ISSN: 2690-0688

Research Article

Journal of Humanities & Social Sciences

Addressing The Risks Of Climate Change

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Submitted: 14 Dec 2022; **Accepted**: 21 Dec 2022: **Published**: 29 Dec 2022

Citation: Radunsky ,K. (2022). Addressing The Risks Of Climate Change, *J Huma Soci Scie*, 5(4), 471-486.

Abstract

This article describes the urgency to address climate change risks. One message is that the focus on mitigation and adaptation alone will not allow to reduce climate change risks with the time left before we reach potential tipping points of the climate system. The article therefore has a focus on additional approaches such as carbon dioxide removal (CDR) by technologies that can be upscaled to limit overshooting to a reasonable period of time (several decades) and approaches to avoid further warming by use of solar radiative management (SRM) approaches to buy time before CDR will have done its job. As a first step with respect to governance, principles that could be the basis for requirements are suggested, based upon recently developed documents in the private and voluntary domain to address greenwashing in the context of carbon neutrality/net zero carbon claims.

Keywords: Climate change management, principles, risks, carbon dioxide removal, solar radiative management, moral hazard

Introduction

The main outcome of this year's United Nations (UN) climate talks in Egypt (COP27) was a fund to pay poor countries for the loss and damage they are suffering due to climate change. There was significant disappointment reported worldwide that no significant progress under these negotiations could be achieved neither with respect to mitigation of greenhouse gas (GHG) emissions nor in the area of adaptation to the impacts of climate change.

This poor outcome had to be reported despite the dire warnings from the Intergovernmental Panel on Climate Change (IPCC) earlier in 2022 that GHG emissions must halve by 2030 and reach net zero by 2050 if humanity is to avert a level of warming it will be unable to cope with (a level of global warming of more than 1.5^0C).

Reacting to such poor outcome some German scientists, e.g., the director of the Potsdam Institute for Climate Impact Research, Johan Rockström, doubt the impact of climate conferences in their current form and argue that an alliance of the biggest emitters of GHGs might be more efficient than struggling to reach agreements with as many countries as possible.

One positive aspect in this context was that the US and China are set to resume formal climate cooperation after their leaders Joe Biden and Xi Jinping held a personal meeting in Bali, Indonesia during the recent G20 summit which took place also in November 2022. Thus, the United States and China are again willing to work together to address climate change, one of the key transnational challenges, after China had suspended climate talks after the leader of the US congress's lower house, Nancy Pelosi visited Taiwan in August 2022.

This article will highlight the most relevant climate risks and what the options are to manage those.

The three Working Group reports issued by the IPCC as a part of the Sixth Assessment Report (AR6) present a sobering picture of the status of the changing climate and humanity's response to date. The average global surface temperature in 2011–2020 was 1.09 °C higher than that in 1850–1900 whereas by 2018, the global mean sea level had already risen by 0.20 m above the 1901 average [1]. Under all shared socioeconomic pathways that serve as a basis for climate projections assessed by the IPCC, global surface temperature continues to rise until at least mid-century [1]. Perhaps most concerning, many changes caused by past and future greenhouse gas emissions are irreversible for centuries to millennia [1,2]. The Arctic faces a particularly dire threat from climate change, warming at roughly twice the global average [1].

An analysis of the National Determined Contributions (NDC) shows that the new and updated NDCs begin to reveal both the potential of the Paris "ratchet mechanism" and its limitations. In November 2022 NDCs are both significantly more ambitious than their predecessors and woefully inadequate to avert the climate crisis. If the pace of improvement from 2016 to today continues, the world will not only miss the Paris Agreement goals, but it will miss them by a long shot. For the most part, the new and updated

NDCs represent incremental improvement, when what is needed is transformational change [3]. We are on a pathway to a global warming of 2.7^{0}C and thus on a pathway that will miss the 1.5^{0}C goal by more than 1^{0}C [4].

Such temperature increase will result in the crossing of so-called tipping points. These are critical thresholds in a system that, when exceeded, can lead to a significant change in the state of the system, often with an understanding that the change is irreversible. Examples are: Greenland ice sheet, Permafrost, Ocean circulation and temperature (AMOC), Monsoons, Antarctic ice sheets. The actual temperature of those tipping points is still quite uncertain. In the early 2000s, there was a general consensus among scientists that most tipping points could be reached in the event of a 4^{0}C-increase in global temperatures. However, more recent assessments found that exceeding 1.5^{0}C of global warming risks crossing several of these thresholds [5].

The World Meteorological Organization (WMO) has published in May 2022 a new climate report and again warns that the 1.5 °C threshold may be exceeded. According to the report, average temperatures could exceed 1.5^{0}C at times in the next five years. The probability that this will happen at least once in the next five years is 50%. The 1.5°C value is an indicator of the point at which climate impacts become increasingly harmful to humans and the planet as a whole [6].

And in the Provisional State of the Global Climate Report 2022, released in November 2022 [8], the WMO informs that
• the past eight years are on track to be the eighth warmest on record, fuelled by ever-rising greenhouse gas concentrations and accumulated heat,
• extreme heatwaves, drought and devastating flooding, have affected millions and cost billions this year; natural catastrophes including extreme weather events globally have caused an estimated $260 billion in damage so far in 2022 [7],
• the tell-tale signs and impacts of climate change are becoming more dramatic. The rate of sea level rise has doubled since 1993. It has risen by nearly 10 mm since January 2020 to a new record high this year. The past two and a half years alone account for 10% of the overall rise in sea level since satellite measurements started nearly 30 years ago,
• 2022 took an exceptionally heavy toll on glaciers in the European Alps, with initial indications of record-shattering melt,
• the Greenland ice sheet lost mass for the 26th consecutive year, and it rained (rather than snowed) there for the first time in September.
According to this WMO report the global mean temperature in 2022 is currently estimated to be about 1.15 [1.02 to 1.28] °C above the 1850-1900 pre-industrial average. A rare triple-dip cooling La Niña means that 2022 is likely to "only" be the fifth or sixth warmest year. However, this does not reverse the long-term trend; it is only a matter of time until another warmest year is on record [8].

The chances of keeping global temperature rise below 1.5^{0}C, the toughest goal of the Paris Agreement, are increasingly slim. Well below 2^{0}C is a stretch. Yet there has been little discussion at an international level on how to handle "overshoot" of those goals.

However, this threat posed by climate change obviously triggered that the White House is investigating whether geoengineering could at least temporarily limit global warming and what risks the technology entails. This can be concluded from a report from the US news portal CNBC, citing the Office of Science and Technology Policy (OSTP), responsible for research and technology policy, which informed on the mandate of the US Congress to develop a five-year plan for the scientific evaluation of rapid climate interventions [9].

And a high-powered commission due to launch in May 2022 also aims to break the silence [10]. Climate diplomats are finalising a 15-strong line-up of former presidents, ministers and representatives of international organisations to explore options for deep adaptation, carbon dioxide removal (CDR) and geoengineering, Climate Home News revealed. The Climate Overshoot Commission will address sensitive questions around the ethics and feasibility of potential ways to reverse warming that are problematic or unproven at large scale [10].

Even more concrete are the plans described in the Carbon Dioxide Removal (CDR) Launchpad which is a coalition of governments who have agreed in 2021 to work together to accelerate the pace of CDR advancements through large demonstration projects and share data and experiences [11,23].

Wake Smith et al. describe that stratospheric aerosol injection (SAI) is a prospective climate intervention technology that would seek to abate climate change by deflecting back into space a small fraction of the incoming solar radiation [13]. While most consideration given to SAI assumes a global intervention, Wake Smith at al. consider an alternative scenario whereby SAI might be deployed only in the subpolar regions. Subpolar deployment would quickly envelope the poles as well and could arrest or reverse ice and permafrost melt at high latitudes. This would yield global benefit by retarding sea level rise. Given that effective SAI deployment could be achieved at much lower altitudes in these regions than would be required in the tropics, it is commonly assumed that subpolar deployment would present fewer aeronautical challenges. An SAI deployment intended to reduce average surface temperatures in both the Arctic and Antarctic regions by 2 °C is deemed here to be feasible at relatively low cost with conventional technologies. However, Wake Smith et al. also point to the myriad governance challenges that would confront any such deployment.

Materials and Methods

This paper addresses one of those challenges, moral hazard. Moral hazard describes a situation characterized by lack of incentive to guard against risk where one is protected from its consequences, in this case by SAI. And in addition, there is the significant risk

of stopping SAI suddenly before the driver of the risk, the high concentration of greenhouse gases in the atmosphere, has been reduced to a safe level. This would result in even greater losses and damages compared to the slower warming the world is showing now. SAI would merely ameliorate a key symptom of climate change without curing the underlying disease.

The following scenario – which is only one of many scenarios – might help to understand the challenge of moral hazard better:
• the carbon budget to avoid dangerous interference with the climate system has already been filled up by the emissions in the past,
• the additional emissions until the point in time by when global net zero carbon emissions will have been achieved will have to be removed by technologies that provide net negative carbon emissions;
• those technologies are in principle available but not yet at a meaningful scale and at feasible cost. The current rate of removal is in the range of about 4000 t CO2 per year and the cost is about 500 USD/t CO2. Construction of new plants started with a planned capacity in the range up to 1 Mio t CO2. These plants are planned to start operation by 2025 [14,15].
• under the optimistic scenario to achieve net zero carbon emissions by 2060 and given the current carbon emissions in the range of 36 bio t CO2/year this means that there will be about 700 bio t CO2 that will have to be removed in order before any SAI would not be required any more.
• NOTE: This assumption assumes mitigation beyond that mitigation that has been already indicated in the NDCs. The assumption is also that the peak in GHG emissions has already been in 2022 – what is also optimistic.
• Given again a quite optimistic assumption that each ton removed requires a cost of 100 USD this means yearly investments in carbon removal in the order of 700 bio USD per year – for a period of 100 years.
• For comparison: According to a report by McKinsey [21]. the transition to net-zero greenhouse gas emissions by 2050 will require an extra $3.5 trillion a year in capital spending on physical assets for energy and land-use systems.

Key Question Related to Governance: How to Avoid Green Washing?

Given these huge investments required to address climate change risks in a meaningful manner it is not surprising that financial regulators are toughening their stance against so-called 'greenwashing' to ensure climate-conscious investing delivers on its promises [16].

This paper includes a summary of the guidance developed/or under development to safeguard against greenwashing in the context of organisations/products and other subjects to become carbon neutral/achieve net zero GHG emissions with a focus on principles (see Appendix). The three initiatives that have been studied relate to
• ISO 14068
NOTE: This International Standard will only be published in 2024 but will become available as Draft International Standard early in 2023. It is developed by WG 15 of SC7 of TC207. Members of the Working Group are identified by National Mirror Committees that are members to TC207.

• IWA 42:2022(E) - Net Zero Guidelines Accelerating the transition to net zero [22].
NOTE: This document has been prepared through a workshop mechanism outside of ISO committee structures, following a procedure that ensures the broadest range of relevant interested parties worldwide have the opportunity to participate, and are approved by consensus amongst the individual participants in the workshops.
• Integrity Matters: Net Zero Commitments by Businesses, Financial Institutions, Cities and Regions [17].

NOTE: The High-Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities ("Expert Group") was tasked by the United Nations Secretary General with addressing net zero pledges and commitments from non-state actors including corporations, financial institutions, and local and regional governments. In undertaking its work, the Expert Group built on existing credibility and standard setting frameworks for net zero pledges to formulate its findings and recommendations.

The reason for examining these principles developed in the context of carbon neutrality and/or zero net carbon emissions is that they can be seen as a good basis for possible moral hazard principles in the context of SAI. In both cases, the root cause of bad behaviour is avoiding spending large sums of money to permanently remove carbon dioxide from the atmosphere, respectively avoiding spending money to reduce long-term climate change risks.

Results

Table 1: Draft Suggested Principles/Recommendations To Address The Risk Of Moral Hazard In The Context Of Solar Radiation Modification - SRM (Radiative Forcing Management - RFM)

Principle/Recommendation	Draft suggested wording
Alignment	Policies and guidance are aligned on common climate action approaches (recognizing common but differentiated responsibilities and respective capabilities) to support meeting the goals of the Paris Agreement and any subsequent United Nations global agreements that supersede the Paris Agreement.
Integrity and Transparency	Demonstrated integrity by aligning commitments with actions and investments Radical transparency in sharing relevant, non-competitive, comparable data on plans and progress Disclosures ought to be accurate and reliable. Independent evaluation of annual reporting and disclosures, including opinion on climate governance, as well as independent evaluation of metrics and monitoring, internal controls evaluation and verification on solar modification activities and associated activities related to carbon dioxide removal (CDR) to eliminate the need for use of SRM within a reasonable time scale (e.g. 100 years) is made publicly available.
Announcing a road map on carbon dioxide removal from the atmosphere	A road map on carbon dioxide removal from the atmosphere should be made publicly and represent the amount of the CDR needed as well as the time line to achieve that goal before use of SRM actually starts. The road map should contain interim targets with respect to the scale of carbon dioxide removal and the time horizon by which SRM could be eliminated without risking overshoot of the 1.5 degrees C goal (stable end-state of the atmosphere).
GHG hierarchy approach (Prioritization)	Plans to address climate change include short-, medium- and long-term absolute emissions reduction targets that limit warming to 1.5°C, ideally with no or, if this is not feasible any more, overshoot limited in extent and time. NOTE In the context of possible climate futures the IPCC in its SPM WG I AR6 specifies the following periods in the 21st century: near-term (2021–2040), mid-term (2041–2060) and long-term (2081–2100)
Ambition	Ambition which delivers significant near— and medium —term emissions reductions with an extent of overshoot that is as small as feasible and not longer than 100 years, stabilizing atmospheric greenhouse gas concentrations at a concentration level that keeps warming below 1.5 degrees C without use of SRM.
Conservativeness	Assumptions, values, and procedures involved in achieving a safe status of the atmosphere after overshooting ensure that the current status and progress towards a stable end-state of the atmosphere are not overstated.
Science-based approach	Decision-making relating to the use of SRM and CDR and the management of the risks linked to overshooting, limiting temperature rise and the protection and improvement of nature, is based on current scientific evidence and indigenous and local knowledge. Decisions align with the principle of equity and justice and take into account fair share and just transition. Decisions are reviewed regularly, and targets, policies and actions are adapted as knowledge and science evolves.

Avoiding adverse impacts (risk-based approach)	Risks related to the use of SRM and CDR, including moral hazard, are assessed and controls are put in place to address them. The risk-based approach takes into account uncertainty, potential negative impacts, unintended consequences and other foreseeable risks. The risks of each action are compared with the risks of not taking action. There is ongoing monitoring of actions taken and a commitment to take urgent corrective action if issues arise.
Credibility	Established credibility through plans and actions based in science and third-party accountability. NOTE Due to the need for accountability over long-term periods (e.g. the next 100 years or even longer) accountability may move from private actors to state actors after a certain period of time.
Equity and justice	Demonstrable commitment to both equity and justice in all actions, in particular in sharing the burden to finance carbon dioxide removal.

NOTE 1
The suggestions included in this table build on the principles/recommendations that have been developed to address issues in the context of carbon neutrality/net zero carbon emissions (see Annex).

NOTE 2
Stratospheric Aerosol Injection (SAI) is one of the approaches of SRM (RFM).

Discussion

1. Climate change risks are increasing significantly. Every 0.1 degree C of global warming matters!
2. Urgent action by all countries is required in order to limit suffering of people all around the world.
3. It will take several generations – or around a century – to get properly rid of the climate change risks.
4. All approaches to limit climate change risks, including SAI, could help to manage climate change risks, provided a governance framework is available that is fit for purpose.
5. Very little time is available to close the current gaps in the governance framework. Application of radiative forcing management could help to buy further time - in the range of a few years [18].
6. Unfortunately, global warming continues up to now at significant speed and the level of 1.5 degrees C will be reached at the latest in the early 2030s , a point in time by which at the latest SAI will have to be deployed in order to avoid crossing of tipping points [19].
7. It will be of utmost importance to adequately address the issue of greenwashing respectively moral hazard in the governance regulations to be developed. Those should definitely include enforcement rules. A recent analysis identified the dimension of greenwashing in the context of carbon neutrality/net zero carbon claims [20].
8. Transformation of human systems to those without net GHG emissions and which are climate resilient as well as upscaling robust and scalable carbon dioxide removal should be of highest priority.
9. Recent guidance documents addressing carbon neutrality/net zero carbon emissions can inform the further development of the existing governance framework.
10. This document suggests a list of principles in order to protect against greenwashing/moral hazard when making use of SAI
11. The availability and willingness of deployment of carbon dioxide removal coupled with permanent safe storage at a scale in the range larger 1 bio t CO2/yr is key to avoid moral hazard and to minimize risks from climate change for natural and human systems. NOTE: Offsetting of residual GHG emissions by carbon dioxide removal combined with permanent carbon storage has also been identified by the co-called Oxford principles as the most sustainable and appropriate approach [12].
12. The time available to develop the necessary governance framework to allow use of SAI is about 10 years. A stepwise approach, starting with principles/recommendations and based on those, and in a second step development of stringent requirements including enforcement rules, is suggested.

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Appendix

This appendix summarizes the principles/recommendations as described in recent documents developed to support achieving carbon neutrality and/or net zero carbon emissions as included in the documents identified in the main text of this paper.

NOTE:

a) Application of principles is fundamental to ensure that the achievement and demonstration of carbon neutrality/net zero carbon emissions/carbon dioxide removal is undertaken in a true and fair manner, is scientifically and technically valid, and is communicated in an accurate and non-misleading way. Principles are the basis for the requirements and guidance. (Based upon ISO 14068)

b) Guiding principles are the foundation for achieving net zero GHG emissions for organizations at every level, through the use of a standard, framework or voluntary initiative. The recommendations provided in the document give guidance on how to take action in alignment with these principles to enable a common and ambitious approach (Based upon IWA 42:2022(E)

c) Integrity matters: this document identifies five principles and 10 recommendations.

Table 1: Principles/recommendations – a compilation in the context of carbon neutrality/net zero carbon

Principle/ Recommendation	**ISO 14068** **Focus: carbon neutrality**	**IWA 42:2022(E)** **Focus: net zero carbon emissions**	**Integrity Matters** **Focus: net zero carbon emissions**
Alignment Announcing a Net Zero Pledge		Policies and guidance align organizations on common climate action approaches (recognizing common but differentiated responsibilities and respective capabilities) to support meeting the goals of the Paris Agreement and any subsequent United Nations global agreements that supersede the Paris Agreement.	A net zero pledge should be made publicly by the leadership of the non-state actor and represent a fair share of the needed global climate mitigation effort. The pledge should contain interim targets (including targets for 2025, 2030 and 2035) and plans to reach net zero in line with IPCC or IEA net zero greenhouse gas emissions modelled pathways that limit warming to 1.5°C with no or limited overshoot, and with global emissions declining by at least 50% by 2030, reaching net zero by 2050 or sooner. net zero must be sustained thereafter

Transparency (Transparency, integrity and accountability), Integrity	Relevant information is disclosed publicly to enable stakeholders to understand all statements concerning a commitment to, and achievement of, carbon neutrality and to make decisions with reasonable confidence.	Information relating to current emissions status, baseline, targets and plans are comprehensive and publicly reported. Independent monitoring is in place to ensure commitments are supported by meaningful actions. Relevant information relating to progress towards achievement of net zero targets by or before 2050 is disclosed to the public regularly. Documented information is accurate, comprehensive and does not overstate achievements. Progress towards interim and long-term targets and associated claims of net zero status are verified through a credible and competent third party. NOTE Some public sector entities monitor, evaluate and report progress through public engagement protocols rather than third-party verification.	Principle Demonstrated integrity by aligning commitments with actions and investments Radical transparency in sharing relevant, non-competitive, comparable data on plans and progress Main Recommendations • Non-state actors must annually disclose their greenhouse gas data, net zero targets and the plans for, and progress towards, meeting those targets, and other relevant information against their baseline along with comparable data to enable effective tracking of progress toward their net zero targets. • Non-state actors must report in a standardised, open format and via public platforms that feed into the UNFCCC Global Climate Action Portal to address data gaps, inconsistencies and inaccessibility that slow climate action. • Non-state actors must have their reported emissions reductions verified by independent third parties. Special attention will be needed to build sufficient capacity in developing countries to verify emission reductions. • Disclosures ought to be accurate and reliable. Large financial and non financial businesses should seek independent evaluation of their annual progress reporting and disclosures, including opinion on climate governance, as well as independent evaluation of metrics and targets, internal controls evaluation and verification on their greenhouse gas emissions reporting and reductions.

Conservativeness	Assumptions, values, and procedures involved in achieving and demonstrating carbon neutrality ensure that the current status and progress are not overstated.		
GHG hierarchy approach (Prioritization) Setting Net Zero Targets	Carbon neutrality is primarily achieved through GHG emission reductions, then GHG removals within the subject's boundaries. Offsetting is only used to counterbalance unabated GHG emissions remaining after those actions.	Reduction of GHG emissions is prioritized for interim and long-term net zero targets, with removals used after all possible emissions reduction actions have been taken, to minimize eventual residual emissions.	Non-state actors must have short-, medium- and long-term absolute emissions reduction targets and, where appropriate, relative emissions reduction targets across their value chain that are at least consistent with the latest IPCC net zero greenhouse gas emissions modelled pathways that limit warming to 1.5°C with no or limited overshoot, and where global emissions decline at least 50% below 2020 levels by 2030, reaching net zero by 2050 or sooner
Supporting Transition	Carbon neutrality takes account of the need for sustainable development and the urgency for a transition away from activities that generate significant GHG emissions and is not used to perpetuate 'business as usual'.		

Ambition	Entities make choices about the subject, their GHG emissions targets and the use of offsetting that 539 represent a high level of ambition in contributing to the achievement of global net zero GHG emissions. Organizations with higher capacity, historical responsibility, or high current emissions, act with higher ambition.	Targets are set to achieve net zero GHG emissions as early as possible. Organizations with higher capacity, historical responsibility or high current emissions take additional and ambitious action to achieve net zero emissions well before the global average. Specific interim targets are derived from long-term targets and take into account all GHG emissions to enable global achievement of net zero and to limit temperature rise to 1,5 °C above pre-industrial levels. NOTE 1 Targets take into account all processes and activities throughout the value chain. NOTE 2 "Pre-industrial levels" refers to the multi-century period prior to the onset of large-scale industrial activity that occurred around 1750. The period 1850 to 1900 represents the earliest period of sufficiently globally complete observations to estimate global surface temperature and is used in the IPCC Sixth Assessment Reports as an approximation for pre-industrial conditions	Ambition which delivers significant near— and medium —term emissions reductions on a path to global net zero by 2050

Urgency	Immediate and ongoing action is taken to contribute to the achievement of global net zero GHG emissions. Interim targets are set to achieve substantial reductions of emissions in the short term and subsequent targets support ongoing action in the long term.	Immediate and ongoing action is taken to effectively contribute to the global efforts to hold the increase in the average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1,5 °C, by organizations achieving net zero GHG emissions as soon as possible and by 2050 at the latest. Organizations set long-term targets to meet net zero by or before 2050, and interim targets to achieve substantial emissions reductions of Scope 1, Scope 2 and Scope 3 emissions by 2030 or earlier. Subsequent targets are no more than five years from the preceding target and support long-term commitments for ongoing action towards and beyond 2050. NOTE In order to make a fair contribution towards global net zero, some organizations, such as those with high current or historical GHG emissions and/or high capacity to act, will need to achieve net zero well before 2050.	
Science-based approach (Decision-making based on scientific evidence and indigenous knowledge)	Carbon neutrality is based on the latest climate science and periodic reviews of climate science (such as IPCC reports) when making decisions.	Decision-making relating to the achievement of net zero by or before 2050, limiting temperature rise and the protection and improvement of nature, is based on current scientific evidence and indigenous and local knowledge. Decisions align with the principle of equity and justice (see 5.9) and take into account fair share and just transition (see 12.2). Decisions are reviewed regularly, and targets, policies and actions are adapted as knowledge and science evolves	

Avoiding adverse impacts (risk based approach)	Measures or activities contributing to carbon neutrality minimize adverse impacts on the environment and society.	Risks related to climate change mitigation actions are assessed and controls are put in place to address them. The risk-based approach takes into account uncertainty, potential negative impacts, unintended consequences and other foreseeable risks. The risks of each mitigation action are compared with the risks of not taking action. There is ongoing monitoring of mitigation actions taken and a commitment to take urgent corrective action if issues arise. NOTE 1 "Unintended consequences" relate to any direct or indirect effect that reduces or eliminates the effectiveness of a mitigation action. For example: — reversal of a removal through non-permanent storage or leakage of GHG emissions; — double-counting of emissions reductions, removals or offset investments made outside the organization's boundaries or influence. Storage permanence relates to risk of reversal. Storage is generally considered at low risk of reversal if no GHG is re-released for at least 100 years after storage or within the lifespan of the GHG being counterbalanced. NOTE 2 Further information on the risks of not taking action is provided in the IPCC Sixth Assessment Report	
Accountability	Accountability for the carbon neutrality claim lies with the entity that controls the subject.		
Value Chain and Life Cycle Approach	Carbon neutrality includes GHG emissions and GHG removals within the whole value chain including upstream and downstream processes.		

Credibility		Mitigation actions can be demonstrated to be real and of high quality, prioritizing significant emissions reductions across all sectors, and are verifiable using internationally accepted accounting standards. GHG emissions removals and offsets address issues of permanence and leakage.	Established credibility through plans based in science and third-party accountability
Equity and justice		Targets and actions align with the United Nations Sustainable Development Goals (SDGs) to support equity and global transition to a net zero economy, and any subsequent UN global goals that supersede the 2030 SDGs. Mitigation actions take a human-centred approach, safeguarding the rights of the most vulnerable people and communities. Activities take into account the burdens and benefits of climate change and ensure that responses, including responsibility for costs, are equitably shared. Mitigation actions take into account the need to preserve or enhance ecosystems and biodiversity. NOTE This principle is based on the IPCC definitions of equity and justice and the IPCC Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services research on nature and climate change linkage	Demonstrable commitment to both equity and justice in all actions
Achievement and continuation of net zero		Action is taken at all levels in accordance with the principles of equity and justice (see above), including fair share, to ensure all feasible GHG emissions reductions are made and residual emissions are balanced by permanent or sufficiently long-term removals to counterbalance the GHG emissions. On achieving net zero, actions are taken towards reaching negative GHG emissions	

Using Voluntary Credits			• Non-state actors must prioritise urgent and deep reduction of emissions across their value chain. High integrity carbon credits in voluntary markets should be used for beyond value chain mitigation but cannot be counted toward a non-state actor's interim emissions reductions required by its net zero pathway. • High-integrity carbon credits are one mechanism to facilitate much needed financial support towards decarbonizing developing country economies. As best-practice guidelines develop, non-state actors meeting their interim targets on their net zero pathway are strongly encouraged to balance out the rest of their annual unabated emissions by purchasing high-integrity carbon credits. • A high quality carbon credit should, at a minimum, fit the criteria of additionality (i.e. the mitigation activity would not have happened without the incentive created by the carbon credit revenues) and permanence
Creating a Transition Plan			Non-state actors must publicly disclose comprehensive and actionable net zero transition plans which indicate actions that will be undertaken to meet all targets, as well as align governance and incentive structures, capital expenditures, research and development, skills and human resource development, and public advocacy, while also supporting a just transition. Transition plans should be updated every five years and progress should be reported annually.

Phasing Out of Fossil Fuels and Scaling Up Renewable Energy			All net zero pledges should include specific targets aimed at ending the use of and/or support for fossil fuels in line with IPCC and IEA net zero greenhouse gas emissions modelled pathways that limit warming to 1.5°C with no or limited overshoot, with global emissions declining by at least 50% by 2030, reaching net zero by 2050. • The transition away from fossil fuels must be just for affected communities, workers and all consumers to ensure access to energy, and avoid transference of fossil fuel assets to new owners. • The transition away from fossil fuels must be matched by a fully funded transition toward renewable energy.
Aligning Lobbying and Advocacy			Non-state actors must align their external policy and engagement efforts, including membership in trade associations, to the goal of reducing global emissions by at least 50% by 2030 and reaching net zero by 2050. This means lobbying for positive climate action and not lobbying against it.

People and Nature in the Just Transition			• As part of their net zero plans, businesses, cities and regions with material land-use emissions must achieve and maintain operations and supply chains that avoid the conversion of remaining natural ecosystems— eliminating deforestation and peatland loss by 2025 at the latest, and the conversion of other remaining natural ecosystems by 2030. • Financial institutions should have a policy of not investing or financing businesses linked to deforestation and should eliminate agricultural commodity-driven deforestation from their investment and credit portfolios by 2025, as part of their net zero plans.
Investing in Just Transitions			To achieve net zero globally, while also ensuring a just transition and sustainable development, there needs to be a new deal for development that includes financial institutions and multinational corporations working with governments, Multilateral Development Banks and Development Finance Institutions to consistently take more risk and set targets to greatly scale investments in the clean energy transition in developing countries.

An additional comparison, e.g. at the level of requirements, is not possible because only ISO 14068 includes such "shall" requirements whereas IWA 42 as well as the "Integrity Matters" document only include recommendations[21-23].