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Geological Net Zero and the need for disaggregated accounting for natural carbon sinks

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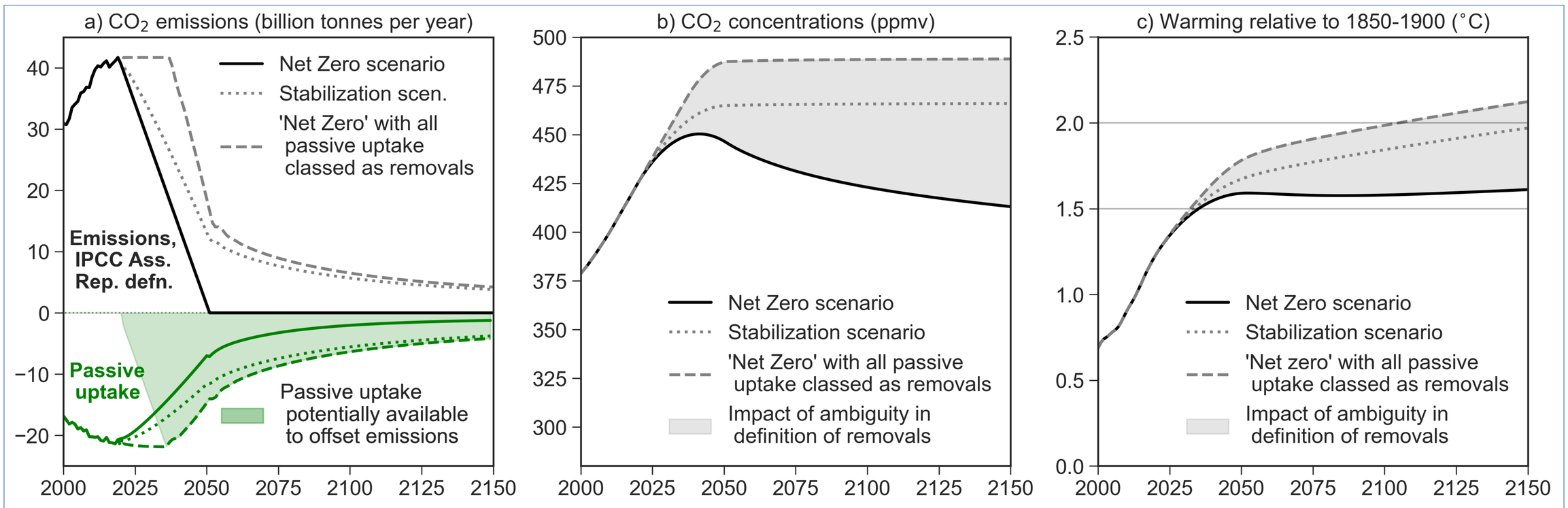
Achieving net zero CO_2 emissions only halts CO_2-induced warming if the definition of removals excludes 'passive' CO_2 uptake, such as enhanced vegetation growth that occurs as a result of past emissions (e.g., CO_2 fertilisation). Many greenhouse gas accounting systems allow some passive uptake to be classed as removals if it takes place on self-defined "managed land". This could compromise achieving the goals of the Paris Agreement. To ensure residual fossil fuel use does not contribute further global warming, countries and corporations need to:

a) Report greater disaggregation of land management categories to better separate passive uptake;
b) Where possible, demonstrate claimed CO_2 removals are additional to passive CO_2 uptake; and
c) Aim for Geological Net Zero, meaning one tonne of CO_2 permanently restored to the solid earth for every tonne still generated from fossil sources.

Scientific understanding of net zero also indicates a basis for allocating responsibility for the protection of passive carbon sinks both during and after the transition to Geological Net Zero.



Impact of ambiguity in the definition of removals in net zero. Black and grey lines in panel a show net CO_2 emissions plotted using the definition of removals adopted in IPCC Assessment Reports. Green lines show corresponding passive uptake by the oceans and biosphere. Panels b and c show a central estimate of the response of CO_2 concentrations and global average surface temperature assuming, for clarity, constant non-CO_2 forcing after 2020. Solid lines show a stylized scenario in which net emissions are reduced linearly to zero in 2050. Dotted lines show net CO_2 flux into the atmosphere (emissions minus passive uptake) reduced linearly to zero. Dashed lines show an extreme scenario that follows the same nominal emissions pathway as the black line but in which 'reductions' are achieved, where possible, by offsetting emissions using passive uptake.

Responsibility for the protection of passive sinks: CO_2-induced warming over a multi-decade time-interval Δt:

$$\Delta T = \kappa_E[E + (\rho_F - \rho_E)G]\Delta t$$

where E is net CO_2 emissions from ongoing human activity, G is cumulative emissions to date, κ_E is the Transient Climate Responses to Emissions; and ρ_F and ρ_E are the Rate of Adjustment to Constant Forcing and Rate of CO_2 forcing decline under zero emissions, both about 0.3% per year. For an entity to have genuinely "ended its contribution to global warming", in *addition* to achieving net zero CO_2 emissions ($E = 0$), it needs either to implement active CO_2 removal equal to $\rho_F G$ tCO_2 per year or to protect an annual passive uptake of approximately half that amount. For Britain, this would mean protecting passive sinks absorbing 120 $MtCO_2$ per year, which is slightly greater than the estimated carbon sink of Gabon. Who is going to pay for this service?