Supplementary information

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Net-zero targets are too opaque

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Supplementary Information

Three ways to improve net-zero emissions targets

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Supplementary Table 1 | A Gold Standard for net-zero targets. Guidelines for setting high-quality net-zero targets. Detailed clarifications and examples are provided in the guidelines overview below.

I. Scope of target

I.1 Define the global climate goal that the individual net-zero target contributes to

Which maximum global temperature level? Peaking and declining, or stabilizing global temperature?

I.2 Define by when net-zero is intended to be achieved

Which year or multi-year period? Over which period is net-zero calculated?

I.3 Define the emissions that are covered by the individual net-zero target

Which gases? All greenhouse gases covered under the Paris Agreement? A subset, or CO_2 only?

I.4 Define which emissions metric is used to aggregate greenhouse gas emissions to assess net-zero

The Paris Agreement's default GWP-100 metric or an alternative? And why?

I.5 Define the boundaries or scope of the emissions covered by the net-zero target

Which territory? Which entities? Which activities? Including indirect as well as direct emissions?

I.6 Describe the expected contribution of direct CO_2 removals and/or offsets to achieve the net-zero target*

What is the share of gross emissions reductions and CO_2 removal by the entity that sets the target? How much is offset with mitigation projects carried out beyond the jurisdiction of a country or outside the direct control of an organization?

I.7 Clarify how direct CO_2 removal and/or offset options included in the net-zero target will deliver*

Which contributions from which kind of project? How is permanence of CO_2 removals (including for offsets) ensured? How do these options deliver net emissions reductions with high environmental integrity?

II. Adequacy and fairness

II.1 Justify how your target is a fair and adequate contribution to the global climate goal

Which fairness principles are applied? What are the implications if everybody were to follow the same principles (both for global emissions reductions and for actions needed by others to achieve the global goal)? How does this deliver the global climate goal (defined in I.1)?

III. Long term roadmap

III.1 Describe the trajectory and implementation plan to reach the net-zero target

What are key milestones? Which policies will be implemented to achieve them?

III.2 Describe the vision for your emissions trajectory after reaching your net-zero target

Maintain net-zero afterwards, or go net-negative?

* Note: We distinguish between 'direct CO_2 removal' that occurs within the territory of a country or results from activities under direct control of an organisation or entity, and 'offsets' which are credits generated from emissions reduction or CO_2 removal projects carried out beyond the jurisdiction of the country or the direct control of the entity that acquires and utilizes the credits.

A gold standard for net-zero targets:

10 guidelines for rigorous and clearer targets

Joeri Rogelj, Oliver Geden, Annette Cowie, Andy Reisinger[1,*]

I. Scope

I.1 Define the global climate or temperature goal that the individual net-zero target contributes to

Each individual net-zero target aims to contribute towards a global climate goal[2]. Because the Paris Agreement's long-term temperature goal (as defined in its Article 2) can be interpreted in a variety of ways[3], the global climate goal that a net-zero target aims to contribute to should be made explicit. This clarity is essential to subsequently assess a net-zero target's adequacy and fairness (see Section II).

Examples: peaking global warming well below 2°C and gradually reversing it; peaking global warming at 1.5°C and gradually reversing it; stabilizing global warming at 1.5°C, …

I.2 Define by when net-zero is intended to be achieved

A net-zero target requires a clear time by which it will be achieved. However, greenhouse gas emissions vary from year to year and at shorter timescales[4]. Some of these year-to-year variations can be influenced by policy decisions or law enforcement (e.g., deforestation rates in a given year) and thus be used to temporarily change annual emissions. A high-quality net-zero target needs to clarify how these inter-annual emission variations will be dealt with, for example, by specifying the time window over which the net-zero state will be assessed.

Examples: in a specified year; as the average over a specified period, ...

I.3 Define the emissions that are covered by the individual net-zero target

The Paris Agreement and the United Nations Framework Convention on Climate Change (UNFCCC) cover a set of greenhouse gases, including carbon dioxide (CO_2),

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[2] Schleussner, C.-F. et al. Science and policy characteristics of the Paris Agreement temperature goal. *Nat. Clim. Change* 6, 827–835 (2016).

[3] The text of the Paris Agreement can be downloaded in the six UN languages (Arabic, Chinese, English, French, Russian, and Spanish) from: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

[4] For example, in context of the COVID-19 pandemic, see: Liu, Z. et al. Near-real-time monitoring of global CO_2 emissions reveals the effects of the COVID-19 pandemic. *Nature Communications* 11, 5172 (2020); Le Quéré, C. et al. Temporary reduction in daily global CO_2 emissions during the COVID-19 forced confinement. *Nat. Clim. Change* (2020); Forster, P. M. et al. Current and future global climate impacts resulting from COVID-19. *Nat. Clim. Change* 1–7 (2020).

methane (CH_4), nitrous oxide (N_2O), the group of hydrofluorocarbons (HFCs), the group of perfluorinated compounds (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). The Paris Agreement demands action to limit the emissions of all these gases and they are all included in the achievement of the Paris Agreement's net-zero greenhouse gas target (in its Article 4). The Paris Agreement's net-zero target does not include aerosols or aerosol precursor gases (e.g., black carbon and SO_2). Specifying which gases are covered by a net-zero target is essential.

Examples: all greenhouse gases covered by the UNFCCC; CO_2 only; a different subset of gases, ...

I.4 Define which emissions metric is used to aggregate greenhouse gas emissions to assess net-zero

Greenhouse gas metrics are conversion factors that translate an emission of a specific greenhouse gas to an equivalent amount of CO_2. Under the Paris Agreement, the Global Warming Potential over a time horizon of 100 years (GWP-100) has been decided as the default metric to report aggregated emissions and removals of greenhouse gases[5]. In addition, parties may use other metrics to report supplemental information. When other greenhouse gas metrics are selected to define a net-zero target differently from the Paris Agreement's default metric, a rationale and comparison to GWP-100 (in terms of mitigation effort to achieve net-zero and in terms of its temperature outcome) should be provided. Calculating net-zero greenhouse gas emissions with different emission metrics leads to different climate outcomes and implies different mitigation ambitions.

Examples: GWP-100 as specified in the rulebook for the Paris Agreement, and with values reported in the IPCC Fifth Assessment Report; an alternative greenhouse gas metric, with a rationale for this choice, a comparison to the Paris Agreement GWP-100, and a description of the implications of this choice, …

I.5 Define the boundaries or scope of the emissions covered by the net-zero target

The boundaries of a net-zero target define the emissions that fall under the remit of the target and would thus need to be reduced to reach net-zero. For countries, targets typically cover emissions occurring within the territory of a country. However, emissions can also be incurred by importing goods or by producing goods for export that over their lifetime will result in greenhouse gas emissions elsewhere (e.g., a car produced in country A, but driven in country B). For administrative entities such as cities, companies, sectors, or organisations the boundaries of the emissions covered by the net-zero target are a determining factor for the ambition of the net-zero target.

Examples:
Spatial: Activities occurring in the territory of a country; activities related to imported goods or beyond national jurisdiction (e.g., shipping and aviation), …
Entity: Emissions assigned to an individual sector (e.g., power sector, dairy sector), or to a company (due to activities under its operational or financial control), or organisation (e.g., a university), …
Scope: processes under direct control (Scope 1), including indirect energy emissions (Scope 2), or life-cycle emissions, upstream and downstream of activities (Scope 3)[6]

I.6 Describe the expected contribution of direct CO_2 removals and/or offsets to achieve the net-zero target

Net-zero is achieved by reducing gross emissions as much as possible and by balancing any remaining emissions by either direct CO_2 removals (within the boundary of the entity) or by offsets (generated by emissions reduction or removal projects carried out beyond the jurisdiction of the country, organization, or entity that acquires and utilizes the credits)[7]. Specifying the intended relative contribution of gross emissions reductions and removals or offsets is essential to understand the ambition of net-zero targets. Environmental integrity of offsets is critical to ensure they contribute to the intended mitigation outcome.

Example: gross emissions will be reduced by 80% relative to 2020 by the net-zero target year, with the remainder matched by CO_2 removal under direct control and no offsets.

I.7 Clarify how direct CO_2 removal and/or offset options included in the net-zero target will deliver

Direct CO_2 removal (within the territory of a country or resulting from activities under direct control of an entity) or offsets (from emissions reduction or removal projects carried out beyond the jurisdiction of a country, organization, or entity) must be shown to be reliable (accurate), permanent, socially acceptable (sustainable), and avoid double-counting (additional). For example, some direct CO_2 removal measures store carbon in natural systems forests or soils, where it is vulnerable to disturbance or reversal. Other measures store CO_2 in geological formations, where it is locked away quasi-permanently for centuries to millennia. Specifying which direct CO_2 removal options are considered clarifies the long-term reliability of a net-zero target. Furthermore, credits for offsets can be issued for activities that save a forest instead of cutting it down or use natural gas

[5] As part of the Paris Rulebook agreed in Katowice in 2018. UNFCCC. FCCC/PA/CMA/2018/3/Add.2 Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement. (United Nations Framework Convention on Climate Change, 2018) from: https://unfccc.int/sites/default/files/resource/4-CMA.1_English.pdf

[6] For example, as described by the GHG Protocol on: https://ghgprotocol.org/corporate-standard

[7] For example, see Carrillo Pineda, A., Chang, A. & Faria, P. Foundations for Science-based Net-zero Target Setting in the Corporate Sector. 1–53 https://sciencebasedtargets.org/wp-content/uploads/2020/09/foundations-for-net-zero-full-paper.pdf (2020).

instead of coal to produce power. In both cases, this avoids emissions that may (or may not) have occurred otherwise. The environmental integrity of offsets depends strongly on setting realistic baselines against which action is compared and ensuring that credits are not counted twice: by the entity that purchases them, and once more by the country in which they effectively occur.

Example: remaining gross emissions in the target year will be matched by removals in equal shares from afforestation and bioenergy with carbon capture and storage.
Key additional specifications: Describe measures to ensure permanence and manage risk of reversal of the intended removals; Where is CO_2 removal planned to occur (e.g., in-country, through purchased offsets, …)?

II. Adequacy & Fairness

II.1 Justify how your target is a fair and adequate contribution to the global climate goal

The combined choices of Section I need to constitute an adequate and fair contribution to the global climate goal one intends to pursue (criterion I.1). The individual net-zero target needs to clarify how the underlying choices contribute to the global climate goal based on the best available evidence. In addition, the individual net-zero target needs to explicitly clarify the fairness principles that were applied to derive it, such as equality per capita emissions, historical responsibility, the capacity to reduce emissions (e.g., mitigation potential, technological or financial capacity), or implications for sustainable development, amongst other aspects. The target should provide a quantitative illustration of those principles and describe the consequences of these principles being adopted universally by other countries or sectors. These consequences include the actions that other countries, companies, or organisations are concomitantly assumed to achieve and the global emissions reductions that this results in. Similarly, the net-zero target should reflect how it is likely to impact the capacity of others to achieve net zero, and how it might impact the pursuit of other societal objectives such as the Sustainable Development Goals (SDGs) which could be impaired, for example, as a result of a target's reliance on CO_2 removal or offsets.

III. Long term roadmap

III.1 Describe the trajectory and implementation plan to reach the net-zero target

Achieving net-zero targets needs planning, intermediate milestones, and policies to be achieved. A high-quality net-zero target announcement should be accompanied by a plausible implementation plan.

Examples: intermediate decadal milestones setting out a trajectory towards the net-zero target; policies drive both the emissions reductions and CO_2 removal upscaling that would be needed to achieve the target, ...

III.2 Describe the vision for your emissions trajectory after reaching your net-zero target

The journey towards climate protection does not end at net-zero. Net-zero targets are milestones on a continuing collective journey. A high-quality net-zero target should include a long-term vision for what will happen after the net-zero target is achieved, and a rationale for this further trajectory. Considerations from Sections I and II should be applied to this 'beyond net-zero vision' as well.

Examples: we intend to maintain net-zero emissions beyond the net-zero date; achieve and sustain net-negative emissions for a period after the net-zero date, ...