3 Net-zero emissions targets

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3.1 Introduction

Achieving global net zero in line with the Paris Agreement requires rapid and deep reductions in global greenhouse gas (GHG) emissions, and the scaling-up of removals. Emissions reductions are essential to keep the challenge of halting global warming as manageable as possible. Removals are used to balance out emissions from activities for which we have not reduced emissions to zero – hence the concept of 'net zero' – as well as to deliver net-negative global emissions that can gradually reverse the warming already caused.

One promising development is the announcement of long-term net-zero emissions pledges by an increasing number of countries that currently account for more than half of global emissions. However, these pledges have large ambiguities and few of the latest nationally determined contributions (NDCs) put countries on a clear path towards their net-zero pledges. There is an urgent need to back net-zero pledges up with near-term targets and actions that give confidence that net-zero emissions can ultimately be achieved.

This chapter looks at how net-zero emissions targets have emerged from the scientific understanding of the climate system and the goals of the Paris Agreement (section 3.2). It sets out the considerations when translating net zero from a global scientific concept to national policy targets (section 3.3), and assesses current targets in terms of their ambition, scope, transparency and consistency with near-term plans and actions (sections 3.4 and 3.5).

3.2 The science of net-zero emissions targets

Net-zero emissions is a state where the sum of all anthropogenic emissions and removals is zero. Net-zero emissions targets are being defined in a variety of ways – the most important aspect from a global geophysical perspective being whether they cover all GHGs or carbon dioxide (CO_2) only (Rogelj *et al.* 2015). Net-zero GHG emissions are achieved when total aggregate GHG emissions over a given period are equal to an equivalent amount of aggregate GHG removal (Intergovernmental Panel on Climate Change [IPCC] 2021b). Net-zero CO_2 emissions are defined similarly but for CO_2 only.

Other terms such as 'carbon neutrality' and 'climate neutrality' are often used interchangeably for net-zero CO_2 and net-zero GHG emissions, respectively. However, as their meaning can differ depending on context and language, further specification is needed to avoid ambiguity (see glossary for various definitions of net-zero terms).

3.2.1. Net-zero CO_2 emissions stabilize global warming, whereas net-zero GHG emissions result in a peak and decline in global warming

As a concept, net-zero emissions were introduced well over a decade ago as a way of thinking about minimizing society's impact on the climate and the environment (United Nations Environment Programme [UNEP] 2008; Worth 2005). The concept gained traction after several scientific studies in the 2000s established a near-linear relationship between global warming and the total amount of net anthropogenic CO_2 emissions ever emitted.

Reaching net-zero CO_2 emissions results in CO_2 concentrations gradually declining over time towards a long-term equilibrium as part of the excess CO_2 in the atmosphere is redistributed by the uptake in the biosphere on land and in the ocean. As a result, CO_2-induced temperature stabilizes (Allen *et al.* 2009; Collins *et al.* 2013; Joos *et al.* 2013; Knutti and Rogelj 2015; Lee *et al.* 2021; MacDougall *et al.* 2020; Matthews *et al.* 2009; Matthews and Caldeira 2008; Meinshausen *et al.* 2009; Solomon *et al.* 2010; Zickfeld *et al.* 2009).

These insights were consolidated in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) where they were used to establish the geophysical requirements for halting global warming and to estimate carbon budgets consistent with preventing warming from exceeding specified levels (Collins *et al.* 2013; IPCC 2014, 2013; Stocker *et al.* 2013) (see box 3.1). The most recent IPCC assessment report (the Sixth Assessment Report, AR6) confirms that warming is expected to stabilize once global CO_2 emissions reach net-zero levels (IPCC 2021a; Lee *et al.* 2021).

For non-CO_2 emissions, the global temperature impact of achieving net-zero emissions depends on how long the GHG persists in the atmosphere (Pierrehumbert 2014; Solomon *et al.* 2010). Methane, currently the second-largest contributor to warming, has a much shorter lifetime than CO_2. Therefore, if methane emissions reduce to zero, concentrations fall faster, and their contribution to global temperature will decline. Achieving net-zero GHG emissions expressed with the default GWP-100 metric through a combination of low residual non-CO_2 emissions and CO_2 removal results in a peak then a decline in global warming (figure 3.1) (Forster *et al.* 2021; Fuglestvedt *et al.* 2018; IPCC 2021b; Rogelj *et al.* 2021). The magnitude of this decline depends on the minimum level to which non-CO_2 GHGs can be reduced, but could potentially be around 0.02–0.05°C/decade (Fuglestvedt *et al.* 2018).

At present, none of the available mitigation scenarios fully eliminate all CO_2 or other GHG emissions (Clarke *et al.* 2014; Gernaat *et al.* 2015; Rogelj *et al.* 2018; Smith *et al.* 2014). To reach net-zero emissions, residual emissions are thus balanced by removals from the atmosphere: hence the inclusion of 'net' in net-zero targets. The most scalable forms of GHG removal are CO_2 removal measures (Fuss *et al.* 2018; Nemet *et al.* 2018). This means that net-zero CO_2 emissions are achieved before net-zero GHG emissions. Reaching net-zero GHG emissions targets therefore involves at least two, and in most cases three, interlinked strategies: deep reductions in CO_2 emissions, the upscaling of CO_2 removal, and deep reductions in other GHG emissions (figure 3.1).

Box 3.1. Carbon budgets

Global warming is close to linearly proportional to the total net amount of CO_2 that has ever been emitted into the atmosphere as a result of human activities. Therefore, limiting global warming to a specified level requires that the total amount of CO_2 emissions ever emitted be kept within a finite carbon budget. Recently, AR6 published new estimates of the remaining carbon budget for limiting warming to 1.5°C or 2°C relative to pre-industrial levels (Canadell *et al.* 2021; IPCC 2021b). According to these, human activities resulted in about 2,390 $GtCO_2$ between 1850 and 2019, contributing around three quarters of the 1.07°C of human-induced warming from 1850-1900 to 2010-2019.

To limit warming to 1.5°C with a 66 per cent or 50 per cent chance, the remaining carbon budget is estimated at 400 and 500 $GtCO_2$, respectively. For 2°C, these estimates are 1,150 and 1,350 $GtCO_2$, respectively. Current annual global CO_2 emissions are above 40 $GtCO_2$/year, meaning that urgent and deep emissions reductions over the next decade are required to stay within the remaining budgets. AR6 clarifies that methodological improvements cause the estimates in the latest report to be markedly larger than in AR5 (Stocker *et al.* 2013), but very similar to those reported in the IPCC Special Report on global warming of 1.5°C (Rogelj *et al.* 2018) (see box 5.2 in Canadell *et al.* (2021) for more information).

Carbon budgets are not the only determinant of global warming. The warming that accompanies non-CO_2 emissions also plays a role. AR6 carbon budgets assume that non-CO_2 emissions are reduced following the median reductions from deep mitigation scenarios (Canadell *et al.* 2021; Rogelj *et al.* 2018). For methane, this implies at least a 30 per cent reduction in 2030 compared with 2010, and about a 50 per cent reduction in 2050. Remaining carbon budgets may vary by an estimated 220 $GtCO_2$ or more, depending on how deeply future non-carbon-dioxide emissions are reduced (Canadell *et al.* 2021). Chapter 6 assesses the role of methane in meeting these emissions reductions and bridging the emissions gap.

Total GHG emissions are aggregated in units of CO_2 equivalence. Although several different metrics for defining this equivalence exist (Myhre *et al.* 2013), under the Paris Agreement GHG emissions must be aggregated using the global warming potential over a 100-year time-horizon (GWP-100) metric[1] (United Nations Framework Convention on Climate Change [UNFCCC] 2018).

1 Parties to the Paris Agreement are mandated to report aggregated greenhouse gas emissions by using the GWP-100 metric, while additional information that uses other aggregations can also be provided. Note that in addition, emissions of the various GHGs also have to be reported individually.

Figure 3.1. Illustration of how net-zero carbon dioxide or net-zero greenhouse gas emissions are reached at a global level (top) and the typical global warming implications of reaching these respective targets (bottom)

Figure 3.1a Global greenhouse gas (GHG) emissions and times of achieving net zero for an illustrative pathway that keeps warming well below 2°C

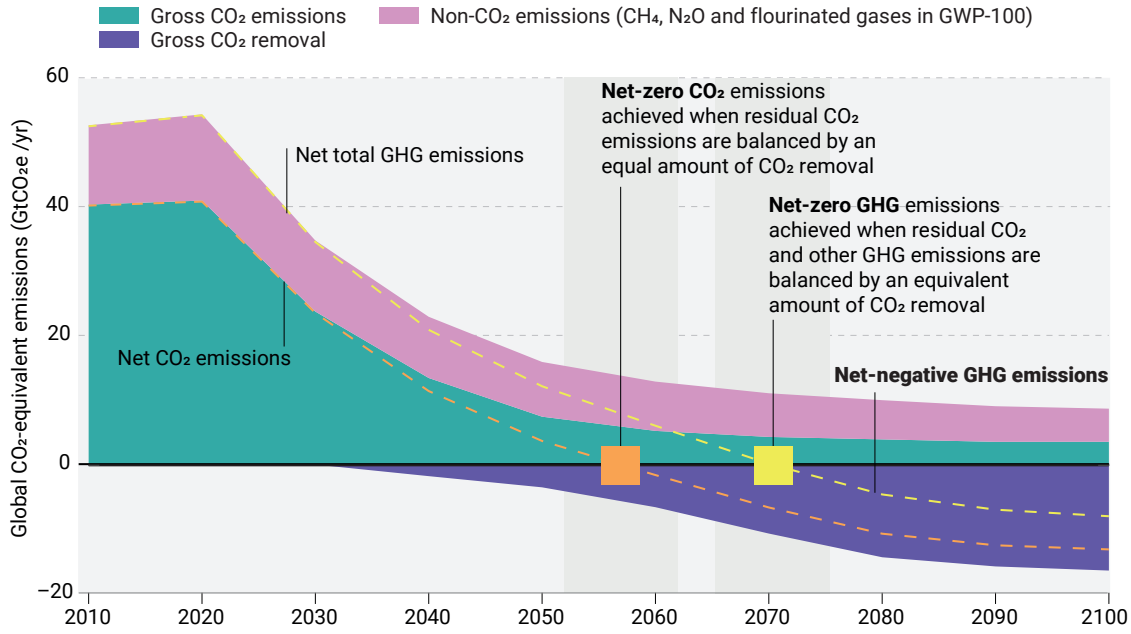
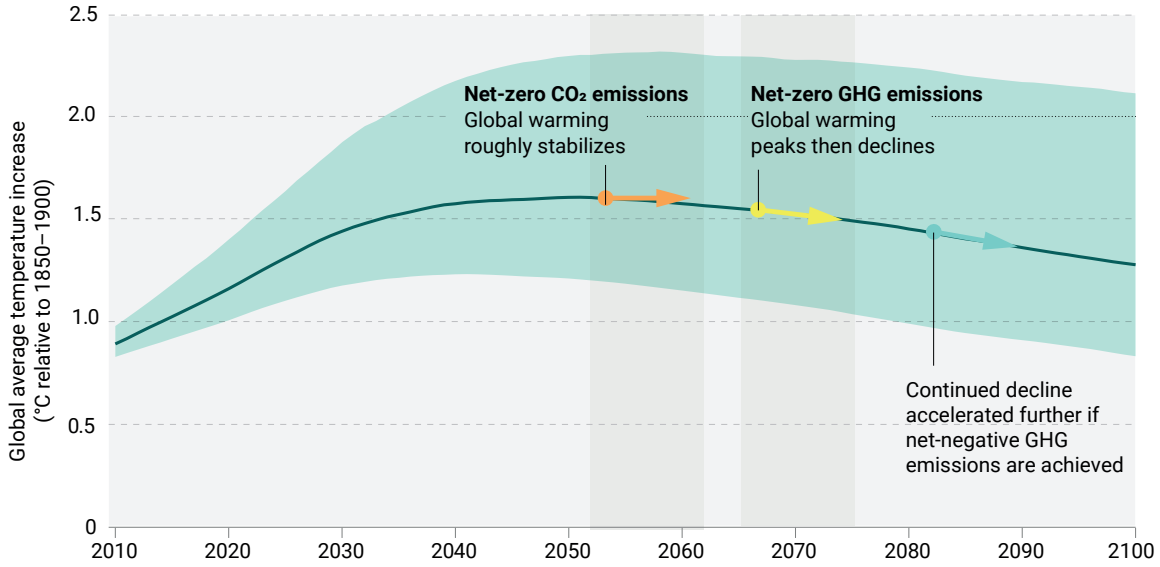


Figure 3.1b Global warming implications



Note: GWP-100 stands for global warming potential over a 100-year time-horizon, and is the metric that is mandated to be used under the United Nations Framework Convention on Climate Change (UNFCCC) to report aggregated anthropogenic emissions and removals of GHGs. Reaching net-zero CO_2 emissions results in global warming stabilizing, provided that non-CO_2 forcing is also stabilized (Allen *et al.* 2018; IPCC 2018), while reaching net-zero GHG emissions defined with GWP-100 results in global warming peaking and subsequently gradually declining (Fuglestvedt *et al.* 2018). Figure adapted from Rogelj *et al.* (2021). Pathway taken from Huppmann et al. (2018a, 2018b) and climate outcome assessed using the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) (Meinshausen *et al.* 2011). Note that this figure shows one illustrative scenario in which the net-zero timings of CO_2 and total GHG emissions are not necessarily equal to the median estimates of the IPCC Special Report on global warming of 1.5°C (IPCC 2018).

3.2.2. The Paris Agreement and the timing of net-zero emissions

In the lead-up to the Paris Agreement, these geophysical concepts of carbon budgets and net-zero emissions were proposed as key elements for a legal architecture (Haites, Yamin and Höhne 2013), and studies proposed net-zero dates for global CO_2 and total GHG emissions in line with specific temperature limits (Rogelj *et al.* 2015). The Paris Agreement marked the incorporation of the net-zero concept into international policy, aiming to "achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty" (UNFCCC 2015). Subsequently, the IPCC Special Report on global warming of 1.5°C highlighted that to limit warming to 1.5°C above pre-industrial levels with no or limited overshoot, global CO_2 emissions should reach net zero around mid-century (IPCC 2018). The latter spurred a wave of net-zero target declarations.

Table 3.1 provides global net-zero timings from model pathways aligned with 1.5°C and 2°C limits. For 1.5°C, CO_2 emissions must reach net zero around 2050, with GHG emissions reaching net zero 15–20 years later. A delay of 15–20 years in either net-zero CO_2 or net-zero GHGs implies limiting warming to 2°C rather than 1.5°C.

Table 3.1. Global timing of net-zero carbon dioxide and net-zero greenhouse gas emissions. Median and interquartile range

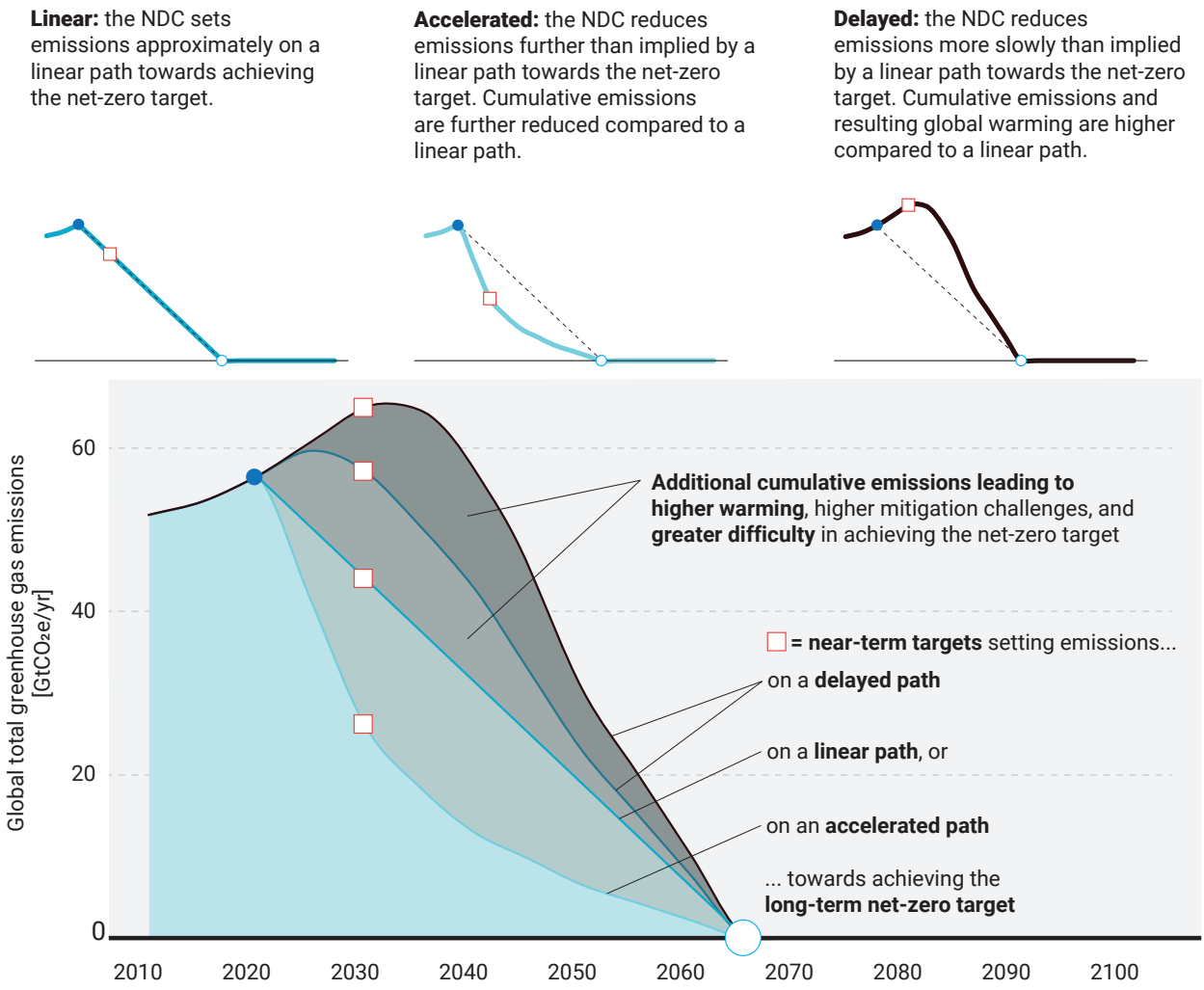
Pathway category	No. of scenarios	Timing of reaching net zero	
		Timing of reaching net zero Global CO_2 emissions	Global GHG emissions
SR1.5: 1.5°C with no or limited overshoot (50–66% chance in 2100 with maximum of 0.1°C overshoot until then)	42	2050 (2046, 2055)	2067 (2061, 2084)
SR1.5: Lower-2°C (66% chance)	54	2070 (2063, 2079)	Post-2100 (2090, post-2100)
1.5°C pathways (66% chance in 2100, and minimum 33% chance over the course of the century, chapter 4)	26	2054 (2049, 2059)	2071 (2058, post-2100)
1.8°C pathways (66% chance, chapter 4)	23	2067 (2057, 2083)	2086 (2068, post-2100)
2°C pathways (66% chance, chapter 4)	71	2069 (2059, 2089)	2090 (2077, post-2100)

Note: SR1.5 stands for IPCC Special Report on global warming of 1.5°C. IPCC estimates as reported in table 2.4 of SR1.5 (Rogelj *et al.* 2018). Values show the median and interquartile range across scenarios available in the SR1.5 scenario database (Huppmann *et al.* 2018a). In the pathway categories as used in chapter 4 of this report, pathways with emissions reductions before 2020 are excluded. The temperature outcomes of these pathways have also been reassessed based on the physical climate assessment of the IPCC AR6 – see cross-chapter box 7.1 in Forster *et al.* (2021).

3.2.3. The pathway to net-zero counts

Carbon budgets come with climate implications for net-zero targets: the path followed from today until net-zero CO_2 emissions are reached determines the total amount of emitted CO_2 and thereby the total carbon budget. Whether we follow a linear, an accelerated, or a delayed path impacts the climate outcome (figure 3.2). Following a delayed path compared to an accelerated path to net-zero GHG emissions by 2065 could lead to about 0.1°C more warming. At worst, a delay could result in a complete failure to achieve the net-zero target, resulting in higher warming. Near-term emissions reductions that sketch a linear or accelerated path towards a longer-term net-zero target therefore provide higher confidence that the net-zero target can ultimately be achieved.

Figure 3.2. Near-term targets are critical to set global emissions on a clear path towards achieving long-term net-zero targets and stringent climate goals



Global net-zero emissions targets in isolation set only a weak limit on the maximum level of global warming (Rogelj *et al.* 2015), as the maximum level of warming is largely defined by the cumulative amount of CO_2 emissions emitted until net zero (IPCC 2018).

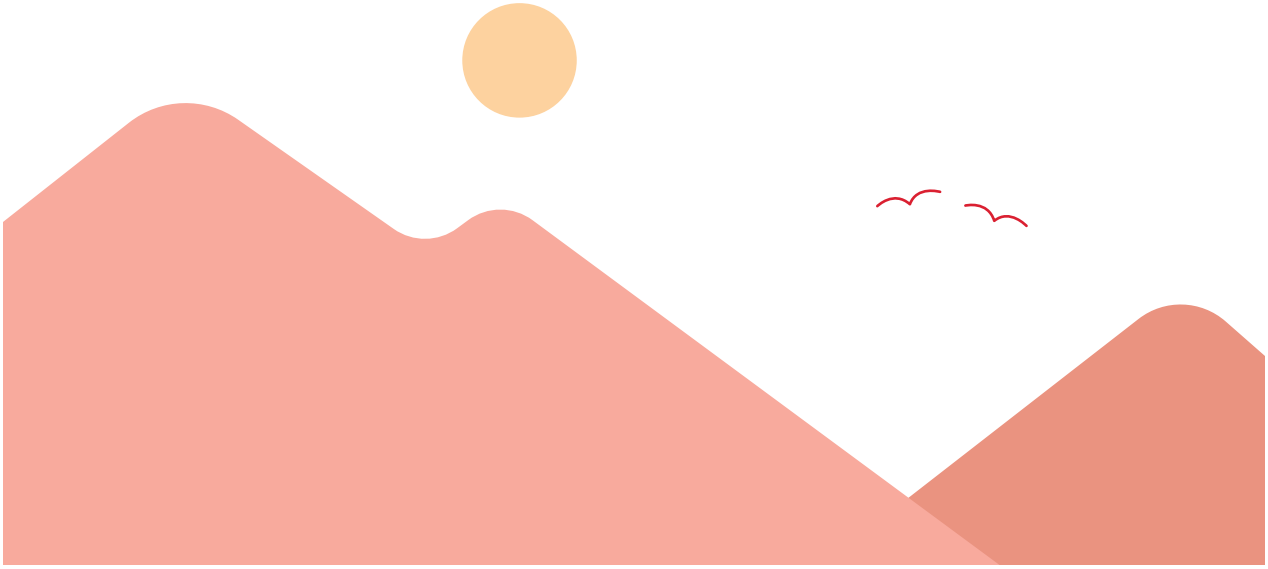
3.3. Net-zero at the national level

Setting net-zero emissions targets at the national level involves several steps in addition to the aforementioned global considerations. These steps represent both technical choices and normative decisions related to equity and fairness. Although this chapter focuses on countries, there are similar steps to translate global net-zero targets to sectors, companies, investment portfolios and other entities (see box 3.2).

First, at a technical level, the scope of emissions covered by a net-zero target needs defining (Levin *et al.* 2020; Rogelj *et al.* 2021). This includes defining the GHGs and activity sectors that are covered. For countries, the UNFCCC's requirement that parties report emissions and removals of a basket of GHGs on a territorial basis informs the scope of national targets. Countries could however exclude some gases or activities, include others such as international aviation and shipping, or take a different approach such as consumption-based accounting (Davis and Caldeira 2010; Munksgaard and Pedersen 2001; Wyckoff and Roop 1994).

A further choice in scope is the inclusion and use of carbon offsets, which are credits generated by projects carrying out emissions reduction or removal outside a country's (or other entity's) boundary. These credits are transferred to be accounted for within the boundary, often – but not always – by financial purchase through a market. Markets can allow entities to meet targets in a more economically efficient way (Grubb *et al.* 2011).

However, experience shows that international carbon markets can have pitfalls. Large numbers of credit-generating projects in the Clean Development Mechanism – the market operated under the Kyoto Protocol – were found not to fully represent additional carbon benefits



(Cames *et al.* 2016). The Paris Agreement anticipates a new international regime for carbon markets under article 6, the operation of which is still under negotiation. This will require clearly defined rules and robust accounting mechanisms to track progress, deliver real emissions reductions and drive ambition. Chapter 7 further discusses challenges and opportunities in using markets in achieving Paris Agreement targets in both the near-term and net-zero context.

Second, normative choices are required when translating global net-zero targets to the country level, involving questions of equity and fairness. A deadline for global net-zero emissions does not require all countries to achieve net zero at the same time (Robiou du Pont *et al.* 2016; Rogelj *et al.* 2021). Factors such as responsibility, capacity and level of development imply that some nations should achieve (and go beyond) net-zero emissions more quickly than others (Dubash *et al.* 2021; Rogelj *et al.* 2021). Furthermore, the costs of and potential for achieving emissions reductions and removals are geographically unevenly distributed. Reaching global net-zero emissions is therefore likely to involve a combination of positive and negative emissions contributions across countries and sectors, keeping in mind that the global potential for negative CO_2 emissions is limited because of technical, social and sustainability reasons (IPCC 2019, 2018). This variation between countries is illustrated by the different times at which regions (Rogelj 2018) or major emitting countries (van Soest *et al.* 2021) reach net-zero CO_2 or GHG emissions as part of a global least-cost transition, irrespective of additional equity or fairness considerations.

Aside from questions of equity and scope, debates have emerged over whether net-zero targets promote or hinder actions consistent with the Paris Agreement. Net-zero is seen as more actor-centred and effective than a temperature limit (Geden 2016). It also represents greater ambition than the current long-term pledges of most countries.[2]

Nevertheless, the concept of net-zero has faced criticism on the grounds that it may slow mitigation, either through over-reliance on carbon removal (McLaren *et al.* 2019) or on carbon credits (Stabinsky, Bhatnagar and Shaw 2021), or because an emphasis on long-term targets can distract from a lack of near-term actions. Other critics highlight that a narrow focus on net-zero targets can lose sight of differences in national climate politics, or the credibility of pledges, as well as equity (Dubash *et al.* 2021; Rogelj *et al.* 2021). Net-zero targets are not to be viewed in isolation as the sole policy mechanism for effecting change; they should be accompanied by near-term actions as well as detailed and transparent plans for delivery (Rogelj *et al.* 2021; Smith 2021). The Paris Agreement encourages these through the submission of NDCs and long-term strategies to the UNFCCC.

In response to these issues and criticisms, several recent studies have focused on identifying a set of criteria against which the robustness of net-zero pledges can be assessed (Black *et al.* 2021; Climate Action Tracker 2021; Levin *et al.* 2020; Rogelj *et al.* 2021). They share several common features, summarized in table 3.2.

2 See https://unfccc.int/process/the-paris-agreement/long-term-strategies.

Table 3.2. Overview of criteria used to assess national net-zero pledges

		Studies			
		Climate Action Tracker (2021)	Energy & Climate Intelligence Unit – Oxford (Black *et al.* 2021)	Rogelj *et al.* (2021)	World Resources Institute (Levin *et al.* 2020)
Goal	**Target year** When will net zero be achieved?	x	x	x	x
	Legal status Is the target binding in domestic law, or what other form of commitment is it?	x	x		x
	Global climate goal What global temperature level is the target designed to contribute to?			x	
	Interim targets/action What is the path to net zero?		x	x	x
	Pathway after net zero Is the intent to maintain net zero, or to reach net negative?			x	
	Reference to fairness Has the target been justified as a fair and adequate contribution to the global goal? If so, how?	x	x	x	x
Scope	**Gas coverage** Does the target include all GHGs under the Paris Agreement, or a subset?	x	x	x	x
	Sector coverage Does the target include all domestic activities, or a subset?			x	x
	Coverage of international aviation and shipping Does the target include a share of international aviation and/or shipping?	x	x		x
	Use of international offsets Does the target allow such offsets to be counted towards the target?	x	x	x	x
Transparency	**Published plan** Has the government set out a plan of actions to achieve the target?	x	x	x	x
	Review process Is there a regular, binding process for reviewing and revising the target?	x			x
	Reporting of progress Is there regular reporting of progress against the target?		x		x
	Separate reductions and removals Does the target include separate subtargets for emissions and removals?	x		x	x
	Transparency on removals Are assumptions about use of removal methods, both in the land and industry sectors, transparent?	x		x	x
	Metric for aggregating emissions If the target is for multiple GHGs, does it use the GWP-100 metric under the Paris Agreement? If not, why not?			x	

Note: "x" indicates which criteria are included in each of the four published studies.

3.4. Tracking national net-zero targets globally

The number of national net-zero targets has grown rapidly over the last four years. By the broadest definition, as many as 136 countries covering more than half of global GHG emissions either have some form of commitment to such a target or are considering it (Climate Action Tracker 2021; Energy & Climate Intelligence Unit [ECIU] 2021; UNEP 2020; World Resources Institute 2020). This includes countries whose governments are merely discussing net-zero targets, and signatories to the Climate Ambition Alliance which cites working towards net-zero CO_2 emissions by 2050 among its aims (Climate Ambition Alliance 2019).

Here we define a net-zero target as a statement in national legislation, in a policy document (i.e. an NDC or long-term strategy communicated to the UNFCCC, or a similar document published by a national government), or a public announcement by the government or a high-level government official (e.g. Head of State). We include references to net-zero emissions, net-zero carbon, carbon neutral(ity), GHG neutral(ity), climate neutral(ity) and a decarbonized economy or society. Our analysis reflects developments up to 13 September 2021.

Using this classification, 50 parties (49 countries plus the European Union) have pledged a net-zero target. These cover around 57 per cent of current global domestic GHG emissions, 60 per cent of gross domestic product (GDP) and 34 per cent of the global population (Climate Watch 2021; World Resources Institute 2021). Eleven targets are enshrined in law, covering 12 per cent of global emissions (table 3.3).

Table 3.3. Overview of current national net-zero pledges across all United Nations Framework Convention on Climate Change (UNFCCC) parties, by year and by legal status

	Parties	Emissions	GDP	Population
In law	11	12%	10%	3%
In policy document	24	15%	24%	7%
Government announcement	15	30%	26%	24%

Sources: Total coverage of current net-zero pledges by percentage of global domestic emissions in 2018 (World Resources Institute 2021), GDP (World Bank 2019, in purchasing power parity (PPP) constant international $ terms) and population (UN World Population Prospects 2019)

By number, the majority of these targets (38) are for 2050, coincident with the mid-century timescale for global CO_2 emissions indicated by the IPCC as necessary for limiting warming to 1.5°C. Eight targets are aimed at earlier years (2030–2045) and four at later years. In terms of emissions, however, the targets are split almost entirely and equally between 2050 (due to the pledges by the European Union and United States of America) and 2060 (due to China's pledge).

It is important to note that approaches to counting carbon sources and sinks can differ between global studies and national reporting. Some care is therefore needed when assigning net-zero status to countries, or interpreting claims by countries that 'carbon neutrality' has been achieved. In particular, national GHG inventories label all carbon uptake on managed land (including naturally occurring uptake) as anthropogenic, resulting in greater removal numbers than in the scientific modelling studies that form the basis for the global emissions pathways assessed in chapter 4 of this report (Grassi *et al.* 2021, 2018). However, one available study indicates that differences between the two approaches at the global level lead to a negligible difference in terms of timing of net-zero emissions (Grassi *et al.* 2021). Further in-depth studies are required to confirm this.

Existing net-zero targets show variations in scope, as well as large ambiguities (World Resources Institute 2020). Thirty-four are clear in including all sectors of domestic activity, while the remaining 16 are unclear or undecided. Regarding inclusion of GHGs, 17 targets are unclear or undecided, however those that are clear all include at least some non-CO_2 gases as well as CO_2. The majority (39) are unclear or undecided on inclusion of emissions from international aviation and shipping. However, three explicitly include them. Similarly, on use of offsets, five include them explicitly, eight rule them out and 37 are unclear or undecided.

As already explained, achieving net-zero emissions is key to halting or even gradually reversing global warming. With an increasing share of global emissions covered by net-zero targets, their impact on temperature projections is also increasingly important. Chapter 4 – which provides an overview of global warming implications of current policies, NDCs and net-zero targets – estimates that if fully achieved, net-zero targets could reduce global warming projections by about 0.5°C relative to projections that only take into account unconditional NDCs.

3.5. A closer look at net-zero targets in the G20

Twelve of the G20 members, covering 54 per cent of global domestic GHG emissions, currently have pledged a net-zero target, of which six are in law, two are in policy documents and four are government announcements. All are for the year 2050, with the exception of China's 2060 target and Germany's target for 2045.

Figure 3.3 provides an assessment of these targets against most of the criteria provided in table 3.3. Where information relevant to the criteria is available from countries, figure 3.3 highlights its existence rather than assessing its sufficiency. For instance, a plan may be published and it may refer to the fairness of its contribution to global efforts, however additional assessment is required to establish whether the plan is detailed enough and the fairness appropriate.

Similar to the global assessment of national net-zero targets, a notable feature of current net-zero targets of G20 members is their ambiguity. Regarding scope, most targets are unclear or undecided on inclusion of offsets and of international aviation and shipping emissions. Lack of clarity is also notable on coverage of sectors and gases, but those that are clear show a tendency for comprehensive coverage. Most show a lack of transparency regarding the approach taken to fairness, the plans for achievement (including on use of removals), and on reporting and reviewing progress. Only Canada, the European Union, France, Germany and the Republic of Korea have published their plans so far, and only these countries plus the United Kingdom have accountable processes for reviewing their targets.

As an indication of the consistency between nearer-term actions and net-zero targets, figure 3.3 also plots the emissions paths for G20 members implied by their most recent NDCs or announced mitigation pledge for 2030 and their net-zero target. As highlighted in section 3.2 and figure 3.2, near-term targets need to be aligned on a clear path towards achieving net-zero targets and limiting cumulative emissions. Indeed, the Emissions Gap Report 2020 (UNEP 2020) argued that the litmus test of net-zero pledges is the extent to which they are reflected in near-term policy action and in significantly more ambitious NDCs for the period to 2030. Near-term emissions reductions that follow a linear or accelerated path towards a net-zero target provide higher confidence that the net-zero target can be achieved.

To summarize, eight G20 members have so far not set net-zero targets, whereas 12 (covering 54 per cent of global domestic GHG emissions) have. Of the nine G20 members for which we can estimate an emissions path based on their net-zero target and their NDC, none have NDC targets that put them on an accelerated path towards their net-zero emissions targets. Five of these nine members (covering 21 per cent of global domestic GHG emissions) have NDC targets that put the country's domestic emissions onto a linear path towards achieving their net-zero targets. For four G20 members (covering 28 per cent of global domestic GHG emissions), the NDCs lead to emissions in 2030 that are about 25 per cent to 95 per cent higher than a linear path towards their net-zero targets would imply. These countries urgently need strengthened and more ambitious near-term climate plans for their net-zero targets to remain achievable.

There is an urgent need for (i) more G20 members – and indeed all countries – to pledge net-zero emissions, (ii) all countries to increase the robustness of their net-zero pledges, and (iii) all net-zero targets to be backed up by near-term actions that give confidence that the net-zero targets can ultimately be achieved.

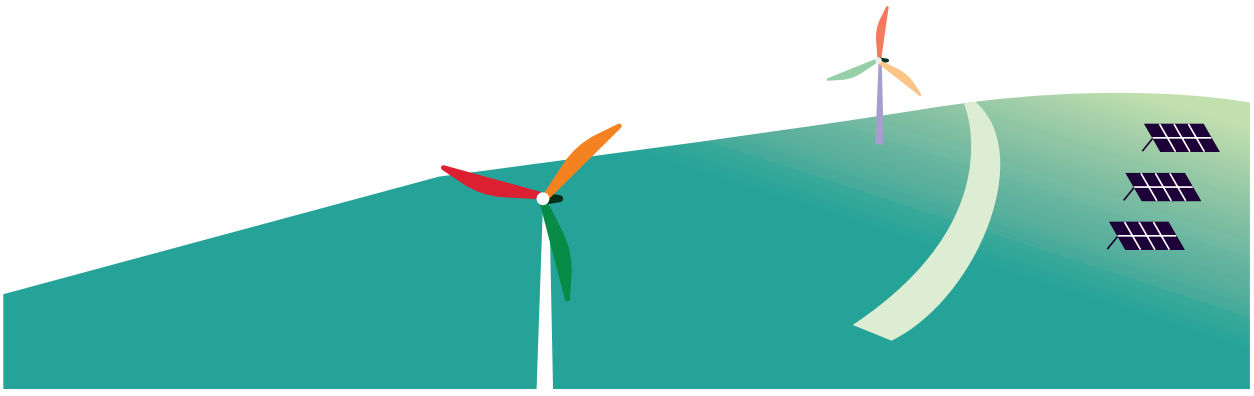


Figure 3.3. Analysis of current net-zero targets of G20 members

Country	Path to net zero	Year	Target status	Refers to fairness	All gases	All sectors	Int. aviation & shipping	Excludes offsets	Pub-lished plan	Review process	Reporting progress	Separate targets	Removals transparency
Argentina	2050	2050	Government announcement	○	?	?	?	?	○	○	○	○	○
Brazil	2050	2050	Government announcement	○	?	●	?	?	○	○	○	○	○
Canada	2050	2050	In law	○	●	●	?	?	●	●	Not annually	○	○
China	2060	2060	Government announcement	○	●	?	?	?	○	○	○	○	○
European Union	2050	2050	In law	○	●	●	?	●	●	●	Not annually	○	●
France		2050	In law	●	●	●	○	●	●	●	Annually	●	●
Germany		2045	In law	○	●	●	○	○	●	●	Annually	●	○
Italy		2050	Government announcement	○	?	?	?	?	○	○	○	○	○
Japan	2050	2050	In law	○	●	●	?	?	○	●	Not annually	○	○
Republic of Korea	2050	2050	In policy document	○	?	?	?	?	●	●	Not annually	○	○
UK	2050	2050	In law	○	●	●	●	○	○	●	Annually	○	○
USA	2050	2050	In policy document	○	●	●	?	?	○	○	○	○	○

Key:

Schematic illustration of whether NDCs are putting national GHG emissions on a delayed, linear or accelerated path towards achieving the national net-zero target (see box 3.1)

● Yes ○ No ? Unclear or undecided Not annually Not annually (reporting progress but less frequently than annually)

Note: Only G20 members with net zero targets are included. Member states of the European Union have no separate assessment of their path to net zero, because their NDC is not assessed separately as part of this report. Table 3.2 provides definitions of what is covered under the various headers.

Box 3.2. Non-state action on net zero

Businesses, cities, regions, investors, civil society groups, and other non-state and subnational actors (NSAs) play an increasingly important role in raising ambition and accelerating implementation. The Paris Agreement institutionalized the engagement of NSAs in achieving long-term climate goals and created an ongoing process to catalyse climate commitments made by NSAs, including net-zero targets (Chan, Ellinger and Widerberg 2018; Hale 2016; Hsu *et al.* 2018).

Efforts by NSAs towards global net-zero emissions are strengthening and broadening, which helps mobilize stakeholders to achieve net zero (Data-Driven EnviroLab and NewClimate Institute 2020; Hsu *et al.* 2020). The United Nations Race To Zero campaign rallies NSAs globally to take rigorous actions to reduce emissions by 50 per cent by 2030 and achieve net-zero carbon emissions by 2050 at the latest, vetting members via an independent expert group. More than 3,000 businesses, 730 cities, 170 investors, 30 regions and 600 universities have joined Race To Zero, together covering around 25 per cent of global CO_2 emissions and 50 per cent of GDP (Black *et al.* 2021; NewClimate Institute and Data-Driven EnviroLab 2020; Smit and Kuramochi 2020; UNFCCC 2021).

Actions taken by NSAs can also contribute to achieving net-zero targets set by governments, while at the same time creating more favourable conditions for governments to increase their ambition going forward. A recent study of major non-state actor initiatives found they had the potential to reduce 2030 emissions by 5–15 $GtCO_2e$ (Black *et al.* 2021; Hale *et al.* 2021; Hsu *et al.* 2019; NewClimate Institute and Data-Driven EnviroLab 2020; NewClimate Institute *et al.* 2021).

At the national level, NSAs are supporting implementation and enhancement of climate goals. For instance, America Is All In, a coalition of over 1,800 institutions representing 65 per cent of the United States of America's population and 70 per cent of its GDP, is an initiative to enhance non-state actions to cut the United States of America's GHG emissions by 50 per cent below 2005 levels by 2030 and put the country on a trajectory consistent with limiting global temperature rise to 1.5°C (Hultman *et al.* 2021). Meanwhile, the European Commission launched the European Climate Pact to mobilize NSAs and communities to participate in climate actions. The Japan Climate Initiative, made up of businesses and municipalities, has played a key role in supporting the government's new NDC.

However, the increase in NSA net-zero pledges needs to be treated with caution, because as they have proliferated, they have varied in robustness. The scope and coverage of net-zero targets; the existence of implementation plans, transparency and reporting to track progress; the alignment between near-term actions and long-term net-zero targets; and the robustness of carbon offsets are critical to credible net-zero targets (Black *et al.* 2021; Hale *et al.* 2021; Hsu *et al.* 2019; NewClimate Institute and Data-Driven EnviroLab 2020; NewClimate Institute *et al.* 2021). NSAs have started to take actions to address these issues. For example, the Taskforce on Scaling Voluntary Carbon Markets, a private-sector-led initiative, aims to develop a threshold standard to ensure high integrity offset credits and create robust and transparent markets.