

10 / 2020

Navigating the nuances of net-zero targets



Authors

NewClimate Institute & Data-Driven EnviroLab

**NEW
CLIMATE**
INSTITUTE



DATA
DRIVEN
ENVIROLAB

Navigating the nuances of net-zero targets

Project number

219051

© NewClimate Institute & Data-Driven EnviroLab 2020



Authors

Thomas Day, Silke Mooldijk, Takeshi Kuramochi
(NewClimate Institute)

Angel Hsu, Elwin Lim, Zhi Yi Yeo, Amy Weinfurter,
Yin Xi Tan, Ian French, Vasu Namdeo, Odele Tan,
Sowmya Raghavan, Ajay Nair (Data Driven EnviroLab)

Disclaimer

The views and assumptions expressed in this report represent the views of the authors and not necessarily those of the funders and partners.

Suggested citation

Suggested citation: NewClimate Institute & Data-Driven EnviroLab (2020). Navigating the nuances of net-zero targets. Research report prepared by the team of: Thomas Day, Silke Mooldijk and Takeshi Kuramochi (NewClimate Institute) and Angel Hsu, Zhi Yi Yeo, Amy Weinfurter, Yin Xi Tan, Ian French, Vasu Namdeo, Odele Tan, Sowmya Raghavan, Elwin Lim, and Ajay Nair (Data-Driven EnviroLab).

Design

Meike Naumann

Acknowledgements

Many thanks to following organisations that shared and, in several instances, helped address questions regarding climate action data: Business Ambition for 1.5°C, C40 Cities Climate Leadership Group, CDP, Energy & Climate Intelligence Unit, Global Covenant of Mayors for Climate & Energy, Global Covenant of Mayors (EU Secretariat), Science-Based Targets Initiative, States and Regions Annual disclosure to CDP, in partnership with The Climate Group, ICLEI carbonn Center Under2 Coalition (Secretariat: The Climate Group), United States Climate Alliance, the United States Climate Mayors.

Thanks also to Oscar Widerberg for sharing data on Swedish subnational climate commitments, and Andrew Clapper for his support with CDP data. Special thanks go to Matthew Phillips (UNFCCC) and Todd Edwards (Mission 2020) for providing valuable feedback and support on the communications and outreach of this report, in collaboration with the High-Level Champions for Chile and UK. Many thanks to Rik van Steekelenburg for his dedicated support in researching companies' targets. Thank you to Kelly Levin of the World Resources Institute for providing review comments.

This work was generously funded by the IKEA Foundation (grant no. G-2001-01507).

IKEA Foundation



Table of Contents

I	Acknowledgements	
III	List of Figures, Tables and Boxes	
IV	Abbreviations	
1	Summary	
6	Foreword	
	1	
7	Introduction: Relevance and rise of net-zero target setting	
	2	
8	Landscape of net-zero targets	
	2.1	
8	Terminology of targets and claims	
	2.2	
14	Overview of subnational and corporate net-zero targets	
	2.2.1	
15	Cities and regions	
	2.2.2	
19	Companies	
	2.2.3	
21	Targets	
	3	
24	Nuances of net-zero targets for climate ambition	
	3.1	
24	Overview of nuances and their implications for climate ambition	
	3.2	
30	Reduction of emissions	
	3.2.1	
30	Operational measures for deep decarbonisation	
	3.2.2	
34	Electricity-related emissions	
	3.2.3	
41	Supply chain and out-of-boundary emissions	
	3.3	
47	Neutralisation of emissions through offsetting	
	3.4	
52	Supporting carbon dioxide removal technologies and practices	
	4	
57	Conclusions: Target transparency for accountability and ambition	
59	References	
70	Annex I: Definitions and data sources	
73	Annex II: Criteria for assessment of net-zero target nuances	

List of Figures, Tables and Boxes

Figures

2	Figure S1	Overview of the key nuances of net-zero target implementation approaches
5	Figure S2	Ten basic criteria for net-zero target transparency
14	Figure 1	Internet searches for net-zero emissions
15	Figure 2	Map of cities and regions pursuing net-zero emissions
16	Figure 3	Population of cities and regions with net-zero targets, by geographic region
20	Figure 4	Revenue of actors pursuing net-zero emissions, according to CDP Industry classifications
22	Figure 5	Net-zero target years for cities, regions, companies and investors
25	Figure 6	Overview of the key nuances of net-zero target implementation approaches
34	Figure 7	How well planned are targets for emission reductions?
34	Figure 8	Types of renewable electricity supply and procurement constructs implemented by companies
36	Figure 9	REC procurement models
41	Figure 10	2019 inventory emissions of companies with net-zero targets, by emission scope and CDP Industry
45	Figure 11	Number of corporate net-zero actors with scope information
45	Figure 12	Emissions included within the scopes of cities' and regions' net-zero targets
50	Figure 13	Trends from carbon credit markets for voluntary offsetting in 2018
51	Figure 14	Use of offsetting approaches for subnational actors' net-zero target implementation

Tables

9	Table 1	Overview of emissions per scope for subnational and corporate actors
12	Table 2	Lexicon of common net-zero terms and vocabulary
29	Table 3	Implications of net-zero target setting approaches for contribution to global decarbonisation
70	Table A1	Data sources

Boxes

10	Box 1	Interpretation of climate positive and carbon negative targets
11	Box 2	Making net-zero commitments transparent
17	Box 3	Consumption-based emissions
18	Box 4	China's subnational actors in support of the country's 2060 carbon neutrality target
21	Box 5	Net-zero goals in hard-to-abate sectors
23	Box 6	Understanding ambition
30	Box 7	Companies aiming for „zero“ emissions

31	Box 8	Commonly implemented operational measures for decarbonisation
36	Box 9	Types of Renewable Energy Certificates (RECs)
38	Box 10	Renewable electricity in the tech industry
39	Box 11	National railways' 100 percent renewable electricity claims
43	Box 12	Decarbonising the portfolios of commercial financial institutions
51	Box 13	Carbon neutral aviation through low-cost offsets
54	Box 14	Permanence and methodological uncertainties of carbon dioxide removal outcomes
55	Box 15	Subnational governments' efforts on Carbon Dioxide Removal (CDR)

Abbreviations

°C	Degrees Celsius
BECCS	Biomass Energy with Carbon Capture and Storage
CCS	Carbon Capture and Storage
CDR	Carbon Dioxide Removal
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CO₂	Carbon Dioxide
CO₂e	Carbon Dioxide Equivalent
DAC(CS)	Direct Air Capture (and Carbon Storage)
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
MRV	Monitoring, Reporting and Verification
NDC	Nationally Determined Contributions (to the Paris Agreement)
NZEB	Near-Zero Energy Buildings
PPA	Power Purchase Agreement
RE	Renewable Energy
REC	Renewable Energy Certificate
SBTi	Science-Based Targets initiative
SME	Small and Medium-sized Enterprise
UNFCCC	United Nations Framework Convention on Climate Change

Summary

Navigating the nuances of net-zero targets analyses the momentum of targets for net-zero emissions across companies, cities and regions worldwide. We seek to unravel the net-zero targets to better enable the identification of truly ambitious actors and enhance support towards them. We offer recommendations for increasing target transparency with the aim of achieving greater accountability and ambition.

The momentum around net-zero target setting is accelerating across cities, regions and companies in every continent

(→ Section 2.2)

The number of net-zero pledges from cities, regions and companies has roughly doubled in less than a year since late 2019. As of October 2020, actors with net-zero targets (either economy- or company-wide, or for a specific sector) cover at least 826 cities, 103 regions, and 1,565 companies across all continents. In total, they represent over 880 million residents, 24.9 million employees, and 10 gigatonnes of greenhouse gas emissions. Cities and regions from Europe, Latin America and the Caribbean, and East Asia and the Pacific lead the way among subnational governments, while companies from the services industry contribute the greatest number of net-zero pledges.

Even companies in emissions-intensive and hard-to-abate industries, such as fossil fuels, materials and transportation services, are setting ambitious targets. Some actors plan to reach net zero the near future, and others are going beyond their direct emission scopes, targeting supply-chain and downstream emissions.

There are indications that increasing citizen, investor, and consumer concern plays an important role in driving this action. Google search interest in

“net-zero emissions” has grown since late 2018, with spikes of activity coinciding with key climate-related events. Simultaneously, civil society mobilisation for climate action has also grown, with increased participation in global climate marches and the youth-led movement Fridays for Future. Citizen-facing service companies are also the most active industry in setting net-zero targets, suggesting an appeal to consumer demands.

Imprecise net-zero terminology prevents clarity in target setting

(→ Section 2.1)

Actors adopt a wide range of terms to represent similar concepts, such as “net zero”, “carbon neutral” and “climate neutral.” Due to a lack of standardised definitions and criteria for use, these terms are often used interchangeably, making it difficult to compare climate commitments between actors based on the terminology alone. By providing examples of how these terms are used in practice, along with suggested definitions, we present a possible starting point for actors who wish to set climate targets transparently.

While many new targets are being set, implementation has yet to follow

Only a limited number of subnational governments and companies have developed action plans towards their net-zero targets or incorporated them into binding legislation. Some actors are setting ambitious timelines for meeting net-zero targets as early as this year, but most pledges target 2050. Accelerated, ambitious action - paired with specific emission reduction targets for direct gross emissions and robust interim targets - is key to ensuring long-term goals for decarbonisation are met.

Nuances in target implementation approaches can determine the real ambition and impact of actors' net-zero pledges

(→ Section 3.1)

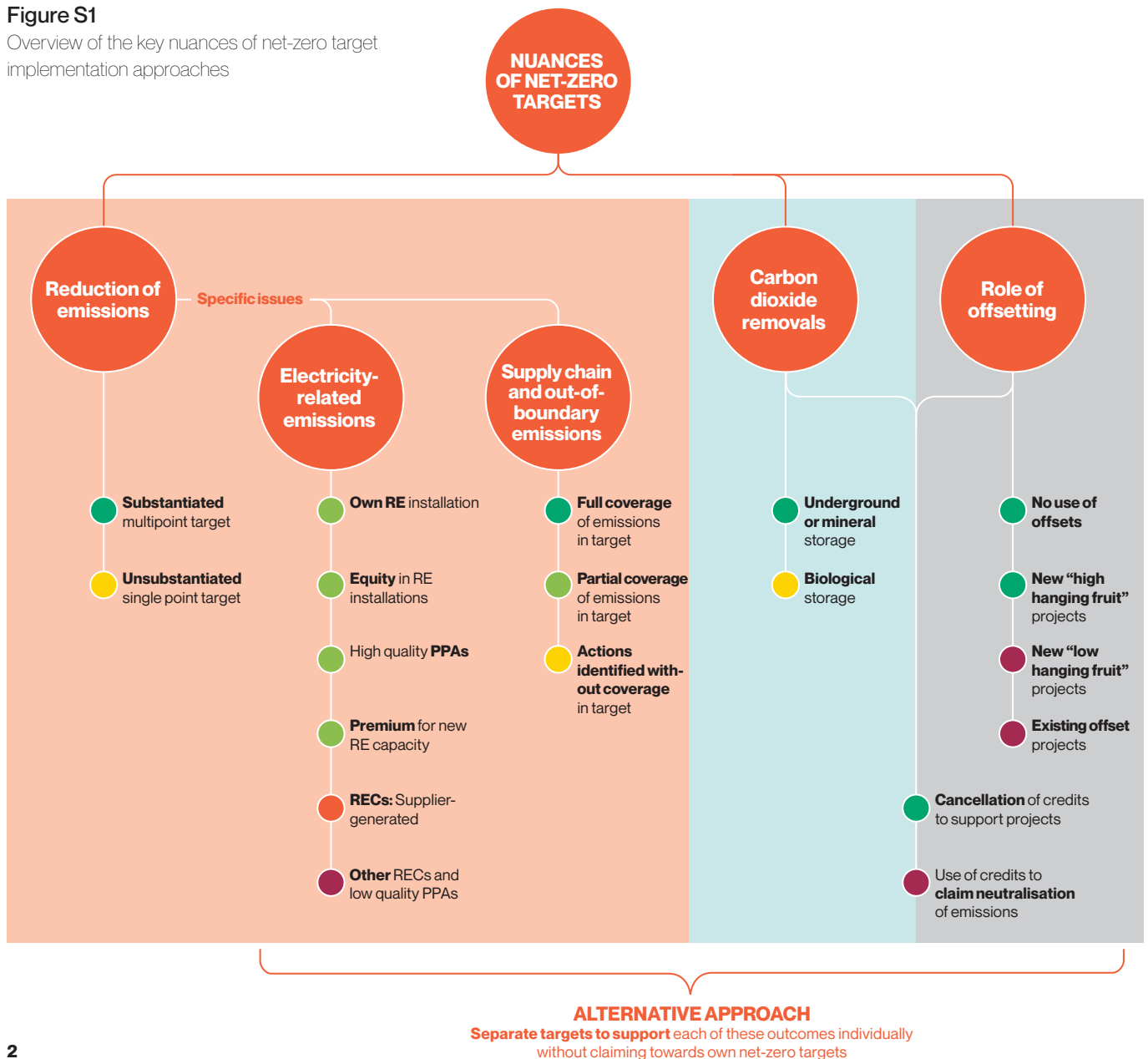
At the highest level, approaches for implementing subnational and corporate net-zero targets can be broadly categorised according to whether they target the **direct reduction of emissions**, claim **neutralisation of emissions through offsetting**, or **support carbon dioxide removal**. Among measures for the direct reduction of emissions, we note a particularly broad range of approaches for claiming the **neutralisation of electricity-related emissions** and for supporting the reduction of **supply chain and out of boundary emissions**.

Nuances in the specific details of those implementation approaches determine whether net-zero targets really contribute to deep decarbonisation, or produce any impact at all. These significant nuances in target implementation approaches have implications for the additionality of impact, the integrity of a claimed outcome, and the extent to which the approaches actively support or hinder problem-solving efforts for the most difficult challenges of deep decarbonisation.

Figure S1 provides an overview of the key distinctions of the approaches identified from the analysis.

Figure S1

Overview of the key nuances of net-zero target implementation approaches



Measures for real emission reductions offer the most direct and unambiguous strategy

(→ Section 3.2.1)

Of the various overarching strategies for net-zero target implementation, those that directly lead to a reduction of the actor's emissions provide the greatest and least disputable impact. These strategies also represent a fair contribution to long-term decarbonisation challenges; if a specific actor deems direct reductions too complex and expensive to pursue as their primary net-zero target implementation strategy, who else should take on this burden to achieve global decarbonisation?

Actors with net-zero targets include those that aim for the full decarbonisation of their own emissions, as well as actors that have no target for the reduction of their own emissions at all. Only 33 percent of subnational governments' and 8 percent of companies' net-zero targets include **interim targets to chart a decarbonisation pathway**.

Interim targets offer clarity and guidance on how particular targets should be implemented. They provide the transparency necessary to ensure accountability. A clear strategy with broad ownership among stakeholders and an accountability mechanism gives such targets the best chance of translating targets to successful and ambitious implementation. In most cases there will still be uncertainty regarding the specific measures that can be applied in the future to reduce the hardest-to-abate emissions; such uncertainties and challenges need not be a barrier for strategy development but rather can be communicated transparently within those strategies.

Speculative and unsubstantiated single-point targets without a clear strategy are less likely to be implemented, and are less likely to result in the identification of solutions for harder-to-abate sectors.

Emission reduction impacts from renewable electricity claims are often ambiguous

(→ Section 3.2.2)

Decarbonisation of electricity cannot be addressed by any single actor in isolation: it is a systemic issue. **Actors can contribute to long-term solutions by lobbying for supportive policy environments for decarbonisation of the energy system**.

The optimal course of action an actor should adopt to ensure their electricity delivery approach yields emission reductions is dependent upon local policy infrastructure and market circumstances. Usually, companies combine several approaches in their renewable energy procurement portfolio.

Approximately 20 percent of companies with net-zero targets have **on-site renewable electricity generation** technologies, which may directly lead to the expansion of renewable energy capacity and a reduction or elimination of electricity demand from the grid, although this rarely accounts for a large proportion of their electricity demand and is usually combined with other approaches. High quality **Power Purchase Agreements (PPAs)** – pursued by approximately 45 percent of companies with net-zero targets – and **capacity expansion premiums** can also lead to the installation of additional renewable electricity capacities under certain circumstances. Demonstrating a causal impact from the purchase of **Renewable Energy Certificates (RECs)** – pursued by approximately 70 percent of companies with net-zero targets – is much more difficult.

While many of these approaches can play an important role in supporting the electricity sector's decarbonisation, their use may not always justify a net-zero emissions claim. Due to the complex causal relationships between renewable electricity procurement models and the installation of additional renewable energy capacity, the impact of that procurement can rarely be quantified with certainty.

Claiming net-zero emissions through offsetting has a number of limitations and risks under the post-2020 Paris Agreement's global governance framework

(→ Section 3.3)

Approximately half of the companies and one quarter of the subnational governments assessed are transparent about their intention to use offsets for their net-zero targets. The number of actors that explicitly rule out using offsets is limited.

Without a radical transformation of the offsetting market and the types of activities it supports, offsetting cannot be considered an equivalent alternative to an actor's own emission reductions in 2020. In the longer-term, plausible prospects for this approach are even more limited. Offsetting may divert attention from the need for deep decarbonisation and the Paris Agreement's ambition ratcheting mechanism. Without stringent safeguards, offsetting projects can set perverse incentives for both developed and developing countries in their efforts to increase domestic ambition. Despite a great variation in the types and quality of offset projects across existing offsetting mechanisms, we identify that these fundamental limitations are relevant across most existing offsetting approaches, as well as for the majority of new projects that are currently being developed or proposed for post-2020 offsetting mechanisms.

A radical transformation of the offsetting market towards “high-hanging fruit” projects could address some of these barriers. Emission reduction projects that are well beyond the potential reach of other governmental and non-governmental actors can support rather than conflict with host country ambition. The relatively higher cost of implementing such projects may provide a price signal that incentivises deep decarbonisation of the actor’s own activities. Such projects are not currently readily available to support through existing offsetting markets, due to the traditional focus of these markets on cost-efficiency and the “low-hanging fruit.”

Some actors support emission reduction projects elsewhere without using offset credits to claim the neutralisation of their own emissions. This contribution claim approach supports ambition in the host country while maintaining constructive transparency about the actor’s own remaining emissions.

Carbon dioxide removals can be supported through separate targets

(→ Section 3.4)

Carbon dioxide removal (CDR) technologies and practices need more support to reach their potential, but uncertainties related to methodologies for calculating their climate impact, as well as the permanence of carbon dioxide storage mean that they should not be considered equivalent to direct greenhouse gas emission reductions and are not suitable for claiming direct neutralisation.

Recognising that the outcomes of CDR activities are generally not directly comparable to the real reduction of one’s own emissions, **actors could set and pursue separate individual targets for each strategy**: one target for emission reductions, and another separate target for carbon dioxide removals. Given the ambiguity of net-zero claims, separate targets can provide actors pursuing ambitious emission reduction targets with the opportunity to stand out and better demonstrate the depth of their ambition.

Whether or not it is appropriate to combine those two targets into a net-zero target expression depends upon the specific circumstances; actors should make

a conscious decision, with full awareness of the nuances and the accuracy of communicated claims. A net-zero target can be an ultimate indication of ambition for some actors, and is popularly perceived as such, but the nuances of net-zero targets mean that a single target may not be the most transparent expression of ambition for all actors.

Low standards for transparency among net-zero targets can create a haven for greenwashing

(→ Section 4)

Net-zero targets can reflect mitigation ambition, but the innate ambiguity of the term “net-zero” can make targets incomparable between actors and even enable greenwashing. There is a significant risk that untransparent net-zero targets may mislead citizens, consumers and investors about the environmental impact associated with a product or service, leading to decisions and behaviour that cause an increase in greenhouse gas emissions. For example, airlines’ carbon neutrality claims may give the false impression that flying is more environmentally friendly than rail travel, and lead to an increase in demand for short haul flights.

Transparency can enable accountability and positive pressure to translate targets to ambitious action

(→ Section 4)

Transparency of net-zero target nuances and their implementation can unravel their potential ambiguity and facilitate constructive dialogue on potential challenges. Ambitious actors, critical observers, and concerned citizens should recognise that constructive transparency can be far more ambitious and solutions-oriented than net-zero claims that are based on opaque accounting approaches.

Guidance and encouragement for actors to set targets should include a greater consideration of these nuances, to better enable the identification of truly ambitious actors and enhance support towards them.

Ten basic criteria for net-zero target transparency



1. **Specify separate targets** for emission reductions and emission removals



2. **Chart a decarbonisation pathway** with interim targets for guidance and accountability



3. **Share information on emission reduction measures** to facilitate good practice replication



4. **Document stakeholder consultation** approaches to demonstrate ownership of plans



5. **Provide details on renewable energy** supply constructs to identify contribution



6. **Specify supply chain emissions coverage** to identify synergies with others' plans



7. **Provide details on offsets**, the perceived theory of change and the claim made



8. **Provide details on CO₂ removals supported**, alongside separate target for removals



9. **Identify and discuss challenges** faced for deeper decarbonisation



10. **Commit to a timeline** for the revision of ambition to establish an ambition ratchet mechanism

Foreword

Commitments to net zero have doubled during the pandemic, and at Climate Week NYC 2020, we saw a new wave of momentum towards net zero: some of the largest companies in the world, including industry leaders in hard-to-abate sectors, have made ambitious net-zero targets.

Meeting the goal of net zero carbon emissions by 2050 requires an unprecedented scale of action and collaboration across all levels of society. That is why we launched the Race to Zero campaign: to encourage non state actors across the world to set ambitious targets that will help move the world towards this goal. It is the largest ever alliance committed to achieving net-zero carbon emissions by 2050.

But with this proliferation of commitments must also come clear and demonstrable criteria for what best practice looks like. Civil society's call for climate action has evolved to encompass demonstrable transparency and accountability from the businesses, investors and financial institutions, city and regional governments and universities now confirming their commitments to our net zero future.

Now, the real work begins: implementing the necessary actions to achieve this unprecedented goal. As actors start their race to net zero emissions, we need to champion those who have matched their long-term ambition with credible plans and interim targets and encourage others to up their pace.

This report serves as an helpful resource for net-zero target setters on the importance of transparency in both target-setting and implementation. Consumers and citizens are scrutinizing the climate ambitions of non-state actors now more than ever, and actors committing to net zero must clearly communicate the details underpinning their net-zero targets.

There is no place for greenwashing in the Race To Zero - we welcome this important new report as a contribution to the robust standards and practices necessary to ensure that all those who join the race are genuinely contributing to the zero carbon future we must build together.

Nigel Topping and Gonzalo Muñoz

High-Level Champions for Climate Action of the COP26 and COP25 Presidencies

1

Introduction: Relevance and rise of net-zero target setting

A growing number of cities, regions, and companies have set or pledged to develop their own net-zero greenhouse gas (GHG) emission reduction targets. These include some of the world's largest companies, from Microsoft to Mahindra & Mahindra, which have garnered headlines for net-zero targets (*We Mean Business*, 2020). Hundreds of cities are also working to decarbonise: some, such as Copenhagen and Glasgow, plan to be carbon neutral within the next decade (*GB News*, 2019; CNCA, 2020). Many regions, including California and New York, have mapped out plans to decarbonise their economies and societies at a scale on par with some national governments.

These targets could play a vital role in addressing the climate crisis. Avoiding the most dangerous impacts of climate change requires cutting GHG emissions at unprecedented rates. To limit the global temperature increase to 1.5°C, with no or limited overshoot, global CO₂ emissions must fall by about 45 percent from 2010 levels by 2030, and reach net zero around 2050 (IPCC, 2018).

On the global balance sheet, net-zero emissions occur when human-driven GHG emissions and removals balance each other out. In practice, reaching net zero means decarbonising rapidly and at scale by aligning political, social and technological systems to shift to renewable forms of energy; decarbonise buildings, transportation, and other infrastructure; reduce food waste; and make industrial processes less carbon-intensive (IPCC, 2018). Simultaneously, the world must expand its capacity to capture any remaining emissions through practices such as protecting and planting forests, practicing climate-smart agriculture, and directly removing emissions through tools like air capture and storage technology.

Strategies for achieving net zero could help to meet other sustainable development goals. Reducing GHG emissions would decrease air pollution and prevent millions of premature deaths (IPCC, 2018). Shifting to energy efficiency and renewable energy

could align with efforts to improve energy security and reduce poverty (IPCC, 2018). As the world seeks to recover from the COVID-19 pandemic, many actors are designing green recoveries that harness these synergies (Hepburn *et al.*, 2020).

However, global emissions prior to COVID-19 have not been decreasing fast enough; in fact, they are actually stalling or increasing in major economic sectors (UNEP, 2019). Current national policies fall far short of the change needed to avoid the worst impacts of global warming, putting the world on course for 3°C of global temperature rise by 2100 (UNEP, 2019). To get back on track, a growing number of national governments have ramped up their climate ambition. So far, 19 countries, along with European Union, have adopted net-zero targets, and more than 100 others are contemplating them (Levin *et al.*, 2020). China's announcement in September 2020 that it aims for carbon neutrality by 2060 may be a catalyst to further increase this momentum. City, region, and company-level climate action could help implement these goals and accelerate the pace of decarbonisation.

At this crucial moment for global climate action and post-COVID 19 recovery, this report aims to **capture the current landscape of cities, regions, and companies setting net-zero targets** (→ Section 2). While the number of net-zero pledges continues to grow, their scope and potential impact remains unclear (Höhne *et al.*, 2019). Net-zero targets can reflect the highest mitigation ambition, but the innate ambiguity of the term "net-zero" and the manifold approaches for target implementation can make targets incomparable between actors and enable greenwashing. We seek to **navigate the nuances of net-zero targets and unravel their ambiguity** (→ Section 3) to enable the identification of truly ambitious actors and enhance support towards them, and to offer recommendations for increasing **target transparency for accountability and ambition** (→ Section 4).

2

Landscape of net-zero targets

Since the IPCC Special Report on Warming of 1.5°C identified the need for global decarbonisation by 2050, various actors have started to adopt emission reduction targets that work towards this goal. Often termed “net-zero,” “carbon neutral,” or “zero emissions,” these targets differ in their emissions scope, timelines, sectors, among other characteristics. This section describes the terminology used across these diverse pledges (→ Section 2.1), and explores the cities, regions, and companies making them (→ Section 2.2).

2.1

Terminology of targets and claims

Net-zero terminology

With the Paris Agreement, countries agreed to a global phase-out of greenhouse gas emissions by the second half of the century (Haites, Yamin and Höhne, 2013). Since then, a number of subnational governments have set their own targets to achieve net-zero emissions. These pledges range from “net-zero emission” to “carbon neutral” to “zero emission” targets. Table 1 surveys some of the vocabulary that most frequently describes these commitments.

Typically, subnational and corporate actors’ **net-zero targets** suggest a state in which an actor achieves a balance of carbon dioxide emissions and removals – using either natural sinks, such as reforesting land or adopting agricultural best practices, or a technological solution, such as carbon capture and storage. “**Climate neutrality**,” “**carbon neutrality**,” and “**zero-emissions**” are other target terminologies related to net zero. Technically speaking, carbon neutrality implies net-zero emissions of only carbon

dioxide, while climate neutrality suggests a broader focus on net-zero emissions of all greenhouse gases. Despite their different implications, in practice these terms are often used interchangeably. As with the phrase “**net-zero emissions**,” there is no definitive agreement on how these targets are put into practice. The content of two net-zero commitments can be dramatically different, aiming for different timelines, covering different kinds of GHG emissions, and relying on offsets to varying extents.

Across this universe of net-zero, climate- or carbon-neutral, and zero-emissions commitments, timelines range widely. Some companies claim that they are already achieving carbon neutrality (typically through heavy reliance on offsets), while others aim to decarbonise by 2050. Some targets focus exclusively on carbon dioxide (CO₂), while others include other greenhouse gases, such as methane or nitrous oxide. Different actors include different emission source scopes (i.e., direct Scope 1 emissions or indirect Scope 2 or 3 emissions – see Table 1) or greenhouse gas coverage.

While theoretically a target that covers all scopes and greenhouse gases would be most comprehensive, in practice suggestions for how to prioritise mitigation efforts vary: some recommend focusing on the activities with the largest impact on emissions, while others suggest focusing on the emissions sources an actor has the most control over (*University of Oxford, 2020*).

Some data platforms and initiatives have developed net-zero guidelines and standards for their members. The Carbon Neutral Cities Alliance, for example, asks its members to achieve net-zero emissions by reducing *total* greenhouse gas emissions by at least 80 percent by 2050 (CNCA, 2017). Meanwhile, the C40 Cities Climate Leadership Group’s Carbon Neutrality Guidance report explains precisely which scopes must be targeted to achieve net-zero emissions (2019). Specifically, it proposes that a net-zero city is one that has demonstrated the following:

“Net-zero GHG emissions from fuel use in buildings, transport, and industry (scope 1); Net-zero GHG emissions from use of grid-supplied energy (scope 2), Net-zero GHG emissions from treatment of waste generated within city boundary (scope 1 + scope 3), [and] Where a city accounts for additional sectoral emissions in their GHG accounting boundary, net-zero GHG emissions from all additional sectors in the GHG accounting boundary.”

While most subnational jurisdictions similarly focus on sector-based or territorial emissions – that is, the emissions produced by an actor – some actors suggest that net-zero goals should also address the consumption emissions embedded in purchases of goods and services (University of Oxford, 2020). For both companies and subnational governments, however, data limitations can create challenges for adopting recommendations to include scope 3 emissions in targets (see Box 3 on consumption-based accounting).

Taking a different tack, some suggest that “carbon neutrality” or “net-zero” applies only to global emissions (Carbone4, 2020). In other words, while individual actors can contribute towards a global carbon neutral trajectory, they should not claim this term for their own emissions. This perspective argues

that in our current inter-connected society, which is far from emissions-free, no entity can truly be carbon neutral, and it is not constructive to make this claim.

High ambition terminology

In addition to phrases that explicitly delineate net-zero emissions goals, there are also phrases that suggest targets of high – but not necessarily net-zero – ambition. “**Deep decarbonisation**” falls under this category. While it can describe action in any sector or the entire economy, this term is used most often to describe “hard to abate” sectors – which include heavy industry, such as steel and cement production, and heavy-duty transport, such as shipping and aviation (*Energy Transitions Committee, 2018*). Importantly, the phrase suggests a focus on reducing emissions as much as possible – contrasting to alternative approaches that rely heavily on offsets (Carrillo Pineda, Chang and Faria, 2020), “**Zero-emissions**” and “**emissions-free**” are also often used in the context of corporate climate action. These phrases refer to the lack of production of greenhouse gases in the first place and are most commonly employed by companies to tout their product or production process.

Table 1

Overview of emissions per scope for subnational and corporate actors (Fong *et al.*, 2014)

	Subnational actors	Corporate actors
Scope 1	GHG emissions from sources within the jurisdictional boundary. These may include emissions from agriculture, forestry and other land use; industrial processes; in-boundary transportation; stationary fuel combustion; and in-boundary waste and wastewater.	GHG emissions that directly arise from the actor’s operations. These include emissions from company vehicles and facilities.
Scope 2	GHG emissions occurring from the use of grid-supplied electricity, heat, steam and/or cooling within the actor’s jurisdictional boundaries.	GHG emissions related to the procurement of electricity, heating and cooling.
Scope 3	All GHG emissions that occur outside the actor’s jurisdictional boundary and that are a consequence of activities within the boundary. These may include emissions from out-of-boundary transportation; out-of-boundary waste and wastewater; and GHG emissions from imported goods.	All upstream and downstream emissions. These may include transport and distribution, use of sold products, end-of-life treatment of sold products, business travel, and investment portfolio emissions.

Another term implicitly tied to net-zero targets is “**1.5°C pathways**” or “**1.5°C mitigation pathways**.” In its Special Report on Warming of 1.5°C, the IPCC (IPCC, 2018) suggested that warming of less than 1.5°C is defined by achieving net-zero carbon dioxide emissions between 2050-2065 and achieving net-zero emissions of all greenhouse gases by 2070-2085. Accordingly, many actors with net-zero goals around this timeframe state that their targets are aligned with the 1.5°C goal or less. The Science-Based Targets Initiative, which is a partnership among several organisations to showcase company efforts to set targets in line with the temperature limits of the Paris Agreement, uses this description as a reference point. Although not all its members have explicitly set net-zero targets, the organisation requires that all must set targets which put them on track to achieve net-zero emissions by 2050. Over 300 companies have also signed onto the Business Ambition for 1.5°C initiative, pledging to set either “science-based emissions reduction target across all relevant scopes, in line with 1.5°C emissions scenarios,” or a “long-term target to reach net-zero value chain emissions by no

later than 2050, alongside science-based targets across all relevant scopes and in line with the criteria and recommendations of the Science Based Targets initiative (Science Based Targets Initiative, 2020; UN Global Compact, 2020).

Some actors have also pledged to go beyond net-zero, setting “**carbon negative**” or “climate positive” targets that entail the actor removing more greenhouse gas emissions than they emit (see Box 1). Inter IKEA Group, H&M, MAX Burgers and the Finnish city of Turku are among the first actors that have developed and launched targets to become “climate positive” (H&M Group, 2019; Inter IKEA Group, 2019; MAX Burgers, 2020) *Microsoft* made headlines when it announced its goal to be carbon negative by 2030, and to “remove from the environment all the carbon the company has emitted either directly or by electrical consumption since it was founded in 1975” by 2050 (Microsoft, 2020a) The Danish manufacturing company *Velux* has a similar target for “**lifetime carbon neutrality**,” under which it aims to remove as much CO₂ from the atmosphere as it has emitted since being founded in 1941, covering scope 1 and 2 emissions (Velux, 2020).

Box 1

Interpretation of climate positive and carbon negative targets

Climate positive or carbon negative targets imply that a subnational government’s or company’s carbon removals exceed its remaining emissions. If this is truly the case, this would be aligned with the IPCC’s finding that global GHG emissions must be net negative by the second half of this century (IPCC, 2018).

Microsoft committed to become carbon negative by 2030. From that year onwards, the company will remove more carbon from the atmosphere than it emits across its own operations and supply chain (Microsoft, 2020a). Inter IKEA Group and H&M use a different term for a similar goal: the companies aim to be climate positive by 2030 and 2040, respectively (H&M Group, 2019; Inter IKEA Group, 2019). In addition to deep emission reductions, Inter IKEA Group plans to sequester carbon in land, plants and products (Inter IKEA Group, 2019). H&M will use natural carbon sinks and is investing different types of technological CDR options (H&M Group, 2019). The fast food chain MAX Burgers, which serves beef burgers, promises its customers that its burgers are climate positive. For each tonne of CO₂e emitted, MAX Burgers removes 1.1tCO₂e through forestry projects (MAX Burgers, 2020).

While it is a good sign that companies try to minimise their impact on the climate as much as possible, it is important to consider how consumers may interpret these claims and if that that interpretation is in line with the objective: there is the risk that climate positive or carbon negative claims may be interpreted by consumers that the more one consumes, the better for the climate.

In this regard, MAX Burgers' claim is particularly problematic. Livestock is responsible for approximately 15 percent of global GHG emissions, with beef accounting for 40 percent of the sector's emissions (Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & Tempio, 2013). The IPCC identified reducing meat and dairy consumption as one of the measures to limit global warming (IPCC, 2019) but the climate positive claim may lead to an increased meat consumption.

Part of the reason that companies, regions and cities may start to introduce new terminologies for their targets may be that they have identified limitations with existing approaches. Companies might want to set themselves apart from other approaches and embark on a more ambitious trajectory. A responsible course of action may be for companies to survey their target audiences to assess how their claims are being interpreted, and whether this interpretation is in line with their objectives.

Standards and guidelines

Numerous efforts are emerging to inform actors on different net-zero target definitions and strategies. Guidelines such as the Foundations for Science-Based Net-Zero Target Setting in the Corporate Sector (Carrillo Pineda, Chang and Faria, 2020), Carbon Neutral Cities Alliance's Framework for Long-Term Deep Carbon Reduction Planning (CNCA, 2017), the C40 Cities Climate Leadership Group's Carbon Neutrality Guidance (2019), the Science-Based Target initiative (SBTi, 2020), Carbone 4's Net Zero Initiative (Carbone4, 2020), Rocky Mountain Institute's Carbon-Free City (Bronski *et al.*, 2017) and Carbon-Free Regions Handbooks (Corvidae *et al.*, 2018) outline suggested approaches to setting and meeting these targets.

A recent working group convened by the University of Oxford also mapped and identified key points of coherence and difference in the approaches to defining and setting net-zero targets exhibited by these guidelines across many of these and other guidelines and approaches (University of Oxford, 2020). This work helped develop baseline minimum criteria for participants in the Race to Zero Initiative, a network collaborating with other initiatives to mobilise subnational and non-state net-zero commitments with the ultimate goal of "reach[ing] (net)-zero in the 2040s or sooner, or by mid-century at the latest, in line with global efforts to limit warming to 1.5°C" (UNFCCC, 2020). Similar and ongoing efforts to identify key criteria for robust targets and enable actors to implement these approaches can help create a more consistent and transparent set of net-zero target approaches.

Box 2

Making net-zero commitments transparent

The transparency around net-zero commitments varies widely. In part, this may reflect the fact that many of these targets have only recently been announced. Some actors, however, have already developed innovative, transparent ways of communicating the possible pathways to net-zero milestones, and their progress thus made so far. London's 1.5°C Compatible Plan was informed by the Zero Carbon Pathways Tool (Greater London Authority, 2018; Mayor of London, 2020). This tool, which is publicly available online, shows what energy, transport and other emissions would look like at the borough level, under different scenarios for reaching net-zero by 2050. Boulder, Colorado, and Flagstaff, Arizona have developed detailed online dashboards tracking progress towards their net-zero goals, across their cities' electricity, transportation, waste and sectors (City of Boulder, n.d.; City of Flagstaff, 2019). Scotland has developed annual targets to help ensure it reaches its long-term goal of cutting emissions 90 percent by 2050, and passed legislation requiring a strategic delivery plan for meeting its climate targets to be published at least every 5 years (Scottish Government, n.d.). This kind of detailed reporting grounds these ambitious, long-term targets in current actions, prevents greenwashing, and enables policymakers, citizens, researchers, and other stakeholders to make adjustments to ensure these goals are met.

Table 2

Lexicon of common net-zero terms and vocabulary

Term	Definition	Example
Net-zero emissions	The achievement of a state in which an entity removes from the atmosphere as much greenhouse gas emissions as it causes (IPCC, 2018)	In June 2019, the UK signed into law a target of reaching net-zero greenhouse emissions by 2050 (Skidmore, 2019). The net zero proposal report from the Committee on Climate Change outlines what this means: a deep reduction in emissions, with carbon dioxide removals equal to any remaining emissions sources, such that net emissions reduce 100 percent by 2050. The UK aims to meet this target through UK domestic efforts, without international carbon credits (Committee on Climate Change, 2019).
Climate neutrality	State in which an entity's actions have no net effect on the surrounding climate; used especially with reference to the global climate system (IPCC, 2018). While carbon neutrality applies to carbon dioxide emissions, climate neutrality applies to all anthropogenic greenhouse gas emissions (Levin, Song and Morgan, 2015).	Climate neutrality is often described as a combination of direct emissions reductions, with emissions offsets for the remainder. For example, the UNFCCC's 2015 Climate Neutral Now initiative stated that climate neutrality should be achieved by first reducing an actor's own emissions as much as possible, and then compensating for the remainder using UN certified emission reductions (CERs), a type of carbon credit (UNFCCC, 2015).
Net-zero CO₂ emissions	The achievement of a state in which any remaining carbon dioxide emissions an entity produces are cancelled out by offsets (IPCC, 2018)	The Race To Zero campaign rallies businesses, cities, regions, and investors to adopt 2050 net-zero emissions, including Scope 3, and limiting offsets to neutralise "residual" emissions that cannot be directly abated (UNFCCC, 2020b).
Carbon neutrality	State in which an entity's actions result in net-zero carbon dioxide emissions (IPCC, 2018)	Carbon neutrality is often described as a combination of direct emissions reductions, with emissions offsets for the remainder. In late 2019, Siemens Gamesa achieved carbon neutrality through "a combination of actions such as energy reduction and efficiency measures, relying on electricity from renewable energy-based sources, a green mobility plan to reduce fleet emissions, and offsetting non-avoidable emissions through compensation projects" (Siemens Gamesa, 2020).
Zero-carbon	Similar to "carbon-free", zero-emissions implies that an actor emits no carbon dioxide emissions.	The <i>Climate Emergency, Urban Opportunity report</i> "shows that a carefully managed transition to zero-carbon, climate-resilient cities could help secure national economic prosperity and improve quality of life while tackling the climate crisis. Science tells us that to keep global temperatures from rising by more than 1.5°C, cities have to achieve that net-zero emissions by mid-century" (Colenbrander <i>et al.</i> , 2019).
Carbon-free	Technically implies the absence of carbon dioxide emissions, but often used as a synonym for carbon neutrality (Colenbrander <i>et al.</i> , 2019)	The Rocky Mountain Institute's <i>Carbon-Free City Handbook</i> provides 22 recommendations for goals in sectors spanning renewable energy supply, net-zero energy buildings, electric vehicles, or waste streams (Bronski <i>et al.</i> , 2017).

Term	Definition	Example
Net-negative emissions	A state in which an entity removes more emissions from the atmosphere than it contributes; can refer to carbon dioxide emissions specifically, or greenhouse gas emissions more broadly (IPCC, 2018)	McLaren <i>et al.</i> (2019) describe how the agriculture industry has the potential to contribute to net-negative emissions if land currently used for livestock were converted to biomass production and BECCS.
Carbon negative	Synonym for net-negative emissions, but typically refers only to carbon dioxide emissions	By 2030, Microsoft aims to remove more carbon than it emits and by 2050 remove all carbon it has directly or indirectly (i.e., Scope 2 emissions) since its 1975 founding. They plan to do this through “a portfolio of negative emission technologies potentially including afforestation and reforestation, soil carbon sequestration, bioenergy with carbon capture and storage (BECCs), and direct air capture (DAC)” (Microsoft, 2020a).
Climate positive	Similar to net-negative emissions, climate positive suggests that an entity removes more greenhouse gas emissions than it contributes.	Inter IKEA Group intends to become climate positive by 2030, through “drastically reducing” absolute greenhouse gas emissions throughout the value chain, and removing carbon from the atmosphere through storing it in land, plants and their products (Inter IKEA Group, 2019).
Deep decarbonisation	A development strategy that aims to reduce carbon dioxide emissions involved in a particular activity (Carrillo Pineda, Chang and Faria, 2020).	The Deep Decarbonisation Pathways Project is a collaborative global research initiative focused on the country-level that seeks to understand transitions towards a low-carbon economy consistent with the Paris Agreement. (SDSN, IDDRI, 2015).
Emissions-free	Producing no emissions; can refer either to carbon dioxide emissions specifically, or greenhouse gas emissions more broadly	According to the Race to 100 percent Clean, “millions of households and businesses [are] served by utilities that have voluntarily committed to providing 100 percent emissions-free energy or those living in communities with other ambitious climate targets” (Ptacek and Levin, 2020).
Zero-emissions	Synonym for emissions-free	Walmart aims to reach zero emissions across global operations by 2040, through a combination of using renewable energy, electrifying transportation, and taking charge of land restoration and regeneration for carbon dioxide removal (Walmart, 2020).
1.5°C pathway	Courses of action that aim to limit warming to 1.5°C, implying the achievement of net-zero carbon dioxide emissions by 2050 (IPCC, 2018)	Over 270 companies (UN Global Compact, 2020) have signed onto the Business Ambition for 1.5°C initiative, pledging to set either “science-based emissions reduction target across all relevant scopes, in line with 1.5°C emissions scenarios,” or a “long-term target to reach net-zero value chain emissions by no later than 2050, alongside science-based targets across all relevant scopes and in line with the criteria and recommendations of the Science Based Targets initiative” (Science Based Targets Initiative, 2020).

2.2 Overview of sub-national and corporate net-zero targets

This analysis draws from nine reporting platforms (see Appendix) to present the most comprehensive assessment of the landscape of subnational and corporate net-zero targets to date. It finds that from 2019 to 2020, momentum towards net-zero targets has grown significantly, with the number of commitments roughly doubling.

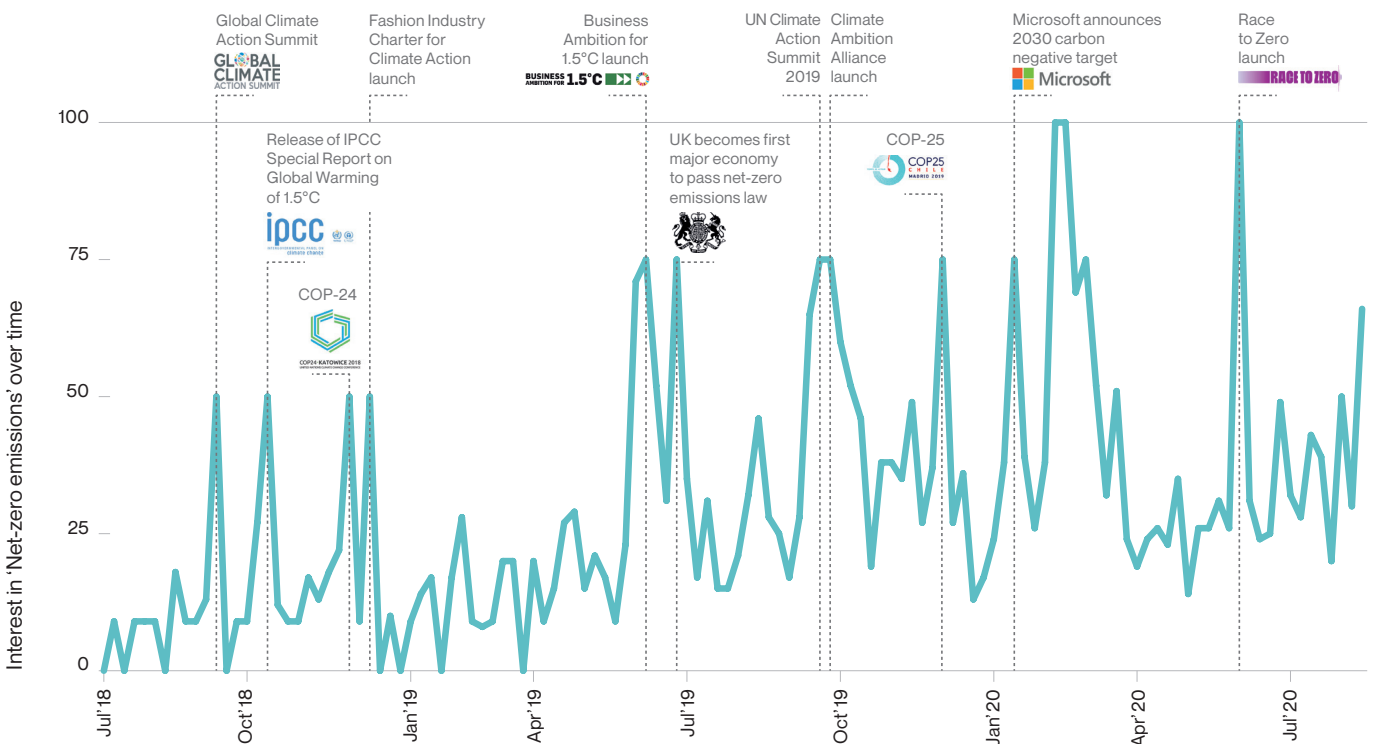
Momentum towards net-zero targets is growing, even in the midst of the global COVID-19 crisis. Specifically, we see that many actors are either making net-zero pledges on their own or joining networks of like-minded actors. For instance, the Business Ambition Coalition for 1.5°C now includes over

300 companies with US\$ 3.6 trillion in market capitalisation, up from just 28 members in July 2019 (UNGC, SBTi & WMBC, 2019; SBTi, 2020). In Japan, the number of net-zero announcements by local governments has steadily been increasing throughout 2020; the population coverage increased from less than 50 million in January 2020 to over 70 million, or 56 percent of the country’s total population, as of August 2020. One 2019 analysis of roughly 6,000 cities and regions making GHG emission reduction commitments found that 65 had made carbon neutrality commitments (NewClimate Institute *et al.*, 2019). A different deep dive into net-zero commitments in that same year identified up 11 regions, more than 100 cities, and roughly 500 businesses making economy-wide net-zero commitments (Höhne *et al.*, 2019). While the underlying data sources for these analyses vary, the overall trend is clear: a growing number of actors are signalling intent to pursue a net-zero trajectory. This momentum represents a crucial first step towards mobilising much-needed speed and scale, though the ambition and implementation of current efforts varies widely.

Figure 1

Internet searches for net-zero emissions
Peaks in the interest in “net-zero emissions” from Sept 2015 to August 2020 align with key climate-related events to galvanise climate ambition

Data source: Google Trends



In total, we find that 826 cities, 103 regions, and 1,565 companies have made net-zero commitments or signed onto initiatives aiming for net-zero targets through nine of the world's largest climate action reporting platforms.¹ These cities and regions represent a total of over 880.5 million people, equivalent to 11 percent of the global population. These companies have a combined revenue of over US\$ 12.5 trillion, equivalent to more than half of U.S. GDP (World Bank, 2020b).

Figure 1 shows Google Trends data for “net-zero emissions” searches, and suggests that interest in net-zero has grown significantly since the 2018 release of the IPCC Special Report on 1.5°C. In some cases, interest seems to be catalysed by big announcements, such as the Race to Zero launch or the United Kingdom’s announcement of the first net-zero emissions law from a major economy.

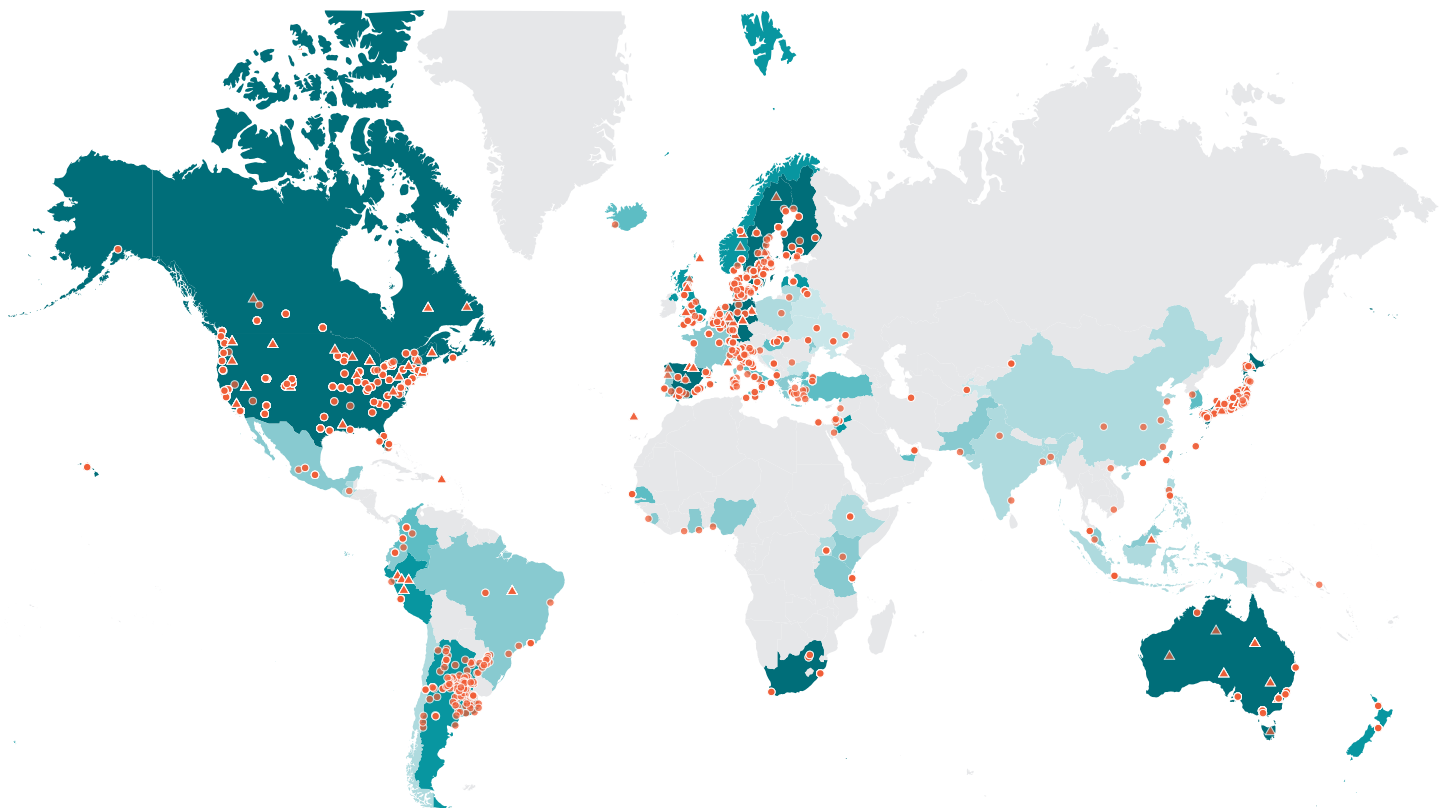
2.2.1 Cities and regions

Governments from 826 cities and 103 regions across every continent have made net-zero commitments, encompassing a total population of 880 million people - about 11 percent of the global population. North America, East Asia and the Pacific, and Europe are leading in the number of subnational governments making net-zero commitments and the population covered by these actors.

Figure 2 captures participation trends across different geographic regions, drawing from nine data sources, and reflecting a wide range of different types of net-zero efforts – from economy-wide targets to more sector-specific goals, and from targets codified in legislature and climate action plans to voluntary announcements or pledges made through global initiatives (see the Appendix for more details about the data sources and selection criteria for net-zero commitments).

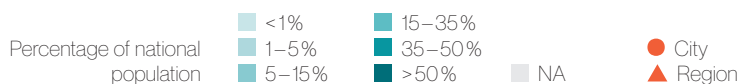
Figure 2

Map of cities and regions pursuing net-zero emissions



Note: NA refers to countries where we did not record actors pledging net-zero emissions targets

Data source: Data-Driven EnviroLab (2020)

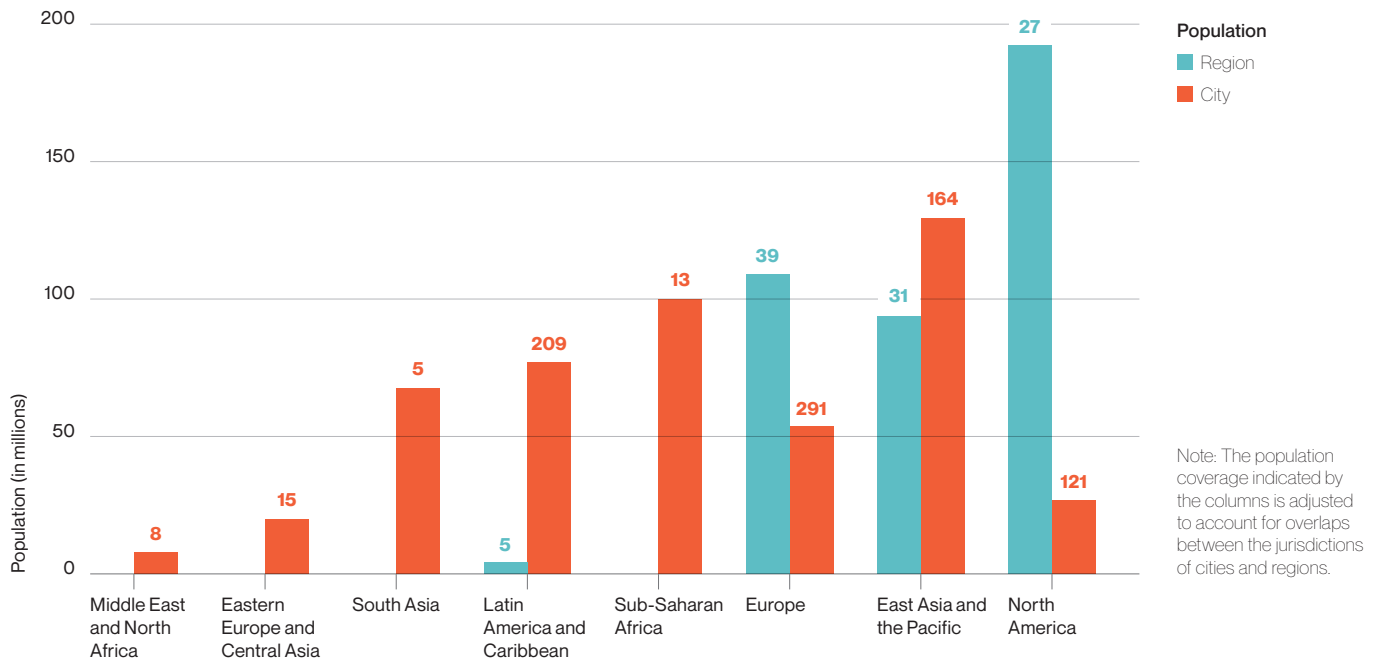


¹ We include any actors that aim to reduce their emissions by at least 80 percent, as well as those that explicitly state that they have made or intend to make a net-zero commitment. See the Appendix for more details about the data sources and methodology.

Figure 3

Population of cities and regions with net-zero targets, by geographic region

Data source: Data-Driven EnviroLab (2020)



The regions with the greatest participation – in terms of both the number of city and regional governments pursuing net-zero emissions, and the population they represent – include North America, East Asia and the Pacific, and Europe. Europe has the highest number of cities and regions pursuing climate action – including many smaller municipalities aiming for net-zero emissions – while the subnational governments working towards net-zero emissions in the East Asia and Pacific region represent the largest combined population.

The population represented by subnational governments pursuing net-zero emissions in all three regions, however, is substantial. Cities and regions in North America aiming for net zero represent over 218 million people, more than 60 percent of this region’s total population (World Bank, 2020a). These include nearly half of all U.S. states² – 24 in total, including Louisiana, California, and New York – aiming to achieve net-zero emissions across their entire economy or within key sectors, such as renewable energy. Subnational governments in the East Asia and Pacific region pledging net-zero commitments represent over 223 million people, over 10 percent of this global region’s total population (World Bank,

2020a). These include eight of Australia’s states, such as New South Wales (8 million) and Victoria (6.3 million), and 135 cities and 22 regions in Japan (combined population of 97 million), most of which are members of the 2050 Zero Carbon Cities in Japan initiative. European cities and regions cover more than 162 million people, over 36 percent of the EU’s total population (World Bank, 2020a).

Although Sub-Saharan Africa has relatively few cities and no regions with net-zero commitments, those that have made pledges are often large megacities like Lagos, whose actions help steer national economies and emissions trajectories. Combined, these cities represent more than 99 million people, roughly 9 percent of this region’s total population (World Bank, 2020a). In other words, despite a smaller number of actors, subnational governments in this region could generate a large mitigation impact.

Participation in the pursuit of net-zero emissions – in terms of both participating actors and the populations they represent – is lowest in South Asia, the Middle East, and Eastern and Central Europe. When interpreting these numbers, it’s important to note that many researchers have noted gaps in the data tracking voluntary climate action, particularly in

developing and emerging economies (Hsu *et al.*, 2019). In other words, low rates of participation in some geographic areas may indicate a gap in climate action reporting rather than a gap in climate action.

In some countries – notably, Australia, Sweden, South Africa, Canada, Japan, and Spain – cities and regions aiming for net-zero have reached a critical mass, representing more than 70 percent of their respective national populations. In Australia, where the national government has yet to set a net-zero target, city and regional actors, including eight of Australia’s largest states, are pursuing this goal. These subnational governments represent over 95 percent of the country’s total population, laying the groundwork for a national decarbonisation strategy. Conversely, national net-zero targets in Sweden, Japan, and Canada may have helped catalyse the creation of city and regional net-zero targets. Japan’s high level of coverage (more than 75 percent of the national population) may additionally stem from national legislation requiring prefectures and municipalities to develop measures to curb GHG emissions (Japan Ministry of the Environment, 2020; Levin *et al.*, 2020).

While baseline emissions data is often missing from actors’ self-reported data, available information suggests that cities and regions with net-zero targets cover more than 6.5 gigatonnes in annual emissions – an amount greater than the total emissions from the U.S. in 2018 (World Resources Institute, 2020).

Additional data on the baseline emissions covered by net-zero targets is essential for understanding the long-term impact of these commitments. For instance, many of the countries where subnational actors with net-zero commitments represent more than 50 percent of the national population have per capita GHG emissions above 10 tons of CO₂ emissions per capita (World Bank, 2020c). For these net-zero goals to be effective, they will need to cover a large share of their actors’ total GHG emissions and drive very steep reductions. However, assuming these conditions are met, and targets are fully implemented, the large emissions footprints of these actors pursuing net-zero emissions targets suggests that their mobilisation could have a significant impact on global and national emissions.

Box 3

Consumption-based emissions

Some subnational actors, such as Seattle, Vancouver, London, Portland, and San Francisco (CNCA, 2017) account for *consumption-based emissions* – that is, the GHG emissions from city residents’ consumption of goods and services like food, clothing, or electronics – alongside the sector-based emissions inventories that track emissions produced within the city, from energy use in vehicles, homes, and companies, and from waste (C40 Cities for Climate Leadership *et al.*, 2018). A consumption-based emissions inventory can offer a more complete estimate of an actor’s emissions. Portland, for instance, found that the city’s consumption-based emissions were more than double the emissions generated locally (City of Portland and Multnomah County, 2015). Likewise, one study found that 80 percent of 79 cities had larger consumption-based GHG emissions than sector-based GHG emissions, though for the other 16 cities – based mostly in South and West Asia, Southeast Asia and Africa – the reverse was true (C40 Cities for Climate Leadership *et al.*, 2018).

On a global scale, it’s clear that addressing consumption-based emissions will be a crucial part of reaching net-zero emissions. An analysis of 94 cities participating in the C40 Cities Climate Leadership Network found that their consumption-based emissions accounted for an estimated 4.5 GtCO₂e in 2017, compared to 2.9 GtCO₂e in total production-based emissions, and a global total of 45 GtCO₂e (C40 Cities Climate Leadership Group, University of Leeds and Arup, 2019). In order to stay on track for a 1.5°C trajectory, the average per capita urban consumption in these cities needs to fall by half by 2030, and 80 percent by 2050, with high-income cities in Europe, North America, and East Asia making the fastest and steepest cuts (C40 Cities for Climate Leadership *et al.*, 2019).

Our analysis did not uncover any consumption-based net-zero targets, but did reveal that cities have begun to use consumption-based GHG emissions inventories to inform their climate action strategies. Seattle used the results of its consumption-based inventory to generate a list of actions that residents can take to reduce their contribution to the city’s emissions (Foster *et al.*, 2013). Portland discovered

that the city's consumption-based emissions were more than double the emissions generated locally, and that income-levels drive consumption emissions within the city. Lifecycle emissions from households with annual incomes less than US\$ 15,000 were 80 percent lower than households with annual incomes above US\$ 150,000 (City of Portland and Multnomah County, 2015). These kinds of detailed analyses can help cities target different kinds of consumers in different ways. In Portland's case, this entailed encouraging higher-income residents to shift to more sustainable forms of consumption while providing financial and technical assistance to lower-income families to improve their quality of life in sustainable ways (City of Portland and Multnomah County, 2015).

The staff time, costs, and challenges involved in acquiring data may explain why more cities have not experimented with consumption-based accounting (CNCA, 2017). Additionally, cities may have more direct control over the sources of sector-based emissions. However, strategies to increase resource productivity, focus on the most carbon-intensive forms of consumption, and shift public preferences towards lower-emissions goods and services can significantly reduce emissions – and generate a wide range of co-benefits (C40 Cities for Climate Leadership *et al.*, 2018). For instance, buying fewer new clothes and textiles could save the residents of 94 C40 cities US\$ 93 billion in a single year (C40 Cities for Climate Leadership *et al.*, 2019).

Box 4

China's subnational actors in support of the country's 2060 carbon neutrality target

President Xi Jinping made international headlines when he announced China's plan for carbon neutrality by 2060 at the UN General Assembly in late September. Currently responsible for nearly 30 percent of global greenhouse gas emissions, the long-term impact of China's carbon neutrality target would be significant - shaving 0.2 - 0.3°C of predicted global temperature increase in 2100 (Climate Action Tracker, 2020). While the details of exactly how China will achieve this target are unclear, given more than half of its current energy mix is still reliant on fossil fuels and predominantly coal (Myllyvirta, 2020), a range of subnational initiatives are already aiming for similar goals to move the country closer towards its carbon neutrality goal.

In January 2020, the "Zero-Carbon China" initiative was launched by the Energy Investment Professional Committee (EIPC), a peer organisation for energy investment leaders under the Investment Association of China (AIC). The initiative aims for more than 1,000 zero-carbon communities, more than 30 zero-carbon technology demonstration parks, and over 100 zero-carbon industrial parks. During a meeting of Beijing's high-level policy makers in March 2020, the term "new infrastructure" became a fixture in discussions on economic responses to COVID-19, referring to infrastructure underpinned by the latest information technology, such as 5G towers, electric vehicle charging stations, and a high-voltage power grid that could accommodate more renewable energy sources (Zhou, 2020).

Urban areas are key levers for decarbonisation in China, the world's largest emitter of greenhouse gases. Because urban residents emit on average roughly 1.4 times more energy-related CO₂ than rural counterparts, the national government has targeted cities for piloting climate change solutions, including the Low-Carbon Pilot Provinces and Cities program, which launched in 2010 and now includes 81 cities and 6 provinces (Yang, Wang and Zhou, 2018).

Take Fuzhou, the capital of Fujian province, for example. As part of the Race to Zero, the city of 7.6 million people is aiming for net-zero emissions by 2050. As a near-zero carbon zone, Fuzhou is piloting strategies to enable a high utilisation of renewable energy in buildings in pursuit of their net-zero goal. In the city's buildings, 1.66 million m² of floor area features solar thermal hot water, and 2.08 million m² of floor area features ground-source heat pumps (Sherlock *et al.*, 2018). Some enabling policies and technical standards for renewable energy have already been passed at the provincial and city level — for example, commercial and public buildings under 12 floors are required to have centralised renewable powered water heating (Sherlock, *et al.*, 2018). In partnership with C40 Cities, Fuzhou is looking towards cities and regions in other countries, for example Boston, to study how they use policy to support air source heat pumps, which are currently not formally recognised as renewable energy resources on the national level in China. In many cases, air source heat pumps are cost-effective, energy efficient options for electrifying building heating and cooling.

Provinces and cities still face implementation issues that could impede the achievement of subnational climate targets as well as the national 2060 carbon neutrality goal. Despite the Energy Transitions Committee finding that it is “technically and economically possible” for China to reach net-zero by 2050, China is currently still heavily reliant on coal — 60 percent of electricity generation in China was from coal in 2019, and some of China's biggest industries, steel, iron and cement production, are hard-to-abate sectors that are heavily coal-reliant and without carbon-free alternatives that have been deployed at scale (Pike, 2020). While local Chinese governments must eliminate coal for China to reach its 2060 carbon neutrality target, coal projects are still being approved at the fastest rate since 2015 in an attempt to stimulate economies from the impact of COVID-19 (Hale and Hook, 2020). For subnational actors to meet the objectives of a “Zero-Carbon China,” green recovery and a just transition towards renewable energy that includes worker reskilling and a shift away from coal are needed.

2.2.2 Companies

1,565 companies, representing over US\$ 12.5 trillion in revenue and 24.9 million employees, have set net-zero targets. The industries with the highest number of participating companies are services (290 companies), manufacturing (120 companies), and retail (67 companies) sectors, out of the companies with available data. In terms of revenue, the service industry leads the way (>US\$ 4.2 trillion), followed by manufacturing (>US\$ 2.8 trillion).

As of September 2020, four platforms were identified as data sources for companies' net-zero goals (see the Appendix for more details about the data sources and net-zero selection criteria). These commitments range from plans that encompass most of a company's scope 1, 2, and 3 emissions to goals that are very narrow in scope- sometimes covering only specific facilities or products. As with

cities and regions, some companies outline specific targets backed up by pledges to track and report their progress while others make more general commitments or sign onto initiatives pledging to further develop their targets and action plans.

In terms of revenue, participation is greatest among companies in the services industry, with over US\$ 4.22 trillion in total revenue from 290 companies (see Figure 4). This sector ranges from information technology services companies such as AT&T and Google, to financial services companies such as AXA. The second-largest sector industry in terms of revenue is manufacturing, with over US\$ 2.8 trillion in revenue from 120 companies aiming for net zero. Of the 24.9 million people working for companies pursuing net zero, companies in the services industry employs the largest share, with over 7.5 million total employees. Manufacturing companies, which includes the like of Apple and AMD follow close behind, employing over 5.4 million people.

Figure 4

Revenue of actors pursuing net-zero emissions, according to CDP Industry classifications



Initiatives such as the Race to Zero campaign – a global effort to bring diverse coalitions together to achieve net-zero emissions by 2050 – can play a crucial role in catalysing action. The Race to Zero campaign includes a particularly high number of services and retail companies, which respectively account for 44 percent and 12 percent of the member companies with available industry data. The industries that the Race to Zero disproportionately attracts are more consumer-facing – many Race to Zero participants are also B Corporations that prioritise sustainability in their corporate identity and as a selling point to consumers.

In total, companies pursuing net-zero emissions have a footprint greater than 3.5 gigatonnes of GHG annual emissions, which is more than India's annual emissions (World Resources Institute, 2020). Data gaps make it challenging to assess what percentage of companies' emissions are covered by their emissions targets, and many have set net-zero goals that focus on a specific scope or subset of their emissions. Still, this figure suggests that companies with an emission footprint equivalent to one of the world's largest emitters have taken initial steps on the path towards decarbonising their operations.

Box 5**Net-zero goals in hard-to-abate sectors**

Recent research demonstrates that deep decarbonisation is possible even in heavy industries. One study found that reaching net-zero emissions by 2050 is both technically and economically feasible for chemicals, steel, and cement at a cost of less than 0.5 percent of global gross domestic product (GDP) (Energy Transitions Commission, 2018). The study focuses on key strategies such as adopting the best available technologies, shifting to a circular economy model, and increasing material and energy efficiency (Ge *et al.*, 2019). Other reports have echoed this message, outlining decarbonisation roadmaps for different regions and sectors (Energy Transitions Commission, 2018; Material Economics, 2019; Wyns *et al.*, 2019). The IEA estimates that while these approaches could keep emissions in check through 2060, innovative low carbon technologies will still be necessary to keep emissions aligned with safe global warming trajectories in the longer term (IEA, 2017, 2018). At the moment, some of these technologies are commercially available, while others remain in the research stage; investing in their rapid development and deployment will be a key part of ensuring these industries reach their goals (Ge *et al.*, 2019).

Some companies have begun to make commitments to implement roadmaps towards decarbonisation. ArcelorMittal, Europe's largest steelmaker, aims to reduce emissions by 30 percent by 2030, before reaching net-zero emissions in 2050. Its strategy rests on a carbon-neutral steelmaking approach that leverages clean energies – circular carbon, clean electricity and carbon capture and storage (CCS) – and replaces natural gas with hydrogen (ArcelorMittal, 2020). In May 2019, the world's fourth largest cement-making company, HeidelbergCement, announced that it had become the first cement company to receive approval for a science-based target - a 2030 emissions reductions goal that marks the first step on the path to developing carbon neutral concrete by 2050 (Geck, 2019). The impact of these commitments will hinge on their emissions coverage and implementation plans – in other words, do these companies fully decarbonise their business model, or simply window-dress it? Even so, these commitments mark a crucial shift from debating whether net-zero emissions is possible in heavy industry to debating the best pathways and timelines to achieve it.

**2.2.3
Targets**

Though most net-zero goals take 2050 as their target year, there is a large degree of heterogeneity in actors' targets. For instance, targets vary in terms of emissions coverage and reliance on offsets.

This analysis includes a wide variety of target types. Net-zero goals range from commitments to reduce emissions by a specific percentage, before a target year, which are reported through platforms such as CDP, to more general announcements of net-zero ambition.

Figure 5 focuses on a subset of targets: economy-wide city and region pledges to reduce emissions by a certain percentage by a specific year, and company targets to reduce emissions by at least

80 percent by a specific year (these company targets are not necessarily company-wide). Of the more than 900 cities or regions aiming for net-zero emissions, only 460 have targets that pledge reductions in emissions by a certain percentage by a specific year, and even fewer - 195 (42 percent) - are economy-wide targets.

Of this subset of actors, most aim to achieve net-zero emissions around the years 2020, 2030, and 2050, or along more loosely defined "long-term" timelines. Most cities and regions aim for 2050 as a target year, though a significant number of cities have set earlier targets. Copenhagen, for instance, aims to become the first carbon neutral capital by 2025 (CNCA, 2020). The Finnish city of Turku has set a goal to become carbon neutral by 2029, and a "climate positive city" with negative net emissions after that point (Turku City Council, 2018).

Companies' targets also vary widely, ranging from some actors claiming to already be achieving annual net-zero emissions, largely through the use of offsets, to one company aiming for a 100 percent reduction in emissions from its purchased electricity by 2100. Even in industries considered traditionally hard to abate, some actors are setting net-zero targets with deadlines in the next few years. Though only seven fossil fuels companies set net-zero targets, those that did set early deadlines, with the median industry deadline year at 2025 — the earliest out of the companies with industry data. However, it is important to note that these targets do not necessarily apply to companies' full emissions.

As Figure 5 discusses, it is difficult to judge an actor's ambition based solely on its timeline. While most guidelines suggest aiming for net-zero emissions by 2040, or 2050 at the latest (University of Oxford, 2020), many other factors, ranging from

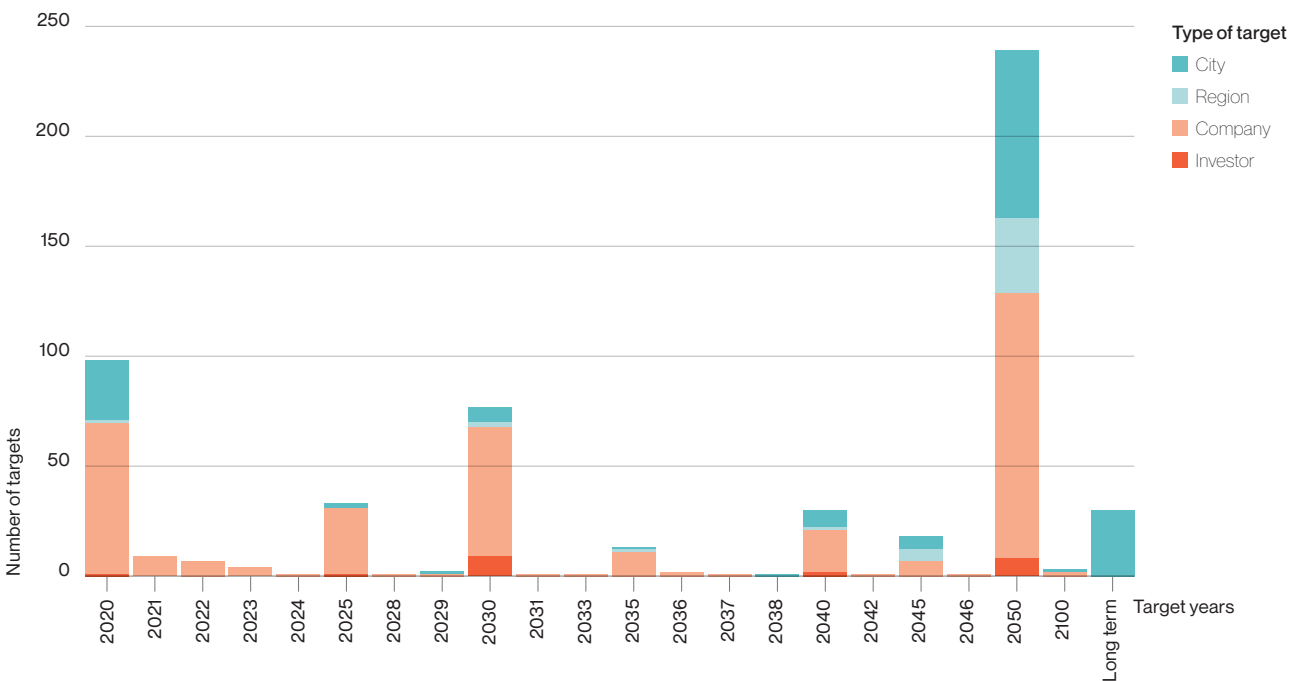
an actor's emissions sources and its control over them, the emissions scopes and greenhouse gases targeted by a goal, and the presence or absence of a plan for implementation, can determine a target's overall impact on emissions.

Additionally, these targets can be extremely heterogeneous. Of the 123 cities and regions that mention specific carbon offset projects in their net-zero plans, these approaches range from reforestation to renewable energy procurement and CO₂ removal. Some actors set goals targeting all or nearly all of their emissions; actors including Microsoft and Moody's have also set out goals to address their historic emissions. Other commitments focus on specific sectors, such as the renewable energy and buildings sector. Many corporate targets focus on certain products or locations – specifying goals in terms of tons of CO₂ per hotel room or outlining goals for specific airports.

Figure 5

Net-zero target years for cities, regions, companies and investors

Note: Only targets that are economy-wide are presented for cities and regions



Box 6

Understanding ambition

It is difficult to evaluate a city, state or region's ambition from its target alone. Targets vary widely, and cover different portions of an actor's overall emissions. A 2050 target that encompasses all of an actor's direct (scope 1) and indirect (scope 2 and 3) emissions and greenhouse gases may be equally or more ambitious than a 2030 target focusing only on carbon dioxide emissions in a single sector.

Actors' varying emissions profiles can also lead to very different climate action plans and timelines. A largely industrialised state or region may be more challenging to decarbonise than a highly forested region. Both Scotland and Wales have set targets supporting the United Kingdom's goal of reducing emissions by 80 percent (from 1990 levels) by 2050. However, the UK Committee on Climate Change suggested that while Wales should target a 95 percent reduction by 2050 relative to 1990, Scotland should set a net-zero GHG target for 2045, "reflecting Scotland's greater relative capacity to remove emissions than the UK as a whole" (Committee on Climate Change, 2019). Given Scotland's "larger land area per person and its significant CO₂ storage potential...it can credibly reach net-zero GHGs earlier," while Wales "has less opportunity for CO₂ storage and relatively high agricultural emissions that are hard to reduce" (Committee on Climate Change, 2019). Similar trends hold true for corporate emissions – some sectors need to harness existing solutions in transportation, energy, and energy and material efficiency, while others must also accelerate the research, development, and adoption of new technologies (*Energy Technology Perspectives 2017*, 2017; Ge *et al.*, 2019; IEA, 2019).

Similarly, actors may have different levels of control over their emissions, according to their resources and the political context they operate in (Bataille, 2019). Low-carbon measures could reduce the emissions from urban buildings, materials, transport and waste by nearly 90 percent in 2050. However, by one estimate, local governments control just 28 percent of urban mitigation potential; 35 percent is in the hands of national and regional governments, and the remaining 37 percent is controlled by collaborations among local, regional and national governments (Colenbrander *et al.*, 2019). Cities and regions with national governments that are also pursuing ambitious emissions reductions goals may have the financial, technical, and political support to move more quickly (Hsu *et al.*, 2020). Local governments in developing and emerging economies often have less access to the capital needed to implement climate policies, even if these strategies end up saving money over the long term (Beard *et al.*, 2016; Colenbrander *et al.*, 2019). The process of setting a target for a large multinational corporation may look quite different than the path taken by small and medium enterprises (SMEs); several reporting platforms have recognised and responded to the work of (Farsan, 2020; Tickell and Robins, 2020), and the recently launched SME Climate Hub (2020) provides actor-specific strategies for target-setting.

→ Section 3 for nuances of net-zero targets for climate action

3

Nuances of net-zero targets for climate ambition

Corporate and subnational actors adopt a wide range of approaches for setting net-zero emission targets. Beyond variations in the terminology used and the claims made, there are also significant differences in how actors intend to achieve “net zero.” In this section, we categorise approaches that underpin net-zero claims, and assess the nuances of their climate ambition.

3.1

Overview of nuances and their implications for climate ambition

At the highest level, strategies and specific measures for subnational and corporate actors' net-zero target implementation can be broadly categorised according to whether they target the **direct reduction of emissions** (Section 3.2), claim **neutralisation of emissions through offsetting** (Section 3.3), or **support carbon dioxide removal** (Section 3.4). We note that companies adopt a particularly broad range of approaches to claim the **neutralisation of electricity-related emissions** (Section 3.2.2), and to support the reduction of **supply chain and out of boundary emissions** (Section 3.2.3). Therefore, we assess these areas from the perspective of companies specifically.

Figure 6 provides an overview of the key distinctions between these approaches. These nuances have key implications for the additionality of impact, the integrity of a claim, and the extent to which the approaches actively support or hinder solutions to the most difficult challenges of deep decarbonisation³, as summarised below and in Table 3.

Reduction of an actor's emissions

(→ Section 3.2)

Net-zero pledges that are built upon robust plans for the real reduction of an actor's emissions and incorporate interim targets offer the greatest clarity in terms of their contribution to global decarbonisation.

Of the various overarching strategies for net-zero target implementation assessed in the previous sections, those that directly lead to a real reduction of the actor's emissions offer the greatest and least disputable impact. These strategies also entail a fair contribution to long-term decarbonisation challenges; if a specific actor deems the reduction of their own emissions to be too complex and expensive to pursue as their primary net-zero implementation strategy, who else should take on this burden to achieve global decarbonisation?

Many companies, cities and regions with net-zero commitments adopt a range of optimisation and improvement measures to achieve moderate emission reductions, but the most ambitious decarbonisation targets may require going beyond quick-wins to radically reorient business models and processes.

Beyond the depth and breadth of emission reduction ambition, Section 3.2 identifies a key distinction in the extent to which a clearly charted decarbonisation pathway and implementation plans underpin companies', cities' and regions' net-zero targets:

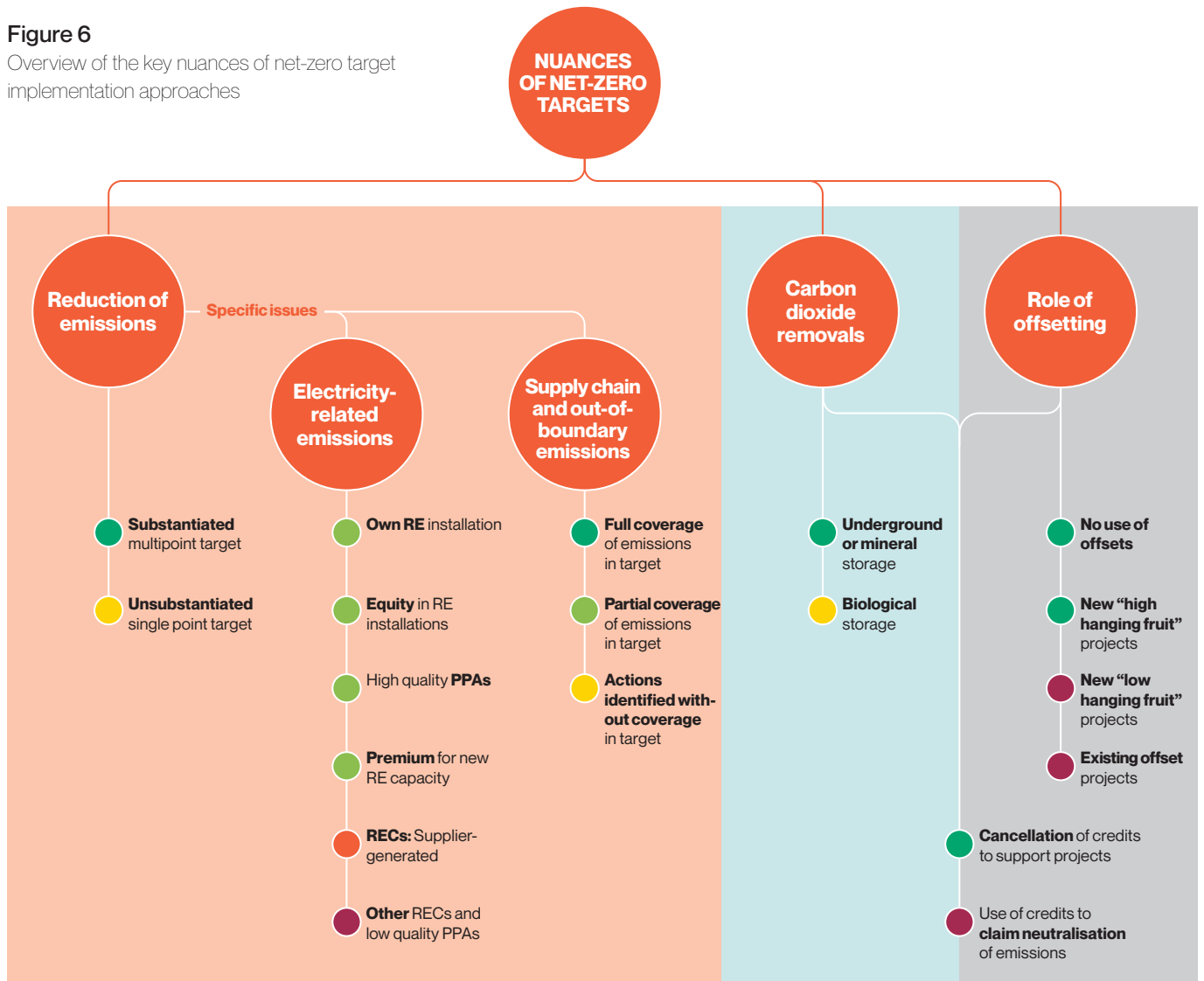
- **Robust targets with a decarbonisation pathway** identified through interim targets offer clarity and guidance on how that target should be implemented. They provide the transparency needed to ensure accountability. A target that

incorporates a clear strategy with broad ownership among stakeholders and an accountability mechanism has the highest chance of translating to successful and ambitious implementation.

- **Speculative and unsubstantiated single-point targets** without a clear strategy provide little guidance or accountability, reducing the likelihood that such targets will be implemented or achieve positive impact. In particular, the lack of a planning process or a decarbonisation pathway makes it less likely that solutions for harder-to-abate sectors will be found.

Figure 6

Overview of the key nuances of net-zero target implementation approaches



ALTERNATIVE APPROACH
 Separate targets to support each of these outcomes individually without claiming towards own net-zero targets

Electricity-related emissions

(→ Section 3.2.2)

For all models of addressing electricity-related emissions, the real emission reduction impact is often ambiguous but depends on the details of the construct. The following key distinctions in companies' implementation strategies are identified in Section 3.2.2.

- **The installation of renewable electricity** generation technologies within a city, a regional jurisdiction or directly linked to a company's own site can directly create additional capacity. However, this may not necessarily entail a strong contribution to long-term sector decarbonisation if such action is merely a cost-saving measure where contributions to system improvements included as components in electricity tariffs are avoided.
- **Equity in renewable electricity generation installations** and the agreement of **high quality PPAs** are likely to ensure truly additional renewable electricity capacity, although a guarantee of additionality depends upon the specific circumstances and overlap or competition with other potential project developers.
- **Procurement of energy supplier-generated RECs** does not currently send any meaningful signal to potential developers of new renewable energy capacity due to oversupply and low prices in major markets. Third-party generated **RECs** can even lead to a net decrease in demand for renewable energy capacity due to the potential for implicit double counting.
- **A capacity expansion premium**, where electricity suppliers charge a premium on electricity sales that is dedicated to funds for additional renewable electricity capacity installations, can channel direct support to additional renewable energy capacity. Such a premium can be bundled with any form of energy procurement model, regardless of the volume of energy procured.

Subnational and corporate actors use all of these approaches to claim the complete neutralisation of their energy-related emissions, although there are many circumstances in which this assertion may not be an accurate representation of the real impact. In those cases, making such claims is not only factually contentious but may also divert attention and prioritisation away from energy efficiency improvements.

Nevertheless, the careful consideration of approaches and specific suppliers for energy procurement can enable actors to constructively contribute to the development of renewable energy capacity and to the reduction of global GHG emissions, even without claiming the neutralisation of their electricity-related emissions.

These issues indicate that the decarbonisation of electricity is not an objective that can be addressed by any single actor in isolation, but rather it is a systemic issue; **actors can contribute to long-term solutions by lobbying for a supportive policy environment** for decarbonisation of the energy system. The best course of action that an actor can take to increase the chance that their electricity delivery approach yields emission reductions also depends upon the local policy infrastructure and market circumstances.

Supply chain and out-of-boundary emissions

(→ Section 3.2.3)

Actors can increase the ambition of their targets by enhancing scope 3 emission reduction efforts and improving transparency about what emission sources they count towards their targets.

Companies with net-zero targets demonstrate a range of approaches to indirectly support the reduction of supply chain and out-of-boundary emissions, both upstream and downstream. These measures should not be seen as alternative options to choose from. On the contrary, the more of these measures an actor pursues, and the stronger they are, the more ambitious an actor's target can be.

It is not necessarily realistic to assume that all actors will be able to obtain and act upon a complete and exhaustive overview of their scope 3 emission sources. While some ambitious actors account for the **complete coverage of scope 3 emissions** in their targets and identify actions to address them, others are only able or willing to include **partial coverage**, while others **identify actions** only to address scope 3 emissions without including any of those emissions within their targets. Less ambitious actors may have **no coverage of scope 3 emissions** at all, either within their target or in the identification of actions.

The coverage of scope 3 emissions within targets and emission reduction strategies is not the only point that differentiates the ambition of actors, but also the transparency around scope 3 emissions coverage represents a key source of variation among actors.

- **Highly transparent communication** regarding the amount of responsibility an actor assumes for upstream and downstream scope 3 emissions, as well as the measures that an actor is pursuing to reduce these emissions, can improve the potential additionality and long-term contribution of an actor's approach. Such transparency helps to ensure the quality and additionality of the measures implemented, while also facilitating a constructive dialogue on gaps in action and challenges faced. There is an emerging consensus and increasing volume of available guidance available on how best to communicate transparently, including materials from the Climate Disclosure Standards Board (CDSB), the Sustainable Accounting Standards Board (SASB) and their Task Force on Climate-related Financial Disclosures (TCFD) (CDSB and SASB, 2019).
- **Vague communication and coverage** of scope 3 emissions can, by contrast, create misunderstandings regarding the ambition of the actor and can lead to missed opportunities for constructive dialogues on barriers to effective action.

Due to limited information on scope 3 emissions and measures to address them, some actors may feel compelled to pursue a vague communication approach. Ambitious actors and critical observers should take note of the inherent difficulties faced and recognise transparency as its own indicator of ambition, even if the level of coverage and action is currently limited.

Whether or not any specific strategy for indirectly supporting the reduction of supply chain emissions leads to the guarantee of additionality and integrity that allows those outcomes to be counted towards net-zero targets, depends on the unique and specific circumstances.

Neutralisation of emissions through offsetting

(→ Section 3.3)

Claiming carbon neutrality through offsetting has a number of limitations and risks under the Paris Agreement's global governance framework.

Claiming carbon neutrality through offsetting may divert attention from the fact that, to meet the objectives of the Paris Agreement, we need to reach net-zero GHG emissions worldwide. Offsetting approaches – whether consciously or inadvertently – may paper over the cracks in a way that runs against efforts for a transparent and facilitative dialogue to find solutions for society's collective decarbonisation challenge. Without stringent safeguards, offsetting projects can also create conflicts and challenges for host countries in their efforts to ratchet up their domestic ambition. Despite great variation in the types and quality of offset projects across existing offsetting mechanisms, we identify that these fundamental limitations are quite broadly relevant across most existing offsetting approaches. This recognition leads to the identification of the following key distinctions between subnational and corporate actor approaches taken by subnational corporate actors, as analysed in Section 3.3:

- **Existing and relatively low-cost offset projects** entail a potential conflict with a host country's own ambition-raising potential, do not provide a clear price signal for the decarbonisation of an actor's own emissions, and may divert attention away from necessary efforts to decarbonise an actor's own emissions. Despite a great variation in the types and quality of offset projects across existing offsetting mechanisms, we identify that these limitations characterise most existing approaches, as well as for the majority of new projects that are currently being developed or proposed for post-2020 offsetting mechanisms.
- **Aradical transformation of the offsetting market towards "high-hanging fruit" projects** could address some of these barriers. Emission reduction projects that are well beyond the potential reach of other governmental and non-governmental actors can support rather than conflict with host country ambition. The relatively higher cost⁴ of implementing such projects may provide a price signal that incentivises the deep decarbonisation of an actor's own emissions in the first place. Such projects are not currently readily available to support through existing carbon credit markets, due to the traditional focus of these markets on cost-efficiency and the "low-hanging fruit".

Some actors prefer to pursue a **contribution claim** model in which they support projects without using offset credits to claim the neutralisation of their own emissions. This leaves ownership of the mitigation outcomes with the project's host country and supports that country's ambition-raising while also maintaining constructive transparency about the actor's own remaining emissions.

Supporting carbon dioxide removal technologies

(→ Section 3.4)

Carbon dioxide removal technologies and practices need to receive more support, but uncertainties related to methodologies for calculating the impact of those measures, as well as questions about the permanence of carbon dioxide storage, mean that they should not be considered equivalent to GHG emission reductions and are not suitable for claiming direct neutralisation. In particular, ambitious actors can contribute to long-term challenges by supporting less mature **CDR technologies based on underground and mineral storage**, which entail greater prospects for the permanence of GHG removal impacts and require significant volumes of investment to fulfil their envisaged role in the global achievement of net-zero emissions. Support for nature-based solutions can also be attractive due to the multitude of environmental and social co-benefits that they entail, particularly if the objective of the support provision is not to claim neutralisation of an actor's emission reductions.

Recognising that the outcomes of CDR activities are generally not directly comparable to the outcomes of emission reduction activities, **actors could set and pursue separate individual and independent targets for each type of outcome**: one target for emission reductions, and another separate target for carbon dioxide removals.

Whether or not it is appropriate to combine these two targets into a net-zero target expression depends upon the specific circumstances of the actor and these sub-targets. Ambitious actors and observers should make conscious decisions regarding the most appropriate expression of their ambition with full awareness of the nuances and the accuracy of their communicated claims.

⁴ Price levels from existing offset projects are substantially lower than the carbon-price levels consistent with the Paris Agreement 1.5°C temperature goal, which the High-Level Commission on Carbon Prices found to be at least US\$40-80/tCO₂e in 2020 and US\$50-100/CO₂e by 2030, provided that a supportive policy environment is in place (High-Level Commission on Carbon Prices, 2017).

Table 3

Implications of net-zero target setting approaches for contribution to global decarbonisation

Approach	Additionality of impact	Integrity and equivalence of action	Solutions for deep decarbonisation
Real emission reductions			
Meaningful target with interim targets and a clear strategy	Most direct and unambiguous impact.	Not applicable.	Taking responsibility for emissions also requires consideration of the hard-to-abate sources.
Unsubstantiated single-point target	Less likely to lead to implementation.	Not applicable.	Harder-to-abate emission sources are less likely to be considered.
Electricity-related emissions			
Own installation of RE	Additionality is likely at the project level but not guaranteed at the network level, depending on overlap or competition with other potential actors.	Measurement of RE generation is accurate	No contribution to energy system upgrade funds through electricity tariffs.
Equity in RE installations elsewhere		+ Measurement of RE is accurate	Potential to contribute to additional RE capacity while also supporting system decarbonisation through tariff payments that include components for system upgrade.
PPAs – New and dependent RE installations		- The procurement of renewable energy from a grid-connected renewable energy installation displaces more carbon-intensive energy to other actors unknowingly, potentially leading to erroneous accounting of emissions.	
Capacity expansion premium			
RECs – Supplier-generated	Low price provides limited incentive for the installation of additional RE.		Believing electricity emissions to be zero may lead to the reduced prioritisation of important measures for improving energy efficiency.
RECs – Non-supplier-generated	Potential for implicit double counting may lead to a decrease in demand for RE.		
Supply chain and out-of-boundary emissions			
Full coverage of emissions in target	Highly situation specific		Contributes to and fosters a dialogue for challenging emission sources
Partial coverage of emissions in target			Contributes to and fosters a dialogue for challenging emission sources
Actions identified without coverage in target.			
Offsetting: neutralisation of emissions			
New high-hanging fruit projects	Projects beyond the reach of host countries can support enhanced ambition, although “inaccessibility” will be difficult to prove.	Documented issues with existing methodologies indicate there is usually a degree of uncertainty in the accuracy of emission reduction calculations.	Could support the development of innovative projects in hard-to-abate sectors.
New-low-hanging fruit projects	Projects are relatively low-cost and represent a potential conflict with host country ambition raising potential.		May divert attention from the fact that global net-zero also requires the decarbonisation of the actor’s own emissions.
Existing offset projects			
Supporting carbon dioxide removal (CDR)			
CDR from biological capture and storage	Projects are relatively low-cost and represent a potential conflict with host country ambition raising potential.	Non-permanence and methodological uncertainty of CO ₂ removal practices means that they cannot be considered equivalent to the reduction of emissions.	These practices are already mature and accessible, but need to be significantly upscaled
CDR with underground or mineral storage	Some measures may be beyond the reach of host country action.		Support the development of innovative removal and storage technologies.

3.2 Reduction of emissions

3.2.1 Operational measures for deep decarbonisation

The most direct approach for the achievement of an emission reduction or net-zero target is for an actor to make real reductions to their own emissions through operational changes.

The real reduction of emissions – including scope 1, 2 and 3 emissions – can be achieved through operational changes to **avoid and shift** emissions-intensive activity, and to improve the emissions-intensity of those activities.

The most commonly implemented operational measures for decarbonisation across the corporate actors and subnational governments surveyed for

this analysis include energy efficiency improvements, installation of renewable energy generation technologies, optimisation of operational processes and logistics, reduction of business travel, recycling strategies and extending the lifetime of products (see Box 7).

These commonly implemented approaches can be quick wins for moderate emission reductions. In many cases, ambitious action for deep decarbonisation will require to go beyond these measures and to consider radical reorientation of business models and processes; such changes may not be possible through contributions from individual actors working alone, but rather only through collective effort.

These operational measures should be considered complementary measures for comprehensive emission reduction plans rather than standalone measures to select from. The mixed coverage of these potential measures across existing net-zero targets indicates potential for more action through the replication of best practices.

Box 7

Companies aiming for “zero” emissions

As of October 2020 at least 28 companies have committed to the full decarbonisation of their own emissions through targets submitted to the Science Based Target initiative (SBTi, 2020a). Most of these targets for complete decarbonisation cover scope 1 and 2 emissions, but some also make such commitments for scope 3 emissions, albeit without clear plans for how this will be achieved. Until recently, carbon offset credits and avoided emissions did not count towards science-based targets under SBTi guidelines; companies that set their targets under these guidelines committed to their own operational measures and procurement of renewable energy to reduce emissions.⁵

Novo Nordisk, a Danish pharmaceutical company, committed to zero emissions from its own operations and transport by 2030. This pledge includes emissions from production, product distribution, business flights, company cars, and office buildings and laboratories (Novo Nordisk, 2019). The company procures renewable energy for all of its offices worldwide, and set a 100 percent renewable energy target for its suppliers (Novo Nordisk, 2020). To achieve its target, Novo Nordisk will shift its entire vehicle fleet to electric and hybrid vehicles by 2030 (Novo Nordisk, 2019). Although business flights fall under the company’s zero emissions target, there is not currently a clear plan for eliminating these emissions. Novo Nordisk is one of several pharmaceutical companies – including also U.S. based Biogen, and Japanese firms *Ono Pharmaceutical Co* and *Takeda Pharmaceuticals* – that commit to a 100 percent reduction in emissions through their science-based targets.

5 More recent guidelines for corporate science-based net-zero target setting now open an avenue for companies to use carbon offset credits to achieve “net-zero” targets (Carrillo Pineda, Chang and Faria, 2020).

Tokyu Construction committed to reducing its scope 1 and 2 emissions by 100 percent by 2050 compared to 2018 levels, as well as to the interim target of reducing scope 1, 2 and 3 emissions by 30 percent by 2030 compared to 2018 levels (*Tokyu Construction*, 2020). The construction firm will, among other measures, switch to hybrid heavy machinery and electric equipment on construction sites and purchase renewable energy for its offices. *Tokyu Construction's* scope 3 emissions are those associated with energy use once the delivered buildings are operational. To reduce these, the company aims to build Net-Zero Energy Buildings (*Tokyu Construction*, 2020). *Tokyu Construction* is one of more than twenty companies from the construction and building materials sector in Japan to have submitted a target to the Science Based Targets initiative, as of October 2020. This scale of participation may be partially driven by the relatively high level of business engagement in the Government of Japan's climate change planning (Aden, 2016).

Box 8

Commonly implemented operational measures for decarbonisation

From the analysis of existing net-zero targets that are built extensively on the direct reduction of emissions, the following strategies are the most commonly implemented.

Energy efficiency improvements: Such improvements are often the first line of action for many corporate and subnational actors; energy efficiency has a high and immediate impact for emission reductions and can be relatively affordable or in some cases even profitable to pursue.

Installation of renewable energy generation technologies: The Danish-based brewer *Carlsberg Group* reduced emissions at their breweries by 30 percent between 2015 and 2019 through a shift from coal to biofuels, alongside energy efficiency and technology improvements. By phasing out coal by 2022, *Carlsberg* targets 50 percent emission reduction in its breweries by 2022 and zero emissions by 2030 (*Carlsberg A/S*, 2019). The UK-based food and beverage company *Muntions* will switch to biomass heating at production sites to reach its target of 45 percent scope 1 and 2 emission reductions by 2025 (CDP, 2019a). *Ajinomoto Co* of Japan has committed to the use of 50 percent renewable energy from bagasse biomass in its production facilities by 2030 (*Ajinomoto Co*, 2020). Section 3.2.2 provides an overview of approaches pursued by actors to reduce or claim the neutralisation of electricity-related emissions.

Optimisation of operational processes and logistics: Process optimisations are often among the first decarbonisation measures companies implement because they tend to reduce costs. However, there are cases where optimising for emissions might lead to a different result than cost-efficiency optimisation, and where emissions need to be given their own valuation or considered separately from cost optimisation. *CHEP*, a logistics subsidiary of *Brambles*, uses data analytics to identify common transport flows between their customers, enabling them to collaborate on transport and reduce empty truck journeys. The initiative has reportedly saved 6.6 million km of empty truck journeys, equivalent to 6.5 ktCO₂ emissions (*Brambles*, 2020).

Reduction of business travel: Actors have achieved emission reductions in this area by establishing organisational travel guidelines and appropriate incentives. The IT consultancy *Sopra Steria* – committed to net-zero by 2028 – reported changes in staff behaviour and a 32 percent reduction in business travel emissions between 2015 and 2018 after introducing internal carbon pricing into business travel procedures (*Sopra Steria*, 2020). The sports equipment company *Vaude* – a member of the Science Based Targets initiative – implemented a strict company policy to shift from air to rail travel in 2019, with the target to reduce business travel by at least 25 percent by 2024 (*Vaude*, 2019).

Recycling strategies, extending the lifetime of outputs and pursuing circular economy: Sustainable fashion and retail brands often refer to *the four Rs: reduce, reuse, repair and recycle*. For example, the clothing and outdoor equipment brand *Patagonia* repairs products under their lifetime guarantee, buys back old products from customers to repair and resell under their Worn Wear programme, and encourages customers to return completely worn out products for material recycling. The company reports that 69 percent of new products are made from such recycled materials (Patagonia, 2019). *Ingka Group* - one of several groups that owns and operates IKEA retail stores - announced that they will test furniture rental programmes in some markets in 2020 as part of its strategy to become fully circular by 2030 (Ingka Group, 2019).

In some cases, strategies to extend the lifetime of products or infrastructure needs to be balanced against energy efficiency measures, which may conversely call for **modernisation through stock turnover**. Indeed, many cities and regional governments have implemented measures to encourage the trade-in of older and inefficient vehicles and to accelerate the rate of building retrofits. The Building Upgrade Finance in *South Australia* provides fixed-interest, long-term loans to incentivise environmental building retrofits (South Australia, 2017). By linking the loan to the land itself rather than to individual landowners, the programs has allowed landowners to reap the benefits of more efficient technology such as heat pumps without having to pay for the full lifetime of the equipment – which they might not use if they move.

Targets for deep emission reductions are only meaningful if they are backed by a well-planned implementation strategy with clear interim targets

Deliberate advance planning that considers political and business interventions and the formulation of policy and financial instruments is necessary to implement measures required for deeper decarbonisation and a shift towards zero-emissions. Such planning requires interim targets to measure progress and re-evaluate plans.

Many subnational and corporate actors communicate **ambitious meaningful targets** for emission reductions that are **derived from planning processes and developed alongside plans for their implementation and interim targets**.

Deriving targets from planning processes

Targets are more meaningful if they include a *broad stakeholder consensus* on what is required and what is possible. An inclusive and broad participatory approach that increases the degree of shared ownership among the staff and partners of a subnational or corporate actor will increase buy-in and support for a target's implementation. For instance, California's Public Utilities Commission (CPUC) employed a comprehensive stakeholder outreach process to develop targets and a strategy for net-zero energy buildings; this process included a stakeholder

survey, four public stakeholder workshops, and 10 subcommittee meetings to refine the action plan (California Energy Commission and California Public Utilities Commission, 2015). Fashion retailer *H&M* reports that its strategy is based on feedback from experts, business partners, and more than 240 staff across different company departments who work with sustainability as their core task (H&M Group, 2019b).

Using interim targets to chart a decarbonisation trajectory

Companies and subnational actors are widely encouraged to set interim targets, indicating the emissions reduction trajectory that they plan to follow to reach their main goal. We find that 33 percent of subnational governments complement their net-zero targets with clearly communicated interim targets, compared to just 8 percent of companies.

Interim targets provide a useful marker for the target setters as well as observers. Actors can use interim targets to better understand the incremental changes that need to happen and to design more targeted interventions. Progress against interim targets can be evaluated with a view to revising target implementation approaches where required and evaluating capacity for potential increases in target ambition. Meanwhile, interim targets can also help observers better understand and compare a target's ambition, and to better identify potential for further action.

The city of Amman used scenario planning tools to assess infrastructure needs and actions required to fulfil their 2050 carbon neutrality goal, identifying an interim target of 40 percent emission reductions by 2030 in the process (Greater Amman Municipality, 2019). The government of Wales set interim targets for emission reductions in 2020, 2030 and 2040, as well as 5-yearly carbon budgets, to chart the path towards its 2050 goal (Government of Wales, 2019).

Several guidelines are available to support actors to plan and set a suitable target trajectory for emission reductions:

- The Science Based Targets initiative (SBTi) provides a knowledge exchange platform for companies to understand how to identify emission reduction trajectories that would be aligned with the objectives of the Paris Agreement, and to communicate and exchange on these science-based targets (SBTi, 2019a).
- C40 Cities (2016) and ICLEI (2018) set out emission reduction trajectories for cities using equity-based approaches to determine Paris-compatible pathways. WWF's One Planet City Challenge (WWF, 2018) provides an exchange platform for cities setting ambitious targets.

Developing targets alongside plans for their implementation

Ambitious subnational and corporate actors need to identify policy interventions and put those in place as early as possible if they are to successfully embark on the decarbonisation trajectory set out in their net-zero target.

Regulatory instruments from subnational jurisdictions and corporate guidelines can ensure that employees and citizens adopt behaviours and make choices that are consistent with the planned emission reduction goals of those corporate and subnational actors. This could include, for example, the introduction of stricter and clearer guidelines for waste disposal and recycling, or the revision of a company travel policy.

Financial incentives and (shadow) carbon pricing are also often used to incorporate emission reduction targets into every-day business decisions as well as subnational government investment decisions. 699 companies reported the use of internal carbon pricing to CDP in 2019, with prices ranging from less than US\$1/tCO₂e to more than US\$900/tCO₂e (CDP, 2019b). Shadow carbon pricing has become a standard business strategy for risk mitigation, but at least 20 percent of these companies reported carbon pricing programmes where fees are levied or traded

internally between departments, with fees often being paid towards a fund for climate or development-related projects. French postal service company *La Poste* – a member of the Science Based Targets initiative with a target to reduce emissions by 51 percent by 2025 – implemented an internal carbon pricing scheme to drive competition between business units and reported positive impacts for emission reductions (Bartlett, Cushing and Law *et al.*, 2016; World Bank Group, 2020). Major Chilean wine producer *Concha y Toro* – a Science Based Targets initiative members with the target to reduce scope 1, 2 and 3 emissions by 55 percent by 2030 – charges all business units an internal carbon price on all scope 1, 2 and 3 emissions, with the aim of increasing awareness of climate change issues across the business and to develop a fund for climate change mitigation action (CDP, 2019b; Concha and Toro, 2020).

In most cases, there will still be uncertainty regarding the specific measures that can be applied in the future to reduce the hardest-to-abate emissions; such uncertainties and challenges need not hinder strategy development but rather can be communicated transparently within those strategies.

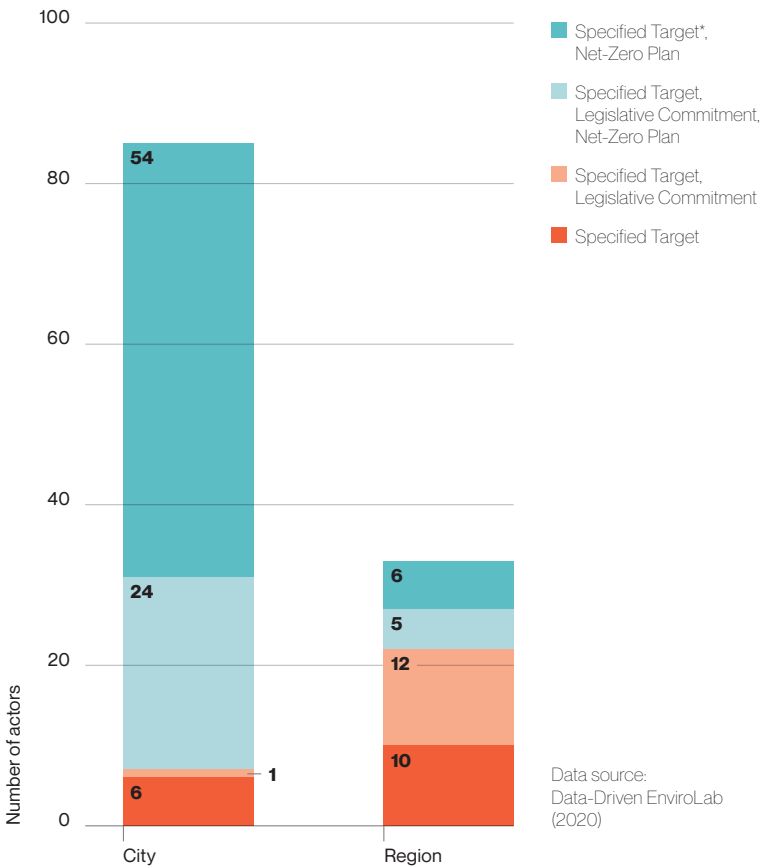
By contrast, **more speculative and unsubstantiated targets** communicated by subnational and corporate actors that do not incorporate these best practices, may be compromised with regards to how meaningful those targets really are, regardless of how ambitious they may appear at first glance.

The meaning and robustness of targets should be especially critically considered, given the mixed record of success that subnational and corporate actors have experienced with the implementation of past voluntary emission reduction targets. A recent study of more than 1,000 cities that participate in the EU Covenant of Mayors for Climate and Energy found that only 60 percent of cities are on track to achieve largely voluntary 2020 emission reduction targets that are more ambitious than the EU's own target of a 20 percent reduction from 1990 levels (Hsu *et al.*, 2020).

For subnational actors, there are positive indications that the majority of targets are meaningfully supported with action plans and legislation. Of the cities and regions where we have identified targets, over 85 percent of these targets are backed by a published plan or a legislative commitment (Figure 7). The proportion of targets that are manifested in legislation is higher for regional governments than for cities, perhaps due to the more stringent parliamentary processes that regional actors must often go through before they are able to communicate targets, compared to city governments.

Figure 7

How well planned are targets for emission reductions?



* We define a Specified Target as a net-zero target where the actor has specified at least an 80 percent emissions reduction target, with a specified target year at or before 2050. This excludes more vague commitments where actors may commit to net zero without defining what that means.

3.2.2 Electricity-related emissions

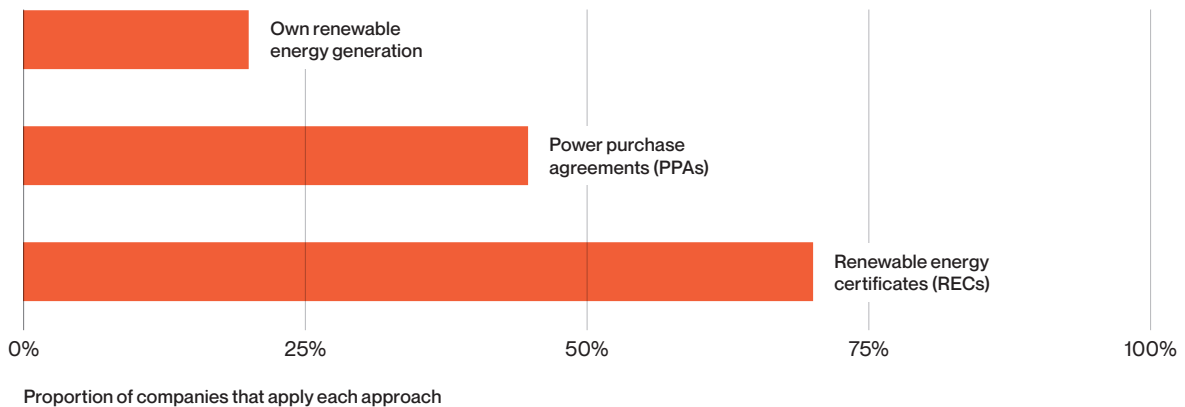
Emissions from the procurement of electricity account for 10.5 percent of the average company’s emissions, although the range can be very broad depending on the business sector. Companies pursue a broad range of approaches to reduce or claim the reduction of these emissions. Such approaches should always be pursued alongside energy efficiency measures (→ Section 3.1), to reduce the demand for electricity in the first place.

Various approaches exist to indirectly reduce the emissions associated with purchased energy. Figure 8 shows that the purchase of Renewable Energy Certificates (RECs) is the most common approach, followed by the arrangement of Power Purchase Agreements (PPAs), and owning or holding equity in renewable energy installations. There are numerous variations of these different strategies, each with its own nuances that carry significant implications.

Actors pursue these approaches to claim reductions in their scope 2 emissions, although the actual GHG emissions associated with procured energy may not necessarily decrease.

Figure 8

Types of renewable electricity supply and procurement constructs implemented by companies



Note: The sum of these approaches reaches more than 100 percent, since many companies report to pursue a combination of several renewable electricity procurement measures.

Own installation of renewable electricity capacity

Installation of renewable electricity generation technologies within a subnational actor's jurisdiction or at a corporate actor's site is the most direct approach to reduce scope 1 and 2 emissions associated with electricity. This approach reduces scope 1 emissions in the case that those renewable energy technologies replace existing on-site fossil-fuelled generators. Scope 2 emissions are reduced in the case that new renewable energy installations shift energy demand away from external energy procurement, bringing renewable energy generation under the direct control of actors. The installation of on-site renewable energy, often in combination with energy efficiency improvements, is a popular approach for actors that have the space and financial capital available for the installation of such facilities. Approximately 20 percent of companies with renewable energy strategies for net-zero targets have their own renewable electricity generation installations, although this very rarely supplies a large proportion of the company's electricity demand and is usually applied alongside other renewable energy procurement constructs. *Amazon*, for example, installed rooftop solar PV on many of its warehouses in the United States, India and Europe, providing up to 80 percent of those warehouses' electricity demand (Amazon, 2020). The falling cost of renewable energy technologies - now at price parity or more competitive than fossil-fuelled generators in most parts of the world (IRENA, 2019) - make installing on-site renewable energy economically attractive in many circumstances.

There are circumstances, however, where it is possible that the construct of installing on-site renewable electricity generation has harmful impacts for the long-term decarbonisation of the grid beyond. Companies that consume electricity from the grid pay a certain tariff that covers the electricity production, as well as additional costs for grid maintenance and upgrade and, in some countries, a component for renewable energy expansion. In many cases, companies install their own renewable energy installations as a cost saving measure, partly

due to not being subject to these additional costs. In the case that a company has solar PV without a base load function and is net-metering, the company still relies on grid electricity services for the provision of that base load, while not contributing to those system costs. If the approach is applied at scale, it is possible that the grid operator would struggle to upgrade grid infrastructure and decommission old fossil-fuel powered plants as planned, due to limited funds. The relevance of this issue is dependent on national policy and the specific setup of the company's own renewable electricity installation. For example, this potential conflict is not relevant in the case that the company is able to supply their own base load, through the use of batteries or other technologies, and is not at all reliant on grid electricity services.

Equity in renewable energy installations

Ownership or equity in renewable electricity generation installations elsewhere is often pursued as a next-best alternative to the installation of on-site renewable energy generation. In this construct, an actor may be either the full owner and operator of those installations, or may enter into an agreement with others and hold equity in the installations. If this construct is used to claim the neutralisation of an actor's own electricity emissions, the accounting arrangements for the renewable energy generated should ensure that no other parties can enter into agreement to claim renewable energy from those installations, and that the power is marketed directly. *Apple* owns a number of renewable energy installations towards its 100 percent renewable energy goal, although the company also uses a combination of other approaches for electricity procurement in addition (see Box 10) (Apple, 2020).

Renewable Energy Certificates

Approximately 70 percent of companies with net-zero targets utilise Renewable Energy Certificates (RECs) as part of their renewable electricity procurement strategies. These companies should be aware of some inherent associated challenges.

The sale of RECs does not necessarily contribute to additional renewable energy supply capacity

While the purchase of RECs could in theory send a signal to investors that there is demand for renewable energy, there are strong indications that RECs do not generally contribute to the development of additional renewable energy installations in practice. Oversupply

of certificates and associated low prices, along with implicit double counting, are key reasons for this problem (Gillenwater, 2008; Mulder and Zomer, 2016; Dagoumas and Koltsaklis, 2017).

For example, in Europe there is an oversupply of RECs⁶ at low prices that mostly stems from decades-old hydropower installations in Scandinavia (Hast *et al.*, 2015). As these installations were operating long before the system of RECs was established, the

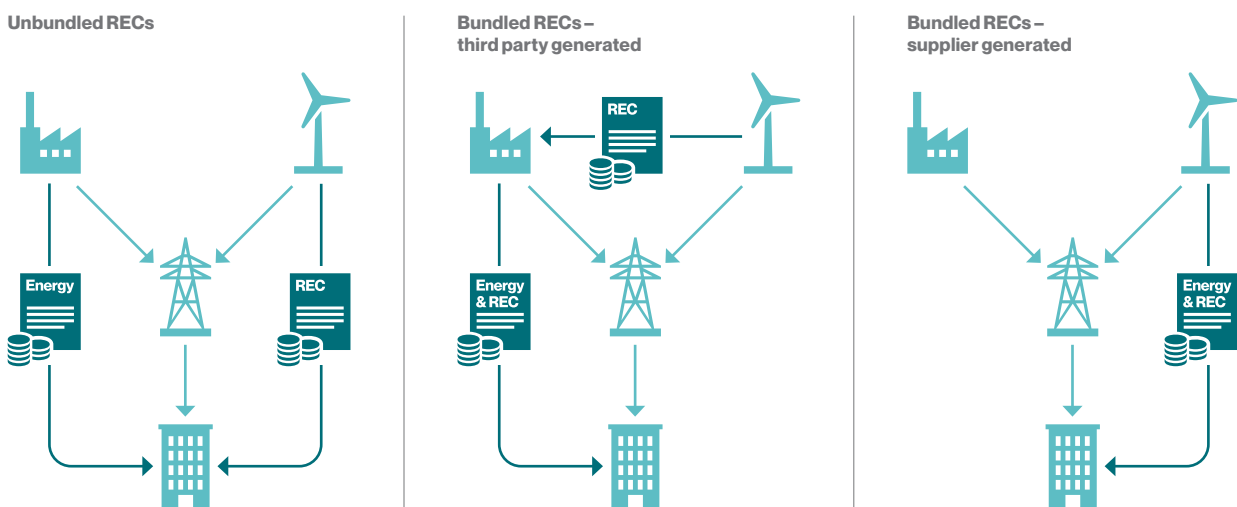
Box 9

Types of Renewable Energy Certificates (RECs)

RECs are used in a number of countries under different names, such as “Energy Attribute Certificates” or “Guarantee of Origin.” Consumers can purchase RECs in different forms.

- **Unbundled RECs:** Consumers purchase RECs on the spot market from a third party, separately from the supplier of the procured energy.
- **Bundled RECs – third party generated:** Some energy suppliers procure RECs from a third party in order to bundle these RECs with energy sales as a green premium product. In this case the energy supplier may be delivering fossil fuel powered energy, while the third party that provides the RECs is producing renewable energy.
- **Bundled RECs – supplier generated:** Energy suppliers with their own renewable energy generation may sell their own RECs bundled together with energy sales.
- **Tailored renewable energy contracts** combine features of REC and PPA energy procurement constructs. Under this model, customers sign a contract with a renewable energy supplier and commit to purchasing renewable electricity and associated RECs for a longer period of time and usually from a determined source or asset. The electricity often comes from a new installation, although this is not necessarily the case (IRENA, 2018).

Figure 9
REC procurement models



The customer receives the same energy mix, although the contracting model may lead to different incentives for the installation of additional renewable energy.
Source: Authors

certificates have had no influence on the development of hydropower capacity in those countries. If Scandinavian customers believe that their energy is unambiguously delivered by renewable energy anyway, they may see little incentive to purchase RECs; consequently, the owners of hydropower installations will sell RECs to foreign customers instead (Hulshof, Jepma and Mulder, 2019), leading to the renewable energy generation being implicitly double counted. In this case, a German customer who consumes predominantly fossil-fuel based energy from the German grid can purchase Norwegian RECs and claim lower scope 2 emissions. Neither the German energy provider nor the Norwegian hydropower owner, however, have an incentive to increase their RE capacity as a result of this transaction, so actual GHG emissions do not change.

While exceptions may exist, the cause-effect relationship between purchasing a REC and contributing to additional renewable energy capacity – and by extension, to the reduction of emissions – is difficult for a customer to control and prove.

RECs can displace carbon-intensive energy to other actors unknowingly

When a customer purchases RECs, the actual energy mix that a certificate owner receives does not change, nor does the energy mix in the grid. If fossil-fired power plants and renewable energy technologies feed electricity into a grid, the actors who draw from that grid would all receive a combination of renewable- and fossil-fired electricity. Consequently, if the owner of a renewable energy generation facility were to sell RECs to one actor, that actor may claim a lower grid emission factor to determine its scope 2 GHG emissions, but would still continue to receive the same combination of renewable- and fossil-fired electricity, as illustrated in Figure 9. The sale of RECs neither results in an increase of renewable energy capacity, nor does it change the electricity mix that each actor receives. Rather, actors who purchase RECs simply displace more carbon-intensive energy to other consumers, who are likely unaware of this new situation and may not account for it in their scope 2 emission calculations. Indeed, when an actor buys RECs to claim a reduction in its scope 2 emissions, there is no counter signal that all other users need to report a rise in their scope 2 emissions.

Capacity expansion premium

A premium for renewable energy capacity expansion can be charged by energy suppliers, separately or in addition to RECs. More

ambitious electricity providers offer their clients an independently verified guarantee that their electricity generation stems from renewable energy installations not older than 5 or 10 years.

Power Purchase Agreements

Approximately 45 percent of companies with net-zero targets sign Power Purchase Agreements (PPAs) as part of their renewable electricity procurement strategies. A PPA is a long-term contract between an electricity provider and an electricity consumer, usually spanning 10-20 years. The consumer agrees to purchase a certain amount of electricity from a specific asset under a pre-determined pricing arrangement. PPAs are generally signed with new renewable energy installations and form part of the project investment decision. PPAs are a suitable approach for large-scale companies with a high energy demand; *Apple*, *Microsoft* and *Google* are particularly active in the use of PPAs (see Box 10). Small- and medium-sized companies may also sign PPAs, but likely face relatively high negotiation costs (Reid and Dingenen, 2019).

High quality PPAs with new and dependent RE installations may contribute to fewer GHG emissions

PPAs can lead to a reduction of GHG emissions under the conditions that the agreement is signed with **new installations** prior to the construction of the RE installation and that the project's viability is **dependent on the financial security** provided by the PPA (Brander, Gillenwater and Ascui *et al.*, 2018). This *can* lead to the installation of a renewable energy project that would not have otherwise occurred, leading to the potential for an emission reduction impact.

In the unusual situation that a PPA is signed with an existing renewable electricity installation, it is difficult to make a convincing argument that the PPA will lead to new and additional renewable energy generation and an associated emission reduction. The PPA will only lead to additional renewable energy supply in the unusual case that the installation would stop operating otherwise. This situation could occur as a result of policy changes. For instance, support from the German Renewable Energy Sources Act, which provides for a feed-in-tariff and priority access to the grid for renewable energy for a maximum duration of 20 years, will end in 2021 for the earliest installations connected to the grid when the Act came into force 20 years ago. These renewable energy installations are currently looking for new business models to ensure they can continue their operations.

However, one would assume that for renewable energy business models, where the vast majority of costs are sunk in upfront capital expenditures and subsequent operation costs are usually considerably lower than available sales revenues, it is easy to identify continuation approaches.

High-quality PPAs and capacity expansion premiums can have an emission reduction impact, but additionality cannot be objectively guaranteed

Depending on the volume and profile of an actor's energy demand, signing a high-quality PPA or selecting an energy supplier that charges a premium for renewable energy capacity expansion is the most realistic approach to reduce energy-related emissions.

Additionality, however, is difficult to prove under any circumstances (Malins, 2019). Even under the circumstances that those models play a role in making a new project viable, this does not necessarily guarantee additional renewable energy capacity at the national or regional level if the existence of the new project reduces

the incentive for subnational or national governmental actors to support the installation of other new projects. For example, in the case that a national or regional government has the target to achieve a certain amount of renewable energy capacity installation within their jurisdiction, a new project supported by the energy procurement model of a company may offset the need for the government to provide alternative support for other projects to meet those targets. Authorities may even suspend the approval of other potential renewable energy projects in the case that they do not wish to exceed those targets due to predetermined plans for the energy mix.

Further, large-scale renewable energy installations that provide companies with electricity may take up all grid capacity and prevent other actors from developing on-site installations. For instance, in the Netherlands, Microsoft signed a PPA to consume 100 percent of the electricity generated by the wind park "Wieringermeer," which will power a new data centre (Microsoft, 2017b). According to the local grid operators, there is no remaining grid capacity left for prosumers who want to install solar PV (Rengers and Houtekamer, 2020).

Box 10

Renewable electricity in the tech industry

Video streaming and cloud computing account for a significant share of global GHG emissions, and these activities are expected to grow in the near future (David Mytton, 2020). PPAs play an important role in tech companies' net-zero strategies.

Apple considers its scope 2 emissions to be zero. The firm explicitly states it minimises its use of RECs, which "take away existing renewable energy available to others." Rather, 83 percent of Apple's renewable energy comes from "Apple-created projects." Of these, 84 percent are new renewable energy installations for which Apple signed a PPA; 12 percent are directly built and owned by Apple; and the remaining 4 percent are projects where Apple is an equity investor in a new project. Another 10 percent of the company's electricity consumption is powered by utility green energy programmes and a further 2 percent comes from colocation facility vendors (where a data centre is shared with other companies). Only when these options are not available, Apple purchases RECs (5 percent of the total electricity load) (Apple, 2020).

Google applies a number of approaches towards its goal of 100 percent renewable energy procurement for its operations. In Europe, where wholesale and retail power markets are deregulated, Google signs PPAs for installations on the same grid as its data centres, as well as balancing agreements with "a competitive power market entity" to ensure a constant and continuous energy supply. In countries with regulated retail markets and deregulated wholesale markets, Google signs PPAs to purchase renewable electricity and associated RECs at the wholesale level. The company retires the RECs but sells the electricity back into the same grid it later draws power from at the retail level. Third, Google signs "utility renewable energy tariffs" with electricity suppliers in countries or regions where retail markets are not open to competitive suppliers. Under this model, Google purchases bundled RECs and electricity that come from the supplier's own renewable energy installation. Finally, Google counts the share of residual renewables – that is, renewable energy not consumed by one specific consumer - on the grid towards its 100 percent renewable goal (Google, 2016).

Microsoft has matched the carbon emissions from its data centres with the direct purchase of renewable energy or in-region RECs (Microsoft, 2020). The company is committed to directly purchase 100 percent renewable energy by 2025 (Microsoft, 2020b) and has signed a number of PPAs with energy providers in the United States, Ireland and the Netherlands to reach this goal (Microsoft, 2017a, 2019a, 2019b).

While all three tech firms mostly rely on PPAs for their renewable energy procurement, the other approaches they take to reduce energy-related emissions vary slightly. In addition to signing PPAs, Apple owns a number of renewable energy installations, for which additionality is likely although still difficult to guarantee. Apple also explicitly states it minimises the use of RECs, and only purchases such certificates when they stem from recently built installations that are connected to the same grid as Apple's facilities. Google and Microsoft, however, rely more heavily on RECs and neither company requires the RECs it purchases to be supplied directly from new renewable energy installations. Electricity suppliers may sell RECs to consumers without changing the grid emission factor. Therefore, it is possible that the renewable energy that these companies claim to use is also implicitly claimed by other actors.

Box 11

National railways' 100 percent renewable electricity claims

A number of national railways claim the use of 100 percent renewable electricity.

The German Railways (Deutsche Bahn, DB) claim that all of its long-distance trains have been running on renewable electricity since 2018 (DB, 2019). Part of the electricity is supplied by old hydropower installations in Germany for which the DB has signed a PPA with energy supplier RWE (RWE, 2011). DB is also contractually bound to consume electricity from the new coal-fired power plant Datteln 4 – a 1,100 MW installation that will supply all electricity that the DB consumes in the State of North Rhine-Westphalia, and about 25 percent of its electricity needs across the rest of the country (Schwietering, 2020). To cover this and the remainder of its electricity consumption, the DB purchases RECs from various installations in Europe (DB, 2019). DB trains operating in Germany do thus not run on 100 percent renewable energy and are unlikely to do so in the near future.

The Dutch Railways (Nederlandse Spoorwegen, NS) claims its customers' travel is climate neutral (NS, 2020). It signed a PPA with an electricity provider to consume a share of the energy produced by new offshore wind parks for a period of ten years. Slightly over 50 percent of this amount is generated in the Netherlands; wind parks in Sweden, Belgium and Finland provide the remaining energy (NS, no date).

These wind parks were tendered and subsidised by national governments, which must reduce their GHG emissions to meet climate targets set under the UNFCCC framework and by the European Union. Therefore, it is uncertain whether and to what extent the PPA that the NS signed has led to additional renewable energy capacity, and consequently, to reduced GHG emissions.

The Austrian Railways (Österreichische Bundesbahnen, ÖBB) also claims that its trains run on 100 percent renewable electricity. About a third of the required electricity comes from the ÖBB's own hydropower stations. Since 2018, the ÖBB has also owned solar power installations that feed directly into the railway's overhead line. Meanwhile, another 25 percent of the company's consumed electricity is produced by partner hydropower installations, and the ÖBB purchases RECs to cover the remaining energy consumption. The ÖBB currently still depends on the direct combustion of fossil fuels, as not all train routes in Austria are electrified and diesel engines are necessary.

The ÖBB has set the goal of becoming a "CO₂-free firm" by 2050 (ÖBB, 2020). By electrifying all routes to avoid use of diesel engines and drastically increasing installations of its own RE capacity, the ÖBB could take convincing steps to meet its 'CO₂-free' target. However, since it is unclear where the RECs that the ÖBB currently purchases come from, and because it is difficult to prove that these agreements lead to additional renewable energy capacity and are not double counted, the company's claim of 100 percent renewable energy is problematic.

Complementary approaches to support decarbonisation

Companies can contribute to long-term net-zero solutions by lobbying for a supportive policy environment

The analysis of electricity procurement options pursued by companies indicates that there is no perfect approach, but rather each has its own potential limitations; the best course of action that an actor can take also depends upon the local policy infrastructure and market circumstances.

As long as the company is reliant on grid electricity services to some extent, and as long as the grid is not 100 percent renewable, a company can make responsible choices to effect positive change, but it cannot guarantee the delivery of 100 percent renewable energy.

As long as the company remains reliant on grid electricity services, a sensible complementary approach to improve the long-term prospects of renewable electricity procurement is to lobby for a supportive policy framework to accelerate the energy transition and address systemic issues.

Lobbying for policy change does not imply any direct impact that would enable a company to immediately claim the neutralisation of its electricity emissions, but it is a constructive measure that more directly addresses the systemic issues of the sector, than individual and isolated action.

Companies can pursue renewable energy procurement models without claiming the neutralisation of electricity-related emissions

For a variety of reasons – both within the project business model and outside of the project boundary – it is difficult to establish with objective certainty the degree to which any of these energy procurement models lead to a net reduction of emissions. This challenge represents a significant limiting factor to the suitability of those models for claiming the neutralisation of electricity-related emissions. Accordingly, some actors pursue PPAs or capacity expansion premiums to contribute to the development of renewable energy capacity within the country/region without claiming neutrality of their scope 2 emissions, instead using a "location-based" accounting approach based on the average grid emissions factor. Many standards and guidelines require or advise that actors report on scope 2 emissions using *both* "location-based" and "market-based" accounting methodologies, with the latter allowing for renewable energy procurement to be accounted (WRI, 2015; Global Reporting Initiative, 2016; CDP, 2020). For example, multinational fashion retailer *H&M*, Spanish pharmaceutical *Almirall*, and multinational telecommunications company *Vodafone* report two sets of emissions data transparently: one accounting for the procurement of renewable energy to reduce emissions, and one using average location-based grid emission factors

without claiming neutralisation from renewable energy (H&M Group, 2019; Almirall, 2020; Vodafone Group, 2020). H&M report that they continually explore the quality of renewable energy supply options and are currently moving away from reliance on RECs and towards a more balanced portfolio including PPAs and on-site solar PV.

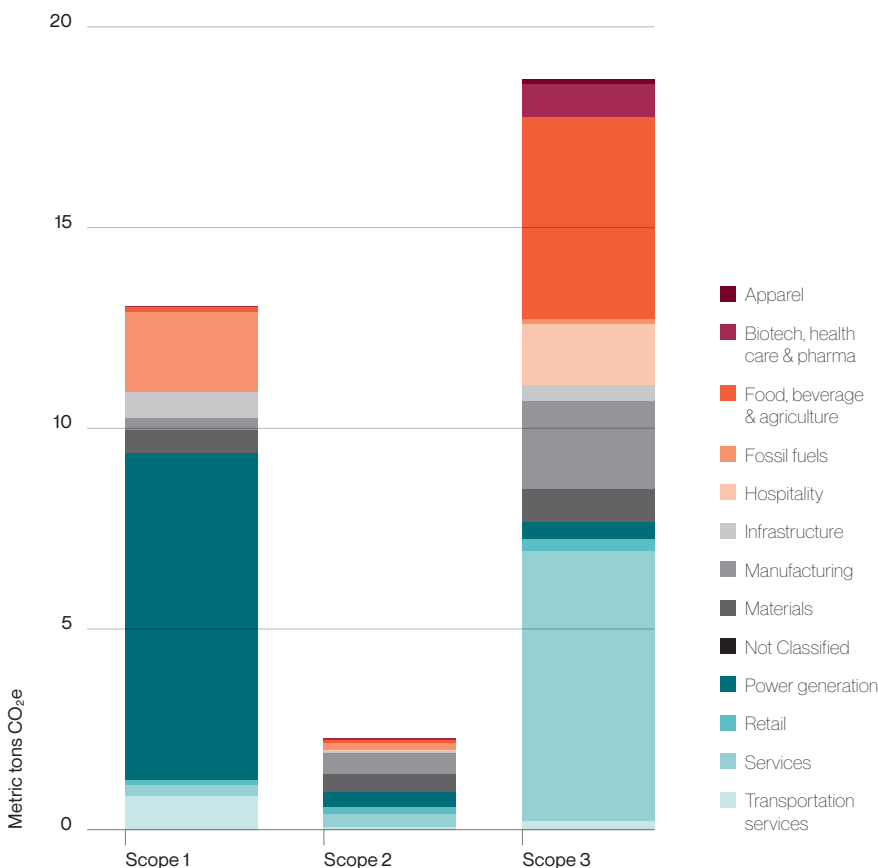
This location-based accounting approach can also ensure that there is no distraction from the prioritisation of necessary energy efficiency measures, which is otherwise possible in the case that companies claim neutralisation. If a company purchases RECs to cover their total energy consumption, it may appear on paper, to the actor as well as other observers, that related emissions are reduced to zero. In this situation, climate change mitigation targets may no longer provide an impetus for companies to improve energy efficiency. Rather, energy efficiency can even be *decreased* compared

with a business as usual scenario without the purchase of RECs, if an actor believes or claims that improved energy efficiency has no significant impact on the climate. For example, manufacturers may lower the prioritisation of investments in more efficient mechanical equipment, or companies in the IT industry may lower the prioritisation of practices to improve efficiency in their data storage.

3.2.3 Supply chain and out-of-boundary emissions

A large proportion of company or subnational emissions is often accounted for by embedded emissions in supply chains and out-of-boundary emissions, as demonstrated by Figure 10. These scope 3 emissions include upstream and downstream emission sources. Upstream emissions sources include emissions from other actors caused by the production of materials or the delivery of services that an actor consumes. For example, scope 3 emissions include travel services operated by third party entities, be it air travel for employees, or courier services for manufacturers and retailers. For subnational actors, upstream scope 3 emissions typically include the emissions from imported goods, out-of-boundary transportation and emissions from electricity transmission and distribution (Fong *et al.*, 2014). Downstream emissions are those arising from the use of an actor's product or service by consumers, customers, and citizens. These sources may include, for example, the emissions associated with vehicle use for a car manufacturer, or the emissions of other business operations for financial institutions that provide capital to those businesses. For subnational jurisdictions, downstream emissions include out-of-boundary emissions associated with exports of materials, products and services to other regions and to actors outside of the jurisdiction's boundary (Fong *et al.*, 2014).

Figure 10
2019 inventory emissions of companies with net-zero targets, by emission scope and CDP Industry



Data source: CDP (2019)

The most direct action to reduce scope 3 emissions is through operational changes that lead to a reduction or a shift in the actor's activity or output, for emissions-intensive activities and outputs (→ Section 3.2.1). Usually, corporate and subnational actors are not in a position to reduce and internalise all activity and output that results in scope 3 emissions; in an inter-connected global society built upon specialisation and trade, internalisation and isolationism are not necessarily attractive strategies for most actors. As such, actors need to also pursue strategies to indirectly support the reduction of emissions that they do not have complete control over themselves.

Indirect approaches to support scope 3 emission reductions

Reflecting the broad nature of scope 3 emission sources, companies and subnational actors exhibit a wide range of approaches to address them. Most of these strategies are based on the conscious selection of suppliers and consumers, or the provision of active support to those suppliers and consumers. Generally speaking, these potential approaches are not alternative options, but rather are approaches that can be pursued in parallel.

Conscious selection of suppliers and service providers

The most common approach for the reduction of scope 3 emissions is for an actor to consider the emissions intensity of the product or service offered by suppliers or service providers at the point of procurement. Many companies and subnational actors include such considerations within procurement guidelines and regulations to ensure that more environmentally friendly suppliers and service providers are given preference. The sports equipment company Decathlon – a Science Based Targets initiative member with a target to reduce scope 1 and 2 CO₂ emissions by 75 percent by 2026 – applies an internal carbon price of EUR 50 /tCO₂e to supplier material catalogues to encourage its internal designers to select less emission-intensive materials for product design (CDP, 2019b).

This approach introduces competition within the supply chain and service industries to encourage a shift towards less emissions-intensive products and services; accordingly, it can lead to an emissions

reduction impact across the market and beyond the operations of the specific supplier or service provider selected.

Conscious selection of consumers and customers

A less common line of action for reducing scope 3 emissions is for an actor to be selective about the consumers and customers to whom they sell or export their own products or services. This approach can be more difficult to implement than the conscious selection of suppliers and service providers: profit-oriented actors – including companies and subnational actors – may not have a strong incentive to limit their offering to a selection of consumers; some actors could also face legal or ethical challenges associated with discriminating against specific consumer profiles.

This approach is particularly relevant for the financial services industry, in which an increasing number of institutions are including climate considerations in their lending criteria (see Box 12).

Active support to suppliers and service providers

Separately or in addition to the conscious selection of suppliers, service providers and consumers, corporate and subnational actors may also work together with those external actors to actively support them to decarbonise their own operations. Such support could be manifested in various ways, including the following:

- Requirements can be placed on selected suppliers and service providers to regularly report on aspects of the supply chain, or even to regularly demonstrate improvements in the decarbonisation of the supply chain. Sony Corporation – one of around 20 Japanese companies from the electronics and computing industries that have set targets under the Science Based Targets initiative, with a pledge of “zero environmental impact” by 2050 – requires manufacturing outsourcing contractors to monitor and report on their GHG emissions and renewable energy support schemes, and to demonstrate emission intensity reductions each year, as part of efforts to reduce scope 3 emissions by 45 percent by 2030. Sony also set the target for 10 percent of its suppliers to have their own science-based targets by 2025 (Sony Corporation, 2020).

- Direct advisory support could be provided to suppliers and service providers on how to decarbonise and optimise their operations. Multinational furniture manufacturer and retailer *Inter IKEA Group* – with the commitment to become “climate positive” by 2030 – works with its glue suppliers to identify bio-based alternatives to fossil fuel-based glue, which Inter IKEA Group identified as a material representing 6 percent of the company’s entire climate footprint. Inter IKEA Group also conducts training sessions with its suppliers on how to comply with the list of “must” requirements it imposes on them (Inter IKEA Group, 2019).

Develop optimised or lower-carbon alternative products

Corporate and subnational actors can improve the emissions-intensity of their products and exporting industries by optimising existing products and processes or developing entirely new lower carbon products. Often, consumer pressure may drive these approaches. For instance, several vehicle companies have set targets to phase out internal combustion engines in favour of electric vehicles, largely in response to a growing number of European countries, including Norway, setting national deadlines for phasing out internal combustion engines as early as 2025. For instance, Ford aims to increase the share of electric vehicles sold in Europe to 50 percent by 2022 (Wappelhorst, 2020).

Build consumer capacity for responsible behaviour

Actors can increase consumer awareness and capacity for responsible consumption behaviour through information campaigns and the provision of monitoring equipment. The utility company *Engie* uses an electricity demand response programme to allow their commercial and industrial consumers to save money and contribute to emissions reduction. Using smart devices attached to commercial and industrial equipment for heating, cooling and lighting, the electricity demand of participants is curtailed when the grid reaches peak demand. This innovation contributes to increased grid flexibility, allowing more renewable energy sources to be used in place of the fossil fuel-based gas peak plants that typically serve the function of meeting peak energy demand (Engie, 2020). The energy multinational *Centrica* also uses a demand-response programme alongside an energy data insights platform to support businesses towards its target to reduce customer emissions by 25 percent by 2030. Centrica additionally claims to lobby governments to create the conditions necessary for decarbonisation and for customers to reduce their emissions (Centrica, 2019).

Box 12

Decarbonising the portfolios of commercial financial institutions

The Paris Agreement calls for “making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development” (Article 2.1c). Currently, financial institutions with cumulative assets of at least US\$ 47 trillion under management are committed to climate-related targets for their investment portfolios, representing 25 percent of the global financial market (Lütkehermöller *et al.*, 2020). These targets vary in their ambition and do not cover all assets under management. Further, financial institutions do not have full control over their investees’ emissions. If a financial institution sells emission intensive assets, others can take these over, so that emission levels do not necessarily decrease. In the end, numerous factors impact the likelihood of climate-related investment targets leading to reduced real emissions at the economy-wide level. These include achieving a critical mass of financial institutions that set and work to achieve robust climate-related investment targets (Lütkehermöller *et al.*, 2020).

Financial institutions have three main instruments at their disposal to reduce the carbon intensity of their portfolios: divestment, engagement and positive impact investment. Most pledges – as measured in assets under management – focus on divestment, and of these, most target coal. For instance, 46 percent of the reinsurance market and 37 percent of the insurance industry’s global assets are covered by coal exit policies (Bosshard *et al.*, 2019). As a result, coal companies face higher costs, which may affect their operations. In Australia, for instance, the Adani Group had difficulties finding insurance to develop the Carmichael mine, which would produce 4.6 billion tonnes of carbon dioxide over its lifetime. At least 16 international insurance companies ruled out underwriting the project (Bosshard *et al.*, 2019). However, while the mine’s scope and scale were reduced, the project is still going ahead (Curran, 2020).

Institutions may use a combination of divestment, engagement and positive impact investment. For instance, they may engage with the targeted investee’s management and threaten, or use, divestment as a measure of last resort. Under the DivestInvest initiative, financial institutions divest from polluting assets and invest the money in climate solutions (DivestInvest, 2020).

Since the impact of climate-related investment targets on global GHG emissions is uncertain, it may be preferable for financial institutions to focus on contributing to net-zero carbon emissions by 2050 and aligning their portfolios with the Paris Agreement temperature goals. A number of organisations have proposed or are developing guidance for “Paris aligned investments” (e.g. Germanwatch & NewClimate Institute, 2018a; UNEP FI; PRI, 2019; IIGCC, 2020).

Financial institutions face two big unknowns when attempting to align their portfolios with the Paris Agreement temperature goals: the timing of policy measures and future carbon prices. Swedish pension fund *Alecta* estimated that the market value of its equity investments would decrease by 48 percent in 2040 under a carbon price aligned with limiting global warming to 1.5°C (Alecta, 2019). Alecta has since become a co-founder of the Net Zero Asset Owner Alliance, an alliance of 30 institutional investors representing 5 trillion under assets that commit to net-zero emission investment portfolios by 2050 (UNEP Finance Initiative, 2020).

Source: Adapted from Lütkehermöller *et al.* (Lütkehermöller *et al.*, 2020)

Key differentiations for ambition

The unique specificity of actors’ scope 3 emission sources and the indirect nature of corresponding reduction methods makes it difficult to objectively compare different actors’ ambition.

Ambitious actors may reflect on the following questions, which were identified from our analysis of subnational governments and companies as some of the most significant differentiating factors, to ensure the ambition of their approaches:

What degree of responsibility is assumed?

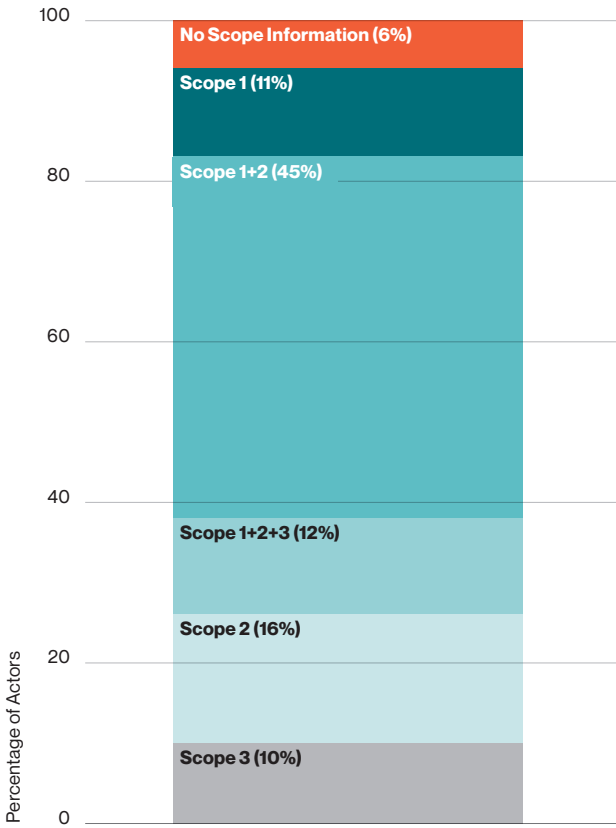
The degree to which companies and subnational actors report and act on their scope 3 emissions is highly variable: only 23 percent of corporate net-zero

targets include scope 3 emissions (Figure 11), while among cities and regions this is an even less common practice (Figure 12).

Of the actors that do include scope 3 emissions in their targets, only a small minority cover the full breadth of upstream and downstream emission sources. There can be several reasons for this gap: initially, the number of emission sources from scope 3 emissions can be extensive or even innumerable, so it may not be possible to obtain an overview or accurate information on all these emission sources. Lack of transparency in reporting greenhouse gas inventories and emissions data may also limit actors’ ability to appropriately account for scope 3 emissions. Methodologically, it may be difficult to fully account for some scope 3 emissions given uncertainties involved in the consumption or lifecycle emission impacts of some products or services.

Figure 11

Number of corporate net-zero actors with scope information



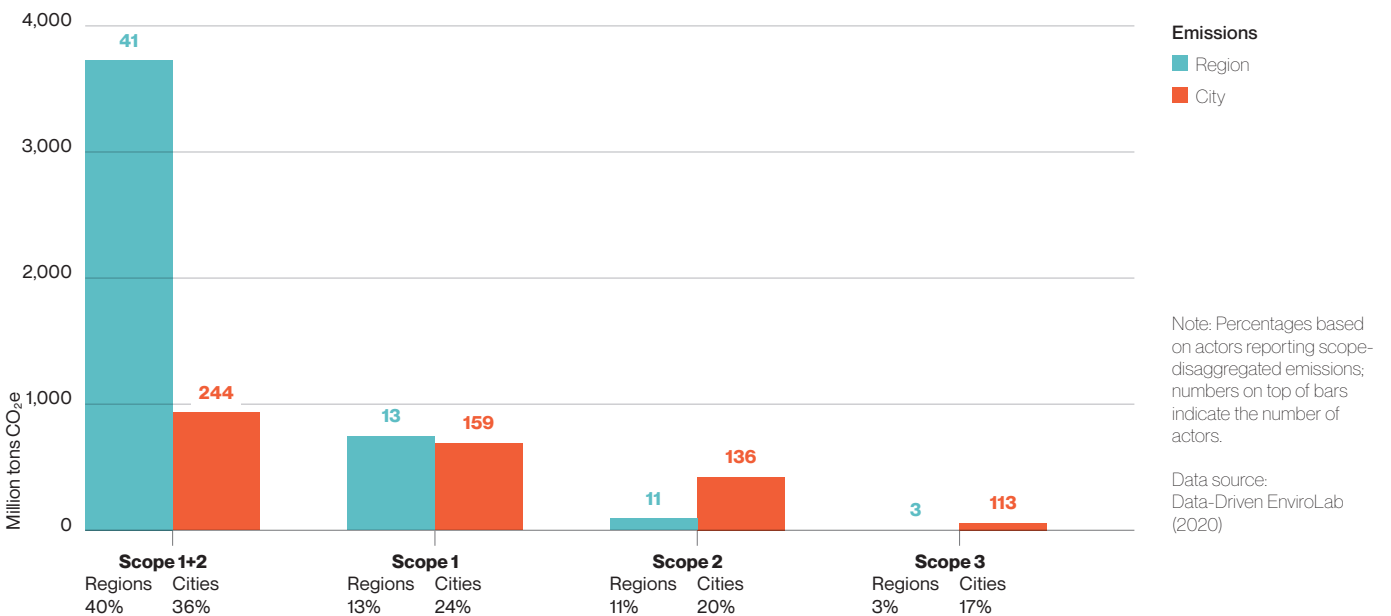
Data source: Data-Driven EnviroLab (2020)

The extent to which actors should assume responsibility for scope 3 emissions is a question for which there is limited definitive guidance. Some actors argue that although they encourage their supply chains and consumers to reduce emissions, they do not consider themselves *responsible* for those emissions. The fact that upstream scope 3 emissions are far more commonly included in company's targets than downstream emissions may be an indication that it is a relatively common expectation for companies to assume responsibility for upstream scope 3 emissions. Only a minority of the most ambitious actors also assume responsibility for downstream emissions.

The coverage of scope 3 emissions that actors include in their net-zero *target* may not necessarily correspond with the coverage of the emission reduction approaches that they implement. What this means for the ambition of the actor's target depends upon the actor's individual circumstances and the transparency of the target's claim. In the case that an organisation is forthcoming that its target only applies to certain scopes, it could be perceived as indication of additional ambition if an actor goes beyond this scope to deliver additional measures. In contrast, where the communication on this issue is less transparent, this could be a factor that leads to a target being less ambitious than an audience is led to believe.

Figure 12

Emissions included within the scopes of cities' and regions' net-zero targets



Note: Percentages based on actors reporting scope-disaggregated emissions; numbers on top of bars indicate the number of actors.

Data source: Data-Driven EnviroLab (2020)

How broad is the coverage of implemented approaches?

Full coverage of scope 3 emissions is not necessarily realistic for many actors, regardless of the actors' ambition. The most ambitious actors will strive to continuously improve their identification of scope 3 emission sources and actions to address them.

Given the probable incompleteness of accounting and reduction strategies for scope 3 emissions, it is worth carefully considering what emission sources an actor addresses, whether the actor's actions target the main emission sources, and whether the actor's climate claims accurately reflect the limitations of its actions. An actor may apply a certain approach to only a portion of its activities. For example, the conscious selection of suppliers may only be implemented for a single material or service, while many other procurement processes remain unchanged; similarly, efforts to raise awareness for responsible consumption of a company's output may only be pursued for one of an actor's many products. Energy company *Total* has a scope 3 target that only applies to its customers in Europe: they plan to reach net-zero emissions from its energy products sold to Europe by 2050 (CDP, 2019). German courier service DHL promises "climate neutral delivery" of parcels and letters within Germany, and to the rest of the world for an additional fee (DHL, 2020). Other delivery services it offers, however, are not climate neutral. Since it is unlikely that any given actor's strategies for reducing scope 3 emissions will be applied across all areas of its operations and all possible emission sources, it is important for ambitious actors and critical observers to assess the true scope of action implied by a target and whether the limitations of this action are transparently communicated.

How consequential are the approaches established?

The quality of action – in addition to the scope of action – is something for ambitious actors to continuously consider and improve upon.

Among the subset of corporate and subnational actors that specify their approaches for reducing scope 3 emissions, strategies range from strong measures with a meaningful impact to measures that lack tooth and represent a continuation of business as usual. For example, the impact of introducing climate-related criteria into procurement decisions is completely dependent on the strength of those

criteria in relation to other considerations integrated into the procurement process. Communicating that approaches for reducing scope 3 emissions are in place may give the impression that action is being taken, but this is by no means a guarantee of any meaningful impact.

The consequentiality of such approaches in practice is difficult for actors to objectively assess; actors can demonstrate ambition here by transparently discussing their situation and challenges, as well as their efforts to improve the effectiveness of their approaches. For example, in Oslo's 2020 climate budget, the city government quantifies the benefit of sustainable procurement policies against a business as usual (BAU) scenario. Specifically, they aim to transition to zero emissions biofuel for vehicles and machinery associated with municipal construction sites in Oslo, with an expected emissions reduction of 14 ktCO₂e by 2023 compared to the BAU (Oslo City Government, 2020).

What is the level of transparency?

Differences in the coverage of scope 3 emissions, strategies for their reduction, and the strength of those measures, make each actor's approach to tackling scope 3 emissions unique and not easily comparable to others. This challenge highlights the importance of the transparency with which an actor communicates its assumed responsibility and action. Level of transparency is something that can be objectively assessed and compared between actors. Given that open communication is key to encouraging constructive dialogues concerning the most challenging emission sources to address, the level of an actor's transparency regarding its scope 3 emissions and strategies for reducing them should be considered an indicator of ambition in its own right. The information technology company *AMD* has separate targets for different aspects of their scope 3 emissions. For instance, since their wafer suppliers are a major source of upstream emissions, they have separate intensity-based targets for the electricity use, water use, and GHG emissions of the wafer suppliers that they use. For their downstream scope 3 emissions, the company also has a goal for energy efficiency improvements in their products compared to the 2014 baseline. On their website, the company also clearly communicates to consumers which of their climate goals are on track, which are challenging, and which are at risk of not being met (AMD, 2020).

3.3 Neutralisation of emissions through offsetting

Many actors choose to support emission reductions elsewhere – i.e. outside the activity boundary of the subnational or corporate actor - and then claim those reductions towards their emission reduction or net-zero targets. This approach is commonly known as “offsetting.” Offsetting projects generate emission reduction credits which can be purchased by individuals or organisations; these are known as carbon offset credits.

Subnational and corporate actors generally use offsetting credits to claim that the emissions in their own GHG inventories have been neutralised – we refer to this as a *compensation claim*. Taking this approach, actors claim that by purchasing a certain number of carbon offset credits which each represent an emission reduction of 1 tCO₂e, they are neutralising their own emissions by the same amount. For instance, an actor with annual emissions of 200 tCO₂e can purchase 100 carbon offset credits and claim to have reduced its carbon footprint by 50 percent.

GHG emission abatement projects from which offset credits are generated are not necessarily located in the same country as the buyer. Indeed, buyers are often located in industrialised countries, while emission reduction projects are usually hosted in developing nations, where they are typically paired with sustainable development objectives.

The following sub-sections explore a number of limitations that challenge the fundamental suitability of offsetting and *compensation claims* and examine important nuances between the quality of different offsetting approaches that subnational governments and businesses adopt when implementing net-zero emissions strategies.

The fundamental suitability of offsetting and compensation claims

Historically, observers and consumers have largely accepted the practice of offsetting emissions, although it has been broadly recognised that the impact associated with the procurement of offset credits is more ambiguous than the impact from direct reduction of one’s own emissions. However, under the global climate governance framework of the Paris Agreement in the post-2020 context, the following

issues demonstrate that the suitability of offsetting as an approach for claiming the neutralisation of one’s own emissions is even more critical than before (NewClimate Institute, 2020).

Claiming climate neutrality through offsetting may divert attention from the fact that, to meet the objectives of the Paris Agreement, we need decarbonise all economies worldwide

The latest scientific evidence on pathways required to meet internationally agreed climate change targets demonstrates more clearly than ever that actors in industrialised nations need to immediately begin a rapid transformation to net-zero and eventually to net-negative emissions within their own territories and operational boundaries (IPCC, 2018); outsourcing emission reductions to actors in other countries is not an option that aligns with these pathways.

Climate neutrality claims that significantly depend on the use of offsets are not conducive to the achievement of the Paris Agreement objectives; rather, we stress the importance of transparency and facilitative dialogue for ambition raising. The transparent communication of an actor’s own emissions and the plans and challenges faced in reducing emissions further can be more constructive and solution-seeking than a subjective claim to carbon neutrality delivered through offsets.

The impact from offset credits cannot be considered additional if it presents developing countries with a perverse incentive to limit the extent to which they ratchet-up their own ambition

The prospect of potential revenues from emission reduction credits associated with offsetting programmes may present countries with a perverse incentive to restrict the extent to which they ratchet-up the ambition of their unilateral action during NDC revision cycles. To maximise foreign investment, countries may limit their own national GHG emission reduction targets so that more of their mitigation potential can be tapped by international offsetting mechanisms.

A key condition for determining the integrity of offset credits is the additionality of the emission reduction project; that is, the guarantee that credited emission reductions are additional to what could be achieved without the offsetting programme. In historical offsetting mechanisms, additionality could be proven by showing that local legislation did not require the activity and that offsetting revenues

could help overcome barriers which would otherwise prevent implementation. Since the coming into force of the Paris Agreement, the concept of additionality needs to be redefined and should imply complete certainty that the project supported could not realistically have been implemented otherwise through unilateral ambition enhancements on the part of the host country.

Stringent safeguards are needed to avoid or reduce the effects of such perverse incentives and to ensure additionality. With these regulations in place, offsetting programmes would need to ensure that they only tap highly ambitious mitigation options that are beyond the reasonable reach of the host country's unilateral action and do not represent a conflict with the country's own mitigation targets. Such stringent safeguards would be technically and politically difficult to establish. Even then, perverse incentives would remain to push the boundaries of those safeguards and seek loopholes. Since most emission reduction projects registered under crediting programmes to date have been developed in the context of cost-saving, rather than ambition-raising mechanisms, there are very few, if any, examples of existing credited projects that represent "high-hanging fruit" and could be considered truly additional in the context of the Paris Agreement. Given the difficulty in objectively determining additionality in line with this definition, it is likely that only a niche and ever decreasing number of activities could qualify, meaning offsetting does not represent a viable option for rapidly increasing demand volume of the subnational and business actor market.

Subnational and corporate actors can better support ambition-raising in developing countries through a *contribution claim* model

Developing countries need more financial support to ramp up their mitigation action, and voluntary subnational and corporate action is a vital channel of such support. However, a more constructive environment where this finance positively reinforces ambition raising efforts is required, rather than one that provides perverse incentives to limit ratcheting up commitments. In contrast to offsetting approaches, if the financial support from voluntary action results in emission reductions that are owned by the host country, this action will not conflict with the host country's GHG emission reduction target, but rather provide support for reaching and ratcheting up those targets.

In recognition of the limitations of offsetting and the need to ramp up financial support to developing countries, some actors are moving away from the

compensation claim model to a **contribution claim**. Actors claim to *contribute* to climate mitigation elsewhere, without claiming ownership of the emission reduction outcomes and without counting associated reductions towards their own GHG inventories or net-zero target.

A number of organisations have proposed or use this or similar approach in recent years:

- The Science Based Targets initiative (SBTi) explicitly rules out offsets toward the progress of companies' science-based targets, and suggests the use of offsets only as an option for companies wanting to finance additional mitigation action beyond their science-based target (SBTi, 2019b). Nevertheless, SBTi recently softened its position on offsetting to suggest actors use offsets projects to meet "science-based net-zero targets". However, these targets are distinct from actors' science-based GHG emission reduction targets, for which the guidelines have not changed (Carrillo Pineda *et al.*, 2020).
- The Gold Standard proposed a "reduce within, finance beyond" approach in which actors reduce emissions by what is required to limit global warming to 2°C and finance emission reductions elsewhere that are at least equal in amount to their own residual emissions; however, actors cannot claim the outcomes of this financial support towards their own emission reductions. Accordingly, the Gold Standard plans to establish a new form of *Certified Statement of Emission Reduction* which, unlike traditional carbon offset credits, may not be transferred to the buyer for use towards carbon neutrality claims (Gold Standard, 2017).
- Carbone4 propose that net-zero emissions should refer only to the global goal of balancing emissions and removals and not to a single actor. Under this logic, they propose the notion that organisations can only contribute to the trajectory towards global carbon neutrality but should not claim that activities supported through carbon finance can cancel the company's operational emissions (Carbone4, 2020)
- NewClimate Institute's *Climate Responsibility* approach pursues the provision of finance to support initiatives for transformational action under a *contribution claim* model, without claiming offset credits or the neutralisation of remaining emissions. The main focus of the approach is the development of a transparent and constructive dialogue regarding an actor's emissions and the challenges it faces to further reduce emissions (NewClimate Institute, 2020).

Transforming the offsetting market to support the high-hanging fruit

Despite the wide variation in existing offsetting projects and their quality, we recognise that existing offsetting programmes were established with the objective of identifying low-hanging fruit for achieving cost-efficient mitigation and that consequently, such programmes have not explored more novel and inaccessible emission reduction projects.

For this analysis, we focus on drawing a distinction between procuring credits from existing and more easily accessible emission reduction projects, and supporting the development of projects that are novel and relatively inaccessible emission reduction projects.

The low prices of existing carbon offset projects cannot incentivise actors to reduce their own emissions

Emission reduction credits generated by existing and more easily accessible projects are generally sold at relatively low prices on both compliance and voluntary markets. A survey of credit buyers showed that buyers paid an average US\$ 3.01/tCO₂e for voluntary offset credits in 2018 (Donofrio *et al.*, 2019). Warnecke *et al.* (2019) found that more than 86 percent of the theoretical CER supply potential from CDM projects in the 2013-2020 period is available at prices of below EUR1/tCO₂e. These price levels are substantially lower than the carbon-price levels that would be consistent with the Paris Agreement 1.5°C temperature goal, which the High-Level Commission on Carbon Prices found to be at least US\$ 40-80/tCO₂e in 2020 and US\$ 50-100/tCO₂e by 2030, provided that a supportive policy environment is in place (High-Level Commission on Carbon Prices, 2017). Compared with these price levels, even carbon offset credits available at prices of US\$ 16/tCO₂e, which represents the 99-percentile upper range outliers of credit prices of existing voluntary market projects (Hamrick and Gallant, 2017), are still relatively low cost, and may not incentivise actors to make operational changes and reduce scope 1, 2 and 3 emissions.

The purchase of inexpensive carbon offset credits from existing and easily accessible projects may have no meaningful climate impact

Existing projects have created a huge surplus of carbon offset credits in recent years because the number of credits issued consistently exceeded the

number of credits retired. Existing projects under the four largest offsetting programmes could supply an additional 18 billion offset credits in the period 2021-2035 (Fearnough *et al.*, 2019). By comparison, fewer than 50 million credits have been retired annually on the voluntary market in recent years (Hamrick and Gallant, 2017).

Merely 4 percent of the credit supply potential from existing projects registered under the Clean Development Mechanism (CDM) comes from projects that are highly vulnerable to discontinuation (Warnecke *et al.*, 2019). This means that whether or not actors purchase offset credits, the projects will continue to operate and deliver emission reductions.

While many existing carbon offset projects represent relatively low-hanging fruit and come at low costs, they may also have significant sustainable development benefits, which makes them attractive to many subnational and corporate actors. Such considerations may make projects worthy of financial support if there are aspects of the project that require ongoing funding support to continue delivering sustainable development impacts. However, support providers should re-consider whether a quantitative emission reduction claim is appropriate in cases where climate impact is highly uncertain.

Actors can achieve a climate impact by supporting the development of new and less accessible projects – the “high-hanging fruit”

The majority of new projects that are currently being developed or proposed for post-2020 offsetting mechanisms represent a continuation of historical offsetting approaches and carry the same limitations.

Recognising the issues associated with existing offsetting projects - especially those that represent more accessible technologies and practices - actors may choose to instead support new mitigation projects that focus on less accessible technologies and practices; these projects can be considered the *high-hanging fruit* of climate change mitigation potential. *The Oxford Principles for Net Zero Aligned Carbon Offsetting* suggests that offsetting for the achievement of net-zero targets should be restricted to the use of high quality credits with a low-risk of non-additionality, and only after prioritising the reduction of one's own emissions and the scaling up of removals (Allen *et al.*, 2020)

This shift would entail a radical transformation of the offsetting market. These “high-hanging fruit” projects are nascent worldwide, require specific know-how, and/or come at high cost (Warnecke *et al.*, 2018).⁷ Such projects are not currently readily available through existing carbon credit markets,

⁷ Specific examples include geothermal heat pumps to replace coal-fired heating plants in Mongolia and Net-Zero Energy Buildings in Colombia (Kachi *et al.*, 2020; Nascimento *et al.*, 2020).

due to the traditional focus of these markets on cost-efficiency and the “low-hanging fruit”. Importantly, what constitutes an inaccessible project depends on the country context. For instance, whereas European countries have experience with constructing Net-Zero Energy Buildings (NZEBs), such buildings are inaccessible to most developing countries, because the required know-how is lacking and pilot buildings are rare to not existent. This expertise cannot simply be imported from North America or Europe, because the climatic conditions in many developing countries require specific changes for the construction of a NZEB (Kachi *et al.*, 2020).

Financial support from subnational and corporate actors can be valuable in unlocking the potential of nascent technologies, particularly in developing countries. This support helps reduce the costs of such technologies, lower barriers to implementation, and facilitates the host country to set more ambitious emission reduction targets in subsequent nationally determined contributions. However, because such “high-hanging fruit” projects are generally novel, they may be less likely to immediately produce quantifiable or credited emission reduction outcomes. This means that even for these projects, a *contribution claim* model might be a more suitable support option than a *compensation claim* with offsetting.

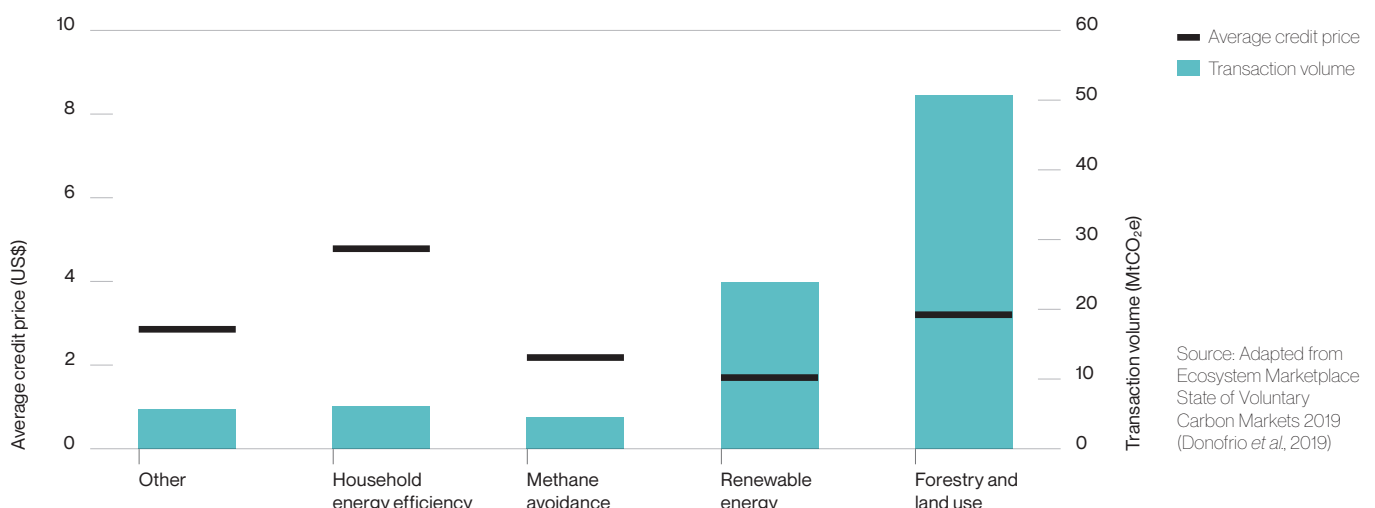
Trends for the use of offsetting in net-zero targets

Offsetting is a common approach for cities, regions and companies. Our sampling of companies’ net-zero targets found that the majority of those companies intend to use offsetting towards their net-zero targets;

for some companies it is the main instrument for target implementation. Approximately one third of companies indicate that they have no plans to use offset credits. For the US manufacturing company *Church & Dwight* – which set a target of carbon neutrality by 2025 – a 1 percent reduction in their emissions between 2018 and 2019 was an overachievement of their 2019 target for no emissions growth year-on-year (CDP, 2019b); their main strategy for achieving carbon neutrality in 2025 is the procurement of forestry offset credits (Church & Dwight, 2020). Contentious net-zero and carbon neutrality targets coming from companies in the aviation industry are also heavily or even exclusively based on the use of offset credits (see Box 13). Very few companies explicitly rule out the use of offsets. The multinational energy services company *Centrica* explicitly rule out the use of offsets for their target to be net-zero by 2050 (Centrica, 2019); the company sets out a number of measures and interim targets for achieving emission reductions, but is also transparent about the fact that they do not yet know how they will address the deeper decarbonisation that they commit to.

Overall trends from voluntary offsetting markets indicate that the vast majority of offset credits used by companies come from forestry and land use and renewable energy projects (Figure 13). Credits related to renewable energy offsetting projects and carbon dioxide removal projects forestry and other land use were purchased by companies, cities and regions at an average price of US\$ 1.7 and US\$ 3.2 respectively, in 2018 (Donofrio *et al.*, 2019). Warnecke *et al.* (Warnecke *et al.*, 2019) found that renewable energy offsetting projects were among the least likely projects to require revenues from carbon credit sales to continue their project operations.

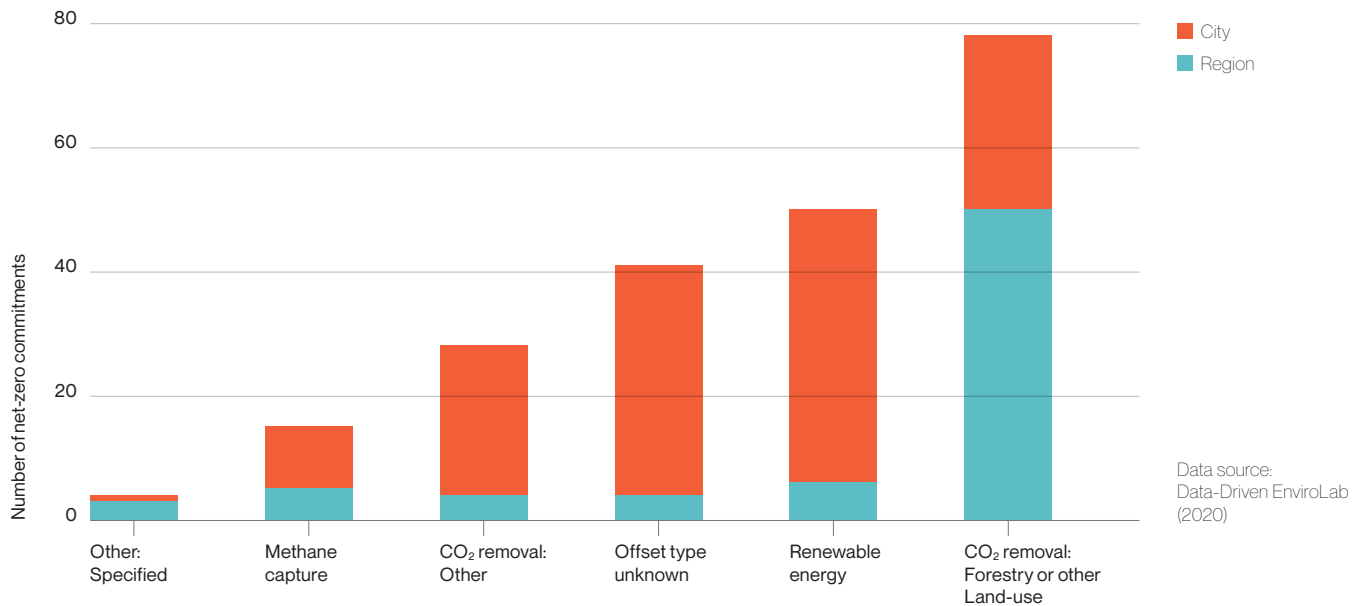
Figure 13
Trends from carbon credit markets for voluntary offsetting in 2018



Source: Adapted from Ecosystem Marketplace State of Voluntary Carbon Markets 2019 (Donofrio *et al.*, 2019)

Figure 14

Use of offsetting approaches for subnational actors' net-zero target implementation



Of the 941 cities and regions with net-zero targets surveyed, 27 percent clearly report intentions to use offsets; the number is likely even higher since the number of cities and regions that explicitly ruled out offsetting is limited, as it is for companies. In the case of cities and regions, references to the use of offsets often relate to offsetting emissions of the specific administrative body rather than the emissions within the geographical jurisdiction, and this approach is commonly achieved by supporting emission reduction or removal projects inside the actor's own geographical jurisdiction. This method is not comparable to the procurement of offset credits from projects outside of the actor's jurisdiction; it

might rather be considered a support option for the reduction of the actor's own emissions, if considering the emissions of the geographical jurisdiction rather than emissions of the administrative body.

Figure 14 provides an overview of the types of offsetting projects that cities and regions are purchasing credits from towards their own net-zero targets, based on our surveying exercise. The trends are similar to the overall voluntary offsetting market trends discussed above: measures for CO₂ removal related to forestry or other land-use are particularly popular, especially among regional governments; for emission reduction projects, renewable energy projects are by far the most popular.

Box 13

Carbon neutral aviation through low-cost offsets

Air transport is one of the hardest to abate sectors, although opportunities for decarbonisation exist.

The sector was one of the first to offer its customers the choice to 'neutralise' emissions by purchasing carbon offset credits. Airlines now increasingly set net-zero targets or offer carbon neutral flights. For instance, in 2019, EasyJet announced all its flights would be 'carbon neutral' (Easyjet, 2019). Air France and British Airways offset carbon emissions from flights within France and the United Kingdom, respectively (Air France, 2019; British Airways, 2019). Moreover, the International Airlines Group – under which numerous airlines, including British Airways and Iberia, fall – have committed to net-zero carbon emissions by 2050 (IAG, 2019).

Some airlines strive to achieve actual emission reductions through operational and technological measures, for instance by improving the energy efficiency of new aircraft and developing alternative fuels. However, all airlines rely heavily on carbon offset credits – mostly from renewable energy and forestry projects – for their carbon neutrality claims. Warnecke *et al.* (2019) show that there is ample potential supply of offset credits for the forecast demand of the aviation sector; credits can be purchased for less than EUR 1/tCO₂e and from existing offset projects that do not actually need those offset revenues to continue their mitigation activities.

None of the assessed airlines offer much information regarding the projects they purchase credits from, or on the price they pay for offset credits. However, based on general project descriptions and the price that customers pay when they voluntarily offset emissions from international flights with British Airways and Air France, airlines likely pay well below US\$ 10/tCO₂. Such low prices send no meaningful signal for decarbonising the aviation sector.

Airlines' net-zero claims are not transparent about the climate impact of aviation and may mislead customers. Passengers may believe that their 'carbon-neutral' flight has no climate impact. This – in combination with relatively cheap flight tickets and short travel times – may lead to an increase in demand for short-haul aviation and associated emissions. For instance, EasyJet launched its shortest domestic route between Birmingham and Edinburgh – a connection served by regular high-speed rail – around the same time that it announced its carbon neutrality claim.

Further, airlines' net-zero targets and claims focus exclusively on carbon emissions. However, air travel has significant non-CO₂ climate impacts that contribute to global radiative forcing (Owen *et al.*, 2010), which are estimated to increase the climate impact of aviation by a factor of up to 3 (Atmosfair, 2016).

Efforts to genuinely decarbonise the aviation sector should be encouraged and applauded, but misleading carbon neutrality and net-zero claims are not a constructive approach to move towards this goal, and do not give an accurate representation of the sector's prospects.

3.4 Supporting carbon dioxide removal technologies and practices

Carbon dioxide removal (CDR) practices and technologies *remove* CO₂ from the atmosphere and store carbon in another medium where it will not act as a direct driver of climate change. Achieving a 1.5°C warming scenario with no temperature overshoot will require significant carbon dioxide removal in addition to emission reductions (IPCC, 2018). Alongside and in addition to deep and expedient emission reductions, the exploration, development and deployment of CDR technologies and practices is also imperative for the achievement of the Paris Agreement.

An increasing number of subnational and corporate actors are drawing on CDR measures, sometimes directly counting this action towards implementation of their climate change mitigation targets. More than 100 of the cities and regions with net-zero targets that we assessed provide support to CDR technologies and practices as a part of their climate change mitigation action. The practice is also popular and gaining traction with corporate actors; the volume of offset credits purchased from forestry-related projects grew 342 percent between 2017 and 2018, making this by far the most popular type of offset credit on the voluntary market, and this trend was predicted to continue into 2019 (Donofrio *et al.*, 2019). Some actors, including *Apple* and *Velux* – both with targets for net-zero by 2030 – report that they intend to exclusively use carbon dioxide removal projects to offset their remaining emissions for the achievement of net-zero targets (Apple, 2020; Velux, 2020). For both of these companies, forestry and land-use related CO₂ removals are currently identified as the preferred approach. Other companies, including

Boston Consulting Group, H&M and Microsoft, are also exploring technological CDR options to offset their remaining emissions (H&M Group, 2019a; BCG, 2020; Microsoft, 2020a). This focus on CO₂ removals is aligned with recommendations from *The Oxford Principles for Net Zero Aligned Carbon Offsetting* (Allen *et al.*, 2020), although these guidelines recommend a shift to carbon dioxide removal measures with longer-lived storage, such as underground and mineral storage.

While it is important for the provision of support to CDR activities to continue to gain momentum, there are issues associated with the comparability of carbon dioxide removal and emission reductions that call into question the suitability of CDR activities for use in offsetting approaches and to meet a corporate or subnational emission net-zero target. There are important distinguishing features between CDR activities that influence the extent to which the activity represents an ambitious action on the part of the support provider.

Carbon dioxide removal technologies and practices have a broad range of costs and potential impacts

A broad range of CDR technologies and practices exist or are under development. Jeffery *et al.* (2020) find that these activities vary significantly in terms of their costs, maturity, global climate change mitigation potential, duration of CO₂ storage, benefits beyond CDR, and potential negative impacts. The authors draw a high-level distinction between *biological capture and storage*, *underground storage*, and *mineral storage* to account for the differences with respect to these issues and to distinguish between the suitability of CDR activities for different support options:

- **Biological capture and storage measures** include *soil carbon sequestration*, *afforestation and reforestation*. Many practices for biological capture and storage have been broadly applied for decades, and in some circumstances can be implemented at relatively low- or even negative-costs due to the associated benefits for the land and local ecosystems. However, the permanence of these measures is unreliable, as soils and forested areas remain vulnerable to anthropogenic or natural disturbances that can lead to the release of captured and stored carbon at any point.
- **Underground storage** of carbon dioxide, for example in depleted oil and gas fields, is usually used for *biomass-fired energy generation with carbon capture and storage (BECCS)*, and for direct air carbon dioxide capture and storage (DACCS). These measures can be very expensive in some circumstances, often due to high energy requirements for operation; consequently, they remain mostly in a demonstration phase to test performance and viability. The underground storage of CO₂ can theoretically be long-term, but the relative technological immaturity of these approaches causes uncertainty in this regard. Turkish conglomerate *Tekfen* supports research on BECCS in cooperation with Istanbul Technical University (Tekfen Holding, 2017; CDP, 2019b). The city of *Stockholm* – committed to targets of being fossil-free by 2040 and net-zero by 2045 (City Executive Office of Stockholm, 2016) – is investing in BECCS with combined heat and power through its energy utility *Stockholm Exergi AB* – which has its own target to be “climate positive” by 2025 (S&P Global Ratings, 2020) – and in cooperation with Finnish energy major *Fortum Oyj* (Bioenergy International, 2019). None of the companies surveyed by CDP in 2019 that communicated net-zero targets, nor the cities and regions assessed in this report, mention support programmes for DACCS.
- **Mineral storage measures** such as *enhanced terrestrial weathering* and *mineral carbonation* can result in very long carbon storage, although most measures remain at an early stage of research or development and there remain many uncertainties with regards to the accuracy of potential monitoring techniques, as well as the costs of implementation. The regional government of *Norrbottn County* in Sweden is pursuing measures for mineral carbon storage, to implement its net-zero by 2045 target, which also includes a real emission reduction target of 85 percent (Norrbottn County, 2020). None of the companies CDP surveyed in 2019 whose targets qualified as net-zero mention support programmes for mineral carbon storage associated with carbon dioxide removals.

Some actors count support for carbon dioxide removals against their own emission reduction targets, whilst others adopt separate targets for emission reductions and removals

CDR is sometimes referred to interchangeably as *negative emissions* technologies and practices, assuming an equivalence between a unit of emissions reduced and a unit of emissions removed from the atmosphere. Assuming CDR to be equivalent to *negative emissions*, the **outcomes of subnational and corporate actors' CDR activities are often used to count towards their single emission reduction targets**. In this construct, CDR activities are generally pursued simply as a type of emissions offsetting project towards carbon neutrality claims and net-zero targets.

The assumption of equivalence between emission reductions and emission removals is problematic. Due to key issues related to the permanence of the CDR outcome or methodological uncertainties (see Box 14), Jeffery *et al.* (2020) concluded that none of the major CDR measures

that they assessed could provide the suitable level of guarantee that they can be considered directly equivalent to emission reductions and suitable for offsetting emissions. Recognising that the outcomes of CDR activities are generally not directly comparable to the outcomes of emission reduction activities, **actors may set and pursue separate and independent targets for each type of outcome:** one target for emission reductions, and another separate target for carbon dioxide removals (Levin *et al.*, 2020). Danish manufacturer *Velux* plans to reduce scope 1 and 2 emissions to zero by 2030, but also has a separate target for carbon dioxide removals. The company plans to remove as much carbon dioxide from the atmosphere by 2041 as it has emitted since its founding in 1941 (Velux, 2020). *Apple* and *Microsoft* both specify separate targets for GHG emissions and GHG removals, but also combine both together into a single net-zero target for 2030 (Apple, 2020; Microsoft, 2020a). After achieving its target for net-zero emissions in 2030, *Microsoft*, like *Velux*, will continue to pursue a separate target for carbon dioxide removals to remove its own lifetime emissions since 1975, by 2050.

Box 14

Permanence and methodological uncertainties of carbon dioxide removal outcomes

Permanence of a CDR outcome refers to the degree of certainty that the previously sequestered carbon will not be released at a later point in time. Permanence is a very important issue when considering the relevance of CDR outcomes for offsetting GHG emission balances, since the release of previously sequestered carbon at any point in the future negates the benefits of the sequestration for the long-term mitigation of climate change. At the point at which the carbon dioxide is released, the atmospheric concentration of carbon dioxide is restored to the same value that it would have been had the CDR activity never taken place. The removal of carbon dioxide from measures without permanence is only a delay in emissions, and therefore should not be used to offset carbon dioxide emissions, which have a higher permanence.

Sequestration in forests or soils is vulnerable to reversal at any point in time, due to disturbances such as tilling, floods, droughts, fires, pest outbreaks, poor management or incentives for land-use change (IPCC, 2019). Although some of the sequestered carbon may end up in more permanent applications – such as the use of wood for building – there can be no reliable guarantee for any specific project that all of the sequestered carbon will find its way to such applications. The permanence of bioenergy or direct air capture combined with underground storage has been tested and shown to be functional in demonstration plants, but still entails a degree of uncertainty; it is reliant on indefinite continued operation and management of the storage technologies, as well as uncertain geological factors unless the carbon is fully mineralised. Permanence of storage in ‘technical’ approaches is therefore not necessarily guaranteed, though far more likely than permanence from ‘biological’ sequestration measures. For enhanced weathering and mineral carbonation, carbon is transformed into a stable solid matter and there is an established likelihood of permanency.

Methodological uncertainties related to MRV are issues that can affect the environmental integrity of any climate change mitigation project, but these uncertainties are particularly pertinent for many CDR technologies; where removals cannot be measured directly, project developers must use complex methodologies or advanced remote sensing technologies (Schneider *et al.*, 2018). For soil carbon sequestration, estimation of removal quantities through sampling has yielded conflicting results (Gross and Harrison, 2018). Direct air capture and capture through biomass in BECCS can be measured during the capture process - the challenge here is verification. For underground and mineral storage, it is challenging to monitor and verify the permanence of the storage.

Source: Adapted from Jeffery *et al.* (Jeffery *et al.*, 2020). See source for further details and supporting analysis

Box 15

Subnational governments’ efforts on Carbon Dioxide Removal (CDR)

Despite an actor’s best efforts, 100 percent emission reduction may not be possible, particularly for hard-to-abate sectors, which is why carbon dioxide removal or CDR is often stated as part of a net-zero strategy. All forms of CDR, however, potentially face issues with the permanence of the sequestered carbon — for instance, a forest fire could release stored carbon from a reforestation programme (Gren and Zeleke, 2016). The most mature forms of CDR are land-based, including reforestation, afforestation, and soil and agricultural management. More novel forms of CDR include direct air capture, carbon mineralisation and ocean-based carbon removal — all of which currently require more research and piloting to increase their potential (Mulligan *et al.*, 2020).

Consider Vancouver, British Columbia for instance — the city of over 600,000 people has committed to reducing their scope 1 and 2 emissions by 80 percent by 2050, and to achieve net-negative emissions in the second half of the century through reforestation on forest and coastal ecosystems (Vancouver City Council, 2019). The city plans to complete this restoration work by 2030, and as these forests continue to grow, they expect this project to remove one million tonnes of CO₂ per year by 2060. Vancouver's reforestation project is promising because of its intersectionality with other social and economic issues, including environmental justice. Vancouver intends to collaborate with indigenous groups, such as the Musqueam, Squamish and Tsleil-Waututh peoples on land restoration. The city's Climate Emergency Response report also articulates the need to conserve key ecosystems, such as coastal forests, eelgrass meadows and salt marshes, which they have identified as contributing to key cultural practices and ecosystem services that increase climate resilience. As with other forms of land-based CDR, however, Vancouver will continue to have to contend with its potential impermanence in light of the effects of climate change, which is increasing the intensity and frequency of wildfires. The 2017 fire season saw an unprecedented 1.2 million hectares of land burned in British Columbia, 10 times the 10-year average (Riley, 2018).

On the other hand, Stockholm, the capital of Sweden is developing its capacities for using biofuels for CDR in pursuit of its target of reaching net-zero emissions by 2040. It is one of the few cities articulating its intention to actively develop biochar technology for CDR to make use of wood chip residues from Swedish forestry (Levihn *et al.*, 2019). Instead of incinerating biomass, baking it slowly in the absence of oxygen produces biochar, a substance that can be buried to store carbon and improve soil quality (Project Drawdown, 2018). Stockholm opened the country's first large-scale biochar plant in 2017, and by 2020, the city is expected to have five biochar plants that capture over 25,000 tonnes of CO₂ annually, while producing enough district heat for 400 apartments (Nordregio, 2018). The biochar is distributed to municipal-owned facilities as well as residents, forming a network for carbon removal within the city's boundaries that also contributes to the growth of urban greenery (Stockholm Vatten Och Avfall, 2019).

More advanced technologies for CDR, such as direct air capture (DAC) — technologies that involve removing CO₂ directly from ambient air — are on the horizon but are not yet available for immediate use (IEA, 2020). Canadian company Carbon Engineering is on the frontlines of developing DAC, and they suggest that their technology will reach the mainstream market in the next few years, having raised US\$ 68 million in investments to scale and commercialise their business (Chan, 2019). Carbon Engineering uses compounds called liquid alkali metal oxides to absorb CO₂, kept at high temperatures to ensure they keep absorbing carbon (Beuttler *et al.*, 2019). Once constructed, these first industrial-scale DAC plants are expected to capture up to one million tonnes of CO₂ each year at costs lower than US\$ 100 per tonne of CO₂. Carbon Engineering's technology has its own drawbacks, however, namely its energy intensity and use of natural gas as a fuel (Beuttler *et al.*, 2019). Given the urgent timeline on decarbonisation, investment into DAC research and development is needed to ensure these technologies could be cheaper and more effective for widespread use (Lebling, 2020).

4

Conclusions: Target transparency for accountability and ambition

This assessment of existing net-zero targets from cities, regions and companies reveals a trend of accelerating target setting and action. Many actors have established themselves as role models for certain specific aspects of their target setting or implementation approaches. We have also identified that there are a broad range of approaches considered under the umbrella of net-zero targets. Targets' details can have significant implications for their climate change mitigation impact and their degree of transparency.

Net-zero targets include a broad range of implementation approaches

Cities, regions, and companies are pursuing a range of strategies to achieve their net-zero targets, including radical operational changes for the direct reduction of emissions, conscious consideration of renewable energy procurement models, diverse approaches to support the reduction of supply chain and out-of-boundary emissions, and neutralisation of their emissions through offsetting programmes. For each of these types of action, there are many examples of positive practices among highly ambitious corporate and subnational actors that other ambitious actors can look to for inspiration.

Nuances in net-zero targets can determine their real ambition and impact

Net-zero targets that are supported by robust plans for the direct elimination of an actor's emissions offer the greatest clarity in terms of their contribution to global decarbonisation.

Besides the direct reduction of an actor's own emissions, the actors assessed employ a range of complementary approaches to address emissions that they are not able, or currently unwilling, to directly reduce themselves. Some of these indirect approaches (e.g., renewable energy procurement) can have a positive impact towards reducing global emissions and should be considered good practice. However, many of these approaches – including several renewable energy procurement models and offsetting schemes – do not carry enough certainty with regards to their outcomes to be considered equivalent alternatives to the direct reduction of one's emissions (→ Sections 3.2.2 and 3.3).

Nuances in the specific implementation details of net-zero targets determine whether they actually lead to deep decarbonisation or have any impact at all.

Low standards for net-zero target transparency can create a haven for greenwashing

Net-zero targets can reflect the highest mitigation ambition, but the innate ambiguity of the term “net-zero” can make these targets incomparable between actors and even enable greenwashing.

There is a significant risk that low standards for net-zero target transparency could mislead consumers and investors about the environmental impact associated with a product or service, resulting in decisions and behaviour that may actually cause an increase in GHG emissions. For example, carbon neutrality claims from airlines may give the false impression that flying is more environmentally friendly than rail travel and lead to an increase in demand for short haul flights.

This risk is particularly important given the complexity of emission sources in most sectors, and the consequent difficulties that consumers and investors face in attempting to understand the real implications of a given target.

Transparency should start with separate targets for emission reductions and removals

A net-zero target can be an ultimate indication of ambition for some actors, but the nuances of net-zero targets and their broad implications for climate impact mean that a single “net-zero” target may not be the most transparent approach for all actors.

Achieving net-zero emissions and removals at the global level is a challenge and goal that can only be reached by society collectively, rather than by single actors in isolation. The nuances of targets and their implications for impact lends credence to the notion that “carbon neutrality” or “net-zero” applies only to global emissions (Carbone 4, 2020). While individual actors can contribute towards a global carbon neutral trajectory, in other words, they should not claim this term for their own emissions. This perspective argues that in our current interconnected society, which is far from emissions-free, no entity can truly be carbon neutral, and it is not constructive to make this claim.

Where net-zero targets are identified as the most appropriate expression of ambition, these targets should only be considered ambitious if communicated with high transparency, including the clear identification of separate targets for emission reductions and emission removals. Collectively reaching net zero at the global level will require cooperation and a mutual understanding of what different national, subnational, and corporate actors can contribute to the common objective. National governments need to understand the full extent of action among subnational and corporate actors with respect to both emission reduction measures and emission removals to formulate coherent policy for these two objectives. Ambitious actors must be able to peer review each other’s approaches in order to exchange and collectively seek solutions to unsolved challenges.

Such transparency also provides a clearer opportunity for ambitious actors to stand out. Given the ambiguity of net-zero claims, and the comparative clarity afforded by direct emission reduction targets

for an actor’s emissions, ambitious actors should consider that their ambition may be better recognised through a separate emission reduction target that demonstrates commitment to deep decarbonisation or near-zero emissions, even if those reductions do not yet imply absolute zero emissions.

Transparency can facilitate accountability and positive pressure for target quality

Figure S2 presents 10 basic criteria for net-zero target transparency. There are indications that increasing citizen concern about climate change is partially accelerating climate action and net-zero target setting across subnational and corporate actors. This trend since 2018 follows the surge of civic activism over the same period and general public interest in net-zero, as seen in search engine user behaviour (→ Section 2.2). The especially high levels of target-setting activity among consumer-facing corporates further indicates concerned citizens and consumers as a driving force (→ Section 2.2.2).

If citizens and consumers have been an impetus for net-zero target setting, they may also offer the best hope for ensuring that ambitious promises translate to ambitious action. For individuals to play this role, greater transparency is necessary to take the ambiguity out of net-zero targets and to clarify the ambition of actors and the potential for further action.

Actors and critical observers need to see the details that allow them to identify, applaud and learn from the most ambitious actors, as well as to apply pressure to actors whose net-zero claims are less substantiated. Transparency of net-zero target nuances and their implementation can unravel their potential ambiguity and facilitate constructive dialogue on potential challenges. Ambitious actors, critical observers, and concerned citizens should recognise that constructive transparency can be far more ambitious and solutions-oriented than net-zero claims that are based on opaque accounting approaches.

Guidance, support and encouragement for cities, regions and corporate actors setting ambitious targets should include greater consideration of the nuances that distinguish different approaches to target implementation and their implications for overall ambition. Actors should be encouraged to provide more details behind their targets and claims to better enable the identification of truly ambitious actors and enhance their support.

References

- Aden, N. (2016) *Japan Is Leading on Business Climate Engagement. Will Ambitious Policies Follow?*, WRI. Available at: <https://www.wri.org/blog/2019/06/japan-leading-business-climate-engagement-will-ambitious-policies-follow> (Accessed: 19 October 2020).
- Air France (2019) *Air France to begin offsetting 100% of CO₂ emissions on its domestic flights on 1st January 2020*. Available at: <https://corporate.airfrance.com/en/press-release/air-france-begin-offsetting-100-co2-emissions-its-domestic-flights-1st-january-2020> (Accessed: 12 October 2020).
- Ajinomoto Co (2020) *Carbon neutral Reduction of greenhouse gas emissions*. Ajinomoto. Available at: https://www.ajinomoto.co.jp/company/en/activity/csr/pdf/2018/SDB2018e_P69-74.pdf
- Alecta (2019) *Klimatredovisning enligt TCFD 2019*. Alecta. Available at: <https://www.alecta.se/globalassets/dokument/finansiella-rapporter/klimatredovisning/alecta-klimatredovisning-2019.pdf>.
- Allen, M. *et al.* (2020) *The Oxford Principles for Net Zero Aligned Carbon Offsetting*. University of Oxford. Available at: <https://www.smithschool.ox.ac.uk/publications/reports/Oxford-Offsetting-Principles-2020.pdf>.
- Almirall (2020) *Annual report 2019*. Almirall. Available at: https://www.almirall.com/documents/portlet_file_entry/4257831/AF_Almirall_AR2019_EN_Dobles.pdf/6c8fe19b-ea8f-073e-5413-cdbf2f14b25a.
- Amazon (2020) *All In: Staying the Course on Our Commitment to Sustainability*. Amazon. Available at: <https://sustainability.aboutamazon.com/pdfBuilderDownload?name=sustainability-all-in-september-2020>.
- AMD (2020) *Planet: Our Commitment to the Future*. Available at: <https://www.amd.com/en/corporate-responsibility/planet> (Accessed: 13 October 2020).
- Apple (2020) *Environmental Progress Report*. Cupertino: Apple. Available at: https://www.apple.com/euro/environment/pdf/a/generic/Apple_Environmental_Progress_Report_2020.pdf.
- ArcelorMittal (2020) *ArcelorMittal Europe sets out path to net zero by 2050, with pioneering technologies at the forefront of the company's roadmap for carbon-neutral steelmaking*. Available at: <https://corporate.arcelormittal.com/media/press-releases/arcelormittal-europe-sets-out-path-to-net-zero-by-2050-with-pioneering-technologies-at-the-forefront-of-the-company-s-roadmap-for-carbon-neutral-steelmaking> (Accessed: 17 October 2020).
- ARUP and C40 Cities (2016) *Deadline 2020: How cities will get the job done*. ARUP, C40 Cities. Available at: <http://www.c40.org/researches/deadline-2020>.
- Atmosfair (2016) *Atmosfair Flight Emissions Calculator*. Available at: <https://www.atmosfair.de/wp-content/uploads/atmosfair-flight-emissions-calculator-englisch-1.pdf> (Accessed: 19 October 2020).
- Bartlett, N., Cushing, H. and Law, S. (2016) *Embedding a carbon price into business strategy*. CDP. Available at: https://b8f65cb373b1b7b15feb-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/reports/documents/000/001/132/original/CDP_Carbon_Price_2016_Report.pdf?1474269757.
- Bataille, C. G. F. (2019) 'Physical and policy pathways to net-zero emissions industry', *WIREs Climate Change*. Wiley-Blackwell, 11(2). doi: 10.1002/wcc.633.
- BCG (2020) *BCG's net-zero pledge*. Available at: <https://www.bcg.com/about/about-bcg/net-zero> (Accessed: 8 October 2020).

- Beard, V. A., Mahendra, A. and Westphal, M. (2016) *Towards a More Equal City: Framing the Challenges and Opportunities*. WRI. Available at: <https://www.wri.org/wri-citiesforall/publication/towards-more-equal-city-framing-challenges-and-opportunities> (Accessed: 17 September 2020).
- Beuttler, C., Charles, L. and Wurzbacher, J. (2019) 'The Role of Direct Air Capture in Mitigation of Anthropogenic Greenhouse Gas Emissions', *Frontiers in Climate*, 1(10), p. 10. doi: 10.3389/fclim.2019.00010.
- Bioenergy International (2019) *Sweden's first bioenergy carbon capture and storage pilot inaugurated*. Available at: <https://bioenergyinternational.com/heat-power/swedens-first-bioenergy-carbon-capture-and-storage-pilot-inaugurated> (Accessed: 17 October 2020).
- Bosshard, P. et al. (2019) *Insuring Coal No More: The 2019 Scorecard on Insurance, Coal and Climate Change*. Insure our Future. Available at: <https://insureourfuture.co/2019scorecard/>.
- Brambles (2020) *Eradicating Empty Transport Miles*. Available at: <https://www.brambles.com/zero-waste-world/eradicating-empty-transport-miles.html> (Accessed: 13 October 2020).
- Brander, M., Gillenwater, M. and Ascui, F. (2018) 'Creative accounting: A critical perspective on the market-based method for reporting purchased electricity (scope 2) emissions', *Energy Policy*, 112, pp. 29–33. doi: 10.1016/j.enpol.2017.09.051.
- British Airways (2019) *British Airways to offset carbon emissions on flights within the UK from 2020*. Available at: <https://mediacentre.britishairways.com/pressrelease/details/86/2019-319/11662> (Accessed: 12 October 2020).
- Bronski, P. et al. (2017) *The Carbon-Free City Handbook*. Rocky Mountain Institute. Available at: <https://rmi.org/insight/the-carbon-free-city-handbook/> (Accessed: 12 October 2020).
- C40 Cities for Climate Leadership et al. (2018) *Consumption-Based GHG Emissions of C40 Cities*. New York. Available at: <https://www.c40.org/researches/consumption-based-emissions>.
- C40 Cities for Climate Leadership et al. (2019) *The Future of Urban Consumption in a 1.5°C World*. C40 Cities. Available at: https://c40-production-images.s3.amazonaws.com/other_uploads/images/2270_C40_CBE_MainReport_250719.original.pdf?1564075036.
- California Energy Commission and California Public Utilities Commission (2015) *New Residential Zero Net Energy Action Plan 2015-2020 Executive Summary*. San Francisco: California Energy Commission California Public Utilities Commission. Available at: <https://www.cpuc.ca.gov/general.aspx?id=10740> (Accessed: 14 October 2020).
- Carbone4 (2020) *Net Zero Initiative: A Framework for Collective Carbon Neutrality*. Paris: Carbone4. Available at: <http://www.netzero-initiative.com/fr>.
- Carlsberg A/S (2019) *Carlsberg Sustainability Report 2019*. Copenhagen, Denmark: Carlsberg. Available at: <https://www.carlsberggroup.com/media/35965/carlsberg-as-sustainability-report-2019.pdf>.
- Carrillo Pineda, A., Chang, A. and Faria, P. (2020) *Foundations for Science-Based Net-Zero Target Setting in the Corporate Sector*. SBTi and CDP. Available at: <https://sciencebasedtargets.org/wp-content/uploads/2020/09/foundations-for-net-zero-full-paper.pdf>.
- CDP (2019) *CDP disclosure 2019, Confidential data set*.
- CDP (2020) *CDP Technical Note: Accounting of Scope 2 emissions*. Available at: https://b8f65cb373b1b7b15feb-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/guidance_docs/pdfs/000/000/415/original/CDP-Accounting-of-Scope-2-Emissions.pdf?1479752807 (Accessed: 18 October 2020).
- CDSB and SASB (2019) *TCFD Implementation Guide: Using SABS Standards and the CDSB Framework to Enhance Climate-Related Financial Disclosures in Mainstream Reporting*. CDSB and SASB. Available at: <https://www.sasb.org/knowledge-hub/tcf-implementation-guide/>.
- Centrica (2019) *CDP climate change Questionnaire 2019*. CDP. Available at: https://www.centrica.com/media/2691/centrica_response_-_cdp_climate_change_questionnaire_2019.pdf.

- Chan, K. (2019) *Squamish company that sucks up carbon dioxide to make fuel gets \$68 million investment*. Available at: <https://dailyhive.com/vancouver/carbon-engineering-investment-march-2019> (Accessed: 16 October 2020).
- Church & Dwight (2020) *2019 Sustainability Report*. Church & Dwight. Available at: <https://churchdwight.com/pdf/Sustainability/2019-Sustainability-Report.pdf>.
- City Executive Office of Stockholm (2016) *Strategy for a fossil-fuel free Stockholm by 2040*. City Executive Office, Stockholms Stad. Available at: <https://international.stockholm.se/globalassets/rapporter/strategy-for-a-fossil-fuel-free-stockholm-by-2040.pdf>.
- City of Boulder (2020) *Community Greenhouse Gas Emissions*. City of Boulder, Colorado. Available at: https://bouldercolorado.gov/boulder-measures/community-greenhouse-gas-emissions?__cf_chl_captcha_tk__=65ab53affaff5f5be0c76f5234e623a789ca0e82e-1599209005-0-AZCRb2KYwMeEC7S50cqeEvkmetoxFgzww1XTiNvE-R3m0XMN1D8wJmXKN8bVammnnozRIsJu-8J2bRKVADvoW_jW0fYIbcGKxe (Accessed: 1 September 2020).
- City of Flagstaff (2019) *Flagstaff Climate Action and Adaptation Plan Dashboard*. City of Flagstaff, Arizona. Available at: <https://gis.flagstaffaz.gov/portal/apps/sites/#/climateplan/pages/climate-plan-dashboard> (Accessed: 1 September 2020).
- City of Portland and Multnomah County (2015) *Climate Action Plan: Local Strategies to Address Climate Change*. Portland: City of Portland, Oregon and Multnomah County. Available at: https://www.portland.gov/sites/default/files/2019-07/cap-2015_june30-2015_web_0.pdf.
- Climate Action Tracker (2020) *Pledges And Targets: China*. Available at: <https://climateactiontracker.org/countries/china/pledges-and-targets/> (Accessed: 17 October 2020).
- CNCA (2017) *Framework for Long-Term Carbon Reduction Planning*. Carbon Neutral Cities Alliance. Available at: <https://carbonneutralcities.org/wp-content/uploads/2018/04/CNCA-Framework-for-Long-Term-Deep-Carbon-Reduction-Planning.pdf>.
- CNCA (2020) *Copenhagen, Denmark, Carbon Neutral Cities Alliance*. Available at: <https://carbonneutralcities.org/cities/copenhagen/> (Accessed: 5 September 2020).
- Colenbrander, S. et al. (2019) *Climate Emergency, Urban Opportunity: How national governments can secure economic prosperity and avert climate catastrophe by transforming cities*. Coalition for Urban Transitions. Available at: <https://urbantransitions.global/urban-opportunity/>.
- Committee on Climate Change (2019) *Net Zero: The UK's contribution to stopping global warming*. London, UK: Committee on Climate Change. Available at: www.theccc.org.uk/publications.
- Concha y Toro (2020) *Carbon Footprint*. Concha y Toro. Available at: https://conchaytoro.com/content/uploads/2020/03/SUSTAINABILITY-REPORT-2014_VCT.pdf.
- Corvidae, J. et al. (2018) *The Carbon-Free Regions Handbook*. Rocky Mountain Institute. Available at: <https://rmi.org/insight/carbon-free-regions-handbook/>.
- Curran, G. (2020) 'Divestment, energy incumbency and the global political economy of energy transition: the case of Adani's Carmichael mine in Australia', *Climate Policy*. Taylor & Francis, pp. 1–14. doi: 10.1080/14693062.2020.1756731.
- Dagoumas, A. S. and Koltsaklis, N. E. (2017) 'Price Signal of Tradable Guarantees of Origin for Hedging Risk of Renewable Energy Sources Investments', *International Journal of Energy Economics and Policy*, 7(4), pp. 59–67.
- David Mytton (2020) 'Hiding greenhouse gas emissions in the cloud', *Nature Climate Change*, 10, p. 701. doi: 10.1038/s41558-020-0807-z.
- DB (2019) *Zugreisen: Unterwegs mit 100 Prozent Ökostrom?* Available at: <https://inside.bahn.de/bahn-umwelt-gruen/> (Accessed: 7 October 2020).
- DHL (2020) *Climate Protection: Ship and receive parcels while protecting the environment, with DHL*. Available at: <https://www.dhl.de/en/privatkunden/kampagnenseiten/dhl-nachhaltigkeit.html> (Accessed: 16 October 2020).

- DivestInvest (2020) *Commitments to DivestInvest*. Available at: <https://www.divestinvest.org/> (Accessed: 14 August 2020).
- Donofrio, S. *et al.* (2019) 'State of the Voluntary Carbon Markets 2019'. Washington D.C: Ecosystem Marketplace. Available at: <https://www.ecosystemmarketplace.com/carbon-markets/>.
- Easyjet (2019) *Resilient Focused Data Driven: Annual Report and Accounts 2019*. Easyjet. Available at: http://www.annualreports.com/HostedData/AnnualReports/PDF/LSE_EZJ_2019.pdf.
- Energy Transitions Commission (2018) *Mission Possible: Reaching net-zero carbon emissions from harder-to-abate sectors by mid-century*. Energy Transitions Commission. Available at: <https://www.energy-transitions.org/publications/mission-possible/>.
- Engie (2020) *ENGIE NextFlex: Demand REsponse specialist and electrical flexibility in Europe*. Available at: <https://www.engie-nextflex.com/en/> (Accessed: 14 October 2020).
- Farsan, A. (2020) *A new, streamlined route for SMEs to set science-based targets*. Science Based Targets. Available at: <https://sciencebasedtargets.org/2020/04/20/smoothing-the-way-for-small-and-medium-sized-businesses-to-set-science-based-climate-targets/> (Accessed: 19 October 2020).
- Fearnough, H. *et al.* (2019) *Offset Credit Supply for CORSIA*. Cologne and Berlin: NewClimate Institute. Available at: <https://newclimate.org/2019/11/05/offset-credit-supply-potential-for-corsia/>.
- Fong, W. K. *et al.* (2014) *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities*. Greenhouse Gas Protocol, World Resources Institute, C40 Cities, ICLEI - Local Governments for Sustainability. Available at: https://ghgprotocol.org/sites/default/files/standards/GHGP_GPC_0.pdf.
- Foster, J. *et al.* (2013) *Seattle Climate Action Plan*. Seattle Office of Sustainability and the Environment. Available at: https://www.seattle.gov/Documents/Departments/Environment/ClimateChange/2013_CAP_20130612.pdf.
- GB News (2019) *Glasgow sets carbon neutral target of 2030*, GB News. Available at: <https://governmentbusiness.co.uk/news/02102019/glasgow-sets-carbon-neutral-target-2030> (Accessed: 15 September 2020).
- Ge, M. *et al.* (2019) *Tracking Progress of the 2020 Climate Turning Point*. World Resources Institute. Available at: https://files.wri.org/s3fs-public/2020-turning-point-progress_2.pdf.
- Geck, M. (2019) *Seven major companies that committed to net-zero emissions in 2019*. Available at: <https://www.unpri.org/pri-blogs/seven-major-companies-that-committed-to-net-zero-emissions-in-2019/5255.article> (Accessed: 17 October 2020).
- Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & Tempio, G. (2013) *Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities*. Rome: Food and Agriculture Organization of the United Nations (FAO). doi: 10.1016/j.anifeedsci.2011.04.074.
- Germanwatch & NewClimate Institute (2018) *Aligning investments with the Paris Agreement temperature goal - Challenges and opportunities for Multilateral Development Banks*. Cologne/Bonn/Berlin. Available at: https://newclimate.org/wp-content/uploads/2018/09/MDB_WorkingPaper_2018-09.pdf.
- Gillenwater, M. (2008) 'Redefining RECs-Part 1: Untangling attributes and offsets', *Energy Policy*, 36, pp. 2109–2119. doi: 10.1016/j.enpol.2008.02.036.
- Global Reporting Initiative (2016) *Gri 305: Emissions*. GRI Global. Available at: <https://www.globalreporting.org/standards/media/1012/gri-305-emissions-2016.pdf>.
- Gold Standard (2017) *A New Paradigm for Voluntary Climate Action: 'Reduce Within, Finance Beyond'*. Geneva. Available at: https://www.goldstandard.org/sites/default/files/documents/a_new_paradigm_for_voluntary_climate_action.pdf.
- Google (2016) *Achieving Our 100% Renewable Energy Purchasing Goal and Going Beyond*. Google. Available at: <https://storage.googleapis.com/gweb-sustainability.appspot.com/pdf/achieving-100-renewable-energy-purchasing-goal.pdf>.

- Government of Wales (2019) *Wales' commitment to tackling climate change*. Government of Wales. Available at: <https://gov.wales/sites/default/files/publications/2019-05/our-commitment-to-tackling-climate-change-infographic.pdf>.
- Greater Amman Municipality (2019) *Amman Climate*. Greater Amman Municipality. Available at: https://www.amman.jo/site_doc/climate.pdf.
- Greater London Authority (2018) *London's Zero Carbon Pathways Tool*. Available at: <https://data.london.gov.uk/dataset/london-s-zero-carbon-pathways-tool> (Accessed: 1 September 2020).
- Gren, I. M. and Zeleke, A. A. (2016) 'Policy design for forest carbon sequestration: A review of the literature', *Forest Policy and Economics*. Elsevier B.V., pp. 128–136. doi: 10.1016/j.forpol.2016.06.008.
- Gross, C. D. and Harrison, R. B. (2018) 'Quantifying and Comparing Soil Carbon Stocks: Underestimation with the Core Sampling Method', *Soil Science Society of America Journal*, 82(4), pp. 949–959. doi: 10.2136/sssaj2018.01.0015.
- H&M Group (2019) *Sustainability Performance Report 2019*. H&M Group. Available at: [https://hmgroupp.com/content/dam/hmgroupp/groupsite/documents/masterlanguage/CSR/reports/2019_Sustainability_report/H%26M Group Sustainability Performance Report 2019.pdf](https://hmgroupp.com/content/dam/hmgroupp/groupsite/documents/masterlanguage/CSR/reports/2019_Sustainability_report/H%26M%20Group%20Sustainability%20Performance%20Report%202019.pdf).
- Haites, E., Yamin, F. and Höhne, N. (2013) *Possible Elements of a 2015 Legal Agreement on Climate Change*. Paris: IDDRI. Available at: http://www.iddri.org/Publications/Collections/Idees-pour-le-debat/WP1613_EH_FY_NH_legal_agreement_2015.pdf.
- Hale, T. and Hook, L. (2020) 'China expands coal plant capacity to boost post-virus economy', *Financial Times*, 25 June. Available at: <https://www.ft.com/content/cdcd8a02-81b5-48f1-a4a5-60a93a6ffa1e> (Accessed: 8 September 2020).
- Hamrick, K. and Gallant, M. (2017) *Unlocking Potential: State of the Voluntary Carbon Markets 2017: Buyers Analysis*. Washington D.C: Forest Trends' Ecosystem Marketplace. Available at: http://www.forest-trends.org/dir/em_newsletter.
- Hepburn, C. *et al.* (2020) 'Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change?', *Oxford Review of Economic Policy*, 36(S1), p. 46.
- High-Level Commission on Carbon Prices (2017) *Report of the High-Level Commission on Carbon Prices*. Washington D.C. Available at: https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/59244eed17bffc0ac256cf16/1495551740633/CarbonPricing_Final_May29.pdf.
- Höhne, N. *et al.* (2019) 'Bridging the gap: Enhancing mitigation ambition and action at G20 level and globally', in *Emissions Gap Report 2019*. Nairobi: United Nations Environment Programme. Available at: <https://www.unenvironment.org/resources/emissions-gap-report-2019> (Accessed: 15 September 2020).
- Hsu, A. *et al.* (2019) 'A Research Roadmap for Quantifying Non-State and Subnational Climate Action', *Nature Climate Change*, 9, pp. 1–17.
- Hsu, A. *et al.* (2020) 'Performance determinants show European cities are delivering on climate mitigation', *Nature Climate Change*, pp. 1–8. doi: 10.1038/s41558-020-0879-9.
- Hulshof, D., Jepma, C. and Mulder, M. (2019) 'Performance of markets for European renewable energy certificates', *Energy Policy*, 128, pp. 697–710. doi: 10.1016/j.enpol.2019.01.051.
- IAG (2019) *Leading Sustainable Aviation*. Madrid: IAG. Available at: [https://www.iairgroup.com/-/media/Files/I/IAG/documents/IAG Annual report and accounts 2019.pdf](https://www.iairgroup.com/-/media/Files/I/IAG/documents/IAG%20Annual%20report%20and%20accounts%202019.pdf).
- ICLEI (2018) *Multilevel climate action: The path to 1.5 degrees*. ICLEI. Available at: <https://e-lib.iclei.org/wp-content/uploads/2018/12/cCR-report-web.pdf>.
- IEA (2017) *Energy Technology Perspectives 2017*. Paris. Available at: <https://www.iea.org/etp2017/> (Accessed: 19 October 2020).
- IEA (2018) *Tracking Clean Energy Progress*. Available at: <https://www.iea.org/topics/tracking-clean-energy-progress> (Accessed: 19 October 2020).

- IEA (2019) *Innovation Gaps: Key long-term technology challenges for research, development and demonstration*. Paris. Available at: <https://www.iea.org/reports/innovation-gaps>.
- IEA (2020) *Direct Air Capture Tracking Report*. Paris. Available at: <https://www.iea.org/reports/direct-air-capture> (Accessed: 19 October 2020).
- IIGCC (2020) *Net Zero Investment Framework for Consultation*. IIGCC. Available at: <https://www.iigcc.org/download/net-zero-investment-framework-consultation/?wpdmdl=3602&masterkey=5f270ef146677>.
- Inter IKEA Group (2019) *IKEA Sustainability Report FY19*. IKEA. Available at: https://weu-sc93-prd-858086-cdn-endpoint.azureedge.net/-/media/aboutikea/pdfs/ikea-sustainability-reports/ikea-sustainability-report-fy19_.pdf?rev=17f025ae6d35420facf7a40d50d4e5a6.
- Ingka Group (2019) *IKEA will test furniture leasing in 30 markets during 2020*. Available at: <https://www.ikea.com/us/en/this-is-ikea/newsroom/ikea-will-test-furniture-leasing-in-30-markets-during-2020-pub1ae9e5e1> (Accessed: 8 October 2020).
- IPCC (2018) *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*. Geneva, Switzerland: IPCC. Available at: <https://www.ipcc.ch/sr15/> (Accessed: 15 September 2020).
- IPCC (2019) *Climate Change and Land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems - Summary for Policymakers*. Geneva, Switzerland: IPCC. doi: 10.4337/9781784710644.
- IRENA (2018) *Corporate Sourcing of Renewables: Market and Industry Trends*. Abu Dhabi: IRENA. Available at: https://irena.org/-/media/Files/IRENA/Agency/Publication/2018/May/IRENA_Corporate_sourcing_2018.pdf.
- IRENA (2019) *Renewable Power Generation Costs in 2018, International Renewable Energy Agency*. Abu Dhabi: IRENA. Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_2018_Power_Costs_2019.pdf.
- Japan Ministry of the Environment (2020) *Status of 2050 zero carbon statements by local governments*. Available at: <https://www.env.go.jp/policy/zerocarbon.html> (Accessed: 15 September 2020).
- Jeffery, L. *et al.* (2020) *Options for supporting Carbon Dioxide Removal*. Cologne and Berlin: NewClimate Institute. Available at: https://newclimate.org/wp-content/uploads/2020/07/Options-for-supporting-Carbon-Dioxide-Removal_July_2020.pdf.
- Kachi, A. *et al.* (2020) *Net-zero energy housing virtual Article 6 pilot*. Cologne and Berlin: NewClimate Institute. Available at: <https://newclimate.org/wp-content/uploads/2020/01/Colombia-Art-6-Virtual-Pilot-15-January-2020.pdf>.
- Lebling, K. (2020) *To Unlock the Potential of Direct Air Capture, We Must Invest Now*, *World Resources Institute*. Available at: <https://www.wri.org/blog/2020/03/to-unlock-the-potential-of-direct-air-capture-we-must-invest-now> (Accessed: 16 October 2020).
- Levihn, F. *et al.* (2019) 'Introducing BECCS through HPC to the research agenda: The case of combined heat and power in Stockholm', *Energy Reports*, 5, pp. 1381–1389. doi: 10.1016/j.egyr.2019.09.018.
- Levin, K., Rich, D., Ross, K., Fransen, T., Elliot, C. (2020) *Designing and Communicating Net Zero Targets*. Washington, D.C.: World Resources Institute. Available at: <https://files.wri.org/s3fs-public/designing-communicating-net-zero-targets.pdf>.
- Levin, K., Song, J. and Morgan, J. (2015) *COP21 Glossary of Terms Guiding the Long-term Emissions-Reduction Goal*, *World Resources Institute*. Available at: <https://www.wri.org/blog/2015/12/cop21-glossary-terms-guiding-long-term-emissions-reduction-goal> (Accessed: 15 October 2020).
- Lütkehermöller, K. *et al.* (2020) *Unpacking the finance sector's investment commitments*. NewClimate Institute and Utrecht University. Available at: https://newclimate.org/wp-content/uploads/2020/09/NewClimate_Unpacking_Finance_Sector_Sept20.pdf.

- Malins, C. (2019) *What does it mean to be a renewable electron? Regulatory options to define the renewability of electricity used to produce renewable fuels of non-biological origin*. Cerology. Available at: https://theicct.org/sites/default/files/publications/Cerology_Renewable-electrons_20191209.pdf.
- Material Economics (2019) *Industrial Transformation 2050 - Pathways to Net-Zero Emissions from EU Heavy Industry*. Stockholm. Available at: <https://materialeconomics.com/latest-updates/industrial-transformation-2050> (Accessed on 13 July 2020).
- MAX Burgers (2020) *Climate-positive Burgers*. Available at: <https://www.maxburgers.com/climate-positive/climate-positive/> (Accessed: 14 October 2020).
- Mayor of London (2020) *1.5C Compatible Climate Action Plan*. Available at: <https://www.london.gov.uk/what-we-do/environment/climate-change/climate-action-plan> (Accessed: 1 September 2020).
- McLaren, D. P. *et al.* (2019) 'Beyond "Net-Zero": A Case for Separate Targets for Emissions Reduction and Negative Emissions', *Frontiers in Climate*. Frontiers Media SA, 1, p. 4. doi: 10.3389/fclim.2019.00004.
- Microsoft (2017a) *Microsoft, GE sign agreement on new wind project in Ireland*. Available at: <https://news.microsoft.com/2017/10/09/microsoft-ge-sign-agreement-on-new-wind-project-in-ireland/> (Accessed: 9 October 2020).
- Microsoft (2017b) *Microsoft announces one of the largest wind deals in the Netherlands with Vattenfall*. Available at: <https://news.microsoft.com/2017/11/02/microsoft-announces-one-of-the-largest-wind-deals-in-the-netherlands-with-vattenfall/> (Accessed: 12 October 2020).
- Microsoft (2019a) *EDP Renewables, Microsoft execute wind energy agreement in Ohio*. Available at: <https://news.microsoft.com/2019/03/07/edp-renewables-microsoft-execute-wind-energy-agreement-in-ohio/> (Accessed: 8 October 2020).
- Microsoft (2019b) *Microsoft and Eneco team up to drive sustainable business transformations: powering the cloud with clean energy*. Available at: <https://news.microsoft.com/2019/05/23/microsoft-and-eneco-team-up-to-drive-sustainable-business-transformations-powering-the-cloud-with-clean-energy/> (Accessed: 9 October 2020).
- Microsoft (2020a) *Microsoft will be carbon negative by 2030, Microsoft Official Blog*. Available at: <https://blogs.microsoft.com/blog/2020/01/16/microsoft-will-be-carbon-negative-by-2030/>.
- Microsoft (2020b) *Operating to drive global change*. Available at: <https://www.microsoft.com/en-us/corporate-responsibility/sustainability/operations> (Accessed: 9 October 2020).
- Microsoft (2020c) 'Welcome to your CDP Climate Change Questionnaire 2019'. CDP. Available at: <https://www.microsoft.com/en-us/corporate-responsibility>.
- Mulder, M. and Zomer, S. P. E. (2016) 'Contribution of green labels in electricity retail markets to fostering renewable energy', *Energy Policy*, 99, pp. 100–109.
- Mulligan, J. *et al.* (2020) *6 Ways to Remove Carbon Pollution from the Sky*, *World Resources Institute*. Available at: <https://www.wri.org/blog/2020/06/6-ways-remove-carbon-pollution-sky> (Accessed: 16 October 2020).
- Myllyvirta, L. (2020) *Influential academics reveal how China can achieve its 'carbon neutrality' goal*. Carbon Brief. Available at: <https://www.carbonbrief.org/influential-academics-reveal-how-china-can-achieve-its-carbon-neutrality-goal> (Accessed: 17 October 2020).
- Nakićenović, N. *et al.* (2019) 'Bridging the gap: Transformations towards zero-carbon development pathways', in *Emissions Gap Report 2019*. Nairobi: United Nations Environment Programme. Available at: <https://www.unenvironment.org/resources/emissions-gap-report-2019> (Accessed: 15 September 2020).
- Nascimento, L. *et al.* (2020) *Renewable heating virtual Article 6 pilot. Ground source heat pumps in Khovd, Mongolia*. Cologne and Berlin: NewClimate Institute. Available at: <https://newclimate.org/2020/01/29/renewable-heating-virtual-article-6-pilot-ground-source-heat-pumps-in-khovd-mongolia/>.

- NewClimate Institute *et al.* (2019) *Global climate action from cities, regions and businesses: Impact of individual actors and cooperative initiatives on global and national emissions. 2019 edition*. NewClimate Institute, Data-Driven Lab, PBL Netherlands Environmental Assessment Agency, German Development Institute/Deutsches Institut für Entwicklungspolitik (DIE), Blavatnik School of Government, University of Oxford. Available at: <https://newclimate.org/2019/09/18/global-climate-action-from-cities-regions-and-businesses-2019/>.
- NewClimate Institute (2020) *Our climate responsibility approach*. Cologne and Berlin: NewClimate Institute. Available at: https://newclimate.org/wp-content/uploads/2020/04/NewClimate_ClimateResponsibility-Approach.pdf (Accessed: 17 September 2020).
- Nordregio (2018) *Stockholm Biochar Project*. Available at: https://nordregio.org/sustainable_cities/stockholm-biochar-project/ (Accessed: 16 October 2020).
- Norrbotten County (2020) *Climate and energy strategy for the county of Norrbotten 2020-2045 - Objectives for 2045*. County Administrative Board of Norrbotten. Available at: <https://www.lansstyrelsen.se/download/18.4a4eb7416faedec1251e974/1580983411596/Climate>.
- Novo Nordisk (2019) *Annual Report 2009*. Novo Nordisk. Available at: <https://www.novonordisk.com/content/dam/nncorp/global/en/annual-report/pdfs/2019/Novo-Nordisk-Annual-Report-2019.pdf>.
- Novo Nordisk (2020) 'Novo Nordisk launches new 100% renewable power target for suppliers'. Novo Nordisk. Available at: <https://pnr-files.pro1.gus.wdc.dianum.io/globenewswire/articles/2096235/en/novo-nordisk-launches-new-100-renewable-power.pdf>.
- NS (2020) 'Nederland duurzaam bereikbaar. Voor iedereen'. Utrecht, the Netherlands: Nederlandse Spoorwegen. Available at: https://www.ns.nl/binaries/_ht_1582797451971/content/assets/ns-nl/over-ns/nederland-duurzaam-bereikbaar.pdf.
- NS (no date) 'Veelgestelde vragen 100% windstroom bij NS'. Utrecht, the Netherlands: Nederlandse Spoorwegen. Available at: https://www.ns.nl/binaries/_ht_1550661008879/content/assets/ns-nl/over-ns/duurzaamheid/veelgestelde-vragen-windstroom.pdf.
- ÖBB (2020) *Das nächste Kapitel beim Klimaschutz*. Available at: <https://infrastruktur.oebb.at/de/unternehmen/umwelt-und-klimaschutz/gruener-bahnstrom> (Accessed: 8 October 2020).
- Oslo City Government (2020) *Climate budget 2020*. Oslo. Available at: <https://www.klimaoslo.no/wp-content/uploads/sites/88/2019/12/Climate-Budget-2020-Oslo.pdf> (Accessed: 14 October 2020).
- Owen, B., Lee, D. S. and Lim, L. (2010) 'Flying into the future: Aviation Emissions Scenarios to 2050', *Environmental Science and Technology*, 44(7), pp. 2255–2260. doi: 10.1021/es902530z.
- Patagonia (2019) *2025 Or Bust: Patagonia's Carbon Neutrality Goal*. Available at: <https://eu.patagonia.com/de/en/stories/2025-or-bust/story-74769.html> (Accessed: 18 October 2020).
- Pike, L. (2020) 'China's climate change commitment to become carbon neutral by 2060, explained', *Vox*, 25 September. Available at: <https://www.vox.com/21455941/china-climate-change-carbon-neutrality-net-zero-solar-electric-vehicles> (Accessed on: 19 October 2020).
- Project Drawdown (2018) *Biochar Production*. Available at: <https://drawdown.org/solutions/biochar-production> (Accessed: 16 October 2020).
- Ptacek, S. and Levin, A. (2020) *Race to 100% Clean, Natural Resources Defence Council (NRDC)*. Available at: <https://www.nrdc.org/resources/race-100-clean> (Accessed: 19 October 2020).
- Reid, E. and Dingenen, S. (2019) *Corporate PPAs: An international perspective*. Bird&Bird. Available at: <https://www.twobirds.com/en/news/articles/2018/global/bird-and-bird-and-corporate-ppas-an-international-perspective>.
- Rengers, M. and Houtekamer, C. (2020) 'Gebroken beloftes: hoe de Wieringermeerpolder dichtslibde met windturbines en datacentra', *NRC Handelsblad*, 5 June. Available at: <https://www.nrc.nl/nieuws/2020/06/05/gebroken-beloftes-hoe-de-wieringermeerpolder-dichtslibde-met-windturbines-en-datacentra-a4001882> (Accessed on: 12 October 2020).

- Riley, S. J. (2018) *How climate change is making B.C.'s wildfire season hotter, longer, drier*, *The Narwhal*. Available at: <https://thenarwhal.ca/how-climate-change-is-making-b-c-s-wildfire-season-hotter-longer-drier/> (Accessed: 16 October 2020).
- Rogelj, J. *et al.* (2018) 'Mitigation Pathways Compatible With 1.5°C in the Context of Sustainable Development', in *Global warming of 1.5°C*. An IPCC Special Report [...]. IPCC, p. 82pp. Available at: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter2_Low_Res.pdf.
- RWE (2011) *Bahn frei für Strom aus Wasserkraft von RWE*. Available at: <https://www.group.rwe/investor-relations/news-und-ad-hoc-mitteilungen/news/archiv-ir-mitteilungen/2011/Bahn-frei-fur-Strom-aus-Wasserkraft-von-RWE> (Accessed: 8 October 2020).
- S&P Global Ratings (2020) *Stockholm Exergi Holding AB*. S&P Global Ratings. Available at: https://www.stockholmexergi.se/content/uploads/2020/07/RatingsDirect_StockholmExergiHoldingABpubl_45275627_Jul-03-2020.pdf.
- SBTi (2019a) *About the Science Based Targets Initiative*. Available at: <https://sciencebasedtargets.org/about-the-science-based-targets-initiative/> (Accessed: 15 August 2019).
- SBTi (2019b) *Science-based Target Setting Manual – Version 4.0*. Science Based Targets. Available at: <https://sciencebasedtargets.org/wp-content/uploads/2018/10/C2A-guidelines.pdf>.
- SBTi (2020a) *Business Ambition for 1.5°C*. Available at: <https://sciencebasedtargets.org/business-ambition-for-1-5c/> (Accessed: 15 September 2020).
- SBTi (2020b) *Current companies taking action*. Science Based Targets. Available at: <https://sciencebasedtargets.org/companies-taking-action/#> (Accessed: 15 September 2020).
- SBTi (2020c) *What is a Science Based Target?* Available at: <https://sciencebasedtargets.org/what-is-a-science-based-target/> (Accessed: 19 October 2020).
- Schneider, L. *et al.* (2018) *Crediting Forest-related Mitigation under International Carbon Market Mechanisms: A Synthesis of Environmental Integrity Risks and Options to Address Them*. Climate Focus and NewClimate Institute. Available at: <https://www.carbon-mechanisms.de/en/2018/new-report-on-crediting-of-redd-activities/>.
- Schwietering, C. (2020) '100 Prozent grün nur auf dem Papier', *Zeit Online*, 23 February. Available at: <https://www.zeit.de/mobilitaet/2020-02/deutsche-bahn-oekostrom-kohlekraftwerk-datteln-4-mobilitaet-klimaschutz> (Accessed: 19 October 2020).
- Scottish Government (2020) *Climate Change: Reducing Greenhouse Gas Emissions*. Scottish Government. Available at: <https://www.gov.scot/policies/climate-change/reducing-emissions/> (Accessed: 1 September 2020).
- SDSN and IDDRI (2015) *Pathways to Deep Decarbonization 2015 Synthesis Report*. Available at: https://www.iddri.org/sites/default/files/import/publications/ddpp_2015synthesisreport.pdf (Accessed: 12 October 2020).
- Sherlock, L. *et al.* (2018) *Constructing a New, Low-Carbon Future*. Available at: <https://www.c40.org/researches/constructing-a-new-low-carbon-future-china> (Accessed: 19 October 2020).
- Siemens Gamesa (2020) *One step closer to our net-zero emissions goal*. Available at: <https://www.siemensgamesa.com/en-int/explore/journal/2020/04/siemens-gamesa-carbon-neutrality> (Accessed: 15 October 2020).
- Skidmore, C. (2019) *UK becomes first major economy to pass net zero emissions law*, *UK Government*. Available at: <https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law> (Accessed: 15 October 2020).
- SME Climate Hub (2020) *SME Climate Hub: Future-proof your business today*. Available at: <https://smeclimatehub.org/> (Accessed: 17 October 2020).
- Sony Corporation (2020) *Sustainability Report 2020*. Sony. Available at: https://www.sony.net/SonyInfo/csr/library/reports/SustainabilityReport2020_E.pdf.

- Sopra Steria (2020) *Sopra Steria commits itself to achieving “net zero” emissions in 2028 and accelerates its climate actions for a sustainable digital transformation*. Available at: <https://www.soprasteria.com/newsroom/press-releases/details/sopra-steria-commits-itself-to-achieving-net-zero-emissions-in-2028-and-accelerates-its-climate-actions-for-a-sustainable-digital-transformation> (Accessed: 8 October 2020).
- South Australia (2017) *Local Government (Building Upgrade Agreements) Regulations 2017*. South Australia. Available at: [https://www.legislation.sa.gov.au/LZ/C/R/LOCAL GOVERNMENT \(BUILDING UPGRADE AGREEMENTS\) REGULATIONS 2017/CURRENT/2017.200.UN.PDF](https://www.legislation.sa.gov.au/LZ/C/R/LOCAL GOVERNMENT (BUILDING UPGRADE AGREEMENTS) REGULATIONS 2017/CURRENT/2017.200.UN.PDF) (Accessed: 13 October 2020).
- Stockholm Vatten Och Avfall (2019) *Biochar*. Available at: <http://www.stockholmvattnochavfall.se/en/current-projects/development/biochar/> (Accessed: 16 October 2020).
- Tekfen Holding (2017) *CDP 2017 Climate Change Information Request*. CDP. Available at: http://www.tekfen.com.tr/docs/surdurulebilirlik/Tekfen-Holding-CDP-Climate-Change-Report_2017.pdf.
- Tickell, S. and Robins, N. (2020) *Financing small and medium enterprises to support a just transition to net-zero emissions in the UK*. London: Grantham Research Institute on climate change and the environment. Available at: <https://www.lse.ac.uk/granthaminstitute/publication/financing-small-and-medium-enterprises-to-support-a-just-transition-to-net-zero-emissions-in-the-uk/> (Accessed: 17 September 2020).
- Tokyu Construction (2020) 'Tokyu Construction obtained SBT certification for greenhouse gas reduction target'. Tokyu Construction. Available at: <https://www.tokyu-cnst.co.jp/topics/assets/20200507newsletter.pdf>.
- UN Global Compact (2019) *28 companies with combined market cap of \$1.3 trillion step up to new level of climate ambition, UN Global Compact, SBTi & We Mean Business Coalition*. Available at: <https://www.unglobalcompact.org/news/4460-07-23-2019> (Accessed: 15 September 2020).
- UN Global Compact (2020) *Business Leaders Taking Action: Business Ambition for 1.5 C, UN Global Compact*. Available at: <https://www.unglobalcompact.org/take-action/events/climate-action-summit-2019/business-ambition/business-leaders-taking-action> (Accessed: 24 August 2020).
- UNEP FI; PRI (2019) *THE NET-ZERO ASSET OWNER ALLIANCE*. FAQ. Available at: https://www.unepfi.org/wordpress/wp-content/uploads/2019/09/AOA_FAQ.pdf (Accessed: 19 October 2020).
- UNEP Finance Initiative (2020) *UN-convened Net-Zero Asset Owner Alliance*. Available at: <https://www.unepfi.org/net-zero-alliance/> (Accessed: 15 September 2020).
- UNFCCC (2015) *Climate Neutral Now*. Available at: <https://unfccc.int/climate-action/climate-neutral-now> (Accessed: 15 October 2020).
- UNFCCC (2020a) *Defining the Starting Line*. Race to Zero. Available at: <https://unfccc.int/sites/default/files/resource/Minimum-criteria-for-participation-in-RTZ.pdf>.
- UNFCCC (2020b) *Race to Zero Campaign*. Available at: <https://unfccc.int/climate-action/race-to-zero-campaign> (Accessed: 28 August 2020).
- University of Oxford (2020) *Mapping of Current Practices Around Net Zero Targets*. Oxford, United Kingdom. Available at: https://4bafc222-18ee-4db3-b866-67628513159f.filesusr.com/ugd/6d11e7_347e267a4a794cd586b1420404e11a57.pdf.
- Vancouver City Council (2019) *Climate Emergency Response*. Vancouver. Available at: <https://vancouver.ca/green-vancouver/climate-emergency-response.aspx> (Accessed: 16 October 2020).
- Vaude (2019) *Vaude-CSR Report: Business travel*. Available at: <https://csr-report.vaude.com/gri-en/environmental/business-travel.php> (Accessed: 18 October 2020).
- Velux (2020) *'It's our nature' is the Velux Sustainability Strategy from 2020*. Available at: <https://www.velux.com/what-we-do/sustainability/sustainability-strategy/historical-carbon-footprint> (Accessed: 8 October 2020).
- Vodafone Group (2020) *ESG Addendum 2020*. Vodafone Group Plc. Available at: <https://www.vodafone.com/content/dam/vodcom/sustainability/pdfs/esg-addendum2020.pdf>.

- Walmart (2020) *Walmart Sets Goal to Become a Regenerative Company*. Available at: <https://corporate.walmart.com/newsroom/2020/09/21/walmart-sets-goal-to-become-a-regenerative-company> (Accessed: 15 October 2020).
- Wappelhorst, S. (2020) *The end of the road? An overview of combustion-engine car phase-out announcements across Europe*. The ICCCT. Available at: <https://theicct.org/sites/default/files/publications/> (Accessed: 14 October 2020).
- Warnecke, C. et al. (2018) *Opportunities and safeguards for ambition raising through Article 6: The perspective of countries transferring mitigation outcomes*. Cologne and Berlin: NewClimate Institute. Available at: https://newclimate.org/wp-content/uploads/2018/05/180508_AmbitionRaising-Article6Paper.pdf.
- Warnecke, C. et al. (2019) 'Robust eligibility criteria essential for new global scheme to offset aviation emissions', *Nature Climate Change*. Nature Publishing Group, 9(3), pp. 218–221. doi: 10.1038/s41558-019-0415-y.
- We Mean Business Coalition (2020) *Zero-Carbon Transition – Latest signals of change*. Available at: <https://www.wemeanbusinesscoalition.org/blog/zero-carbon-transition-latest-signals-of-change-04-09-20/> (Accessed: 15 September 2020).
- World Bank (2019) *GDP (current US\$)*. World Bank. Available at: <https://data.worldbank.org/indicator/ny.gdp.mktp.cd> (Accessed: 1 August 2019).
- World Bank (2020a) *CO₂ emissions (metric tons per capita)*. Available at: <https://data.worldbank.org/indicator/> (Accessed: 17 October 2020).
- World Bank (2020b) *Population, total*. Available at: https://data.worldbank.org/indicator/SP.POPTOTL?most_ (Accessed: 17 October 2020).
- World Bank Group (2020) *State and Trends of Carbon Pricing 2020*. Washington D.C: World Bank Group. doi: 10.1596/978-1-4648-0268-3.
- World Resources Institute (2020) *Historical GHG Emissions (CAIT data, 2016)*. *ClimateWatch*., World Resources Institute. Available at: https://www.climatewatchdata.org/ghg-emissions?end_year=2018®ions=TOP%2CEUU%2CNAR%2COECD%2CWORLD%2CGBR%2CCHN%2CDEU%2CIDN%2CJPN%2CZAF%2CUSA&source=GCP&start_year=1960 (Accessed: 15 September 2020).
- WRI (2015) *GHG Protocol Scope 2 Summary*. World Resources Insitute. Available at: [https://ghgprotocol.org/sites/default/files/standards/Scope 2 Guidance_Final_Sept26.pdf](https://ghgprotocol.org/sites/default/files/standards/Scope%20Guidance_Final_Sept26.pdf).
- WWF (2018) *One Planet City Challenge*. Available at: https://wwf.panda.org/our_work/our_focus/projects/one_planet_cities/one_planet_city_challenge/ (Accessed: 29 September 2020).
- Wyns, T. et al. (2019) *Industrial Transformation 2050 - Towards an Industrial Strategy for a Climate Neutral Europe*. IES. Available at: <https://www.ies.be/node/5074>.
- Yang, X., Wang, X. C. and Zhou, Z. Y. (2018) 'Development path of Chinese low-carbon cities based on index evaluation', *Advances in Climate Change Research*. National Climate Center, 9(2), pp. 144–153. doi: 10.1016/j.accre.2018.05.004.
- Zhou, X. (2020) *China's Inevitable Low-Carbon Future*, Nepal24Hours. Available at: <https://nepal24hours.com/chinas-inevitable-low-carbon-future/> (Accessed: 17 October 2020).

Annex I: Definitions and data sources

Defining net-zero targets

This analysis considers an actor to be pledging a net-zero target if it meets one of the following criteria:

- It sets a GHG emissions reduction target of 80 percent or more, either on an economy or operations-wide level, or for a specific sector (i.e., energy, buildings, or transport).
- The actor explicitly mentions a “net-zero,” “carbon neutral,” or “zero emissions” goal in its pledge or disclosure.
- The actor has set an approved Science Based short-term or medium-term target that extrapolates to an 80 percent emissions reduction by 2050 (assuming a linear extrapolation of the annualised percentage reduction goal to 2050).

This analysis casts a wide net, particularly for companies, including both sector-specific and economy-wide targets, based on the definitions above. Since our goal was to understand the full range of net-zero commitments, we did not apply any other filtering criteria (e.g., such as only including commitments that included particular emissions scopes or GHGs, or only applied to economy or community-wide emissions).

Data sources

Actors that choose to report their climate action often have multiple platforms where they can report their commitments, ranging from global initiatives (such as the Global Covenant of Mayors) to more localised ones (examples include We Are Still In and the US Climate Alliance). Table A1 summarises the data sources for both net-zero commitments, and for the contextual information (such as population, revenue, and emissions) noted in the report.

Table A1
Data sources

Description	Data source
Business ambition for 1.5°C	SBTi (2020a) <i>Business ambition for 1.5°C</i> . Data shared directly by Business ambition for 1.5°C.
<p>CDP Cities Data</p> <p>This includes data reported as part of cities participating in other networks, such as the C40 Cities Climate Leadership Network and the ICLEI carbonn Climate Registry.</p> <p>Data from the 2019 Full Cities Dataset was used as the primary data source; if an actor was not included in this source, then data from the 2018-2019 Full Cities Dataset was used.</p>	<p>CDP. (2020). <i>2019 Full Cities Dataset</i>. https://data.cdp.net/Governance/2019-Full-Cities-Dataset/iapx-bpuk (Accessed on: 1 July 2020).</p> <p>CDP. (2020). <i>2018 - 2019 Full Cities Dataset</i>. https://data.cdp.net/Governance/2018-2019-Full-Cities-Dataset/vzxs-ejjs (Accessed on: 1 July 2020).</p> <p><i>In their disclosures, actors report on the results of the earlier year's GHG emissions and activities (e.g., a 2019 disclosure form reports on an actor's 2018 emissions and activities).</i></p>

Description	Data source
<p>CDP States and Regions Data</p> <p>This includes data reported as part of cities participating in other networks, such as The Climate Group and the ICLEI carbonn Climate Registry.</p>	<p>CDP. (2020). <i>2018-2019 Full States and Regions Dataset</i>. https://data.cdp.net/States-and-Regions/2018-2019-Full-States-and-Regions-Dataset/hmhn-9g99 (Accessed on: 15 July 2020).</p> <p><i>In their disclosures, actors report on the results of the earlier year's GHG emissions and activities (e.g., a 2019 disclosure form reports on an actor's 2018 emissions and activities).</i></p>
<p>CDP Companies Data</p>	<p>CDP. (2020). <i>2019 Disclosure Survey</i>. Provided directly by CDP.</p> <p>In their disclosures, actors report on the results of the earlier year's GHG emissions and activities (e.g., a 2019 disclosure form reports on an actor's 2018 emissions and activities).</p>
<p>ClimActor R Package</p> <p>A harmonised dataset of 10,000+ city and region transnational climate network participation, along with contextual information including population, geographic location, and administrative jurisdiction.</p>	<p>Hsu, A., et al. (Forthcoming). <i>ClimActor, a harmonised dataset of 10,000+ city and region transnational climate network participation</i>. Nature Scientific Data.</p>
<p>Energy and Climate Intelligence Unit (ECIU)</p>	<p>Energy and Climate Intelligence Unit (ECIU). (2020). <i>Net Zero Tracker</i>. https://eciu.net/netzerotracker/map (accessed September 2020).</p> <p>We included company and subnational net-zero commitments from the ECIU's Net Zero Tracker in our analysis.</p>
<p>EU Covenant of Mayors for Climate & Energy</p>	<p>EU Covenant of Mayors for Climate & Energy. (2020). Individual targets and emissions data for reporting members. www.globalcovenantofmayors.org (Accessed on: July 2020).</p>
<p>Forbes Global 2000</p> <p>Forbes Global 2000 was used as a source of company revenue data.</p>	<p>Murphy, A., Tucker, H., Coyne, M., and Touryalai, H. (13 May 2020). <i>Global 2000: The World's Largest Public Companies</i>. Forbes. https://www.forbes.com/global2000/#6f882c67335d</p>
<p>Fortune Global 500</p> <p>Fortune Global 500 was used as a source of company revenue data.</p>	<p>Fortune. (2020). <i>Global 500</i>. https://fortune.com/global500/</p>
<p>Global Climate Action Portal</p> <p>The Global Climate Action Portal synthesis data from many climate action reporting platforms. We used this data source primarily to identify the city, region, and company participants in initiatives that are part of the Race to Zero campaign.</p>	<p>United Nations Framework Convention on Climate Change. (2020). <i>Global Climate Action Portal</i>. https://climateaction.unfccc.int/ (Accessed on: June 2020).</p>
<p>Global Covenant of Mayors for Climate & Energy</p>	<p>Global Covenant of Mayors for Climate & Energy. (Data provided directly by Global Covenant of Mayors in July 2020). Individual targets and emissions data for reporting members.</p>

Description	Data source
<p>Dun & Bradstreet Hoovers</p> <p>Hoovers was used as a source of company revenue data.</p>	<p>Dun & Bradstreet Hoovers. (2020). <i>Sales Revenue</i>. https://www.dnb.com/products/marketing-sales/dnb-hoovers.html (Accessed on: August 2020).</p>
<p>Government of Japan, Ministry of the Environment</p>	<p>Government of Japan, Ministry of the Environment. (2020). <i>2050 Zero Carbon Cities in Japan</i>. http://www.env.go.jp/en/earth/cc/2050_zero_carbon_cities_in_japan.htm (Accessed on: August 2020).</p> <p>Government of Japan, Ministry of the Environment. (2020). <i>Status of 2050 carbon dioxide emission virtually zero statement by local governments</i>. https://www.env.go.jp/policy/zerocarbon.html (Accessed on: August 2020).</p>
<p>Swedish municipalities</p>	<p>Widerberg, O. & C. Fast (2020) <i>Zeroing in on cities: Exploring definitions, scope and residual emissions in net-zero emission targets by Swedish municipalities</i>. Manuscript in preparation. (https://act-sweden.se/)</p>
<p>Thomson Reuters</p> <p>Thomson Reuters was used as a source of company revenue and emissions data, if they were not available from the company's disclosure form or through the other sources for revenue data.</p>	<p>Thomson Reuters. <i>Company dataset</i>. Shared directly by Thomson Reuters in October 2016.</p>
<p>US Climate Alliance</p>	<p>U.S. Climate Alliance. <i>State Climate Energy Policies</i>. https://www.usclimatealliance.org/state-climate-energy-policies (Accessed on: June 2020).</p> <p>Information from this source was supplemented through desk research of participants' climate action targets or plans.</p>
<p>US Climate Mayors</p>	<p>US Climate Mayors. http://climatemayors.org/actions/climate-action-compendium/ (Accessed on: June 2020).</p> <p>Information from this source was supplemented through desk research of participants' climate action targets or plans.</p>

Annex II: Criteria for assessment of net-zero target nuances

Net-zero targets should be defined not only by the target date for achieving of net-zero and the depth of decarbonisation envisaged by interim targets, but also by the small print that explains how those targets are intended to be achieved. These often-overlooked aspects can crucially determine the extent to which implementation strategies might elevate the ambition of a target, or rather completely negate it.

The nuances of the approaches identified in the following sections are assessed with regards to the following criteria. Ambitious actors should carefully consider these criteria to ensure the strength of their plans. Observers can use these criteria to identify praiseworthy ambition, and to call out less meaningful claims.

Solution seeking for long-term deep decarbonisation

Achieving the Paris Agreement objectives requires a shift to a steep decarbonisation trajectory to net-zero emissions and eventually net-negative emissions globally (Rogelj *et al.*, 2018). This goal does not entail only a minor deviation from the business as usual, but rather a thorough transformation of the infrastructure that our economies are built upon, including the decarbonisation of harder-to-abate sectors.

The most ambitious actors consider not only the low-hanging fruit of mitigation potential, but rather they seek to also support the identification of solutions for the more difficult challenges that need to be overcome. Where solutions do not yet exist, this requires a transparent recognition of the challenges faced in order to foster a constructive solution-oriented dialogue.

Ambitious actors should consider the following criteria to support solution seeking for long-term deep decarbonisation:

- Can the approach facilitate the identification and implementation of transformational solutions for a shift towards long-term deep decarbonisation?
- Can the approach contribute to a transparent and facilitative dialogue to seek solutions for hard-to-abate emission sources?
- Can the approach avoid locking-in to infrastructure, technologies and practices that are not aligned with long-term deep decarbonisation?

Additionality, integrity and equivalence

The direct reduction of an actor's emissions is the clearest and most unambiguous way it to move towards net-zero emissions. However, most subnational and corporate actors also claim emission reductions for mitigation activities supported elsewhere. This could be in the form of the purchase of "green" electricity (Section 3.2.2), supporting other actors in the supply chain (Section 3.2.3), or the purchase of offset credits (Section 3.3).

In such cases, it is critical to consider whether there is enough certainty in the perceived impacts and additionality of those activities to consider them as equivalent to the reduction of an actor's emissions, and account them towards these targets.

In the post-2020 era, the concept of additionality requires re-defining. The additionality of an emission reduction action has historically often been assessed at the activity level only, considering the degree to which the specific activity is additional to what the actor might have done with the emission source otherwise. Under the Paris Agreement, countries have committed to set and regularly increase the ambition of climate change mitigation targets. Where subnational and corporate actors face increasing pressure and incentives to pursue and scale-up their own efforts, the **potential overlap with the ambition of other actors** must also be considered to obtain a more thorough understanding of the additionality of impact at the global level.

Ambitious actors should consider the following criteria to implement approaches that ensure additionality, integrity and equivalence:

- Does the approach objectively lead to additional action at the activity level, considering what might happen in the absence of the actor's planned approach?
- Does the approach objectively lead to additional impact at the global level, considering the potential overlap of the approach with the ambition of other actors?
- How certain is the causal relationship between the supported action and the perceived impact?
- How reliable and accurate are methodologies and processes to calculate and correctly account for impacts?
- Can those calculated impacts be considered directly equivalent to the reduction of an actor's emissions?

While the objective determination of additionality at the activity level may be difficult, determining the additionality of impact at the global level can be far more complex, and may not even be possible. Similarly, for some activities it may not be possible to objectively demonstrate certainty in the perceived outcome's integrity. These considerations need not necessarily rule out certain approaches that an actor believes to have potentially attractive impacts; rather it is important that the actor takes into consideration any additionality limitations when communicating and making claims based on those approaches.

**NewClimate – Institute for Climate Policy
and Global Sustainability gGmbH**

Data-Driven EnviroLab

Cologne Office
Waidmarkt 11a
50676 Cologne
Germany

Berlin Office
Schönhauser Allee 10-11
10119 Berlin
Germany

Yale-NUS College
16 College Avenue West
#01-220 Singapore 138527
datadrivenlab.org

T +49 (0) 221 999833-00
F +49 (0) 221 999833-19

E info@newclimate.org
www.newclimate.org

