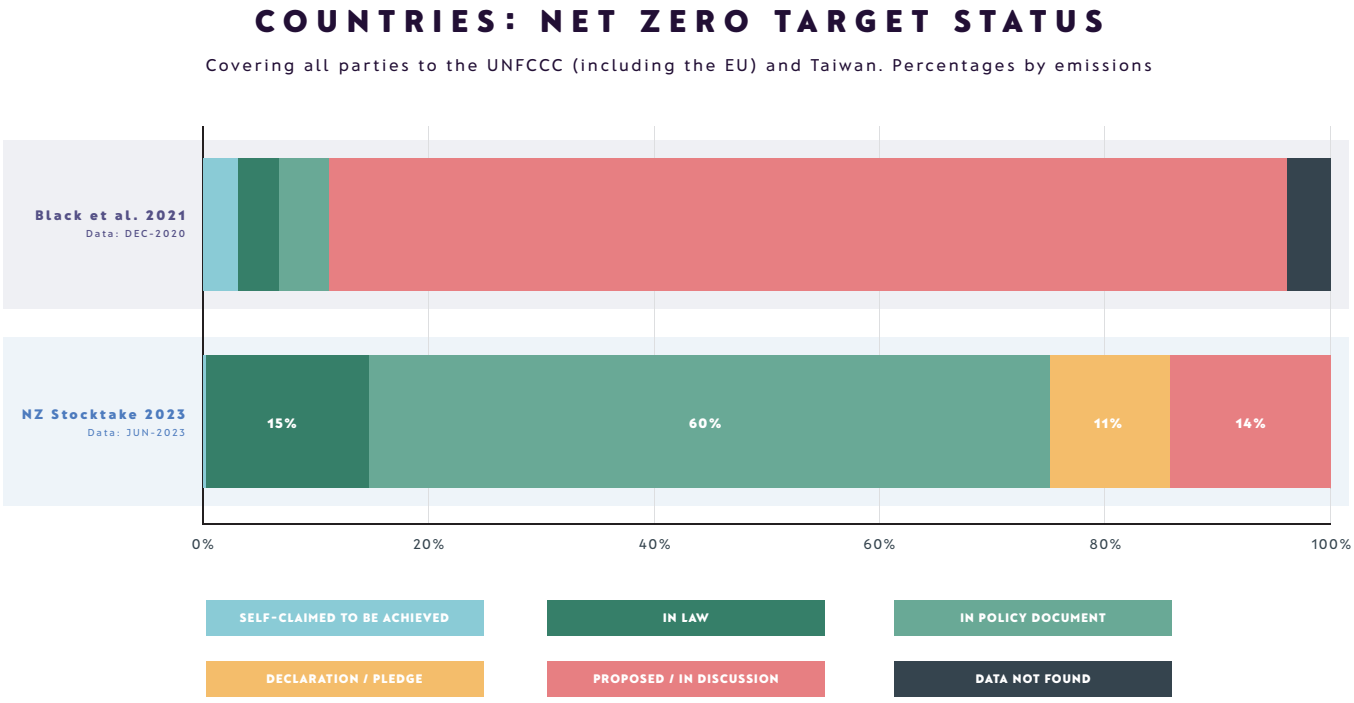


Figure 3: Status of national net zero targets: comparison between Black et al. (December 2020) and this report's (June 2023) datasets. 'In policy document' for the December 2020 results also include declarations and pledges. Percentages are with respect to set of countries with a net zero targets, not to all countries.

A significant share of subnational and corporate entities still lack any emission reduction target, at the global level and within the G7

States & regions

The GHG emissions covered by subnational state & region-level net zero targets account for about one-third of total emissions from the 25 countries whose states and regions we include in the Net Zero Tracker database (Figure 4). The estimation assumes that the states & regions' emission coverage in a country is proportional to their share of the national population.

The share of national emissions covered by states & regions' net zero targets is similar for G7 countries and China, at around 40-50%. Within the G7, high coverage rates for a few countries (e.g. Japan, Germany, UK) are counterbalanced by low rates in other countries, including the USA (Figure 4). The emission coverage for the rest of the 25 countries in the database remains low at around 20%.

Across all 25 countries, any kind of emission reduction target is entirely lacking for states and regions that account for more than 40% of emissions. The results are concerning, given that all but three[7] of the 25 countries have set net zero targets; the lack of climate targets at the subnational level may hinder implementation of national net zero targets.

Among G7 countries, about 20% of emissions come from states and regions that have only set have emission reduction targets for 2030 or earlier. These entities should also urgently set net zero targets soon. States & regions with long-term, non-net zero emission reduction targets may also consider setting clear (net) zero emission targets. (See Table A-3 in Appendix III for the 50 largest states & regions, by population, without an identified net zero target.[8])

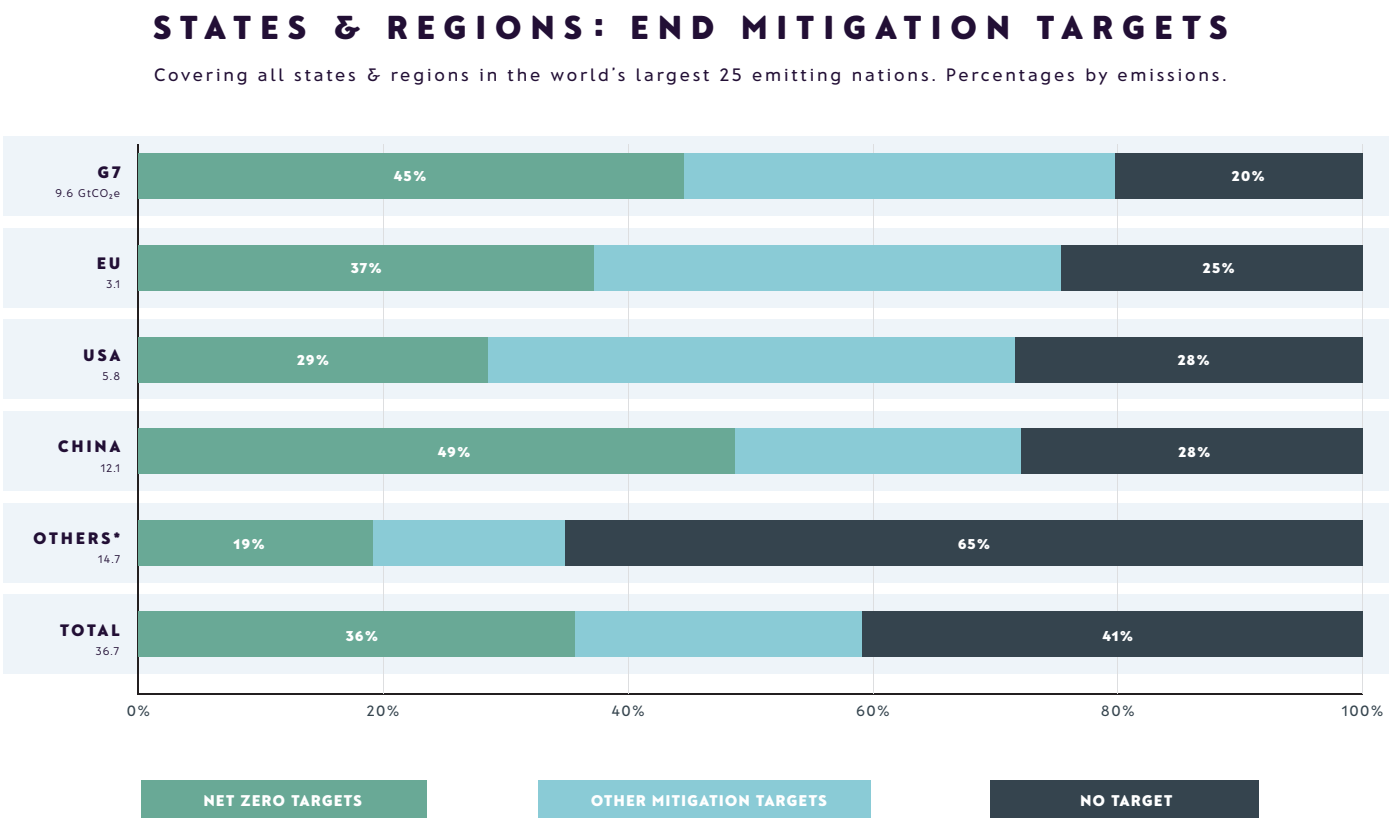


*Figure 4: Breakdown of national GHG emissions coverage by subnational state- and region-level GHG mitigation targets per end-year targetype for different country groups. Annual GHG emissions (2021) are also presented. *'Others' include those in the world's largest 25 emitting countries besides G7 members, the EU and China: Australia, Brazil, India, Indonesia, Iran, Kazakhstan, Mexico, Malaysia, Poland, Russia, Saudi Arabia, South Africa, South Korea, Spain, Taiwan, Thailand and Turkey. 'Other targets' include non-greenhouse gas targets.*

7. Iran, Mexico and Poland.
8. As at 1 June, 2023.

Cities

The 252 cities with net zero targets account for over one-third (37%) of the 2.1 billion people living in cities with populations over 500,000 (hereinafter, 'large cities') that are covered in the Net Zero Tracker database (Figures 1 and 2). Across G7 countries, about 70% of people living in large cities are covered by net zero targets; the same figure holds for the EU (Figure 5).

A low population coverage rate is observed for Chinese cities, but this may change in the coming years as implementation of the national carbon neutrality target is delegated to the subnational level. As with subnational states and regions, we could not identify any GHG mitigation target for cities that account for more than half of this 2.1 billion urban population. (See Table A-3 in Appendix III for a list of the 50 largest cities, by population, without an identified net zero target.[9])

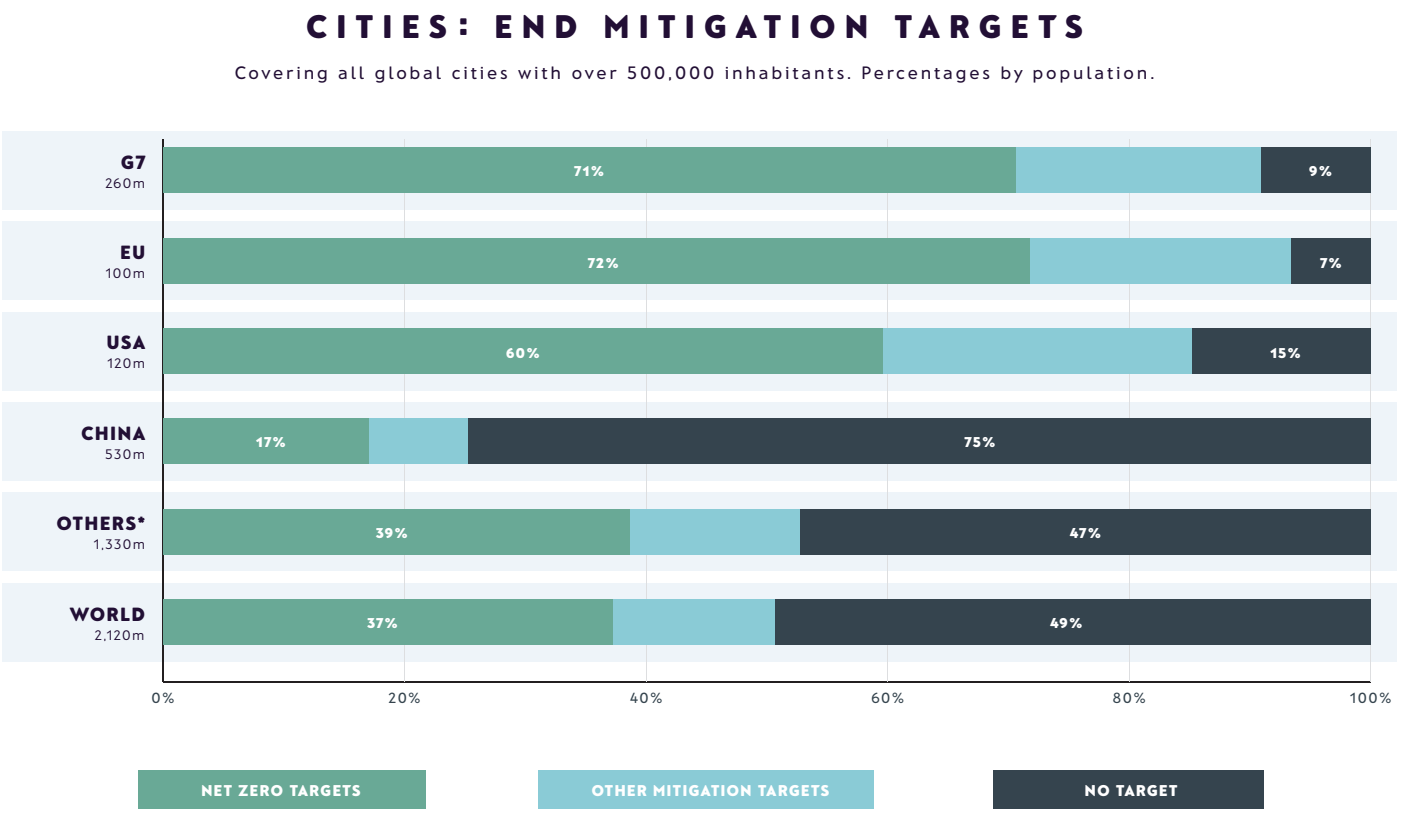


*Figure 5: Breakdown of end mitigation targets (by population) in cities with over 500,000 inhabitants. *'Others' include those in the world's largest 25 emitting countries besides G7 members, the EU and China. See full country list in the Figure 4 caption above.*

9. As at a June, 2023.

Companies

Although the number of corporate entities setting net zero targets has more than doubled in the last two and a half years, as mentioned above, this still means that most entities in the Forbes 2000 lack a net zero goal. Furthermore, the Net Zero Tracker could not identify any mitigation target for nearly 40% of companies (Figure 6). Companies headquartered in G7 countries do not fare much better than the global average — no target was identified for nearly 30% of them. Even among EU-headquartered companies, over 10% do not have either a net zero or other mitigation target. The share of Chinese companies without any mitigation target was almost 90%, reflecting the ongoing challenge of operationalising national targets across its economy.[10]

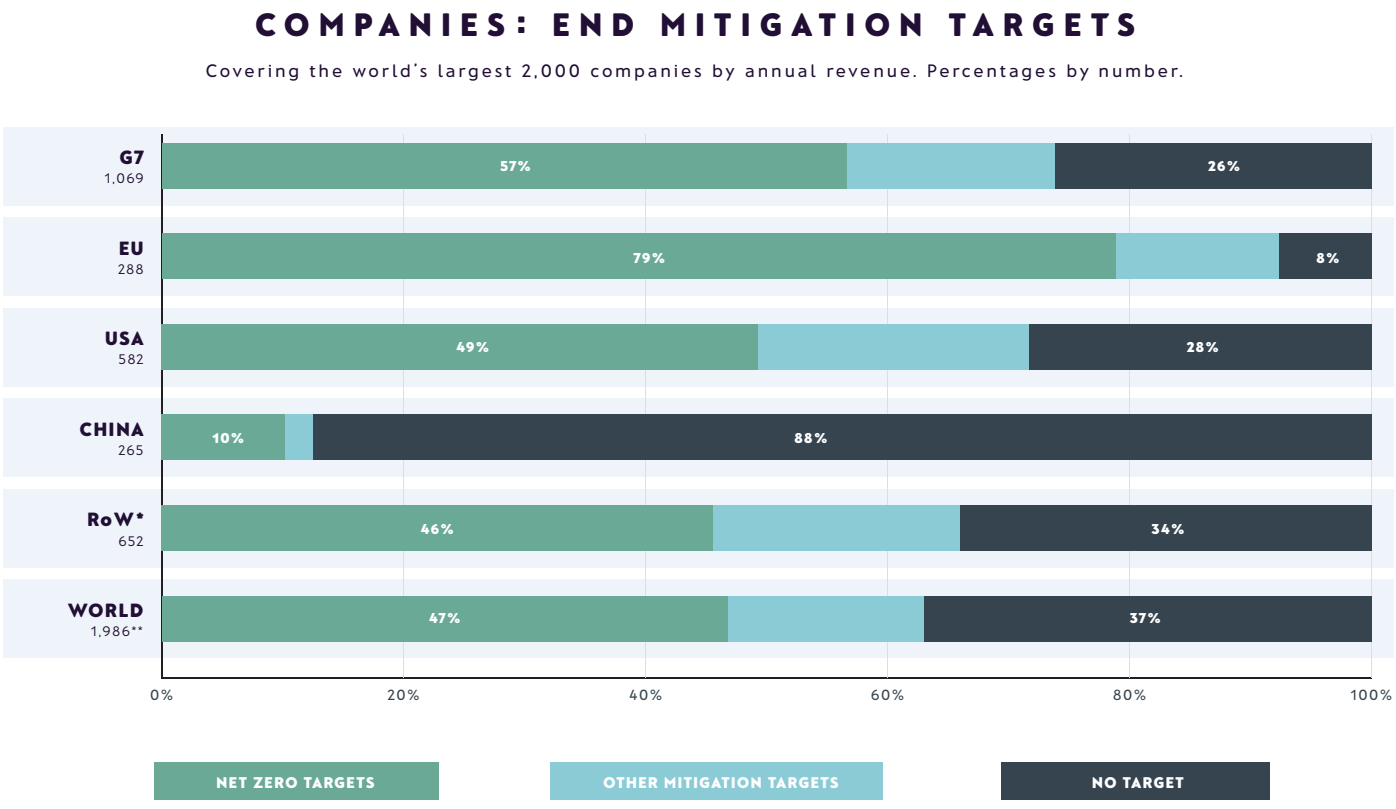


***Figure 6**: Breakdown of end mitigation targets for those Forbes Global 2000 companies in the Net Zero Tracker database. *Rest of the World (RoW) **The global total is 1,986 because some companies have been acquired or moved to private ownership.*

Although the Net Zero Tracker does not look in depth at the credibility of individual company targets, this is covered in several recent studies (e.g., Climate Action 100+, 2022; Mooldijk et al., 2022; Shugar et al., 2022; TPI, 2022; Day et al., 2023b; Odawara and Hirata, 2023). These all highlight the fact that omissions, caveats and distortions often mean a company's commitment is far weaker than the headline target would indicate. Furthermore, the Forbes 2000 publicly-listed companies are not the worst

10. It also reflects the ongoing challenge of data collection for Chinese entities, relating to language and accessibility constraints.

performing company group in the world. Our 2022 analysis, Everybody's Business, scrutinised the world's 100 largest private companies by revenue, showing that less accountable private firms are performing significantly worse on net zero target setting and measures of integrity compared with their publicly-listed counterparts (Net Zero Tracker, 2022b). (See Table A-3 in Appendix III for a list of the 50 largest publicly-listed companies, by annual revenue, without an identified net zero target.[11])

The US Inflation Reduction Act

Since our Net Zero Stocktake 2022 report, major emitters have implemented policies that will speed up the net zero transition, most notably the Inflation Reduction Act (IRA) in the US and the Net Zero Industry Act (NZIA) in the EU. While the Russian invasion of Ukraine has led to pockets of short-term investment in fossil fuel infrastructure (e.g. LNG terminals), the longer-term energy security response will accelerate the deployment of renewables and other clean technologies. Through measures including tax breaks, the $369bn IRA is set to catalyse several trillions of dollars more of private-sector investment in low-carbon technologies and industries. International Energy Agency (IEA) Executive Director Fatih Birol has hailed the US IRA as the most important climate action since the 2015 Paris Agreement.

This changing real world context is yet to be reflected in many of the largest US-based companies' net zero ambition, with 51% yet to set a net zero target. Furthermore, the relatively large share of US companies with non-net zero targets in or before 2030 (16%) and no targets (28%) highlight that almost half do not have long-term decarbonisation strategies. With IRA set to fast-track emission reductions over the coming years, and increase the availability and deployment of low-carbon technologies such as electric vehicles and renewables, greater onus may fall on the half of the US's largest 582 companies that do not have net zero targets.

And while EU companies are ahead of their US counterparts with 79% having now set a net zero target, greater investment, led by the NZIA, should encourage these companies to enhance the integrity of their net zero strategies, particularly near-term ambition on interim targets to limit cumulative emissions. Clearer and stronger government-level policy usually leads to greater private-sector investment, which, in turn, enables those governments to be yet more ambitious — the 'net zero ambition loop'.

Company sectors

Industrial sectors vary significantly in their target setting status (Figure 7; see Appendix II for details on the sector classification). As identified in the Net Zero Stocktake 2022, sectors that are generally considered the main contributors to climate change, such as the **Fossil Fuels** and **Power Generation** sectors, have among the highest percentages with net zero targets (see later subsections for more discussion and analysis).

11 As at 1 June, 2023.

The **Biotech, Health Care & Pharma**, **Infrastructure**, and **Services** sectors have particularly high percentages of companies without any emission reduction target at all. These findings call for urgent action from companies in these sectors to take the first step towards reducing emissions.

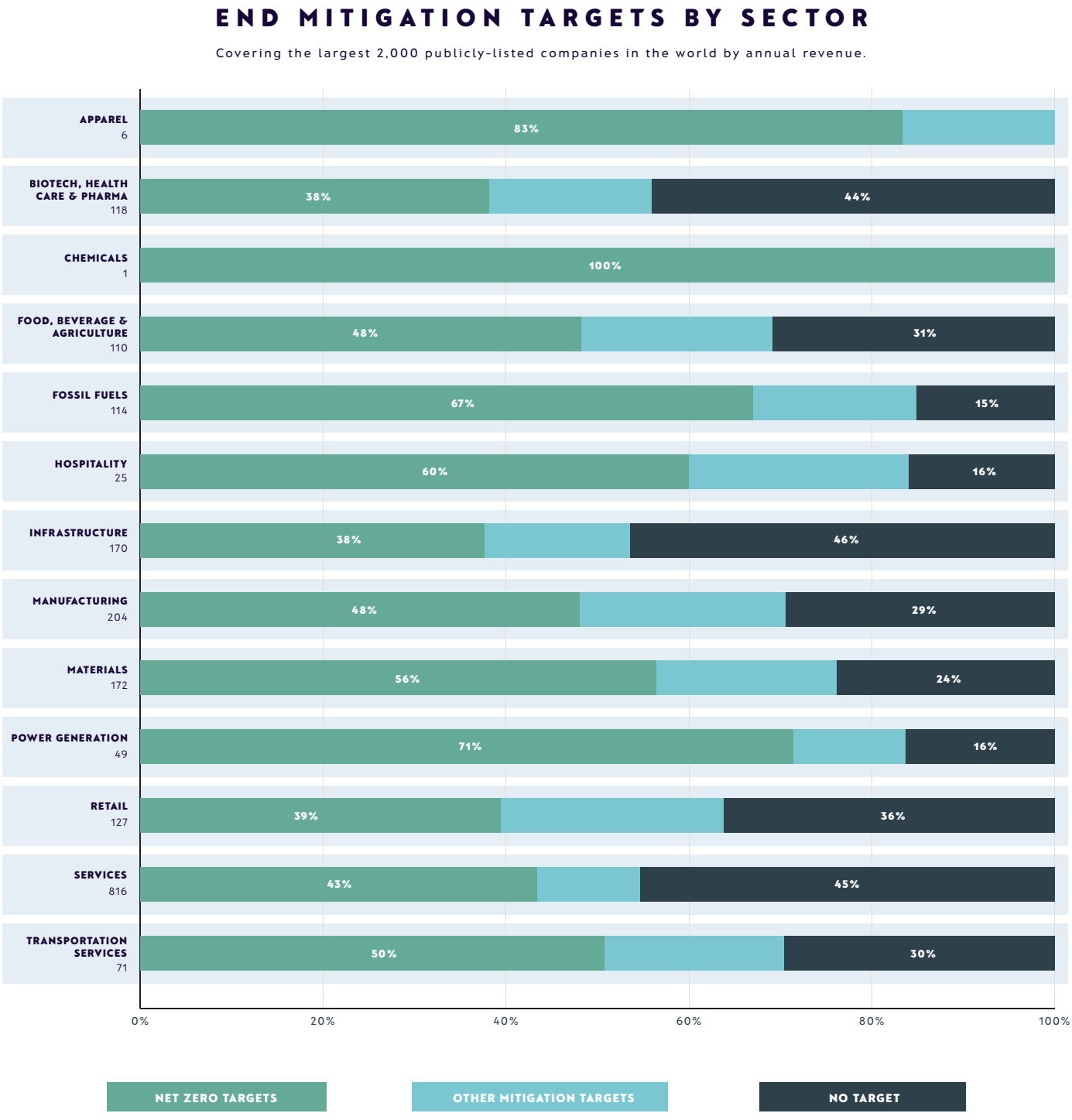


Figure 7: End target types of of Forbes 2000 companies per CDP-ACS industry group.

Collectively, there are limited signs of improvement in subnational and corporate net zero integrity

The Net Zero Stocktake 2022 report assessed all subnational and corporate net zero targets against procedural and substantive criteria applied to the partners of the UNFCCC Race to Zero campaign (see Appendix I for details). The entity must:

1. set a specific net zero pledge (by 2050 for entities within OECD countries)
2. include all GHGs (all emission scopes in case of companies)
3. clarify conditions on the use of offsetting
4. publish a plan on how it intends to achieve its interim and long-term targets
5. implement an immediate action to proceed on its commitments
6. publish annual progress reports on both their target achievements and measures undertaken annually.

Our up-to-date assessment based on the June 2023 dataset indicates that trends remaine similar for most indicators across different entity groups: national governments, subnational states and regions, cities, and companies.[12] Subsequently, we observe little progress on the percentage of entities that meet all six Race to Zero criteria (Table 1). These results indicate that there will hardly be any non-state and subnational entities that would meet all the recommendations in the recent UN Expert Group's report, the ISO Net Zero Guidelines (ISO, 2022; UN HLEG, 2022), or in other recently-published sets of standards. (see Section 4 for a detailed assessment of the recent developments of net zero integrity standards, guidelines and assessment frameworks).

For companies, several recent analyses highlight the lack of Scope 3 emissions coverage and the unregulated use of offsets as key concerns that undermine the integrity of corporate net zero targets (Day et al., 2023b), which is why they became part of the starting line criteria of the Race to Zero campaign from June 2022 (Race to Zero, 2022a).

However, in this analysis we observe little progress for both indicators; only 37% of corporate net zero targets fully cover scope 3 emissions (on a self-reporting basis, compared to 38% in the 2022 Stocktake report) and only 13% specify quality conditions under which any offsets would be used (compared with 12%) (see Appendix III, Figure A-1 and A-2).

12. Up-to-date results can be found in our recently-launched Net Zero Tracker Data Explorer.

Table 1: Percentage of net zero pledges by non-state entities that meet the Race to Zero campaign's starting line criteria (ver.3.0) as at 1 June, 2023. The results are compared with the findings in last year's Net Zero Stocktake 2022 report (Net Zero Tracker, 2022).

Entity group	Meeting Race to Zero's 'Starting Line' 3.0[13]
States & regions	3% (4 of 145) No change from June 2022
Cities	3% (7 of 252) No change from June 2022
Companies	4% (38 of 929) Up from 3% in June 2022

More entities clarify their intention to use carbon dioxide removals within their value chain

To keep warming to 1.5°C. rapid emission reductions need to be accompanied by carbon dioxide removal (CDR) (IPCC, 2022). However, the international community has raised serious concerns over many non-state actors' unrealistic and/or excessive dependence on CDR to achieve their net zero emission targets (e.g., UN HLEG, 2022). Companies can use carbon credits from CDR projects to claim achievement of their target or they may use CDR within their value chain. Our data shows that a significant percentage of companies plan to use carbon offset credits without clear conditions to claim achievement of their net zero targets in the future (see Figure A-2 in the Appendix III). While we do not track whether companies plan to source their carbon credits from emission reduction or CDR projects, other research indicates that a large majority of global corporates expect to buy carbon credits from reforestation and afforestation projects (Day et al., 2023b). Our most recent data shows that at least 25% of companies plan to use CDR to achieve their net zero targets (Figure 8). This number includes corporates that plan to procure carbon credits from CDR projects outside their value chain and companies that invest in CDR within the value chain, also referred to as 'insetting'. For instance, a company in the food sector may claim that because of enhanced soil carbon sequestration on its farmers' lands, emissions elsewhere in the value chain are offset. Emerging literature has identified several cases of major global companies that plan for biological carbon storage within their value chain to achieve their net zero targets (e.g., Day et al., 2023b). 'Insetting' with CDR is potentially even more problematic than offsetting with verified carbon credits from CDR projects, because the companies may not seek independent measurement and verification of the CDR projects they implement (Day et al., 2023b; Mardirossian and Arnold, 2023).

The national governments that account for about 70% of global GHG emissions explicitly consider some

13. Version 3.0 of the Race to Zero Starting line except for external policy and engagement. Condition to commit to '(net) zero GHGs as soon as possible, and by mid-century at the latest' not applied non-OECD countries to account for fairness and equity considerations.

form of CDR within their national borders to achieve net zero emissions. While there are limits to how much and how quickly CDR can be deployed, the amount of CDR that countries are planning for falls short of what is required in IPCC scenarios to meet the Paris Agreement's long-term temperature goal (Smith et al., 2023). The percentage of subnational state and regional governments explicitly considering CDR has increased considerably since 2022 (Figure 8). The increase is mainly due to the recent identification of Chinese provinces that set carbon neutrality targets and consider "nature-based solutions" as part of their achievement plans.

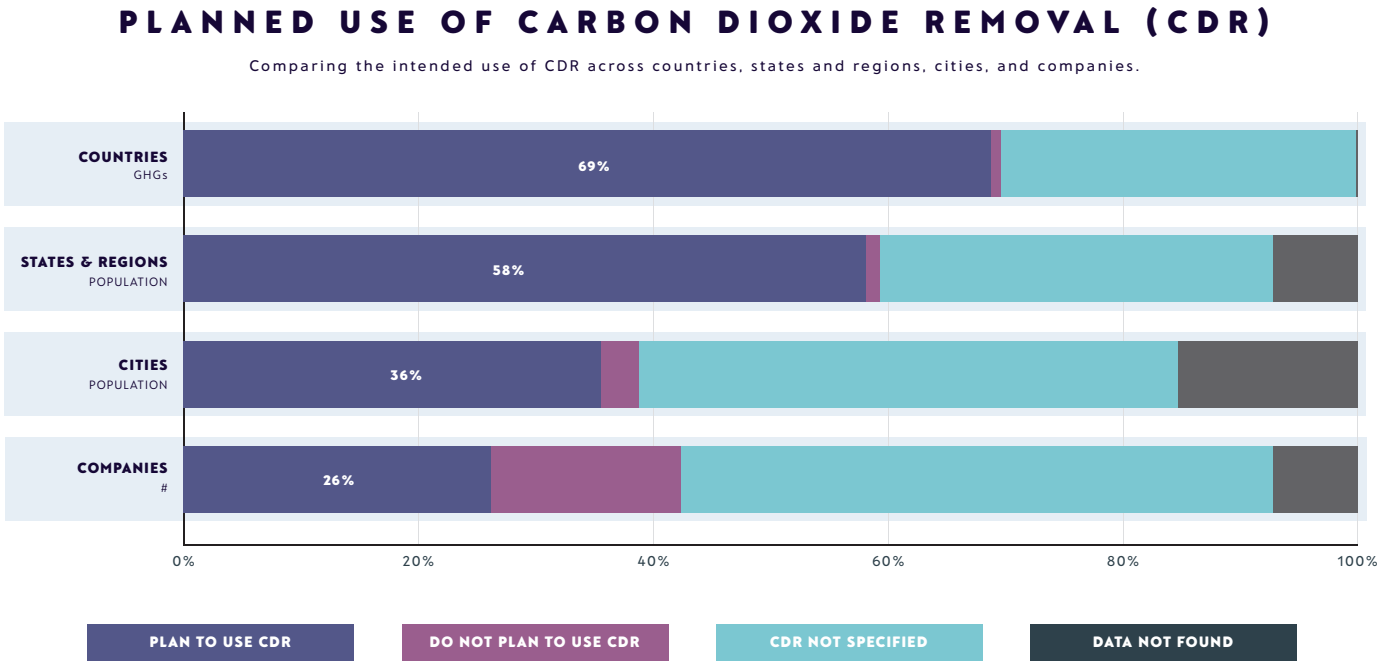


Figure 8: Consideration of carbon dioxide removals within the net zero target boundary across national and subnational governments as at 1 June, 2023. For companies, the percentage includes corporates that plan to source carbon credits from carbon dioxide removal projects outside their value chain and those that plan for carbon dioxide removals within their value chain.

Fossil fuels: Despite net zero pledges, no major producer countries or companies have committed to a fossil fuel phase-out

One of the key political issues in the lead-up to the UAE-hosted COP28 is fossil-fuel producing countries' decarbonisation commitments. Both the IPCC and IEA have shown that deep cuts in fossil fuel consumption and production are essential components in delivering the Paris Agreement targets; projected cumulative CO_2 emissions from existing fossil fuel infrastructure already exceed the remaining carbon budget to keep warming to 1.5°C with limited or no overshoot (IPCC, 2022).

Last year's UN expert group report outlined that a credible net zero target "should include specific targets aimed at ending the use of and / or support for fossil fuels in line with IPCC and IEA pathways," and not include plans to open up new oil or gas production capacity. To keep the Paris Agreement's temperature goal of 1.5°C alive, the IPCC projects that the use of fossil fuels without carbon capture and storage (CCS)

needs to be reduced by 95% for coal, 60% for oil, and 70% for gas by 2050 (IPCC, 2022). The IEA's net zero by 2050 scenario is even more ambitious: a 98% decline in coal, 75% decline in oil, and 55% decline in gas by 2050 (IEA, 2021).

At a national level, many of the top 10 producers of coal, gas, and oil are also among the largest (territorial) GHG emitters in the world; three countries (China, Russia, USA) are ranked among the top 10 producers for all three fossil fuels while four other countries (Australia, Canada, Iran, Saudi Arabia) are top 10 producers in two (Table A-2) (EIA, 2023). Although the UN Expert Group report applies overtly to non-state entities rather than countries, the IEA report that underlies it is clearly relevant to national governments in terms of both production by national oil and gas companies and licensing of development within their sovereign territories.

Despite the greenwashing criticism directed at fossil fuel companies, more have pledged net zero targets since our previous stocktake. The number has increased from 51 in June 2022 to 75, or 67% of all fossil fuel companies in the Net Zero Tracker database (Figure 7). However, most of these 75 targets do not fully cover or do not clarify coverage of Scope 3 emissions (the largest scope of emissions by far for fossil fuel companies), making them largely meaningless (Figure A-3 in Appendix IV).[14]

To further align with the UN Expert Group's recommendations, the Net Zero Tracker is preparing to introduce a new indicator that assesses whether entities intend to phase out fossil fuels. For this report, we piloted the indicator against the 112 fossil fuel companies in our database. These companies are categorised under the following CDP activity categories: coal mining, oil & gas extraction & production, oil & gas processing, oil & gas retailing, oil & gas storage & transportation. On the country side, existing research and analysis indicate that none of the top 10 producers of coal, gas and oil have committed to phasing out production (Climate Action Tracker, 2023; Fossil Fuel Non-Proliferation Treaty Initiative and University of Sussex, 2023).

We selected five sub-elements to form the basis of our new fossil fuel indicator, focussing mainly on *extraction* rather than use to align with the IEA and UN Expert Group reports:[15]

1. No new coal mines or extensions from 2023[16]
2. No new coal-fired power stations from 2023
3. End coal-fired generation completely by 2030 for OECD countries and 2040 for non-OECD nations
4. End exploration for new oil and gas fields and the expansion of current reserves from 2023
5. A commitment to phase out oil and gas production by 2050.

14. The Science Based Targets initiative (SBTi) even publicly acknowledged the flaws with their own standards for fossil fuel companies; in March 2022 they paused the validation of fossil fuel company targets until a new, and more robust, sector guidance is developed (SBTi, 2022b).
15. The UN expert group's recommendations focussed on fossil fuel extraction and production, not their consumption (UN HLEG, 2022).
16. The UN expert group's recommendations were only published in November 2022 hence it is reasonable to expect commitments to begin emerging this year.

We found that no fossil fuel companies are making the necessary commitments to fully transition away from fossil fuel extraction or production. Engie (France), Naturgy Energy Group (Spain), NiSource (US) and Origin Energy (Australia) show signs of alignment, with all four companies planning to end their involvement in coal-fired generation. However, none of these companies plans to transition away from its oil and gas assets or associated businesses.

Table 2: A count of how many Fossil Fuels companies in the Net Zero Tracker database (114) have committed to phasing out coal mining (1), coal-fired electricity generation (2, 3), and oil & gas exploration (4) and production (5). The figure in brackets represents the number of companies we found active in these respective areas from the overall total.

Phasing out fossil fuels indicator sub-elements	*1. No new coal mines or extensions from 2023*	*2. No new coal-fired power stations from 2023*	*3. End coal-fired generation completely by 2030 for OECD nations and 2040 for non- OECD nations*	*4. End exploration for new oil & gas fields and the expansion of current reserves from 2023*	*5. A commitment to phase out oil & gas production by 2050*
Count of commitments	**2** (19)	**2** (23)	**4** (23)	**0** (96)	**0** (97)

Of the 114 fossil fuel companies in total, 77 have pledged a net zero target (or similar), 75 of which are to be achieved 'by 2050'. It is worth noting that most of these companies (107) are headquartered within G20 nations, 19 of which have a net zero target by mid-century.

Achieving credible net zero requires the phasing down and out of fossil fuel extraction and use, with any residual emissions being removed by like-for-like[17] carbon dioxide removal later in the century. For the 77 fossil fuel companies with net zero targets, as well as those without them, they should reflect on the UN Expert Group's fifth recommendation that a fossil-fuelled future is incompatible with what 195 nations agreed to in 2015 when they signed the Paris Agreement. The UN expert group also clarified that the focus should not just be on transitioning away from fossil fuels by mid-century, but 'must be matched by a fully funded transition toward renewable energy.'

17. When a source of emissions and an emissions sink correspond in terms of their warming impact, and in terms of the timescale and durability of carbon storage. See the UNFCCC's Race to Zero Lexicon for more information.

4. Net zero integrity: convergence of standards, guidelines & accountability frameworks on company net zero target setting

Key messages

- In the absence of universal and binding net zero-related policy and regulation, voluntary standards, guidelines and accountability frameworks provide guidance to corporate entities on how to pursue net zero with integrity.
- **Broadly, guidance converges at the high-level, but more specificity is required to make pathways clearer for all entities wishing to set credible and robust net zero targets**.
- **The most recent guidance represents significant progress on specific recommendations and guidelines for corporate entities**, through the release of the UN Expert Group's report in 2022, the ISO Net Zero Guidelines in 2022, the Race to Zero (RtZ) Starting Line and Leadership Practices 3.0 criteria in 2022, the updated Science Based Targets initiative (SBTi) Corporate Net Zero Standard in 2023 and the updated Corporate Climate Responsibility Monitor (CCRM) methodology in 2023.
- The standards, guidelines and accountability frameworks show high levels of convergence on guiding principles and specific criteria for operationalisation for the scope coverage of emission reduction targets and time intervals for interim emission reduction targets.
- For the first time, the UN Expert Group, ISO Net Zero Guidelines, the Race to Zero and the CCRM introduces language that mandates fossil fuel phase-out as part of a net-zero strategy.
- While the voluntary standards, guidelines and accountability frameworks show a moderate level of convergence on guiding principles, other key dimensions of net zero strategies require further convergence on specific criteria for operationalisation. These include, among others, specific requirements for 1.5°C-aligned emission reduction target setting or the use of offsetting claims.
- There are more areas where further guidance is needed in the voluntary landscape, namely recommendations on fossil fuel financing within a net zero strategy, and how to define equitable target-setting.
- There is a gap in the ecosystem when it comes to holding non-state entities accountable for their net zero claims. Ultimately, regulation is needed, as recommended by UN Expert Group (10th recommendation). By their nature, voluntary standards, guidelines and accountability frameworks do not offer a regulated accountability system, whereas most regulation is currently limited to disclosure. Opportunities for increasing accountability include mandating transition plans, conditioning procurement to firms and products to meet net zero standards, subjecting products and services claiming net zero to transparent standards. Policymakers can use good practice from voluntary guidance and standards, and identify areas of high consensus among the voluntary initiatives, to form the basis of regulation.

Analysis

The proliferation of company net zero targets has led to concern about the integrity of these targets and underlying plans. As it stands, net zero-related policy and regulation is largely limited to climate- or sustainability-related risk disclosure, which is or will soon be mandatory in jurisdictions that account for nearly half of global GDP (48% of 2021 GDP) (Race to Zero, 2022b). Voluntary initiatives and standards have sought to fill the integrity gap to ensure that corporate entities are pursuing legitimate net zero pathways across the planning, implementation, and reporting phases.

This section provides an overview of the key documents on company net zero targets released since COP26, including five voluntary standards, guidelines, membership requirements and accountability assessments (hereinafter: the five initiatives). These include the UN Expert Group's report (UN HLEG, 2022), the ISO Net Zero Guidelines (ISO, 2022), the SBTi Corporate Net Zero Standard (SBTi, 2023), the Corporate Climate Responsibility Monitor methodology (Day et al., 2023a) and the Race to Zero Starting Line and Leadership Practices 3.0 criteria (Race to Zero, 2022a). The analysis is contextualised by Oxford Net Zero's mapping of key net zero criteria across 33 voluntary initiatives and standards to trace common and emerging good practice (McGivern et al., 2022).

Our comparative analysis focuses on the following five key *mitigation-related* dimensions of corporate net-zero target setting, namely:

1. The **coverage of emission scopes** including scope 1, scope 2, upstream and downstream scope 3, and non-GHG climate forcer effects, and other climate forcer effects
2. The **time intervals of interim emission reduction targets** towards a net zero target year
3. The specification of **1.5°C-aligned emission reduction targets** alongside a net zero pledge. These include minimum emission reductions required to make the net-zero terminology meaningful and the mandated compliance with 1.5°C-aligned decarbonisation milestones in the literature
4. The specification of **1.5°C-aligned transition plans** underpinning a net zero pledge. These include emission reduction measures towards 2030, the phase-out of fossil fuels and emission-intensive products, and the alignment of lobbying and advocacy activities
5. **Offsetting with carbon credits, or carbon dioxide removals inside the value chain**. This includes offsetting to claim achievement of interim and net zero targets, and requirements to ensure the integrity of any offsetting approach.

These five key dimensions were selected as they are relevant for transparent, comprehensible and ambitious corporate target-setting in light of the IPCC's Sixth Assessment Report's findings on the need for deep and credible emission reductions towards mid-century to stand a reasonable chance of limiting global warming to 1.5°C (see Table SPM.1 in: IPCC, 2023). We compare each key dimension in terms of their level of convergence on **(a) guiding principles**; and **(b) specific criteria for operationalisation**.

*Table 2: Comparison of the UN Expert Group (UN HLEG, 2022), the ISO Net Zero Guidelines (ISO, 2022), the Race to Zero Starting Line and Leadership Practices 3.0 (2022), the updated SBTi Corporate Net Zero Standard (SBTi, 2023), the updated Corporate Climate Responsibility Monitor methodology (CCRM, 2023) and a summary across 33 initiatives (McGivern, 2022) in terms of their level of convergence on **(a) guiding principles** and **(b) specific criteria for operationalisation** across key mitigation-related dimensions.*

WHAT DOES 'GOOD NET ZERO' LOOK LIKE?

We investigate where there is net zero target setting convergence across emerging voluntary global standards

LEVEL OF SPECIFICITY FOR OPERATIONALISATION	LEVEL OF CONVERGENCE ON PRINCIPLES		UN High-level Expert Group on the Net Zero Emissions Commitments of Non-State Entities	International Organization for Standardization's 'ISO Net Zero Guidelines'	UN Race to Zero (RtZ) Starting Line and Leadership Practices 3.0	Science Based Targets initiative's 'Net Zero Standard'	Corporate Climate Responsibility Monitor (2023)	SUMMARY OF 33 OTHER INITIATIVES University of Oxford's 'Defining Net Zero for organisations' report (McGivern et al, 2022)
1. COVERAGE OF EMISSION SCOPES	HIGH	HIGH	ALL SCOPES	ALL SCOPES	ALL SCOPES	OVER 90% ACROSS ALL SCOPES	ALL SCOPES	ALL SCOPES (ACCORDING TO 75% MAJORITY OF INITIATIVES)
2. INTERVALS OF INTERIM TARGETS	HIGH	HIGH	5 YEARS	2-5 YEARS	NOT SPECIFIED	5-10 YEARS	5 YEARS	5 YEARS FROM 2030 (SOME FROM 2025)
3. 1.5°C-ALIGNED EMISSION REDUCTIONS	MODERATE	MODERATE						
• RECOMMENDATION TO ALIGH WITH 1.5°C COMPATIBLE PATHWAYS	HIGH	N/A	YES	YES	YES	YES	YES	YES (BUT WEAK CONSENSUS ON WHAT CONSTITUTES PARIS-ALIGNED AMBITION)
• MINIMUM REDUCTION FOR 'CREDIBLE NET ZERO'	MODERATE	MODERATE	NOT SPECIFIED	OVER 95% (INCLUDING SCOPE 3 (FOR MOST SECTORS)	NOT SPECIFIED	OVER 90% (OVER 72% FOR FOREST, LAND AND AGRICULTURE SECTOR)	OVER 90%	UNCLEAR (FOR INITIATIVES THAT DEFINE RESIDUAL EMISSIONS, MINIMUM OF 90% MENTIONED)
• SPECIFIC REQUIREMENTS TO COMPLY WITH 1.5°C-ALIGNED MILESTONES	MODERATE	LOW	NOT SPECIFIED	YES	NOT SPECIFIED	YES	YES	NOT COVERED
4. 1.5°C-ALIGNED TRANSITION PLANS	MODERATE	LOW - MODERATE						
• SPECIFIC REQUIREMENTS TO SET 1.5°C-ALIGNED EMISSION REDUCTION TARGETS TO 2030	LOW - MODERATE	LOW	NOT SPECIFIED	NOT SPECIFIED	NOT SPECIFIED	YES	YES	YES (FOR THOSE INITIATIVES THAT SPECIFY A REDUCTION PACE)
• SPECIFIC REQUIREMENTS FOR TRANSITION PLANS AND / OR KEY MITIGATION AREAS TO 2030	MODERATE	MODERATE	YES	YES	NOT SPECIFIED	NOT SPECIFIED	YES	NOT COVERED
• FOSSIL FUEL PHASE-OUT	MODERATE	LOW - MODERATE	REQUIRED	REQUIRED	REQUIRED	NOT SPECIFIED	REQUIRED	NOT COVERED
• ALIGNING LOBBYING & ADVOCACY	HIGH	LOW - MODERATE	REQUIRED	REQUIRED	REQUIRED	NOT SPECIFIED	NOT SPECIFIED	ENCOURAGED (BY JUST OVER HALF OF THE 33 INITIATIVES)
5. OFFSETTING WITH CARBON CREDITS & CDR INSIDE THE VALUE CHAIN	MODERATE	LOW						
• TO ACHIEVE INTERIM EMISSION REDUCTIONS	HIGH	LOW - MODERATE	NOT ALLOWED	NOT ALLOWED	RECOMMENDS PRIORITISING REDUCTIONS OVER OFFSETTING	NOT ALLOWED	NOT ALLOWED	MIXED
• TO CLAIM NET ZERO	MODERATE	LOW - MODERATE	ALLOWED	ALLOWED	ALLOWED	ALLOWED	NOT RECOMMENDED	NOT COVERED
• CRITERIA FOR HIGH QUALITY CREDITS AND/OR CDR WITHIN THE VALUE CHAIN	MODERATE	LOW	NOT SPECIFIED	SPECIFIED	NOT SPECIFIED	NOT SPECIFIED	SPECIFIED	MIXED

4.1. Coverage of emission scopes for interim targets and net zero pledges

Table 3: Comparison across five initiatives and a summary across 33 initiatives (McGivern, 2022) on the net zero targets' coverage of emission scopes in terms of their level of convergence on (a) guiding principles and (b) specific criteria for operationalisation.

Convergence on guiding principles	Specific criteria for operationalising	UN Expert Group (2022)	ISO Net Zero Guidelines (2022)	Race to Zero (v3, 2022)	SBTi Net Zero Standard (2023)	Corporate Climate Responsibility Monitor (2023)	Summary across 33 initiatives (2022)
HIGH	HIGH	**All scopes** 'Scope 1, 2 and 3 emissions for businesses'	**All scopes** 'Scope 1, 2 and all "relevant" s3 emissions'	**All scopes** 'Scope 1, 2 and 3 emissions for businesses'	**Over 90% across all scopes** 95% of scope 1 and 2; 90% of scope 3 for long-term targets	**All scopes** Scope 1, 2 and 3 emissions and non- GHG climate forcer)	Over three quarters of surveyed initiatives recommend inclusion of all scopes, as per GHG Protocol Guidance

The five initiatives show a **high level of convergence** both on guiding principles and specific criteria for their operationalisation, mandating that net zero targets cover all emission scopes, namely scope 1, scope 2 and upstream and downstream scope 3 across all GHGs (see Table 3 above). Of the five standards assessed in detail, only the SBTi Net Zero Standard allows companies to explicitly exclude emissions as part of its 'expansive boundary' approach (SBTi, 2023; pp.33-36), for example up to 10% of scope 3 emissions and up to 5% of scope 1 and 2 emissions for long-term net zero targets. For the short- and medium-term, targets must only cover 67% of scope 3 emissions if scope 3 emissions are at least 40% of the total (scope 1, 2 and 3 emissions combined).

Across 33 initiatives assessed as of November 2022, over three quarters recommend targets should cover all emission scopes as per the Greenhouse Gas Protocol (Corporate) standard (GGPC) (McGivern et al., 2022). The GGPC initiated a revision process for all three protocols to be completed by 2025, although it remains unclear to what extent the process will consider findings on scope 2 emissions, scope 3 emissions, and wider climate forcer effects (for instance contrails from aviation as explained in the IPCC AR6 WGI report chapter (Szopa et al., 2021).[15]

15. For example, non-GHG climate forcers in the aviation sector such as the formation of contrail cirrus clouds can have climate effects which are temporarily larger than the CO2-induced effect of aviation (Lee et al., 2021)

4.2. Intervals of interim target towards a net-zero pledge's target years

*Table 4: Comparison across five standards and a summary across 33 initiatives (McGivern, 2022) on the time intervals of interim emission reduction targets towards a net-zero pledge's target year in terms of their level of convergence on **(a) guiding principles** and **(b) specific criteria for operationalisation**.*

Convergence on guiding principles	Specific criteria for operationalising	UN Expert Group (2022)	ISO Net Zero Guidelines (2022)	Race to Zero (v3, 2022)	SBTi Net Zero Standard (2023)	Corporate Climate Responsibility Monitor (2023)	Summary across 33 initiatives (2022)
HIGH	HIGH	**5 years** 2025, 2030 & 2035	**2 to 5 years**	**Not specified** 'Set an interim target... by 2030'	**5 to 10 years**	**5 years**	At least 50% of guidance initiatives stipulate an interim target, most recommend an initial target for 2030, while pace-setters recommend 2025

The five initiatives show a **high level of convergence** on mandating companies to set short- and medium-term interim targets towards 2030 (see Table 4 above). Most standards (ISO Net Zero Guidelines, UN Expert Group, CCRM) recommend intervals of five years or less between interim targets, while the SBTi Net Zero Standard requests a first interim target within 5 to 10 years from the net zero targets submission to SBTi (SBTi, 2023). The UN Expert Group further specifies interim target years of 2025, 2030 and 2035 (UN HLEG, 2022).

4.3. 1.5°C-aligned emission reductions alongside a net zero pledge

Table 5: Comparison across five initiatives and a summary across 33 initiatives (McGivern, 2022) on 1.5°C-aligned emission reductions alongside a net zero pledge in terms of their level of convergence on (a) guiding principles and (b) specific criteria for operationalisation.

	Convergence on guiding principles	Specific criteria for operationalising	UN Expert Group (2022)	ISO Net Zero Guidelines (2022)	Race to Zero (v3, 2022)	SBTi Net Zero Standard (2023)	Corporate Climate Responsibility Monitor (2023)	Summary across 33 initiatives (2022)
OVERALL	MODERATE	MODERATE						
Higher-level recommendation to align with 1.5°C compatible global pathways with no or limited overshoot	HIGH	NOT APPLICABLE	**Yes** 'Reach net zero in line with IPCC or IEA net zero GHG emissions modelled pathways that limit warming to 1.5°C with no or limited overshoot'	**Yes** 'Stay within the remaining carbon budget for a high likelihood of limiting global warming to 1,5°C above pre-industrial levels'	**Yes** '(Net) zero GHGs as soon as possible, and by 2050 at the latest, in line with the scientific consensus on the global effort needed to limit warming to 1.5C with no or limited overshoot'	**Yes** 'Limit warming to 1.5°C with no or limited overshoot reach net-zero CO2 emissions around 2050'	**Yes** 'Align with 1.5°C compatible emission pathways with no or limited overshoot'	While there is wide acknow-ledgement of global 1.5°C pathways with reference to the latest IPCC reports, there is **little consensus** amongst standards and voluntary initiatives regarding what **constitutes** 'Paris-aligned' ambition at the **corporate** level
Minimum reduction for 'credible net zero'	MODERATE	MODERATE	**Not specified**	**Target >95% including scope 3 for most sectors for net- zero targets by 2050** Varied by sector, illustrative examples of sectoral targets in Table 1; compared with 2020 emissions	**Not specified**	**>90% for all sectors** **>72% for Forest, Land and Agriculture (FLAG) sector** compared with base year emissions	**>90% for all sectors** compared with 2019 emissions	Across the landscape, there is not enough guidance or specific criteria as to how to define residual emissions. Those that do define residual emissions include 90% absolute emissions reduction as the necessary, but not sufficient, reduction to emissions
Specific requirements to comply with 1.5°C-aligned decarbonisation milestones	MODERATE	LOW	**Not specified** But general recommend ation to 'us[e] a robust methodology consistent with limiting warming to 1.5°C with no or limited overshoot verified by a third party'	**Yes** Through illustrative examples using SBTi's sector-specific and economy- wide 1.5°C pathways mentioned as one option	**Not specified** But general reference that entities should contribute to UNFCCC 2030 Breakthroughs	**Yes** By using SBTi's sector- specific and economy-wide 1.5°C pathways	**Yes** By using entire range of 1.5°C benchmarks identified in literature	Not covered

The five initiatives show a **high level of convergence** on guiding principles to limit global warming with no or limited overshoot. The UN Expert Group guidance specifically requires alignment "with IPCC or IEA net zero GHG emissions modelled pathways" (UN HLEG, 2022), while others refer more generally to 1.5°C-compatible scenarios with no or limited overshoot.

The initiatives show a **moderate level of convergence** on the minimum reduction of emissions to be considered a credible net zero target. The ISO Net Zero Guidelines underline a numerical goal of greater

than 95% for targets set for 2050, while SBTi and the CCRM underline a numerical goal of greater than 90% in the respective target year. We designate this as **moderate convergence** on guiding principles, mainly because neither the UN Expert Group nor the Race to Zero campaign require any minimum reduction target next to a net-zero pledge. While ISO Net Zero Guidelines, SBTi and the CCRM require such a minimum reduction target, we designate only a **moderate convergence** on specific criteria for operationalisation. For example, the SBTi Net Zero Standard allows each entity to define a base year against which its emissions target is set. This practice has been criticised as being a part of a 'shifting baselines' implementation that can impede ambitious progress (Rekker et al., 2022).

Guidance that net-zero pledges must align with specific 1.5°C-aligned decarbonisation milestones (UN Expert Group, ISO Net Zero Guidelines, SBTi, CCRM) shows a range of specificities. For example, the UN Expert Group makes only a high-level recommendation to use a robust methodology consistent with limiting warming to 1.5°C with no or limited overshoot, while CCRM includes an entire range of 1.5°C-compatible benchmarks identified in literature (see Table 4 in CCRM, 2023).

4.4. 1.5°C-aligned transition plans underpinning a net-zero pledge

Table 6: Comparison across five initiatives and a summary across 33 initiatives (McGivern, 2022) on 1.5°C-aligned transition plans underpinning a net-zero target in terms of their level of convergence on (a) guiding principles and (b) specific criteria for operationalisation.

	Convergence on guiding principles	Specific criteria for operationalising	UN Expert Group (2022)	ISO Net Zero Guidelines (2022)	Race to Zero (v3, 2022)	SBTi Net Zero Standard (2023)	Corporate Climate Responsibility Monitor (2023)	Summary across 33 initiatives (2022)
OVERALL	MODERATE	LOW - MODERATE						
Specific requirements to set 1.5°C-aligned emission reduction targets to 2030	LOW – MODERATE	LOW	**Not specified** But general reference to 'credible sector pathways consistent with limiting warming to 1.5°C with no or limited overshoot' and need for third-party verification	**Not specified** But minimum target to 'halve all types of GHG emissions every decade' to 'reflect maximum effort towards the full mitigation potential of the organisation, consistent with a fair share of 50 % global GHG emissions reduction by 2030'	**Not specified** But must generally reflect "maximum effort toward or beyond a fair share of the 50% global reduction in CO_2 by 2030"	**Yes** By using SBTi's economy-wide absolute annual reduction rates or SBTi's sector-specific intensity convergence	**Yes** By using entire range of 1.5°C benchmarks identified in the literature	Those that specify a reduction pace (only 8/33) all recommend compliance with a global 50% reduction of emissions by 2030, or at least as ambitious as the minimum of the approved range of compatibility with the 1.5°C goal as appropriate for sectors
Specific requirements for transition plans and/or key mitigation areas to 2030	MODERATE	MODERATE	**Yes** Including (1) estimated impact of emission reduction measures, (2) disclose how capital expenditure plans, R&D plans and investments align with targets, (3) detail value chain engagement approach	**Yes** Including detailed requirements for (1) content of mitigation plans, (2) prioritisation of mitigation actions across scope 1, scope 2, and scope 3 emissions	**Not specified** Beyond general requirement to adopt transition plan	**Not specified** But generally recommended to report on emission reduction measures and set transition plans as part of wider guidelines in Section 4.1 and Section 4.7 in SBTi's Corporate Manual	**Yes** Including (1) details plan of measures for all scopes, (2) estimated impact of emission reduction measures, (3) adoption of existing measures, demonstrated flagship projects, R&D in new technological solutions, and (4) highest quality renewable electricity procurement	Not covered
Fossil fuel phase-out	HIGH	LOW – MODERATE	**Required** Including 'specific targets aimed at ending the use of and/or support for fossil fuels'; for both coal for power generation and oil & gas	**Required** Including 'transitioning away from dependence on the use of fossil fuels, including phasing out the use of coal' and 'establish, apply and disclose financing policies to phase out fossil fuels (e.g., halting coal use by 2030 in OECD countries and 2040 in non-OECD countries), both by selling assets and responsibly retiring them, meeting obligations to local ecology and communities' for scope 1 and 2 emissions	**Required** By phasing down and out all unabated fossil fuels as part of a global just transition	**Not specified**	**Required** As 'clear plan to phase out all carbon-intensive infrastructure and products'	Not covered

Align lobbying and advocacy	HIGH	LOW – MODERATE	**Required** By publicly disclosing trade association affiliation and encouraging associations to advocate for positive climate action	**Required** By working with trade associatio ns and initiatives to support and amplify others' emissions reduction efforts	**Required** By aligning external policy and engagement, including membership in associations, to the goal of halving emissions by 2030 and reaching global (net) zero by 2050	**Not specified** But generally recommended to disclose all public advocacy, lobbying and policy engagement expenditures as part of wider guidelines In Section 4.7 in SBTi's Corporate Manual	**Not specified**	Half (17/33) of initiatives encourage companies to align lobbying and advocacy with their climate target. Methods include mobilising and building capacity across a company's value chain, influencing policy and regulation and joining memberships and alliances to engage and collaborate across regions, sectors and markets to drive climate action

Across the five initiatives we identify **low to moderate convergence** on guiding principles for setting 1.5°C-compatible emission reductions targets to 2030. Race to Zero and ISO Net Zero Guidelines do not specify minimum (sector-specific) targets but do reflect that there should be a maximum effort to reach a fair contribution to 50% global reduction in CO_2 by 2030. SBTi allows for either absolute annual reduction rates or intensity convergence in line with SBTi's suite of methods (see Table 5 in SBTi (2023)), which can allow for absolute growth in emissions in the short-term. Similar to reduction targets next to net-zero pledges, the CCRM recommends that interim targets align with the rage of 1.5C-comptatible benchmarks identified in literature.

As it stands, there is a **moderate level of convergence** on the measures that non-state entities should use to achieve 1.5°C-compatible reduction targets among three of the initiatives providing specific recommendations (UN Expert Group, ISO Net Zero Guidelines, CCRM), though these at times remain high-level and will require further specification. The ISO Net Zero Guidelines provide the most detailed requirements by both specifying the content of mitigation plans and prioritising actions across scope 1, scope 2, and scope 3 emissions (ISO, 2022).

The key change from previous voluntary initiative guidance is on fossil fuel phase out, where the UN Expert Group, ISO Net Zero Guidelines and Race to Zero require a transition away from fossil fuel production and use, and CCRM stipulates a clear plan to phase out all emissions-intensive infrastructure and products.

Finally, on lobbying and advocacy, there is clear alignment among the UN Expert Group, ISO Net Zero Guidelines and RtZ that entities trying to reach net zero (in particular, corporate entities) must align their trade associations with a bid for climate positive action. However, there is a lack of specificity on the guidance to understand what aligning lobbying plans should look like, particularly where it goes beyond simple disclosure of trade affiliations.

4.5. Offsetting emissions with carbon credits, or carbon dioxide removals inside the value chain

Table 7: Comparison across five initiatives and a summary across 33 initiatives (McGivern et al., 2022) on offsetting with carbon credits, or with carbon dioxide removals inside the value chain in terms of their level of convergence on (a) guiding principles and (b) specific criteria for operationalisation.

	Convergence on guiding principles	Specific criteria for operationalising	UN Expert Group (2022)	ISO Net Zero Guidelines (2022)	Race to Zero (v3, 2022)	SBTi Net Zero Standard (2023)	Corporate Climate Responsibility Monitor (2023)	Summary across 33 initiatives (2022)
OVERALL	MODERATE	LOW						
Offsetting with carbon credits, or with carbon dioxide removals inside the value chain	HIGH	LOW - MODERATE	**Not allowed**	**Not allowed**	**Recommends prioritising reductions over offsetting**	**Not allowed** Except for FLAG sector interim targets that allow companies to use carbon dioxide removals within the own value chain next to emission reductions	**Not allowed**	Over three-quarters of voluntary initiatives recognise that some net zero strategies may leave actors with residual emissions to be can counterbalanced through investment in credits or offsets. However, pace-setter initiatives prohibit the use of carbon credits towards near-term science-based emissions reduction targets.
Offsetting to claim net zero	MODERATE	LOW - MODERATE	**Allowed** Maximum amount not specified	**Allowed (e.g. <5%)** Target for <5% of emissions (including scope 3 emissions) for net-zero targets by 2050 compared to 2020 emissions, with illustrative examples of emissions reductions targets to be met first by sector	**Allowed** Maximum amount not specified	**Allowed** Maximum amount of 5-10% of emissions covered by the net zero target for most sectors with the exception for the FLAG sector	**Not recommended** Recommends not to use any carbon credits and removals for offsetting claims as part of long-term targets and use climate contribution approach instead If company decides to use offsetting as part of net-zero target, maximum amount of 5%-10% of 2019 emissions	Not covered
Specific criteria for high-quality carbon credits and/ or carbon dioxide removals within the value chain	MODERATE	LOW	**Not specified** General recommendation that 'high integrity carbon credits' must fit criteria of additionality and permanence as to be defined by ongoing processes by third-party initiatives such as ICVCM, VCMI, and SBTi	**Specified** Both high-quality carbon dioxide removals and high-quality carbon credits must fit criteria of, among others, (1) credible accounting standards, (2) additionality, (3) measurement, reporting and verification by third party, (4) permanence, sufficiently long-term storage and plans to manage potential impermanence, (5) avoided double-counting	**Not specified** No specific criteria outlined for either 'high quality carbon credits' or 'high-quality permanent removals'	**Not specified** No specific criteria outlined for 'permanent emission removals' beyond a company's value chain FLAG sector targets additionally allow carbon dioxide removals inside the company's value chain, for which no further criteria has	**Specified** Carbon credits based on high-quality permanent removals or emission reduction projects must fit criteria of (1) avoiding double counting, (2) avoiding the risk of distraction and delay, (3) additionality in the context of safeguarding Paris ambition, (4) net zero compatibility, and (5) permanence and scarcity of carbon dioxide removals	Initiatives most focused on the issue of net zero-aligned offsetting, like SBTi, ICVCM, VCMI, ISO, and Race to Zero, stipulate that offsets for residual emissions at the net zero target date should be based on removals with a high likelihood of sufficient permanence (low risk of reversal) to meet net zero.

For short- and medium-term targets, all five initiatives show **high convergence** on the fact that carbon credits purchased from outside the value chain should generally not be used to achieve any short- and medium-term emissions reduction targets. The SBTi is the only initiative that currently allows companies operating in the forest, land and agriculture (FLAG) sector to explicitly use carbon removals within the companies' value chain to count towards short- and medium-term targets (SBTi, 2022a, 2023; pp.43-44).

For net-zero targets, all five initiatives, except for the CCRM, recommend to use a share of carbon credits and/or carbon dioxide removals within the value chain to claim net zero. ISO Net Zero Guidelines and SBTi specify that this can only be between 5-10% of emissions covered under the respective target, while the UN Expert Group and RtZ specify no maximum threshold. For this reason, we designate the level of specific criteria for their operationalisation as **low to moderate** given that it is not clear what type of emission removals could be reasonably used to claim net zero. The CCRM generally recommends against making any offsetting claims as part of emission reduction targets (Day et al., 2023b). If companies opt to pledge to reach net zero, the CCRM requires that the use of carbon credits for offsetting should be limited to a maximum amount of 5%-10% of 2019 emissions to ensure that net zero targets are not misleading.

Across the board, all five initiatives mention the importance of using high-quality carbon credits and/or high-quality carbon dioxide removals within the value chain but offer a great deal of leniency in how 'high quality' is defined. Only the ISO Net Zero Guidelines and the CCRM define specific criteria for carbon credits. The UN Expert Group recommendations offer ambiguous and contradictory criteria: high-quality carbon credits with additionality and permanence are recommended, but specific initiatives that do not deliver on these basic criteria are explicitly endorsed (Mooldijk et al., 2022; UN HLEG, 2022). Race to Zero and SBTi do not specify any criteria that define high-quality carbon credits and/or high-quality carbon dioxide removals within the value chain.

5. Conclusions and way forward

The implementation era of global net zero demands renewed effort from national and sub-national governments, and from the private sector.

After rapid expansion in 2020 and 2021, national net zero targets covered the bulk of the world economy. Since then, few governments at any level have set new net zero targets, though corporate targets have continued to expand. Strikingly on the eve of the first Global Stocktake under the Paris Agreement, we could not identify any emission reduction target for four UNFCCC member states, 439 states & regions in the top 25 emitting countries, 766 major cities, and 734 of the world's largest publicly listed companies. These entities are dangerously out of sync with economic trends and globally agreed goals. In countries with national targets, the lack of corresponding sub-national and private sector targets creates a significant barrier to implementation of national climate policies and undercuts the credibility of national pledges. As the world looks to assess collective progress toward the goals of the Paris Agreement at COP28, entities that have not taken the basic step of setting a target merit particular scrutiny.

Equally important, the growth in the quantity of net zero targets has resulted in a variable mix of quality. Most net zero targets lack key features that make them robust. Targets need to be converted into laws (for governments) and other strong, binding frameworks that can drive implementation. All scopes of emissions need to be covered. Transition plans need greater detail, including interim targets that drive immediate reductions. Progress needs to be reported frequently and transparently. Offsets and carbon removal cannot be used to substitute for or delay decarbonization, and, at a minimum, their use must be clearly specified and transparently reported. This conclusion is abundantly supported by science, and has been confirmed at high political level by the UN Expert Group. Yet, to date, only a small fraction of entities are enacting all or even most of these essential best practices.

On the positive side, the issue of net zero target accountability has been taken seriously, with a flurry of voluntary initiatives, orchestration efforts, and standards emerging to steer targets and plans toward the requirements of science. These governance initiatives have created a high-level consensus of what 'good' net zero looks like. The challenge now is to operationalise them.

Interestingly, regulators are increasingly taking up this task. In regulatory domains as diverse as disclosure rules, product standards, procurement, trade, and advertising claims, governments are putting in place binding rules to drive net zero alignment for companies (Race to Zero, 2022b). For example, nearly half the world economy is now covered by jurisdictions with some form of mandatory sustainability disclosure rules (Hale, 2022). This trend remains in its early stages, with many rules lacking decisive alignment to science, and differences between rules creating unhelpful regulatory fragmentation. Governments therefore have a major opportunity to accelerate implementation of their national targets by building a

coherent and rigorous regulatory framework around net zero, potentially include through the Task Force on Net Zero Regulation proposed by the UN Expert Group.

Net zero is now in an age of implementation, when governments and companies need to tighten their targets and deliver real progress in emissions reductions. As the world this year takes stock of our collective progress toward the goals of the Paris Agreement, it must shine a spotlight on three things:

1. **Entities that, eight years after the Paris Agreement was signed, have yet to set a target aligned to its goals**
2. **Entities that, having set a target, now need to ensure it is robust and aligned to the requirements of science**
3. **The clear consensus that has emerged on what is required for robust net zero targets, serving as a guiding star for both commitments and implementation.**

Bibliography

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

Black, R., Cullen, K., Fay, B., et al. (2021) Taking Stock: a global assessment of net zero targets. Energy & Climate Intelligence Unit and Oxford Net Zero. Available at: https://ca1-eci.edcdn.com/reports/ECIU-Oxford_Taking_Stock.pdf?v=1616461369 (Accessed: 8 April 2022).

Carbon Neutrality Coalition (2023) The framework. Carbon Neutrality Coalition. Available at: https://carbon-neutrality.global/the-framework/ (Accessed: 30 May 2023).

CDP (2021) 2020 - Full States and Regions Dataset. CDP. Available at: https://data.cdp.net/Governance/2020-Full-States-and-Regions-Dataset/d4kx-9jfn/data (Accessed: 30 May 2023).

CDP (2022a) CDP-ICLEI Unified Reporting System (2019-2021). CDP, ICLEI. Available at: https://data.cdp.net/.

CDP (2022b) CDP's Activity Classification System (CDP -ACS). CDP. Available at: https://cdn.cdp.net/cdp-production/cms/guidance_docs/pdfs/000/001/540/original/CDP-ACS-full-list-of-classifications.pdf.

Chan, S., Ellinger, P. and Widerberg, O. (2018) 'Exploring national and regional orchestration of non-state action for a < 1.5 °c world', International Environmental Agreements: Politics, Law and Economics, 18(1), pp. 135–152. doi:10.1007/s10784-018-9384-2.

Chan, S. and Hale, T. (2015) Galvanizing the groundswell of climate actions in the developing world. Written for the Bonn Groundswell Workshop "Catalyzing Climate Action for Resilient Development". Bonn 5 June 2015, hosted by the German Development Institute/ Deutsches Institut für E. Blavatnik School of Government; Deutsches Institut für Entwicklungspolitik. Available at: http://static1.squarespace.com/static/552be32ce4b0b269a4e2ef58/t/55afedf9e4b05618327de34c/1437593081002/WP_Galvanizing+the+Groundswell+of+Climate+Actions+in+the+Developing+World%284%29.pdf.

City of Helsinki (2019) Carbon Neutral Helsinki: Action Plan. CIty of Helsinki. Available at: https://www.stadinilmasto.fi/files/2018/03/Executive_summary_HNH2035.pdf.

Climate Action 100+ (2022) Climate Action 100+ Net Zero Company Benchmark shows an increase in company net zero commitments, but much more urgent action is needed to align with a 1.5°C future. 30th March 2022, Press release. Climate Action 100+. Available at: https://www.climateaction100.org/news/climate-action-100-net-zero-company-benchmark-shows-an-increase-in-company-net-zero-commitments-but-much-more-urgent-action-is-needed-to-align-with-a-1-5c-future/ (Accessed: 31 May 2022).

Climate Action Tracker (2022) CAT net zero target evaluations (update November 2022). Climate Action Tracker (Climate Analytics, NewClimate Institute). Available at: https://climateactiontracker.org/global/cat-net-zero-target-evaluations/ (Accessed: 1 June 2023).

Climate Action Tracker (2023a) COP28: time for world to focus on oil and gas phase-out, renewables target, not distractions like CCS. Climate Action Tracker briefing. June 2023. Climate Action Tracker (Climate Analytics, NewClimate Institute).

Climate Action Tracker (2023b) Country assessment: New Zealand (last update: 7 March 2023). Climate Action Tracker (Climate Analytics, NewClimate Institute). Available at: https://climateactiontracker.org/countries/new-zealand/ (Accessed: 30 May 2023).

Climate Watch (2022) Historical GHG Emissions. Washington DC, USA: World Resources Institute. Available at: https://www.climatewatchdata.org/ghg-emissions (Accessed: 12 May 2022).

Climate Watch (2023) Net-Zero Tracker. World Resources Institute. Available at: https://www.climatewatchdata.org/net-zero-tracker (Accessed: 1 June 2023).

Corb, L., Henderson, K., Koller, T. and Venugopal, S. (2022) Understanding the SEC's proposed climate risk disclosure rule. June 3, 2022. Podcast.

McKinsey & Company. Available at: https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/understanding-the-secs-proposed-climate-risk-disclosure-rule (Accessed: 30 May 2023).

Day, T., Mooldijk, S., Hans, F., et al. (2023a) Corporate Climate Responsibility: Guidance and assessment criteria for good practice corporate emission reduction and net-zero targets. Version 3.0, February 2023. NewClimate Insitute. Available at: https://newclimate.org/sites/default/files/2023-05/NewClimate_CCRM2023_Methodology_Feb23.pdf.

Day, T., Mooldijk, S., Hans, F., et al. (2023b) Corporate Climate Responsibility Monitor 2023. Berlin and Cologne, Germany: NewClimate Institute, Carbon Market Watch. Available at: https://newclimate.org/sites/default/files/2023-02/NewClimate_CorporateClimateResponsibilityMonitor2023_Feb23.pdf (Accessed: 20 February 2023).

EIA (2023) International: Rankings. U.S. Energy Information Administration. Available at: https://www.eia.gov/international/rankings/world (Accessed: 30 May 2023).

European Parliament (2022) P9_TA(2023)0209 Corporate Sustainability Due Diligence. Amendments adopted by the European Parliament on 1 June 2023 on the proposal for a directive of the European Parliament and of the Council on Corporate Sustainability Due Diligence and amending Direc. European Parliament. Available at: https://www.europarl.europa.eu/doceo/document/TA-9-2023-0209_EN.pdf.

FAOSTAT (2022) Emissions Totals. Food and Agricultural Organization of the United Nations. Available at: https://www.fao.org/faostat/en/#data/GT (Accessed: 31 May 2022).

Forbes (2020) Global 2000: The world's largest public companies. Forbes. Available at: https://www.forbes.com/global2000.

Forbes (2022) The Global 2000. Forbes. Available at: https://www.forbes.com/lists/global2000/ (Accessed: 30 December 2022).

Fossil Fuel Non-Proliferation Treaty Initiative and University of Sussex (2023) Fossil Fuel Non-Proliferation Tracker. Fossil Fuel Non-Proliferation Treaty Initiative, University of Sussex. Available at: https://fossilfueltracker.org/app/ffnpt (Accessed: 30 May 2023).

Gütschow, J., Günther, A. and Pflüger, M. (2021) 'The PRIMAP-hist national historical emissions time series v2.3 (1750-2019)', Zenodo [Preprint]. doi:10.5281/zenodo.5175154.

Hale, T. (2021) Governing net zero: the conveyor belt. Blavatnik School of Government, University of Oxford. Available at: https://www.bsg.ox.ac.uk/sites/default/files/2021-11/2021-11 Hale Net Zero Policy Memo.pdf.

Hale, T., Smith, S.M., Black, R., et al. (2022) 'Assessing the rapidly-emerging landscape of net zero targets', Climate Policy, 22(1), pp. 18–29. doi:10.1080/14693062.2021.2013155.

Hale, T. (2022) the Net-Zero Governance Conveyor Belt. Kleinman Center for Energy Policy, University of Pennsylvania. Available at: https://kleinmanenergy.upenn.edu/wp-content/uploads/2022/12/KCEP-Net-Zero-Governance-Conveyor-Belt.pdf.

Hemming, P. (2023) Australian Government Breaching Consumer Law Following Four Corners. Media Release, February, 14. The Australia Institute. Available at: https://australiainstitute.org.au/post/australian-government-breaching-consumer-law/ (Accessed: 30 May 2023).

IEA (2021) Net Zero by 2050: A Roadmap for the Global Energy Sector. Paris, France: International Energy Agency. Available at: https://www.iea.org/reports/net-zero-by-2050 (Accessed: 10 August 2022).

IPCC (2018) 'Summary for Policymakers', in Masson-Delmotte, V. et al. (eds) Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change,. Cambridge, UK and New York, NY, USA: Cambridge University Press, pp. 3–24. doi:10.1017/9781009157940.001.

IPCC (2022) 'Summary for Policymakers', in Pörtner, H.-O. et al. (eds) Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, NY, USA: Cambridge University Press, pp. 3–33. doi:10.1017/9781009157926.002.

IPCC (2023) Synthesis Report of the IPCC Sixth Assessment Report (AR6) - Summary for policymakers. Intergovernmental Panel on Climate Change (IPCC). doi:10.4324/9781315071961-11.

ISO (2022) Net Zero Guidelines – Accelerating the transition to net zero. Geneva, Switzerland: International Organization for Standardization (ISO). Available at: https://www.iso.org/obp/ui/en/#iso:std:iso:iwa:42:ed-1:v1:en (Accessed: 25 November 2022).

Lee, D.S., Fahey, D.W., Skowron, A., et al. (2021) 'The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018', Atmospheric Environment, 244, p. 117834. doi:10.1016/J.ATMOSENV.2020.117834.

Mardirossian, N. and Arnold, J. (2023) Nature-Based Insetting : A Harmful Distraction from Corporate Decarbonization. New York, NY, USA: Columbia Center on Sustainable Investment. Available at: https://ccsi.columbia.edu/sites/default/files/content/docs/publications/align-insetting-harmful-distraction.pdf.

McGivern, A., Axelsson, K., Straub, S., et al. (2022) Defining Net Zero for organizations: How do climate criteria align across standards and voluntary initiatives? Oxford, UK: Smith School of Enterprise and the Environment. Available at: https://netzeroclimate.org/wp-content/uploads/2022/12/Summary-Report_Oxford-Net-Zero_October-2022.pdf (Accessed: 24 April 2023).

Ministry for the Environment of New Zealand (2022) Emissions reduction plan. Available at: https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/emissions-reduction-plan/ (Accessed: 30 May 2023).

Mooldijk, S., Hans, F., Marquardt, M., et al. (2022) Evaluating corporate target setting in the setting in the Netherlands. Berlin and Cologne, Germany: NewClimate Institute. Available at: https://newclimate.org/sites/default/files/2022-07/NewClimate_Evaluating_corporate_target_setting_in_the_Netherlands_Report_July22.pdf (Accessed: 14 July 2022).

National Statistics of the Republic of China (2022) Statistical Yearbook of the Republic of China 2021. Table 3: General situation of population. National Statistics of the Republic of China (Taiwan). Available at: https://ws.dgbas.gov.tw/public/data/dgbas03/bs2/yearbook_eng/yearbook2021.pdf (Accessed: 31 May 2023).

Net Zero Tracker (2021) Net Zero Tracker codebook. Energy & Climate Intelligence Unit (ECIU); Data-Driven EnviroLab (DDL); NewClimate Institute; Oxford Net Zero. Available at: https://docs.google.com/document/d/13bGE8FCOeF5QweoOvyMPZi3XbZrGLEPL2aM04LuZQcc/edit#heading=h.mrt8hcjc74gx (Accessed: 14 April 2022).

Net Zero Tracker (2022) Net Zero Stocktake 2022. Cologne, Berlin, Oxford, London, North Carolina, Germany, UK, United States of America: NewClimate Institute, Oxford Net Zero, Energy & Climate Intelligence Unit; Data-Driven EnviroLab. Available at: https://ca1-nzt.edcdn.com/Net-Zero-Tracker/Net-Zero-Stocktake-Report-2022.pdf?v=1655074300 (Accessed: 14 July 2022).

Odawara, H. and Hirata, K. (2023) Assessing Net Zero: Integrity Review of 10 Japanese Companies. Climate Integrate. Available at: https://climateintegrate.org/wp-content/uploads/2023/05/Assessing-Net-Zero-EN.pdf.

Race to Zero (2021) Starting Line and Leadership Practices 2.0. Race to Zero Campaign. Available at: https://racetozero.unfccc.int/wp-content/uploads/2021/04/Race-to-Zero-Criteria-2.0.pdf (Accessed: 14 March 2022).

Race to Zero (2022a) Starting Line and Leadership Practices 3.0 - Minimum criteria required for participation in the Race to Zero campaign. Bonn, Germany: UNFCCC. Available at: https://climatechampions.unfccc.int/wp-content/uploads/2022/06/Race-to-Zero-Criteria-3.0-4.pdf (Accessed: 27 July 2022).

Race to Zero (2022b) The Pivot Point: Building the groundswell of voluntary climate action into ground rules for the economy. UNFCCC High Level Climate Champions. Available at: https://climatechampions.unfccc.int/wp-content/uploads/2022/09/R2Z-Pivot-Point-Report.pdf (Accessed: 27 May 2023).

Rekker, S., Ives, M.C., Wade, B., et al. (2022) 'Measuring corporate Paris Compliance using a strict science-based approach', Nature Communications, 13(4441). doi:10.1038/s41467-022-31143-4.

SBTi (2022a) Forest, Land and Agriculture Science Based Target-Setting Guidance. Science Based Target Initiative. Available at: https://sciencebasedtargets.org/resources/files/SBTiFLAGGuidance.pdf.

SBTi (2022b) Oil and Gas: What is the SBTi's policy on fossil fuel companies? (last updated 3 July, 2022). Science Based Targets initiative. Available at: https://sciencebasedtargets.org/sectors/oil-and-gas#what-is-the-sb-tis-policy-on-fossil-fuel-companies (Accessed: 30 May 2023).

SBTi (2023) SBTi Corporate Net-Zero Standard. Version 1.1 (April 2023). Science Based Targets initiative. Available at: https://sciencebasedtargets.org/resources/files/Net-Zero-Standard.pdf.

Shugar, D., Myers, D. and Fugere, D. (2022) Road to zero emissions - 55 companies ranked on net zero progress. As You Sow. Available at: https://www.asyousow.org/report-pages/2022/road-to-zero-emissions (Accessed: 14 July 2022).

Smith, S.M., Geden, O., Nemet, G., et al. (2023) The State of Carbon Dioxide Removal - 1st Edition, The State of Carbon Dioxide Removal. Available at: https://www.stateofcdr.org.

Stellantis (2022) 'Dare Forward 2030: Stellantis Long-Term Strategic Plan'. Amsterdam, the Netherlands: Stellantis N.V., p. 54. Available at: https://www.stellantis.com/content/dam/stellantis-corporate/investors/events/strategic-plan-2030/2022_03_01_Strategic_Plan.pdf.

Stellantis (2023) An Ambitious Decarbonization Strategy. Stellantis N.V. Available at: https://www.stellantis.com/en/responsibility/carbon-net-zero-strategy (Accessed: 30 May 2023).

Szopa, S., Naik, V., Adhikary, B., et al. (2021) 'Short-Lived Climate Forcers', in Masson-Delmotte, V. et al. (eds) Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. doi:10.1017/9781009157896.008.

TPI (2022) Carbon Performance in 2050: All sectors [status as of August 2022]. Transition Pathway Initiative (TPI). Available at: https://www.transitionpathwayinitiative.org/sectors (Accessed: 26 August 2022).

UN HLEG (2022) Integrity Matters: Net Zero Commitments by Businesses, Financial Institutions, Cities and Regions. United Nations' High-Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities. Available at: https://www.un.org/sites/un2.un.org/files/high-level_expert_group_n7b.pdf (Accessed: 29 November 2022).

United Nations Statistics Division (2022) Methodology: Standard country or area codes for statistical use (M49) - Overview. United Nations Statistics Division. Available at: https://unstats.un.org/unsd/methodology/m49/overview/ (Accessed: 12 May 2022).

World Bank (2022) World Bank Country and Lending Groups. World Bank. Available at: http://databank.worldbank.org/data/download/site-content/CLASS.xlsx (Accessed: 12 May 2022).

World Bank (2023) World Development Indicators (last updated date: 10/05/2023). World Bank. Available at: https://databank.worldbank.org/source/world-development-indicators (Accessed: 1 June 2023).

Wray, S. (2022) Helsinki updates carbon reduction plan as progress 'too slow'. 25 August 2022. Cities Today. Available at: https://cities-today.com/helsinki-revamps-carbon-reduction-plan-as-progress-too-slow/ (Accessed: 30 May 2023). .

Appendix I: Summary of data and methods

This section updates the description presented in the Net Zero Stocktake 2022 report (Net Zero Tracker, 2022).

Data collection

The Net Zero Tracker database has been updated regularly through continuous coding, led by the University of Oxford with support from all Net Zero Tracker project partners, and occasional code-a-thon events at the University of Oxford. Students, from across a range of disciplines and speaking a variety of languages, were trained in coding information on targets into a set of standardised metrics. Information on these metrics is further set out in our codebook (Net Zero Tracker, 2021). The efforts of the coders were supported by web-scraping for net zero targets, led by the Data-Driven EnviroLab and Arboretica.

For national and global totals, Gross gross domestic product (GDP, PPP in 2017 constant international dollar) and population data were taken from the World Development Indicators database (World Bank, 2023). Country-level and world total GHG emissions data including land-use change and forestry (LUCF) were taken from Climate Watch (2022). Data for Taiwan are taken from IMF (2022) for GDP PPP, national statistical yearbook (National Statistics of the Republic of China, 2022) for population, PRIMAP data (Gütschow et al., 2021) for GHG emissions excluding LULUCF (country reported) and FAOSTAT (2022) for LULUCF emissions. Income country groups were based on the World Bank classification (World Bank, 2022). A UN classification was used to group countries by geographic regions (United Nations Statistics Division, 2022). Subnational GDP and population data were taken from CDP (CDP, 2021).Corporate data (e.g., annual revenue, number of employees) were taken from Forbes (Forbes, 2022). Population data for cities were taken from multiple sources including the CDP-ICLEI Unified Reporting System (CDP, 2022a) and city-specific sources.

Although we set out to capture in the Net Zero Tracker database all publicly-communicated net zero targets set by states and regions, cities and companies, we may not have been totally successful due to a number of reasons, including: net zero targets being communicated in languages other than English or another major language; or limited participation in the networks of non-state and sub-national climate action, which facilitates coders finding relevant information (see, e.g. Chan et al. (2018) and Chan and Hale (2015) for more discussions). Our data on countries may differ slightly to other similar country tracking initiatives (e.g., the World Resources Institute's Climate Watch), as we aim to update country entities within a 12-15 month period.

Assessment of net zero targets

he database includes all targets that use one of the following terms: carbon negative, carbon neutral(ity),

climate neutral(ity), climate positive, GHG neutral(ity), net negative, net zero, zero carbon, zero emissions, 1.5°C -compatible and science-based targets. This was done to account for often vaguely defined terminology, resulting in terms that equate to net zero being used interchangeably. Selection and coding of the targets was also not limited solely to CO_2 but allowed for a wider range of GHGs. In the assessment of national net zero targets, we considered the targets of individual Member States of the European Union (EU27) but excluded the EU27's collective target.

As in the 2022 edition, the assessment presented in this report uses the indicators partially informed by the Starting Line and Leadership Practices criteria (ver.2.0) of the UNFCCC Race to Zero campaign, which were applied to candidate networks and initiatives before June 2022 (Race to Zero, 2021). Since then, a more ambitious set of criteria have been introduced by Race to Zero, as well as in other criteria bodies such as the UN Expert Group and ISO (see Section 4) that cover more aspects of robustness. Our analysis can therefore be seen as focusing on a central core set of considerations for the robustness of net zero targets, not a comprehensive assessment of all characteristics of robustness. Net zero targets were assessed against four procedural criteria and two substantive criteria (Race to Zero, 2021): (1) a specific net zero pledge, (2) a published plan on how they intent to achieve their interim and long-term targets, (3) immediate action to proceed on their commitments, (4) published progress reports on both their target achievements and measures undertaken annually, 5) a net zero target covering all GHGs (all emission scopes in case of companies), and (6) a clarification of conditions on the use of offsetting. The starting line criteria are the bare minimum expected from non-state actors at the start of their net zero journeys and in our opinion are the minimum that should be expected from national targets as well. Meeting all the criteria is necessary but by no means sufficient. Most of the assumptions and decisions regarding calculation and analysis followed the process used in Hale et al. (2022).

Detailed description of the six key procedural and substantive criteria used for the assessment are provided below. As described in Section 3, T the Race to Zero criteria ver.2.0 has been replaced by a stricter and more comprehensive criteria ver.3.0 since June 2022 (Race to Zero, 2022a).The Net Zero Tracker is currently developing an extended set of indicators e.g. the 'Persuade' criterion to align external policy and engagement as well as fossil fuel phase-out indicators, to enable assessment of net zero targets against the latest Race to Zero criteria and UN Expert Group recommendations.

Pledge

Procedural

Target status: Given that the status of a target is a useful indicator of intent, we categorised the targets by their location along a continuum from non-existence to achievement. Broadly, this falls into four major stages—target has been proposed or is in discussion target, target has been publicly declared, target is included in official documentation, and target is claimed by the entity itself to have been achieved—but the exact categorisation varies across the type of entity. National targets can be found in government

announcements, official policy documents (e.g., Nationally Determined Contributions), draft legislation, or existing statutes. Cities, states and regions are broadly similar but with variations depending on the entity's ability to draft its own laws. The coding of corporate entities, on the other hand, is more focused on analysing corporate documents such as annual or sustainability reports, business strategy documents and press releases.

Net zero target timeline and interim targets: The coding of this indicator is based on what an entity communicates and does not include an assessment of whether the target is in line with global temperature goals.

Substantive

Emissions coverage: Assessing the coverage of a given target requires a range of indicators that vary across the four types of entity. Targets may cover CO2 only or may relate to all major greenhouse gases (CO2, N2O, CH4 and F-gases). In general, nations tend to cover all sources and sinks relating to the full suite of gases, while other entities show more variation. Different entities provoke different questions relating to coverage. National targets, for example, must be scrutinised for the inclusion of international aviation and shipping emissions. In the case of companies, targets are assessed for coverage of scope 1, 2 and 3 emissions.

Offsetting: The nature of net zero means that many net zero targets include explicit or implicit reference to emission offsets; that is, avoided emissions, reductions or removals outside of an actor's activities. Coding of offset commitments categorises these into internal (i.e., removal within territorial or scope 1 and 2 boundaries) and external projects, and captures any conditions that might be attached.

Plan and Proceed

Procedural

Publication of net zero implementation plan: During the coding process, we record whether the entity has published a plan for reaching the target. Clear plans with concrete operational ramifications are critical to the achievement of net zero. However, due to our model of representing only publicly-available data, assessment of whether these plans are realistic and/or are in in line with international obligations is not carried out.

Interim targets: In addition to long-term targets, our process also considers whether entities have included clear interim targets as part of the overarching final target. These typically relate to emission reductions (whether absolute, intensity, percentage reduction or compared to business as usual (BAU)).

Publish

Procedural

Reporting mechanisms: Targets are measured against whether an entity commits to reporting consistent and public information on its progress. These are captured either as no commitment, less-than-annual, or annual reporting.

Fulfilment of the UNFCCC Race to Zero criteria

Finally, we assessed how many entities with net zero targets would meet all six of the procedural and substantive criteria. This assessment aims to provide an indication of the extent to which entities are meeting the minimum set of common criteria laid out by the High-Level Climate Champions and reflected in other standards and criteria. While the Race to Zero campaign, UN Expert Group, ISO, and other such initiatives formally only apply to sub-national and non-state actors, we also apply these criteria to countries for comparison. We did not consider the criterion to reach '(net) zero GHGs as soon as possible, and by mid-century at the latest' for non-OECD countries to account for fairness and equity considerations. The tracking of wider empowerment and equity considerations also currently remains outside the scope of the Net Zero Tracker. As described above, this report continues assessing net zero targets against the earlier Race to Zero criteria mainly to assess collective progress on the robustness of existing net zero targets over time.

The analysis here is not a direct test of compliance with the Race to Zero, UN Expert Group, ISO, or other criteria. For example, we note that Race to Zero is an umbrella campaign that brings together a diverse array of initiatives and networks that seek to mobilize climate action from cities, businesses, investors, states and regions, and other non-state actors. While the Race to Zero sets criteria for partner initiatives and approves them via an independent Expert Peer Review Group, it is the partner initiatives that are responsible for assessing the robustness of individual entities' net zero targets. To do this they operationalize the general Race to Zero criteria in more specific ways.

For example, a partner initiative may be in the process of developing a target with an entity, but this information is not yet publicly available, or scope may be defined in a particular way for a given sector. Please refer to the Race to Zero partner initiative for the precise requirements they ask from their member entities.

In many cases entities with net zero targets have not specified some of the criteria mentioned above. For example, many national targets do not specify whether they cover CO2 only or all GHG emissions; many entities are not explicit about reliance on carbon removals. Our analysis captures this lack of clarity; if the 'ambition loop' model holds, clarity should improve over time.

Appendix II: CDP industry classification

Table A-1 notes the CDP industry classification and the relevant Forbes sector(s) for each industry. Companies' sector information was collected from the Forbes 2000 list before being mapped onto the relevant CDP industry based on the business activities of the company. For companies identified as Conglomerates in the Forbes 2000 list, the most relevant CDP industry was applied.

Table A-1: CDP industry classification (CDP, 2022)

CDP industry	Activities (as per CDP activity group)	Relevant Forbes sectors
Apparel	Textiles & fabric goods	Retailing
Biotech, health care & pharma	Biotech & pharma, Health care provision, Medical equipment & supplies	Drugs & Biotechnology; Health Care Equipment & Services
Food, beverage & agriculture	Crop farming, Fish & animal farming, Food & beverage processing, Logging & rubber tapping, Tobacco	Food, Drink & Tobacco; Food Markets
Fossil fuels	Coal mining, oil & gas extraction & production, Oil & gas processing, Oil & gas retailing, Oil & gas storage & transportation. A few companies classified in Materials, Manufacturing, Infrastructure and Power generation were reclassified as Fossil fuels based on examination of their business operations.	Oil & Gas Operations; Retailing
Hospitality	Bars, hotels & restaurants, Entertainment facilities	Hotels, Restaurants & Leisure; Retailing
Infrastructure	Construction, Energy utility networks, Land & property ownership & development, Non-energy utilities	Construction; Utilities
International bodies	Government agencies, Government banks, Government bodies, International bodies	
Manufacturing	Electrical & electronic equipment, Leisure & home manufacturing, Light manufacturing, Metal products manufacturing, Paper products & packaging, Plastic product manufacturing, Powered machinery, Renewable energy equipment, Transportation equipment, Wood & rubber products	Aerospace & Defense; Consumer Durables; Semiconductors; Capital Goods; Retailing
Materials	Cement & concrete, Chemicals, Metal smelting, Refining & forming, Metallic mineral mining, Other materials, Other mineral mining, Wood & paper materials	Chemicals; Materials; Household & Personal Products
Power generation	Nuclear power generation, Renewable power generation, Thermal power generation, Waste power generation	Utilities
Retail	Convenience retail, Discretionary retail, Trading, wholesale, distribution, rental & leasing	Consumer Durables; Technology Hardware & Equipment; Retailing
Services	Commercial & consumer services, Financial services, Industrial support services, IT & software development, Media, telecommunications & data services, Other services, Print & publishing services, Specialized professional services, Web & marketing services	Media; Telecommunication Services; IT Software & Services; Business Services & Supplies; Consumer Durables; Insurance; Diversified Financials; Banking; Trading companies; Retailing
Transportation services	Air transport, Intermodal transport & logistics, Marine transport, Rail transport, Road transport	Transportation

Appendix III: Supplementary figures and tables

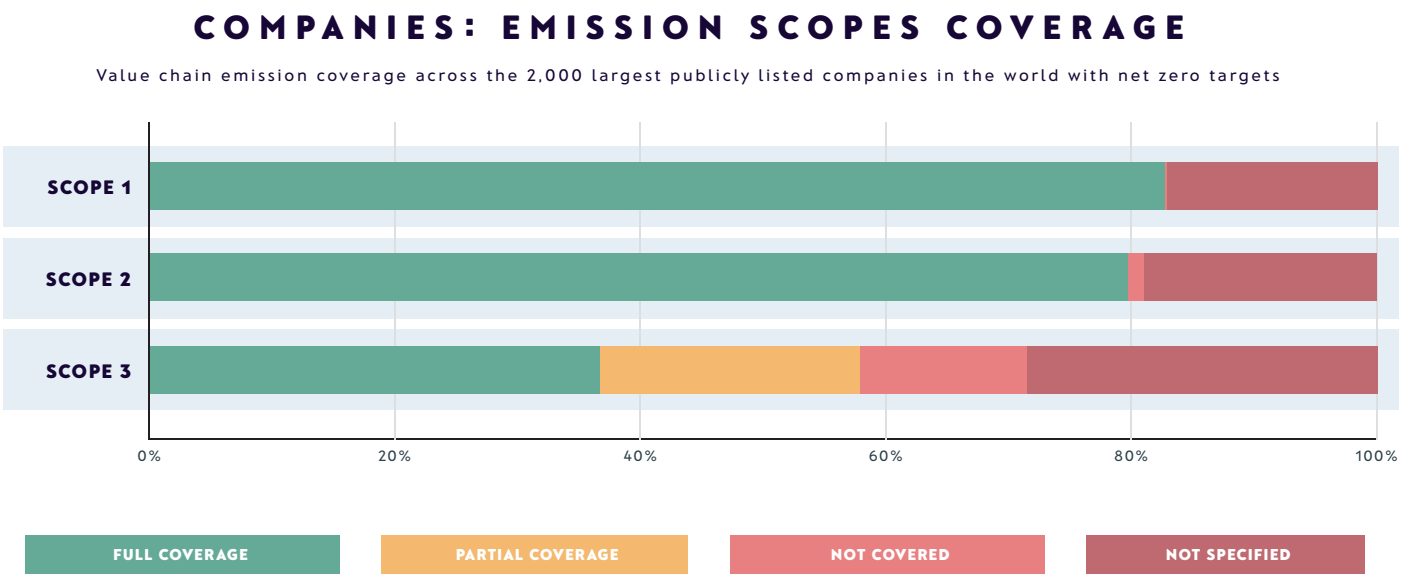


Figure A-1: Emissions scope coverage of net zero targets across 929 Forbes Global 2000 companies as of 1 June, 2023

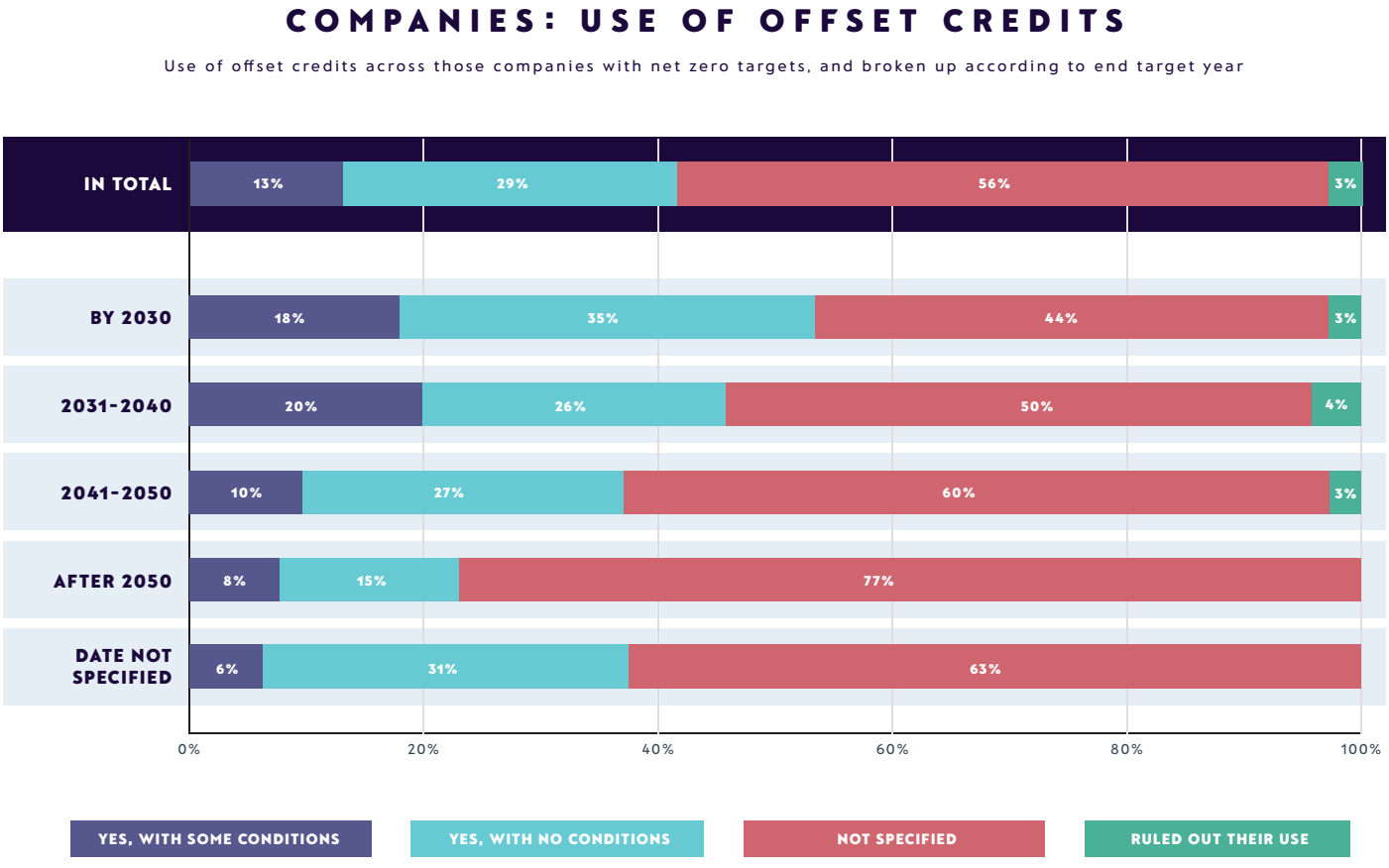


Figure A-2: Use of offset credits across 929 Forbes Global 2000 companies as of 1 June, 2023 (top panel) and according to the net zero target year (bottom panels)

Table A-2: Top 10 producers of coal, natural gas and petroleum in 2021 (EIA, 2023). Three countries (China, Russia, USA) are ranked among the top 10 producers for all three fossil fuels, while four other countries (Australia, Canada, Iran, Saudi Arabia) are top 10 producers in two.

COAL			NATURAL GAS			PETROLEUM & OTHER LIQUIDS		
#	Country	quadrillion Btu	#	Country	quadrillion Btu	#	Country	quadrillion Btu
1	China	93.96	1	United States	35.80	1	United States	30.47
2	India	12.82	2	Russia	26.61	2	Russia	22.67
3	Indonesia	12.10	3	Iran	9.26	3	Saudi Arabia	22.30
4	United States	11.61	4	China	7.52	4	Canada	10.85
5	Australia	11.06	5	Canada	6.78	5	Iraq	8.80
6	Russia	10.49	6	Qatar	6.63	6	China	8.56
7	South Africa	4.98	7	Australia	5.48	7	United Arab Emirates	7.65
8	Kazakhstan	2.41	8	Norway	4.28	8	Iran	7.22
9	Poland	1.76	9	Saudi Arabia	4.27	9	Brazil	6.41
10	Colombia	1.48	10	Algeria	3.83	10	Kuwait	5.76

*Table A-3: The largest 50 entities from each category that we could not find net zero targets for, as of 1 June 2023. Listed in descending order by GDP (PPP) for countries, population for states & regions and cities, and revenue for companies. **Note:** the Netherlands and Poland are listed, but covered by the EU's net zero ('climate neurality') target; others have high ambition long-term mitigation targets that are not termed 'net zero' e.g. Norway (90-95% below 1990 levels by 2050) and the Netherlands (95% below 1990 levels by 2050).*

#	COUNTRIES	STATES & REGIONS	CITIES	COMPANIES
1	Congo	Uttar Pradesh	Shanghai	Berkshire Hathaway
2	Norway	Bihar	Al-Qahirah (Cairo)	McKesson
3	Zimbabwe	Maharashtra	Karachi	AmerisourceBergen
4	Albania	North Carolina	Chongqing	Costco
5	Azerbaijan	Shandong Province	Manila	Agricultural Bank of China
6	Belarus	Madhya Pradesh	Tianjin	Walgreens Boots Alliance
7	Bermuda	Rajasthan	Guangzhou, Guangdong	Bank of China
8	Bolivia	Sichuan	Moskva (Moscow)	Kroger
9	Brunei Darussalam	Jiangsu	Lahore	China Railway Construction
10	Botswana	Tamil Nadu	Atlanta, GA	Fannie Mae
11	Côte d'Ivoire	Hebei	Krung Thep (Bangkok)	Anthem
12	Cameroon	Karnataka	Tehran	Centene
13	Cuba	Hubei	Luanda	JDcom
14	Cayman Islands	Andhra Pradesh	Ahmedabad	SAIC Motor
15	Algeria	West Java	Xi'an, Shaanxi	Valero Energy
16	Egypt	Odisha	Dongguan	Gazprom
17	Georgia	Guangxi	Foshan	PICC
18	Equatorial Guinea	Jiangxi	Shenyang	Metallurgical of China
19	Guatemala	Liaoning Province	Baghdad	Humana

20	Honduras	East Java	Hyderabad, India	Marathon Petroleum
21	Iran	Telangana	Suzhou, Jiangsu	Evergrande Real Estate
22	Iraq	Jharkhand	Haerbin	CITIC
23	Israel	Central Java	Al-Khartoum (Khartoum)	Freddie Mac
24	Jordan	Shanxi	Sankt Peterburg (Saint Petersburg)	Bank of Communications
25	Kenya	Assam	Yangon	Country Garden Holdings
26	Kuwait	Guizhou	Ji'nan, Shandong	Lockheed Martin
27	Libya	Punjab	Zhengzhou	Archer Daniels Midland
28	Liechtenstein	Texas	Ankara	Phillips 66
29	Morocco	Haryana	Chittagong	Raytheon Technologies
30	Moldova	Inner Mongolia	Monterrey	Vanke
31	Macedonia	Xinjiang Uygur	Brasília	Sinopharm
32	Montenegro	Florida	Jiddah	China Pacific Insurance Co
33	Mongolia	Minas Gerais	Changsha	HCA Healthcare
34	Netherlands	South Kazakhstan	Xinbei	Dai-ichi Life Insurance
35	Philippines	Delhi (union territory)	Kunming	China Telecom
36	Poland	México State	Changchun	Legend Holding
37	North Korea	Istanbul	Shantou	Power Construction Corporation of China
38	Paraguay	Tehran	Ürümqi (Wulumqi)	Shanghai Pudong Development Bank
39	Palestine	Gauteng	Pôrto Alegre	Wuchan Zhongda Group
40	Qatar	North Sumatra	Kabul	Xiamen C&D
41	San Marino	Bahia	Hefei	China Minsheng Bank
42	Serbia	Jammu and Kashmir	Shijiazhuang	Hna Technology
43	Eswatini	Banten	Ningbo	Sysco
44	Syria	Rio Grande do Sul	Kano	Allstate
45	Tajikistan	Georgia	Yaoundé	Pegatron
46	Turkmenistan	Lombardy	Jaipur	China Unicom
47	Uzbekistan	Kurdistan	Taiyuan, Shanxi	Power Corp of Canada
48	Venezuela	Pernambuco	Dar-el-Beida (Casablanca)	Hanwha
49		South Sulawesi	Xiamen	Couche Tard
50		Lampung	Lucknow	Finatis