

Long-term climate goals

Decarbonisation, carbon neutrality, and climate neutrality

The terms 'decarbonisation', 'carbon neutral', and 'climate neutral' are frequently used in climate discussions. This document reviews and clarifies our understanding of these terms and explores some of their implications.

In Brief

Decarbonisation: We understand this term to refer to the process of reducing the CO₂ emissions of a given activity. The ultimate end state of this process would be a 'decarbonised' global economy in which no fossil CO₂ is emitted to the atmosphere.

Carbon neutral: We understand this term to describe a state in which the activities of an individual, an organisation, a city or a country result in net-zero emissions of CO₂. Either the activities must release no CO₂, or the CO₂ they still release after decarbonising as much as possible must be permanently sequestered. Some, but not all, carbon offsets can help to achieve carbon neutrality.

Climate neutral: We understand this term to describe a state in which the activities of an individual, an organisation, a city or a country result in net-zero climate impact from greenhouse gas emissions. Either the activities must release no greenhouse gases, or the warming that results from the greenhouse gases they still release after reducing emissions as much as possible must be balanced out by CO₂ sequestration. Some, but not all, carbon offsets can help to achieve climate neutrality.

Carbon offsets: Carbon offsets involving reduced or avoided emissions are sometimes referred to as carbon neutral or climate neutral. They can contribute to the process of decarbonisation, but should not be considered as neutral because they result in a net release of greenhouse gases when used to offset emissions that occur elsewhere. Only offsets that permanently sequester CO₂ can help to achieve carbon neutrality or climate neutrality. However, the technologies for large-scale, sustainable and cost-efficient sequestration of CO₂ have not yet been realised and so cannot be relied upon. We therefore conclude that:

Decarbonisation is the most effective and reliable road to the goals of carbon neutrality, climate neutrality, and a decarbonised global economy.

Interpreting key climate terms

The terms decarbonisation,¹ carbon neutral,² and climate neutral³ appear to lack clear, widely accepted definitions, rendering them open to a range of interpretations. Here, the authors outline their specific understandings of the terms in order to inform climate change discussions, including ongoing international climate negotiations.

Decarbonisation

In the authors' understanding, **decarbonisation** refers to a process during which emissions of CO₂ from human activities are reduced. The ultimate end state of this process is a '**decarbonised**' global economy in which no fossil CO₂ is emitted to the atmosphere. As we argue below, decarbonisation is also the essential means of achieving a carbon-neutral or climate-neutral state.

Carbon neutral

In the authors' understanding, the term **carbon neutral** refers to a state in which the activities of an individual, an organisation, a city or a country result in net-zero CO₂ emissions. We see a carbon-neutral state as a desirable long-term goal of international climate mitigation efforts, provided a number of considerations are taken into account (see *Considerations and cautions* below). For a given set of activities to be carbon neutral, either

- the activities themselves must have zero CO₂ emissions, or
- the same amount of CO₂ released by the activities must be permanently sequestered from the atmosphere elsewhere by making use of a so-called carbon sink.

Climate neutral

In the authors' understanding, and for the purpose of climate negotiations,⁴ the term **climate neutral** is similar to carbon neutral, but has one crucial difference: it covers all greenhouse gases (GHGs) as defined by the Kyoto Protocol.⁵ Different GHGs may be compared with each other in terms of their climate impact by means of their Global Warming Potential (GWP).⁶ Climate neutral refers to a state in which the activities of an individual, an organisation, a city or a country result in net-zero GHG emissions. For a given set of activities to be climate neutral, either

- the activities themselves must have zero GHG emissions, or
- the warming that results from the GHGs released by the activities must be offset by sequestering an equivalent amount of CO₂ elsewhere.⁷

¹ This term is used in the Leaders' Declaration, G7 Summit, 7–8 June 2015, Elmau, Germany.

² This term is used in the UNEP "Emissions Gap Report", 2014.

³ This term is used in the UNFCCC "Climate Neutral Now" initiative, the UNEP "Moving Towards a Climate Neutral UN" report, and the UNECE "Climate Neutral Cities" publication.

⁴ This is a practical interpretation of the term climate neutral. A technical definition would include all known influences on the climate, for instance black carbon emissions and albedo changes, but that would be impractical.

⁵ Carbon dioxide (CO₂); methane (CH₄); nitrous oxide (N₂O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride (SF₆). In this document, the term GHG refers to these gases.

⁶ This is calculated by comparing the radiative forcing of each gas to the emission of an equivalent amount of CO₂ in a manner specified for this purpose in the Kyoto Protocol.

⁷ There is currently no known reliable method of removing non-CO₂ GHGs from the atmosphere, so only CO₂ sequestration activities can be used to offset greenhouse gas emissions.

The inclusion of non-CO₂ GHGs in the term climate neutral provides additional options for climate mitigation. We see a climate-neutral state as a desirable long-term goal of international climate mitigation efforts. Yet it must be achieved almost entirely through emissions cuts, and not through carbon-sequestering offsets (see *Considerations and cautions* below).

Considerations and cautions

1. Not all offsets are neutral

Offsets are usually understood to refer to GHG emissions that are reduced, avoided, or sequestered to cancel out emissions that occur elsewhere.⁸ It has become common to refer to offsets as carbon neutral or climate neutral. However, there are different kinds of offsets, and only some are neutral.

Where the emissions from one activity are offset by reducing or avoiding emissions elsewhere, there is still a net release of GHGs to the atmosphere. Therefore, these activities should not be seen as carbon or climate neutral. However, in our opinion, this form of carbon offset can make a useful contribution to the process of decarbonisation by allowing market mechanisms to identify and prioritise the most cost-effective ways of reducing emissions.

The only kinds of offsets that can be considered carbon neutral or climate neutral are those that sequester an amount of CO₂ equivalent to the amount of GHGs that was released.

We recommend that a distinction be made between offsets that actually remove CO₂ from the atmosphere (neutral offsets) and those that reduce or avoid emissions elsewhere (non-neutral offsets).

2. CO₂ sequestration is not a substitute for GHG emission cuts

Currently, CO₂ is the only GHG that can be sequestered from the atmosphere. Some sequestration of CO₂ to offset the release of CO₂ elsewhere could help to achieve a carbon-neutral state. And some sequestration of CO₂ to offset the release of other GHGs elsewhere could help to achieve a climate-neutral state. However, the technologies for large-scale, sustainable and cost-efficient sequestration of CO₂ have not yet been realised. And the question of whether they can be developed at a scale required to offset a significant fraction of projected future GHG emissions is uncertain.⁹ Research into sequestration technologies should continue apace, but sequestration should not be a substitute for the reduction of GHG emissions.

Sequestration technologies cannot be relied upon to achieve either carbon neutrality or climate neutrality. Reducing emissions of CO₂ and other GHGs remains the most effective and reliable road to carbon neutrality and climate neutrality.

⁸ <http://climateneutralnow.org>.

⁹ See, for example the final report of the EuTRACE project: http://www.iass-potsdam.de/sites/default/files/files/rz_150715_eutrace_digital_0.pdf

3. The concept of climate neutral and its limits

The concept of climate neutral rests on the notion that the radiative forcing from one activity (e.g. releasing GHGs) can be balanced out by another activity (sequestering CO₂). The term climate neutral could be a helpful concept if it were tightly defined and if the GHGs it covers as well as the method for calculating the GWPs from these GHGs were agreed on unambiguously. But the notion that the radiative forcing from one activity can be balanced out by another activity has its limits.

Reducing the emissions of short-lived substances that warm the climate, such as black carbon, can contribute to slowing the rate of near-term warming.¹⁰ However, there is currently no agreed method for calculating GWPs for many of these substances.¹¹ Additional immediate action to address emissions of these substances is to be encouraged (see below, *Short-Lived Climate-forcing Pollutants (SLCPs) need special consideration*). However, we caution against including them in any definition of climate neutral until a common scale has been found and agreed upon, which would allow their climate impacts to be compared with those of CO₂.

Furthermore, a loose definition of climate neutral could, in theory, consider the radiative forcing change from emissions of GHGs to be offset by a radiative forcing change from solar radiation management geoengineering. We strongly advise against this interpretation.

In order to avoid the possibility of undesirable outcomes from an overly broad interpretation of the term climate neutral, we recommend that the substances and activities to be covered by the term be clearly defined.

4. Short-Lived Climate-forcing Pollutants (SLCPs) need special consideration

Even though we advise against the concept of climate neutral extending to substances such as black carbon (see above, *The concept of climate neutral and its limits*), we strongly recommend that action be taken in order to simultaneously reduce emissions of SLCPs and their precursors¹² alongside reductions of GHGs. Reducing SLCPs can considerably reduce the amount of near-term warming, and is to be encouraged. However, SLCP reductions should in no way imply a right to emit any amount of CO₂ or delay action on cutting CO₂ emissions, since there is currently no accepted way to compare their effects.

¹⁰ Near-term Climate Protection and Clean Air Benefits: Actions for Controlling Short-Lived Climate Forcers, UNEP (2011).

¹¹ It is important to also note that the regional forcing from these substances is much more heterogeneous than that from long-lived GHGs such as CO₂.

¹² Some SLCPs such as methane (CH₄) and hydrofluorocarbons (HFCs) are already defined as GHGs by the Kyoto Protocol. Here, we refer to black carbon (BC; more commonly known as soot) and tropospheric ozone (O₃).

CONCLUSION

If the concepts carbon neutral and climate neutral are to make a useful contribution to climate action as desirable states to be reached, there needs to be a clear, shared understanding of what these terms mean. For the authors, the key attribute of 'carbon-neutral' and 'climate-neutral' activities is that they are neutral: carbon-neutral activities have net-zero CO₂ emissions; and climate-neutral activities have net-zero GHG emissions.

Sometimes carbon offsets involving reduced or avoided emissions are referred to as 'carbon neutral' or 'climate neutral'. In our opinion they should not be considered as carbon neutral or climate neutral, as they entail a net release of GHGs to the atmosphere. However, the use of such offsets (which we refer to as non-neutral offsets) can be a useful part of the decarbonisation process, as they can help to identify and prioritise the most cost-effective means of reducing GHG emissions.

While 'neutral offsets' (those that sequester carbon) can help to achieve carbon neutrality and climate neutrality, the authors strongly advise against relying on CO₂ sequestration to achieve either goal. The technologies for large-scale, sustainable and cost-efficient sequestration of CO₂ have not yet been realised, and may never be developed at a scale required to offset a significant fraction of projected future GHG emissions. Decarbonisation remains the most effective and reliable road to the goals of carbon neutrality,

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