

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
45787	0	0			The dependence on large-scale (and as yet in large parts not available) CDR options in the IAMs needs please to be mentioned in more detail throughout Ch. 3 as there is an implicit impression that CDR is already a portfolio of immediately available solutions to meet the climate targets - diminishing and postponing the need for mitigation for short-term scenarios. In this regard, more cross-references to Chapter 3.5.2.1 would be useful.	Noted. The text has been substantially revised in response to reviewer comments.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
45789	0	0	0	0	The methods of assessment and the gaps in knowledge and data given in section 3.9 should be referenced widely and prominently in the whole WGIII AR6 report. Beyond representing methodical explanations, they give guidance on how the results of the models described in chapter 3 and used in many other chapters are to be interpreted. Such information will be extremely valuable for policymakers. However, so far it is lacking in the SPM (see also Chapter 3.7.7). We therefore urge the authors to add a box to the SPM explaining models, scenarios and pathways that support this assessment as well their advantages and limitations. Please see also our comment on the "knowledge gaps" on the Entire Report".	Noted. The text has been substantially revised in response to reviewer comments.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
45791	0	0	0	0	Chapter 3: Please make sure to provide consistent numbers for CO2/GHG reduction levels to achieve certain temperature targets. For net-zero targets, please specify whether this entails a linear progression or rather a long tail progression. Net-zero dates without this information could be misleading with regards to the required mitigation effort.	Noted. The text has been substantially revised in response to reviewer comments.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
65517	0	0	0	0	Several abbreviations are used without introducing the whole name of them, especially in the "Executive Summary", making it a bit difficult to read for general public.	Noted. The text has been substantially revised in response to reviewer comments.	Cristian Chadwick	University of Chile	Chile
65533	0	0	0	0	When we get to subsection in the fourth category, we have differences between subsections. For example, in subsection 3.2.1 has subsections without numbering, while section 3.3.2.1 exist. Is this correct? Or the subsections under 3.2.1 should also have numbering?	Noted. The text has been substantially revised in response to reviewer comments.	Cristian Chadwick	University of Chile	Chile
65551	0	0	0	0	There are last names such as "Van Ruijven" that in some places are written with lower case, while in other with upper case "Van Ruijven" or "van Ruijven".	Noted. The text has been substantially revised in response to reviewer comments.	Cristian Chadwick	University of Chile	Chile
65569	0	0	0	0	Most of the references with two authors use and, but there are some with &, for example "Muldoon-Smith & Greenhalgh (2019)" reference in page 71, line 2.	Noted. The text has been substantially revised in response to reviewer comments.	Cristian Chadwick	University of Chile	Chile
72179	0	0			The regional net-zero timing is extremely problematic and, could be interpreted as being highly policy prescriptive. Net-zero goals are a focal point of climate policy. The regional timings given here, however, are the outcomes of globally optimizing models and the regional CDR distribution in such models (which also differs widely – see e.g. Seneviratne et al 2018). But indicating that LAM (or in extreme cases even Africa, 1.5NBZ) needs to be net-zero before OECD is extremely unrealistic – and in direct contradiction with the language in PA Article 4.1a. It, however, illuminates a key problem of the net-zero focus – that the accounting of sources and sinks on anything than the global level comes with all kinds of issues. Fyson et al. (2020) or Pozo et al. (2020) have deployed equity concepts to illustrate the implications of equity and fairness in this context. The authors should reflect very critical on how to communicate these findings and might find it advisable to not present regional net-zero targets, but rather separate regional emission reduction targets and global CDR needs or else.	Noted. The text has been substantially revised in response to reviewer comments.	Carl Schleusner	Climate Analytics	Germany
72181	0	0			Similarly, to the interregional layout, the sectoral assessment is problematic. Because CDR is possible in some sectors, in some it is not. Assessment in separation thus doesn't make much sense or, if anything, could run the risk of misinterpretations in terms of sectoral ambition levels. Again, it is recommended to separate out emission sources and CDR here.	Noted. The text has been substantially revised in response to reviewer comments.	Carl Schleusner	Climate Analytics	Germany
72183	0	0			In general, the whole report and the SPM are in a very good shape and I would like to thank the author team for all their hard work. I want to highlight two major issues, to them, though. The policy context of net-zero starts to play out highly problematically in climate policy largely due to the ambiguity of how to balance sources and sinks (see e.g. all kinds of companies coming forward with offset based net-zero targets). The report stumbles over several of the related issues. The NBZ zero IPs are quite strange, and the regional and sectoral net-zero timings just outright dangerous to present to policy makers, in my view. I therefore strongly suggest a critical reflection on the use of the net-zero concept and for all sub-global analysis a separation of emission reductions and removals. I would even go as far as to suggest the inclusion of a box in the SPM on net zero.	Noted. The text has been substantially revised in response to reviewer comments.	Carl Schleusner	Climate Analytics	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
72185	0	0			In general, this chapter is in a very good shape and I would like to thank the author team for all their hard work. I, however, want to highlight one major issue in my view. The policy context of net-zero starts to play out highly problematically in climate policy largely due to the ambiguity of how to balance sources and sinks (see e.g. all kinds of companies coming forward with offset based net-zero targets). The report stumbles over several of the related issues. The NBZ zero IPs are quite strange, and the regional and sectoral net-zero timings just outright dangerous to present to policy makers, in my view. I therefore strongly suggest a critical reflection on the use of the net-zero concept and for all sub-global analysis a separation of emission reductions and removals. I would even go as far as to suggest the inclusion of a box in the SPM on net zero.	Noted. The text has been substantially revised in response to reviewer comments.	Carl Schleusner	Climate Analytics	Germany
79851	0	0	0	0	net-zero carbon involves non-CO2 emissions. Suggest including net-zero carbon in the Glossary and use the terms such as net-zero CO2 emissions, net-zero carbon emissions, net-zero carbon system carefully so as to not confuse readers.	Noted. The text has been substantially revised in response to reviewer comments.	Madoka Yoshino	United Nations University Institute for the Advanced Study on Sustainability	Japan
81151	0	0			Terminology: the chapter in some places refers to pathways that limit warming to X degrees, and in other places to limit warming to below X degrees. The latter strikes me as confusing - a limit in itself implies that the outcome is at or below the stated level. Also it is misleading and potentially incorrect for 1.5 degree pathways, which in most cases do not fall below 1.5 degrees at their peak but actually exceed it (despite the wording). I suggest authors adopt consistently the wording "limit peak warming to X degrees with Y probability" or "likely limit peak warming to X degrees" for all temperature statements to provide a consistent terminology. And make sure to always include overshoot in this statement where this is embedded (i.e. for 1.5°C pathways).	Noted. The text has been substantially revised in response to reviewer comments.	Andy Reisinger	Ministry for the Environment	New Zealand
81155	0	0			The chapter jumps back and forth between characterising emissions consistent with long-term temperature outcomes based on GHG and CO2, including on net-zero. It's clear that both are relevant and are different, and hence both need to be discussed - but please do this in a more systematic, consistent and transparent manner. There is a high risk that readers will interpret some figures and statements as referring to CO2 even though they are about GHG, and vice versa, and some will focus only on CO2 whereas others will focus only on GHG and get very different key messages.	Noted. The text has been substantially revised in response to reviewer comments.	Andy Reisinger	Ministry for the Environment	New Zealand
81157	0	0			I had understood and hoped that Chapter 3 would include a box on net-zero emissions (which could build on and complement a box on net-zero in the final draft of WGI - Box 1.4). I would consider such a box an extremely useful addition for the final draft and I urge the authors to make its development a priority, drawing on inputs from authors from other chapters and other WGs as appropriate. There is a lot of confusion and misunderstanding out there about the different roles and requirements for net-zero (CO2 or GHG), and this chapter can do more to avoid this confusion by (a) ensuring a more consistent and transparent treatment of CO2 and GHG emissions, and (b) condensing key issues around net-zero into a dedicated box. I'd be very happy to help with this. Note WGI now has a box (1.4) on net zero in its final draft that will serve as a useful starting point for this.	Noted. The text has been substantially revised in response to reviewer comments.	Andy Reisinger	Ministry for the Environment	New Zealand
81169	0	0			It seems the chapter uses in some places 5-95 percentiles and in others 10-90 percentiles to report ranges. This is confusing and unless there is a very good reason for it, I would recommend that the authors settle on one or the other. Also, there may be instances (for some key variables) where reporting interquartile values in addition to the 9-95, or 10-90, percentiles would be useful. Especially 9-95 percentile values can be skewed heavily by just a few outliers especially where the total number of scenarios is limited (or the ensemble is dominated by a large number of scenarios with a specific feature), so providing information on the interquartile range would offer additional information.	Noted. The text has been substantially revised in response to reviewer comments.	Andy Reisinger	Ministry for the Environment	New Zealand
83645	0	0	0	0	There is much progress on the categories/bins for the global emissions pathways. However, I find the terminology still too close to be policy prescriptive. The PA uses "well below", and the chapter 3 uses "below" throughout. First I doubt this is mathematically correct as \leq is IMHO not the same as $<$. Secondly, in the policy making context I read/hear often just "below" when citing the PA Art.2, which is of course not correct, but makes then the terminology of this table identical to such misunderstandings. I therefore urge authors to consistently use new terms such as "less or equal to" instead of "below".	Noted. The text has been substantially revised in response to reviewer comments.	Andreas Fischlin	IPCC Vice-chair WGII, ETH Zurich	Switzerland

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
83659	0	0	0	0	<p>The chapter uses the term 'target' many many times. I believe in general this term is lacking the necessary sharpness that is needed in a policy making context.</p> <p>'Temperature target' can always be replaced by 'temperature limit' and avoids already many of the problems the term 'target' creates. The climate change policy making does not aim at warming targets the globe should reach for sure and as if this would be desirable to reach such a warming. Unfortunately this misleading term "target" is used a lot, not only in this chapter, but also in the scientific literature, while actually the UNFCCC including its PA aim at limiting global warming. A real long-term warming level that may well differ from the limit as agreed in the PA has not yet been discussed seriously, let alone agreed on. Only for warming limits exists consensus. Therefore please do not use this term 'target' when you can as well use the term 'limit'.</p> <p>'Climate target' is generally questionable as its meaning is unclear. Here the question arises whether 'climate target' means an overarching climate policy that aims for mitigation as well as adaptation policies as e.g. described in the Paris Agreement (PA), policies which include to limit warming to well below 2°C with efforts to limit to 1.5°C. Authors need to understand that the majority of developing countries (Non Annex I) understand with a Long-term Global Goal much more than merely limiting warming. In such an understanding important aspects such as substantive financial flows matter in addition to merely limiting warming. Or perhaps 'Climate target' means 'temperature limit' (for sure the case on page 70, line 44). If the latter, then please write 'temperature limit' so that the text becomes clearer and is easier to understand.</p> <p>The majority of uses of the word 'target' in this chapter are questionable. I do here not list them all and trust the authors can search for them systematically themselves and fix the bad uses of this term for clearer wordings whenever appropriate. Thanks.</p>	Noted. The text has been substantially revised in response to reviewer comments.	Andreas Fischlin	IPCC Vice-chair WGII, ETH Zurich	Switzerland
85135	0	0	0	0	Dear authors, thank you very much for a very clear and excellent Chapter 3. It is very insightful and contains a wealth of policy relevant information. This is IPCC work at its best ;)	We thank the reviewer very much for his very positive comment.	Jens Tambke	Umweltbundesamt	Germany
85755	0	0	0	0	<p>To strengthen the information presented in this chapter, it would be helpful to include an adequate assessment of literature that better explains to governments the assumptions inherent in Integrated Assessment Models which may limit their utility. This area of science is complex; policymakers are looking for information that can help us understand IAM assessments. For example, what are the assumptions in the model inputs, in overshoot pathways, or CDR late century? This chapter is dominated by IAM analysis, and a critique of the IAMs' limitations is given disproportionately limited space.</p> <p>The approved outline for Chapter 3 seeks information on: 'Methods of assessment, including approaches to analysis of mitigation and development pathways; Socio-cultural-techno-economic assumptions.... and Risk analysis of emission pathways considering uncertainty about climate response.' Suggest that authors provide further transparency and analysis to support policymakers.</p> <p>See for example: Butnar I. et al. 2019 A deep dive into the modelling assumptions for biomass with carbon capture and storage (BECCS): a transparency exercise Environ. Res. Lett. 15 (2020) 084008 https://doi.org/10.1088/1748-9326/ab5c3e. Nikas A. et al. 2021 Perspective of comprehensive and comprehensible multi-model energy and climate science in Europe. Energy 214 (2021) 119153 https://doi.org/10.1016/j.energy.2020.119153; John Bistline, Mark Budolfson & Blake Francis (2021). Deepening transparency about value-laden assumptions in energy and environmental modelling: improving best practices for both modellers and non-modellers, Climate Policy, 21:1, 1-15, DOI: 10.1080/14693062.2020.1781048</p>	Noted. The text has been substantially revised in response to reviewer comments.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
85923	0	0	0	0	Suggest that the chapter as a whole needs a better explanation of the Illustrative Pathways (IPs). In particular for readers who may already be somewhat familiar with RCPs and SSPs, how do the 'IPs' differ from those earlier pathways? What do they add in terms of sectoral or regional granularity that the SSPs and RCPs do not present? Chapter 1, pp. 1-21 through 1-23 does some of this explanation, but it could be expanded upon in this chapter.	Noted. The text has been substantially revised in response to reviewer comments.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
85925	0	0	0	0	Suggest that the chapter as a whole, for greater clarity and readability, could adopt a consistent terminology around probabilities of remaining below warming thresholds. E.g. in some places the phrase 'likely chance' is used; it's not clear if this refers to a 67% chance or other probability.	Noted. The text has been substantially revised in response to reviewer comments.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
85927	0	0	0	0	The chapter could clarify and ensure consistency of the use of the term "baseline scenario".	Noted. The text has been substantially revised in response to reviewer comments.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
1773	0				<p>Chapter 3 provides a rigorous and excellent review of the latest literature on mitigation pathways compatible with long-term goals and is generally written in a very accessible manner. However, there are some areas in which improvements relating to clarity and overall coherence could be pursued further. These include:</p> <ul style="list-style-type: none"> - Probabilities: the chapter almost exclusively adopts 50% probability related to 1.50C scenarios, with 20C scenarios generally provided for a 66% probability. While there may be good reasons for this, such as a smaller number of scenarios available for 1.50C pathways, it is not explained in the report. A better description of probabilities and results for various levels of probabilities would enrich the chapter. - Links to the Paris Agreement long term temperature goals and the use of "well below 20C": well below 20C is introduced and used throughout the chapter without any definition. The definition only becomes apparent in the table on page 25 of the chapter, where it is simply used for scenarios that keep global warming below 2 below 20C with 67% probability. Combined with the paragraph on page 11, which clearly outlines the controversies and weaknesses around the well below issue, there is a strong case for refraining from using the well below 20C terminology in the chapter/report. There is no consensus and weak scientific justification. - Implications of postponed/limited near-term action: there is excellent discussion of this very important issue, but it is currently presented in a very scattered way across sections, which runs the risk of making the findings less powerful. It would be advisable to pulling some of the main messages around this better together, including in the executive summary. - Scenarios: The chapter could provide a clearer description of the IAM scenario base used (including issues of which scenarios are included, such as whether these still include scenarios that assume peak emissions in 2010), the SSPs, the IPs and the linkages between and use of these. - Section 6.3 on economy wide effects would benefit from a more direct comparison and comparability across the sub sections on costs and benefits. Currently, such comparison is prohibited by the metrics used and obviously also by the literature available. - Feasibility: the section on feasibility comes very late and adopts a style that is quite different from the sections that go more into the scenario work. It could be beneficial to integrate the feasibility discussion into the scenario sections. <p>Finally, in general the key messages from chapter 3 are presented in a clearer and better way in the SPM than in the chapter. In some cases, there seems to be slight discrepancies between the SPM and the chapter main text. For example, Chapter 3.3 seems more vague about when below 2C scenarios peak, saying they mostly peak before 2030. The SPM seems more accurate. Similarly, the SPM seems clearer with respect to the time at which net zero must be reached and on the emissions associated with 2 and 1.5C pathways.</p>	Noted. The text has been substantially revised in response to reviewer comments.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
9663	0				<p>There seems to be a lot of focus on the literature which tries to underestimate mitigation costs and overestimates benefits setting aside the large body of literature accumulated over decades on mitigation costs and economic impacts of stringent GHG emissions reductions. May be more balanced assessment of the literature is needed.</p>	Noted. The text has been substantially revised in response to reviewer comments.	Mustafa Babiker	Saudi Aramco	Saudi Arabia
14933	0				<p>Pathway classification and illustrative pathways are at the core of the chapter and need to be revised in parts as commented in the SPM. For the classification, some of the labels are seen as problematic, particularly the high overshoot 1.5°C label cannot stay for the same reasons it was removed from SR1.5. Also, if understood correctly, there is a need to reconsider the "below X°C" category label as this basically only covers pathways staying below X°C with a 50/50 chance, which can be hardly summarised as truly "below". Please also reconsider the number of illustrative pathways. To be indeed illustrative, fewer example pathways should be selected.</p>	Noted. The text has been substantially revised in response to reviewer comments.	Government of Saint Kitts and Nevis	Department of Environment - Ministry of Agriculture, Marine Resources, Cooperatives, Environment and Human Settlements	Saint Kitts and Nevis
15221	0				<p>Many countries have announced their targets to achieve carbon neutrality or near-zero emissions by mid-century. It is suggested that the report give additional references on the assessment of the effects of these updated targets, or comparisons with updated targets based on existing studies, to clarify the contribution and gaps of carbon neutral or near-zero emission targets to achieving long-term temperature control goals.</p>	Noted. The text has been substantially revised in response to reviewer comments.	Government of China	China Meteorological Administration	China
15223	0				<p>The descriptions of the impact of short-term goals in Chapters 3 and 4 are relatively similar, and it is suggested to compress the length and avoid duplication in these two chapters.</p>	Noted. The text has been substantially revised in response to reviewer comments.	Government of China	China Meteorological Administration	China
23539	0				<p>A key perspective that is missing in Section 3.7.5 Biodiversity (land and water) and which should be included is an overview of the literature that points to the highly deleterious impacts that the large-scale deployment of some climate mitigation and CDR land-use measures such as BECCS/bioenergy is set to have on biodiversity. (cf Santangeli, A., et al. (2016) Global change synergies and trade-offs between renewable energy and biodiversity. GCB Bioenergy, 8(5), 941–951. and Hof, C., et al. (2018). Bioenergy cropland expansion may offset positive effects of climate change mitigation for global vertebrate diversity. Proceedings of the National Academy of Sciences, 115(52), 13294–13299)</p>	Noted. The text has been substantially revised in response to reviewer comments.	Government of France	Ministère de la Transition écologique et solidaire	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
23541	0				In this chapter, the mitigation pathways for the AFOLU sector remain very much oriented towards afforestation/reforestation and BECCS (see Section 3.4.5). The chapter does not consider possible emissions reductions from efficiency gains, including the pathways to increase food production without expanding agricultural land. There is very little on non-CO2 gases whose emissions remain surprisingly constant, while substantial potential for cost-effective emissions reductions have been identified, e.g., regarding the methane emissions from livestock production. This chapter therefore seems to retain only a small part of the reduction potentials identified in Chapter 7	Noted. The text has been substantially revised in response to reviewer comments.	Government of France	Ministère de la Transition écologique et solidaire	France
23543	0				The scenario modelling in this chapter often includes CDR options, but it is sometimes done at the expense of demand-side mitigations options. Also, CDR options are often assumed to be readily available, along with the speculation on “early deployment”, both of which bear the risk of being misleading.	Noted. The text has been substantially revised in response to reviewer comments.	Government of France	Ministère de la Transition écologique et solidaire	France
23545	0				It is suggested to create a box with the presentation of all the costs of different kinds (mitigation costs, macroeconomic costs, welfare costs, co-benefits, damage costs, adaptation costs) that must be considered around these trajectories and the way in which they are taken into account (with their limits) or not in the modelling exercises, just as it would be relevant to have a summary of all these costs. A cross-reference to the sections of chapters in which each of these costs are addressed would also be useful. This also applies to the SPM and the TS.	Noted. The text has been substantially revised in response to reviewer comments.	Government of France	Ministère de la Transition écologique et solidaire	France
24903	0				The chapter flows well and includes a lot of useful information - well done. However, it should be made clear that, for CO2 AFOLU, estimates provided here are not fully comparable with LULUCF in GHG inventories (GHGI) and thus in national climate plans (a gap of > 5GtCo2/y exists between IAMs and GHGI in the period 2010-2020, see box 5, ch 7) . This is not a criticism to IAMs or to GHGIs, but just a factual and policy-relevant observation. This is acknowledged in Ch 7 and in the Glossary; in the SPM of IPCC SRCCCL and in the SPM of SR 1.5C; and is an issue of concern under UNFCCC (in light of the GST starting in 2022). The IAMs' emission pathways and the associated remaining global carbon budgets have an enormous conceptual importance for climate policy. To be fully useful as a benchmark, however, these pathways/ budgets should be conceptually comparable with national GHG inventories / climate targets, which are the basis for any climate policy and for checking compliance towards the PA targets. For the AFOLU CO2 (LULUCF), this comparability is still largely lacking (see Chapter 7). This should be noted very clearly in the executive summary, in ch 3.4.5 (AFOLU) and if possible in all the figure / table legends where AFOLU estimates are shown. A standard sentence can be used is "AFOLU CO2 estimates included in this chapter are not necessarily comparable with country GHG inventories, due to different approaches to estimate the 'anthropogenic' CO2 sink (see Chapter 7.2.2.5)". Furthermore, the possible way forward to reconcile IAM and GHGIs proposed in Cross-chapter Box 5 in chapter 7 is very relevant also for this chapter. An explicit reference to this box is needed. Possible text for consideration could be: "Adjusting global models' results to make them more comparable with national GHG inventories is possible (see Cross-Chapter Box 5 in Chapter 7) and would enable a more accurate assessment of collective progress towards the Paris Agreement's climate goals."	Noted. The text has been substantially revised in response to reviewer comments.	Giacomo Grassi	Joint Research Centre, European Commission	Italy
28661	0		0		The IEA has produced two very relevant and influential reports on emissions reductions from the energy system to achieve net zero scenarios but these are not mentioned anywhere. IEA Energy Technology Perspectives 2020 should be read by all authors, and IEA Special Report on CCUS (2020) by those covering CCUS aspects.	Noted. The text has been substantially revised in response to reviewer comments.	Tim Dixon	IEAGHG	United Kingdom (of Great Britain and Northern Ireland)
31049	0				The role of military contributions to greenhouse gas emissions are mostly missing from Chapter 3: Mitigation Pathways Compatible with Long-Term Goals. Since global military emissions are so large, a detailed treatment ought to be included here. It's absence erodes trust in the ability of the report to do its work.	Noted. However, public information on this in the peer reviewed literature is almost absent.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
31441	0				We would like to flag one concerning aspect regarding the illustrative pathway selection at this high level already. It is very much unclear what the added value of the NBZ pathway group is. NBZ pathways assume enormous amounts of negative emissions to offset large remaining fossil fuel emissions and should not be presented alongside illustrative pathways that are actual 1.5dec/2degC pathways to avoid the misunderstanding that these NBZ pathways would be equally acceptable. It is useful to discuss these pathways, of course, but not as illustrative pathways.	Noted. The text has been substantially revised in response to reviewer comments.	Government of Palau	Government	Palau
37003	0				This is a general comment for the whole chapter. Nuclear energy is generally missing when different configurations are mentioned for a net-zero carbon system.	Noted. However, nuclear energy is normally not seen by IAMs as a least-cost mitigation option according to the peer reviewed literature..	Emilio Minguez	Universidad Politécnica de Madrid (UPM)	Spain

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
47431	0				As Chapter 3 is the home for the pathway classification and illustrative pathway selection, we would like to flag as a general comment that we are concerned about the inclusion of a high overshoot 1.5°C category and would suggest its removal/relabeling (similar to SR1.5). Also, we feel that the number of illustrative pathways is too large to be illustrative and would suggest to remove the NBZ categories, in particular, because they are not consistent with Art. 4 of the Paris Agreement.	Noted. The text has been substantially revised in response to reviewer comments.	Government of Saint Lucia	Department of Sustainable Development - Ministry of Education, Innovation, Gender Relations and Sustainable Development	Saint Lucia
47733	0				Does zero net emission in long term will	Thank you. Comment is incomplete as it continues below.	Yulizar Yulizar	Universitas Pertamina	Indonesia
47735	0				influence a decreasing of emission globally?	Thanks for the comment. When net zero CO2 is reached temperature peaks and then stabilizes.	Yulizar Yulizar	Universitas Pertamina	Indonesia
50173	0				Thank you to the authors for the hard work put into this draft. We would like to suggest some reflections on the pathway selection and categories, and the current representation of the timing of net-zero emissions for different regions. More specific comments are provided in the following.	Noted. The text has been substantially revised in response to reviewer comments.	Anna Main	Ministry of Foreign Affairs and Trade	Samoa
52031	0				Scenarios in this chapter must serve the Paris Agreement and the convention, not just PA. As it is reflected frequently in the chapter, the comparison of scenarios is solely against PA goals. Rephrase to give focus to the convention.	Noted. The text has been substantially revised in response to reviewer comments.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
52037	0				The Cost analysis comparing scenarios (e.g. Pathways, Sectoral Scenarios etc.) should be included and broken down.	Noted. The text has been substantially revised in response to reviewer comments.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
52041	0				Scenarios and Pathways must always be compared to the different temperature scenarios (1.5 & 2 and above). E.g, Sectoral Final energy are only performed on 1.5 scenarios (Figure 3.25). Include all scenarios.	Noted. The text has been substantially revised in response to reviewer comments.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
61619	0				The chapter refers to “renewable energy” throughout in regards to climate mitigation, even though it would be much more accurate and scientifically correct to use “low carbon”. Renewable energy includes unsustainable and problematic – even high climate impact – energy sources while it also excludes one of our most potential low-carbon energy source nuclear energy. See more on the problems of the term “Renewable energy” and why “low carbon” should be used instead from Harjanne and Korhonen, 2018, https://doi.org/10.1016/j.enpol.2018.12.029	Noted. Chapter relies 100% in the peer-reviewed literature, and most IAMs do not see nuclear energy as a cost-effective technology to mitigate climate change as compared to most renewable energy technologies.	Rauli Partanen	Think Atom	Finland

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
66879	0				Nuclear as a clean technology Nuclear technology is one of the only technologies in widespread use that manages its complete lifecycle including the handling of waste products. In contrast to the conventional view of nuclear waste as an “unsolved problem”, extensive research has established long-term options for storage and disposal – and nuclear operators world-wide set aside funds for this. And world-wide, nuclear waste materials, and potentially recyclable materials such as used fuels, are being stored safely with no impacts on the environment. Less well-known: nuclear energy technology uses fewer resources including raw materials and land area per unit of energy production than other technologies including fossil, hydro, wind and solar. And, importantly, nuclear as a base-load technology places far less pressure on expanding grid resilience, and in particular on electricity or energy storage facilities, which themselves require very dramatic increases in raw material requirements.	Styji3%Hmfuyjw%wjgajx% 655*%ns%ymj%ujjw2 wj{nj ji%qnyjwfyzwj1%fsi% rtxy%NFRx%it%sty%xj% szhgjfw%jsjwl-%fx%F% htxy2jkkjhyn{j% yjhmqstql-%yt%rnynlfyj% hqnrfyj%hmfslj%fx% htrufwj%yt%rtxy% wjsj fgqj%jsjwl-% yjhmqstqlnjx3	Jerry Hopwood	President, UNENE (University Network of Excellence in Nuclear Engineering)	Canada
66887	0				Nuclear alignment with SDG's; We recognize that the United Nations' Sustainable Development Goals represent a well-known definition of crucial aspirations for all organizations and groups seeking a better world. Comparing nuclear technologies and enterprises to these goals is a way of studying the level of benefits that can be achieved. The International Atomic Energy Agency, as a UN organization, takes these goals to heart, and has published a comparison of nuclear technologies to the SDG's (Reference below). The report notes the strong alignment of nuclear technologies to these goals, noting the close connection between nuclear power technologies and the production and use of vital and beneficial medical isotopes, and the ability of nuclear technology to deliver crucial attributes such as clean drinking water. Reference for example: IAEA Report: Nuclear Power and Sustainable Development, September 2016	Styji3%Hmfuyjw%wjgajx% 655*%ns%ymj%ujjw2 wj{nj ji%qnyjwfyzwj1%fsi% rtxy%NFRx%it%sty%xj% szhgjfw%jsjwl-%fx%F% htxy2jkkjhyn{j% yjhmqstql-%yt%rnynlfyj% hqnrfyj%hmfslj%fx% htrufwj%yt%rtxy% wjsj fgqj%jsjwl-% yjhmqstqlnjx3	Jerry Hopwood	President, UNENE (University Network of Excellence in Nuclear Engineering)	Canada
66889	0				Nuclear in combination with other low-zero carbon technologies; Electricity has become a ubiquitous and essential source of energy partly because of its ready availability to the end-user. This requires power availability in predictable ways and on-demand. While improvements in storage technologies will help smooth out the inherent intermittent, unpredictable nature of the principal future renewable technologies, there will be limitations of cost, resource availability which severely restrict the ability to deliver power in the most beneficial way for society. It is difficult to imagine a world benefiting from this essential energy source without some dispatchable, reliable source of base-load power. Therefore, as the principal source of clean, non-GHG dispatchable power, nuclear represents a natural ally and counterpart to renewable technologies in providing electricity and power in a net-zero world. Many nuclear specialists recognize this and are working on how to deliver electricity from combined nuclear-renewable hybrid systems. We believe it is vital that, in context of the IPCC report message of urgency, an “all-of-the-above” approach, recognizing the essential contribution of all non-GHG technologies, must be taken. Reference for example: “How nuclear hybrids could redefine the industry's future” Sonia Patel, Power Magazine, August 2019.	Styji3%Hmfuyjw%wjgajx% 655*%ns%ymj%ujjw2 wj{nj ji%qnyjwfyzwj1%fsi% rtxy%NFRx%it%sty%xj% szhgjfw%jsjwl-%fx%F% htxy2jkkjhyn{j% yjhmqstql-%yt%rnynlfyj% hqnrfyj%hmfslj%fx% htrufwj%yt%rtxy% wjsj fgqj%jsjwl-% yjhmqstqlnjx3	Jerry Hopwood	President, UNENE (University Network of Excellence in Nuclear Engineering)	Canada
71253	0		0		General comment on 1.5°C scenarios The treatment of the most ambitious scenarios needs a re-think, since the current classification sends mixed messages to policymakers and society. In the current Table 3.2, the most ambitious of the "C" scenarios is C1, a 50% chance of 1.5°C with low or no overshoot. However, several other diagrams show the (presumably more ambitious) scenario 1.5-NBZ. Why is 1.5-NBZ (or another ambitious scenario such as 66% chance 1.5°C) not featured in Table 3.2? Is it because of feasibility? If so, then is it appropriate to include 1.5-NBZ in the other figures such as 3.12 & 3.13?	Noted. The text has been substantially revised in response to reviewer comments.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
72817	0				An overarching comment on Chapter 3. The usefulness of illustrative pathways reduces with the number of them. Are these pathways at all indicative of the wider set they are 'illustrating'? Why are so many 1.5C pathways infused with residual fossil fuel CO2? Suggestion: Target pathways consistent with PA which are somehow indicative statistically across a range of indicators.	Noted. The text has been substantially revised in response to reviewer comments.	Matthew Gidden	Climate Analytics	Germany
72823	0				A general comment on the Illustrative Pathways. The AIM model is used to supply both the 1.5C supply and NBZ scenarios. There is clear bias in this model's results towards strong negative emissions in Africa in order to balance positive emissions in the OECD (e.g. see Figure 3.12). This again elides the suggestion to reduce the number of illustrative pathways and for them to be representative of the overall scenario and model set.	Noted. The text has been substantially revised in response to reviewer comments.	Matthew Gidden	Climate Analytics	Germany
75971	0				The ES is quite long and you may consider inserting some headings/titles to indicate grouping and structure (e.g., timing, sectors, costs, feasibility).	Noted. The text has been substantially revised in response to reviewer comments.	Jan Fuglestedt	CICERO	Norway
75973	0				I think you need to define GHG early; i.e., which gases you include when you write GHG	Noted. The text has been substantially revised in response to reviewer comments.	Jan Fuglestedt	CICERO	Norway

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
75975	0				Very often it is referred to AR6 when you mean (as far as I can see) the WGIII contribution. Please make that clear. As it is now in some places, it may be understood as all WGs	Noted. The text has been substantially revised in response to reviewer comments.	Jan Fuglestedt	CICERO	Norway
75977	0				A discussion of timing on SLCF mitigation (mainly CH4) would be useful. Sorry if I overlooked something.	Noted. The text has been substantially revised in response to reviewer comments.	Jan Fuglestedt	CICERO	Norway
75983	0				I think the chapter would benefit from more systematic and consistent use of the terms net zero CO, net zero GHG, carbon neutrality and GHG neutrality. Please see glossary.	Noted. The text has been substantially revised in response to reviewer comments.	Jan Fuglestedt	CICERO	Norway
76139	0				On overshoot scenarios: You may refer to finding and statement on this in WGI Ch4. That will show consistency across the two WGs also on this issue.	Noted. The text has been substantially revised in response to reviewer comments.	Jan Fuglestedt	CICERO	Norway
81869	0				Thank you to the authors for the hard work put into this draft. We would like to suggest some reflections on the pathway selection and categories, and the current representation of the timing of net-zero emissions for different regions. More specific comments are provided in the following.	Noted. The text has been substantially revised in response to reviewer comments.	Francella Strickland	Ministry of Foreign Affairs and Trade	Samoa
5247	1	1	168	30	After lecture of the whole chapter, I have the strong feeling that the content is not correctly balanced between renewable and nuclear. To often, when speaking of electricity or heat production, the authors refers only to "renewables", specially wind and solar. It is clear that antinuclear lobbyist are very active, promoting the use of gas, solar and wind, but IEA and other international offices announce nevertheless a substantial increase in nuclear production worldwide. So, I have proposed in some case corrections to refer to nuclear besides renewable energy. If the word "Nuclear" hurts the author, you may use "low carbon production" or "non fossil". This wording is fully consistent with the objective of CO2 emissions and with actual perspectives given by official sources.	Noted. The text has been substantially revised in response to reviewer comments.	Michel SIMON	Retraité/ Pdt d'association	France
14893	1	1			There were three major developments in terms of technological deployment and awareness in strategies since AR5: a) cheap and rapidly growing intermittent RE and batteries; b) sectoral coupling (road transport electrification, heat pumps, PtX, etc.); and c) awareness of the opportunity to reduce primary energy demand and associated GHG emissions with better service provisioning systems that simultaneously lead to equitable outcomes in wellbeing. While all issues are mentioned, especially b) sector coupling is shortlined (6.4.3 is a good and valuable starting point), especially in terms of high-level messages. Only few models deal with these issues explicitly and chapter 3 only points to electrification on the side, while spending pages after pages on potentially unsustainable high level of bioenergy deployment. This seems to represent more the content of models than the overall level of insights of what works and what doesn't. Energy system model with high resolution in sector coupling are existing but not represented (e.g. in chapter 3, chapter 6 cites some studies). Most importantly, the combination of the 3 strategies remains unconsidered: very aggressive RE/battery deployment, rapid sector coupling, and building better service provisioning systems (the current US minister of transport seems to be ahead of the curve here). Importantly, while also very rapid deployment of intermittent RE is likely to be insufficient to meet rising demand for Primary Energy in 2050, it may meet demand if combined with low energy demand trajectories (especially 2020-2050). This seems to be a no-lose-option, with few side effects (mining for Li is an issue), compared to all other options discussed. However, this combination of solution pathways is not mentioned. Instead, potentially planet-endangering bioenergy trajectories get outsized attention.	IPCC ARs need to review the existing literature. As such, when there is literature already taking into account the COVID-19 impacts on emissions this was also considered.	Felix Creutzig	MCC Berlin & TU Berlin	Germany
18103	1	1	1	1	Overall comment about ch.3 - it's tone on CDRs is not consistent with that of the SPM, where IAM results are not considered in isolation, but instead technologies are considered on the basis of real-world evidence. Ch.3 must avoid presenting modelled pathways as if they can all be assumed to be reasonable portrayals of the future. Could the authors please consider how they present results as well as what results they present?	Noted. The text has been substantially revised in response to reviewer comments.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
47675	1	1	168	13	It would be good to include more details on the long term effects of the COVID-19 pandemic and the resultant fiscal stimulus (green recovery) on long term trends in emissions. To my understanding a number of papers have already been published on this, and more are in the works. https://link.springer.com/article/10.1007/s10640-020-00454-9 https://www.nature.com/articles/s41558-020-00977-5 https://www.nature.com/articles/s41558-021-01001-0 https://academic.oup.com/oxrep/article/36/Supplement_1/S359/5832003?login=true	Noted. The text has been substantially revised in response to reviewer comments.	Vassilis Daioglou	Utrecht University	Netherlands
61245	1	1	168	13	Consider replacing or amending the term “renewable energy” by “low-carbon energy.” “As noted in Harjanne and Korhonen 2019, “renewable” by no means equals “sustainable” or even “low carbon” energy. Furthermore, there are good reasons to believe that the confusion permitted by equating “renewable” with “sustainable” and “low carbon” has helped and will help those parties who have a vested interest in promoting technically renewable but actually problematic if not downright unsustainable energy sources and practices, most prominently large scale bioenergy use (op. Cit.) Reference: Harjanne, A. & Korhonen, J. M. (2019). Abandoning the concept of renewable energy. Energy Policy 127, DOI: 10.1016/j.enpol.2018.12.029	Noted. The text has been substantially revised in response to reviewer comments.	Janne M. Korhonen	Lappeenranta University of Technology	Finland
71255	1	1	168	13	The chapter should discuss how the rebound effect induced by a more energy efficient economy impact mitigation pathways reducing the impact of traditional energy efficiency policies. See Ruzzenenti F., Bertoldi P. (2017) Energy Conservation Policies in the Light of the Energetics of Evolution. In: Labanca N. (eds) Complex Systems and Social Practices in Energy Transitions. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978-3-319-33753-1_7 and the discussion in section 9.9.3	Noted. The text has been substantially revised in response to reviewer comments.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
72307	1	1	168	13	The chapter should discuss how the rebound effect induced by a more energy efficient economy impacts mitigation pathways reducing the expected impact of traditional energy efficiency policies. See Ruzzenenti F., Bertoldi P. (2017) Energy Conservation Policies in the Light of the Energetics of Evolution. In: Labanca N. (eds) Complex Systems and Social Practices in Energy Transitions. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978-3-319-33753-1_7 and the discussion in section 9.9.3.	Noted. The text has been substantially revised in response to reviewer comments.	bertoldi paolo	european commission	Italy
305	1		117		The term non-CO2 gases is used throughout the chapter instead of short-lived climate forcers (SLCFs). And in some parts black carbon is classified as non-CO2 gases which is of course not correct. I suggest substituting non-CO2 gases with SLCFs to take into account both short-lived gases and aerosols. This also in order to be consistent with other chapters and, more in general, with the whole AR6.	Noted. We tried to amend text where necessary.	Sandro Fuzzi	ISAC CNR	Italy
3983	1		168		The text is very clear, complete and objective. It brings, in my understanding, fundamentally all the information pertinent to the treated subject. The section is very well written and the authors were very responsible and assertive in dealing with the subject in question. For these reasons I have nothing significant to add as I understand that the topic is being treated very clearly and completely. The authors are to be congratulated for the excellent work.	Noted. The thank the reviewer for the comment.	FABIO RUBENS SOARES	USP - Universidade de São Paulo	Brazil
29829	2	2	3	3	Throughout the Chapter there are several Boxes and at least one Cross-Chapter Box that are of high interest for readers. Please consider to expand the table of content by including these boxes, to increase accessibility and visibility of these boxes. This is already established practise in other underlying chapters.	Noted. The text has been substantially revised in response to reviewer comments.	Government of Norway	Norwegian Environment Agency	Norway
4387	2	10	2	10	pt. 3.2 , delete 'what are'	Noted.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4389	2	11	2	13	swap pts. '3.2.1 & 3.2.3'	Noted.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4391	2	22	2	26	swap pts. '3.4.1 & 3.4.5'	Noted.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
4393	2	27	2	27	pt. 3.4.6 .. Other ?	Noted.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4395	2	28	2	28	Add pt. 3.4.8 ... major cross sectors' options	Noted.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4397	3	1	3	1	pt. 3.6.2 ... Add subheads of few scenarios	Noted.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4399	3	5	3	5	pt. 3.7 ... Delete 'and avoided'	Noted.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
9659	3	7	3	14	Are comparisions to 2020 taking into account Covid-19 impacts on emissions?	IPCC ARs need to review the existing literature. As such, when there is literature already taking into account the COVID-19 impacts on emissions this was also considered.	Mustafa Babiker	Saudi Aramco	Saudi Arabia
4401	3	12	3	12	pt. 3.7.7. ... to be brought in as preamble of 3.7	Noted.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4403	3	14	3	15	check on overlapping and gaps of 3.8.1 & 3.8.2	Noted. The text has been substantially revised in response to reviewer comments.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
74809	3	33	34		SSPs permit a systematic assessment of future GHG emissions and their uncertainties (compared to AR5). Consider providing intercomparison of the new SSP to the RCP used in AR5	Noted. The text has been substantially revised in response to reviewer comments.	Government of Kenya	Kenya Meteorological Service	Kenya
7823	4	1	10	23	It would be helpful for readers to understand easier if same but simpler kind of table shown as Table SPM.1 is also shown here. Another idea is to refer to the table where necessary.	Noted. The text has been substantially revised in response to reviewer comments.	Mitsutsune Yamaguchi	Research Institute for the Innovative Technology for the Earth (RITE)	Japan
18073	4	1	10	24	GENERAL COMMENT ON EXEC SUMMARY - overall this is a very strong executive summary, well written and informative. To strengthen it further, we would recommend a discussion of how the assumptions and model structure of IAMs influences many of the conclusions in this section. This has been one of the most important developments in recent years, a more explicit recognition of the extent to which model assumptions and normative choices are influencing and framing our understanding. Example recent issues include https://www.nature.com/articles/s41586-019-1541-4 or https://iopscience.iop.org/article/10.1088/1748-9326/ab3cc9/meta .	Noted. The text has been substantially revised in response to reviewer comments.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
84419	4	3	4	4	"renewable energy" change to "renewable and nuclear energy", or "nonfossil energy"	Noted. Text has been substantially revised in response to reviewer comments.	Mattias Lantz	Uppsala university	Sweden

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
1775	4	5	4	6	The start of the sentence "This focus dictates..." seems odd	Noted. Text has been substantially revised in response to reviewer comments.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
29545	4	5	4	9	Unclear regarding what is meant by "deep mitigation", and it's not sufficiently substantiated why taking a long-term perspective dictates a view on issues related to path-dependency. Also, the whole sentence could be revised for clarity and perhaps split into two sentences.	Noted. Text has been substantially revised in response to reviewer comments.	Government of Norway	Norwegian Environment Agency	Norway
71257	4	5	4	6	The start of the sentence "This focus dictates..." seems odd	Noted. Text has been substantially revised in response to reviewer comments.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
23289	4	6	4	9	The part of the sentence starting at "and on issues" is too long and thus hardly understandable, we suggest to add one or two comas	Noted. Text has been substantially revised in response to reviewer comments.	Government of France	Ministère de la Transition écologique et solidaire	France
75725	4	8	4	8	Emissions trajectories themselves do not reduce the effect of climate change. It is rather the actions that affect the trajectories. The sentence needs to be rephrased.	Noted. Text has been substantially revised in response to reviewer comments.	Alfred Ahenkorah	Regulatory	Ghana
75985	4	9	4	9	Here you use the term "carbon neutrality". See earlier comment to entire chapter about consistent use of the terms net zero CO ₂ , net zero GHG, carbon neutrality and GHG neutrality. And on line 43 below you use net zero GHG	Noted. Text has been substantially revised in response to reviewer comments.	Jan Fuglestad	CICERO	Norway
83135	4	9	4	9	While the informed reader might be able to detect that you are talking about two different net-zero concepts here, it might be better - given the prominence of this message - if you weave "CO ₂ " and "GHG" in here to make clearer that carbon neutrality is not the same as the PA balance requirement (and if you keep the latter as a quote - which would mean you'd only need to add "of greenhouse gases" - you probably need to indicate where it is from)	Noted. Text has been substantially revised in response to reviewer comments.	Geden Oliver	German Institute for International and Security Affairs	Germany
51985	4	10	4	10	Quotes are not needed.	Noted. Text has been substantially revised in response to reviewer comments.	Government of Saudi Arabia	Sustainability Advisor to the Minister of Petroleum and Mineral Resources	Saudi Arabia
37409	4	12	4	13	Rewrite the statement to include the word "modeled" before pathways. Edited Sentence: "Various modeled mitigation pathways limit global average temperature change to below 2 °C or below 1.5 °C"	Noted. Text has been substantially revised in response to reviewer comments.	Government of India	Ministry of Environment, Forests and Climate Change	India
54759	4	12	4	13	This conclusion needs to be re-worded to make clear that these are modeled scenarios rather than countries' planned mitigation efforts, and that the "high confidence" characterizes that models have demonstrated such scenarios; elsewhere in the chapter it is made clear that the feasibility of reaching 1.5°C and even 2°C is very difficult with known NDCs. The chapter should take care not to downplay the difficulty of achieving these targets.	Noted. Text has been substantially revised in response to reviewer comments.	Government of United States of America	U.S. Department of State	United States of America
65277	4	12	4	13	Again, concerned over potential readers' confusion to this reference of 'below 1.5C'. The PA calls for 'pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels', not 'below 1.5C'. Following findings of the SR1.5C, the climate advocacy world has continued calls to 'limit to' (not 'below 1.5C'). The WG3 drafts so far are confusing - as if the goal posts have shifted to 'below 1.5C' and a narrative that 'below' is not possible, which we knew - but the KEY message is if with radical, urgent and healthy root cause transformations, and adequate political will, is there still a chance at limiting TO 1.5C. This would be helpful to clarify.	Noted. Text has been substantially revised in response to reviewer comments.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
65461	4	12	4	19	Could it be worth specifying what the 'various mitigation pathways' are her? I say this as, it is again, quite confusing with regard to the findings in WG1. Making it clear, upfront, that WGIII has considered a wide variety of scenarios (compared to WG1) would be a very helpful introduction to this chapter. For example integrating some of the wording from the next point (line 20-26)	Noted. Text has been substantially revised in response to reviewer comments.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
81145	4	12	4	13	The headline finding is rather bland and doesn't strike me as useful, as it could easily be understood as implying that 'anything goes'. I would recommend adding something about shared features in these pathways, such as deep reductions in emissions over the next 2 decades and net CO ₂ emissions approaching zero between 2050 and 2100. Yes there are different pathways but they all share a common direction of travel.	Noted. The Executive Summary has been completely redrafted.	Andy Reisinger	Ministry for the Environment	New Zealand

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
75979	4	13	4	13	What is meant by "natural ... systems" here? And how is this taken into account?	Noted. The Executive Summary has been completely redrafted.	Jan Fuglestedt	CICERO	Norway
72159	4	20			The inclusion of illustrative pathways is useful to illustrate different futures to policy makers. However, their prominence in the report also means that they need to be selected and assessed carefully. Few general thoughts: a)The number should be drastically reduced. 4 pathways maximum. b)All pathways should be Paris-compatible meaning that they comply with Article 2.1a and 4.1a achieving net-zero GHGs (GWP100). c)They should limit the deployment of CDR to identified sustainability criteria. The IPCC and the mitigation community got enormous criticism for deployment ranges of CDR beyond sustainability limits. It is unclear to me, why this mistake needs to be repeated here. d)They should resemble real world politics with respect to long-term outcomes – in particular account for the existing net-zero targets of 60% of the global emitters and rather than illustrating very different, very hypothetical futures, they should illustrate different ways to get there, and different warming outcomes for different assumptions about near-term emission reductions. e)From all the points above, the category that is the least compelling to me is the 'NBZ' scenarios. I understand the impetus of having scenarios that don't go 'negative' – but only from a limited CDR viewpoint. But it seems to me completely contradictory to have those scenarios then deploy massive amounts of CDR to keep constant fossil fuels after 2040. If such a scenario category was to be included, it should be called 'offsetting gone wrong'. Not NBZ.	Noted. The text has been substantially revised in response to reviewer's comments.	Carl Schleusner	Climate Analytics	Germany
37595	4	25	4	26	In the selection of illustrative pathways, there is an explicit bias against nuclear. Please see s. no. 6 as well.	Noted. Illustrative Mitigation Pathways rely on published literature using IAMs.	Ravi B Grover	Homi Bhabha National Institute	India
75727	4	25	4	25	The chapter is Chapter 3. Reference should be made to "this chapter"	Noted.	Alfred Ahenkorah	Regulatory	Ghana
16911	4	27	4	29	In the chapter 3 it's stated that "resulting in a global average temperature change of 3.29 to 5.02 °C". . . In the Summary for Policymakers instead it's stated that "Baseline scenarios without any new climate policies lead to a median global warming of 3.3°C-5.4°C by 2100"Which is the correct range?	Noted. The Executive Summary has been completely redrafted.	Government of Spain	Area de Estrategias de Adaptacion - Oficina de Cambio Climatico - Ministerio de la Transicion Ecologica	Spain
17543	4	27	4	27	I suggest adding a footnote after 63-110 GtCO2-eq yr-1 to state:"Emissions of GHGs are weighed by Global Warming Potentials with a 100 year time horizon (GWP100) from the Sixth Assessment Report. GWP-100 is commonly used in wide parts of the literature on climate change mitigation and is required for emissions under the United Nations Framework Convention on Climate Change (UNFCCC). All metrics have limitations and uncertainties." Or something to this effect. This is the statement used in Ch2 at the first mention of CO2-eq too. Thanks	Noted. The Executive Summary has been completely redrafted.	Alaa Al Khourdjajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
37411	4	27	4	29	remove brackets and put the disclaimer upfront. Edited Statement: Based on a range of model emissions pathways, it is likely that in the absence of any new climate policies, GHG emissions may increase to 63-110 GtCO2-eq yr-1 by 2050, likely resulting in a global average temperature change of 3.29 to 5.02 28 °C by the end of the century.	Noted. The Executive Summary has been completely redrafted.	Government of India	Ministry of Environment, Forests and Climate Change	India
47385	4	27	4	38	Is the "absence of any new climate policies" synonymous to current policies scenario in Chapter 4? The terminology wasn't entirely clear, even after reading Section 3.2. Perhaps even better clarification on the terms and definitions used would be helpful. If we're indeed referring to current policies scenario, then the temperature estimate of above 5C seems extremely high, compared to the estimates from e.g. UNEP Emissions Gap Report.	Noted. The Executive Summary has been completely redrafted.	Takeshi Kuramochi	NewClimate Institute	Germany
60335	4	27	4	38	The stated temperature level is very high with 3.29 to 5.02°C by 2100. Are you sure that these estimates take into account all recent developments and do not present an old picture from several years ago? With the Climate Action Tracker we have updated our temperature estimate on the basis of detailed research of most recent policies each year and find that this temperature estimate decreases each year as a result of new policies and developments. While in 2015 our estimate for current policies was at 3.6°C, it is today at 2.9°C. https://climateactiontracker.org/publications/global-update-paris-agreement-turning-point/ This may not be representative, but 5°C seems really high.	Noted. These temperature ranges derived from MAGGIC 7.	Niklas Höhne	NewClimate Institute	Germany
65279	4	27	4	30	Please clarify if these numbers are 'above preindustrial levels'. Very important if we are to understand the difference between AR5 findings ('temperature rise of approximately 4.8 by 2100 compared to preindustrial levels'. Important to also note how the figures '3.29 to 5C by the end of the century' relate to how much we have already warmed - for example, if already over 1C warming, then complete warming by 2100 above preindustrial levels is -- what?	Noted. The Executive Summary has been completely redrafted.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
69425	4	27	4	46	What seems missing here, and should be introduced first time "net zero CO2" and "net zero GHg" are introduced, is first a definition (does anyone understands this is "when anthropogenic CO2 emissions are balanced globally by anthropogenic CO2 removals over a specified period" as defined in SR1.5?) and a short analysis of what this may mean in terms of gross emissions. On p.4 line 27 GHG emissions are mentioned, which I suppose are gross emissions. In lines 39-42 there are mention of peak time for GHG emissions, presumably gross emissions. Suddenly, on line 43, the concept of net-zero GHG appears, followed by net zero CO2 on line 45, but there is no definition no explanation given for this sudden change, and the reader is left with his own suppositions. How much gross GHG and gross CO2 emissions are compatible with net-zero? At this point, the reader has no clue. Something like the paragraph in Chapter 6, p.79, lines 2à to 33, would help here.	Noted. The Executive Summary has been completely redrafted.	Cédric PHILIBERT	Institut Français des Relations Internationales	France
71259	4	27	4	27	Is it possible to define more precisely what is meant by "in the absence of any new climate policies"?	Noted. The Executive Summary has been completely redrafted.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
83137	4	27	3	28	2050 emissions influence, but do not result in a 2100 temperature	Noted. The Executive Summary has been completely redrafted.	Geden Oliver	German Institute for International and Security Affairs	Germany
85929	4	27	4	29	Suggest clarification: It is not clear what is meant by "in the absence of new climate policies". Do "new policies" include all policies since AR5, e.g. the Paris Agreement?	Noted. The Executive Summary has been completely redrafted.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
15367	4	28			Given the uncertainty, it would seem to make more sense to write "change of 3.3 to 5.0 °C"	Noted. The Executive Summary has been completely redrafted.	Thomas Wiedmann	UNSW Sydney	Australia
23291	4	28	4	28	We suggest to replace "3.29 to 5.02°C" by "3,3 to 5,0°C".	Noted. The Executive Summary has been completely redrafted.	Government of France	Ministère de la Transition écologique et solidaire	France
44021	4	28	4	28	3.29 to 5.02 please use two significative numbers: 3.3 to 5.0	Noted. The Executive Summary has been completely redrafted.	Stefano Caserini	Politecnico di Milano	Italy
54761	4	28	4	29	Note that this result is somewhat buried in the very detailed Table 3.2, but otherwise does not appear to be highlighted anywhere else in the chapter text; if this is such a high-level conclusion of the chapter, it should actually be discussed in the underlying text.	Noted. The Executive Summary has been completely redrafted.	Government of United States of America	U.S. Department of State	United States of America
66827	4	28	4	28	Is 2 decimal places for the temperature projections an appropriate level of precision here? Also what is the baseline period (assume 1850-1900 but please state).	Noted. The Executive Summary has been completely redrafted.	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
75981	4	28	4	28	Can this level of precision be justified (i.e., 3.29 to 5.02) ?	Noted. The Executive Summary has been completely redrafted.	Jan Fuglestad	CICERO	Norway
81147	4	28			Is "likely" a probabilistic assessment of likelihood? If so, specify whether this is for the mean climate outcome from each scenario, or does this include climate uncertainty; unless the latter, a "likely" statement is misleading. If the range is based on the ensemble of opportunity of scenarios in the database, I'm not sure that a likelihood statement is justified as this is not about probabilities in the real world. Also, I suggest to drop one decimal point from the temperature outcomes as this is a misleading degree of precision.	Noted. The Executive Summary has been completely redrafted.	Andy Reisinger	Ministry for the Environment	New Zealand
77103	4	29	4	49	Again, the statement that "global GHG emissions will grow (from 59 GtCO2eq now) to 63-110 GtCO2eq by 2050" demonstrates that WGIII really has little idea how the future will transpire. It also demonstrates that IPCC has not narrowed down climate sensitivity since the Charney report of 1979, despite \$ trillions being expended on research over 40+ years.	Noted. The Executive Summary has been completely redrafted.	Jim O'Brien	Expert Reviewer AR6 SOD WG1	Ireland
51987	4	34	4	34	Spell out AR5 to read Fifth Assessment Report. AR6 in paragraph above follows this approach of spelling out AR6	Noted. The Executive Summary has been completely redrafted.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
11427	4	35	4	35	The figures "8.5-9.5 billion people" do not tally with the main text ("8.5-11 billion people", P.25, line 16-17). Please check and revise as appropriate.	Noted. The Executive Summary has been completely redrafted.	SAI MING LEE	Hong Kong Observatory	China
23293	4	35	4	35	The population range (upper bound) in 2050 in Figure 3.7 seems to be higher than 9.5 billion people in 2050	Noted. The Executive Summary has been completely redrafted.	Government of France	Ministère de la Transition écologique et solidaire	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
65281	4	35	4	36	The AR5 Synthesis Report highlights 'economic growth and population growth' as the most important drivers to increases in CO2, then states economic growth contribution has risen higher than population growth. This draft chapter statement here is limited to population. Has there been a striking change in the AR5 findings of this relationship and if not, please keep these two together.	Noted. The Executive Summary has been completely redrafted.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
76337	4	35	4	36	"...population growth, reaching between 8.5-9.5 billion people by 2050" a) contextually inaccurate, as the total population reaches 8.5-9.5 M, not pop growth; b) please check population projections across the report for consistency, e.g. in Ch 7 ES starts with "As the global human population approaches a projected nine billion by 2035,..." which seems at odds with the range stated here and given in Fig.3.7. I did a cursory search across some chapters (1, 3,4,5,6,and 7) but could not find a clear definition/discussion of projected population numbers. While it is clear that these numbers are uncertain and will always span a range, consistency across chapters is crucial.	Noted. The Executive Summary has been completely redrafted.	Gerrit Hansen	Robert Bosch Stiftung	Germany
76923	4	35	4	36	This sentence about main emission drivers is both evident and potentially misleading. Population is evidently a driver. But is it one of the two most important ones, given that only two are cited? Just looking at global percent changes can be misleading, because population and emission increases are not geographically correlated (drivers needs to be evaluated on more or less homogenous population groups). In addition, while population is an important driver for the coming decades, there are other drivers which are more important to explain the differences across scenarios in a large ensemble. Accordingly, section 3.3 does not list population as one of the two main drivers: instead, it points out to energy intensity and economic growth. I would like to suggest reconsidering this sentence.	Noted. The Executive Summary has been completely redrafted.	Philippe Marbaix	Université catholique de Louvain	Belgium
85931	4	35	4	35	Suggest it would be useful to provide the current rate of GDP growth and the current population (or population growth rate) as a point of reference.	Noted. The Executive Summary has been completely redrafted.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
11429	4	36	4	36	The source of the statement "the increase in the global GDP of 2.5-4.2% per year between 2015 and 2050" cannot be found in the main text. Please check.	Noted. The Executive Summary has been completely redrafted.	SAI MING LEE	Hong Kong Observatory	China
65657	4	36	4	38	In the absence of new climate policies, by 2050, the final energy demand is expected to multiply by a factor of 1.4-2.1 from the 2015 level. In every developed country, the growth of well-being and that of GDP has historically displayed a strong positive correlation with the use of energy. Even if there has been a recent decoupling of energy and GDP in certain few developed countries, the same would be highly unlikely for the still developing countries. Consequently, the Illustrated Pathway scenarios, expecting only a modest increase or even a decrease in use of final energy, seem to be in conflict with the ideas of eradicating energy poverty in developing countries. Please adjust the Illustrative Pathway scenarios to be more realistic.	Noted. The Executive Summary has been completely redrafted.	Eero Hirvijoki	Aalto University	Finland
37021	4	39	4	41	What is the approximate time frame for net zero emission for < 3 °C?	The scenario database shows that net zero CO2 and GHG are not reached within this century for <3C mitigation pathways.	Arun kumar Nayak	Bhabha Atomic Research Centre Trombay Mumbai	India
37413	4	39	4	46	Scenarios with and without negative emission assumptions cannot be compared across temperature targets without any qualification. A statement about the number of scenarios for each temperature target mentioned that include negative emissions and the number that don't should be added.	Noted. The Executive Summary has been completely redrafted.	Government of India	Ministry of Environment, Forests and Climate Change	India
45793	4	39	3	46	Please check for consistency: "Typically, CO2 emissions reach net zero about 5-25 years before total GHG emissions reach net zero" - Does this apply for 1.5°C pathways as well? If so, the net-zero targets for CO2 (2055) and GHG (2075) would differ by 20 years. This seems to be at the higher end of the range provided in this paragraph (5-25 years). Perhaps it would help to provide a mean for this range.	Noted. The Executive Summary has been completely redrafted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
54763	4	39	4	46	The bold sentence in this section is vague. Can this be more specific, for instance by including the idea of temporal or temperature differences? The header on page 7, line 16, may serve as a better model. The authors may want to consider moving the last sentence on lines 45-46 to the net-zero discussion in the next paragraph.	Noted. The Executive Summary has been completely redrafted.	Government of United States of America	U.S. Department of State	United States of America
65283	4	39	4	46	This paragraph is really confusing. For example, if emissions were to peak in 2020, since it is now 2021, are you saying that it is not possible even with the most stringent mitigation scenarios, to limit GTR to below 2C? This is the confusion a policy maker might have in reading the paragraph, as s/he is a policy specialist, not a scientist and language sometimes needs to be more simple.	Noted. The Executive Summary has been completely redrafted.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
65463	4	39	4	46	Do you think there is space to briefly discuss, or refer to, the zero emissions commitment (ZEC) as explored in Chapter 4 of WG1 (4.7.2.2). This chapter stops at how to get to net-zero, and I understand discussing "climate change following net-zero" may be out of scope for this WG/Chapter. However, signposting the research and discussion could be a very helpful way for policy audiences to link the concepts.	Noted. Unfortunately space constraints preclude us to go into details.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
71261	4	39	4	46	This paragraph is organised by phenomenon (first peaking, then net zero). This is quite confusing and could be open to misinterpretation. E.g. the finding that around a quarter of 2°C scenarios achieve net zero GHG by 2100 is only valid in the context of the finding about 2020-45 peaking that occurs a few sentences earlier. Better to organise by temperature and consider the peaking and net zero aspect jointly. e.g. 'likely below 2°C pathways achieve peaking by 20XX and net zero by 20YY.' At this point it might also be useful to highlight the '3-way trade-off' between pre-2030 emissions, 2030-50 transition and long-term CDR deployment (p69, line 3).	Noted. The Executive Summary has been completely redrafted.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
81149	4	39			The headline finding is rather bland and doesn't strike me as useful, as it could easily be understood as implying that 'anything goes'. Be clear that this is for emission pathways resulting in different temperature outcomes.	Noted. The Executive Summary has been completely redrafted.	Andy Reisinger	Ministry for the Environment	New Zealand
83139	4	39	4	40	Maybe better not to call 3C a "mitigation level", although this might be technically correct, compared to a BAU scenario	Noted. The Executive Summary has been completely redrafted.	Geden Oliver	German Institute for International and Security Affairs	Germany
16279	4	41	4	41	Scenarios lower than 1.5oC most scenarios reach net-zero GHG around 2075.This is not consistent with the main results of IPCC special report on 1.5 degree and the sentence on page 27, "In fact, for scenarios in the category that avoid temperature overshoot for the 1.5oC scenario, GHG emissions are reduced already to almost zero by 2050."	Noted. The Executive Summary has been completely redrafted.	Government of Republic of Korea	Korea Meteorological Administration (KMA)	Republic of Korea
30651	4	41	4	43	The peak emission year for the 1.5°C scenario needs to be added. This report is published in 2021, and it would be better to include the implications what if emissions continue to increase beyond 2020, which is considered to be the peak year for 2°C scenario.	Noted. The Executive Summary has been completely redrafted.	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
51989	4	42	4	42	C1-C3 need to be defined in this chapter.	Noted. The Executive Summary has been completely redrafted.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
10537	4	43	4	43	Sentence ought to be corrected	Noted. The Executive Summary has been completely redrafted.	Philippe Waldteufel	CNRS	France
16913	4	43	4	43	"Scenarios lower than 1.5oC most scenarios reach net-zero GHG around 2075." Confusing redaction.	Noted. The Executive Summary has been completely redrafted.	Government of Spain	Area de Estrategias de Adaptacion - Oficina de Cambio Climatico - Ministerio de la Transicion Ecologica	Spain
44023	4	43	4	43	"Scenarios lower than 1.5oC most scenarios reach net-zero GHG around 2075" please rephrase	Noted. The Executive Summary has been completely redrafted.	Stefano Caserini	Politecnico di Milano	Italy
45795	4	43	4	43	Please be more specific about the emission pathways to net-zero GHG in 2075 (1.5°) and 2100 (2°), and whether these paths entail a linear progression or rather a long tail progression. Net-zero dates without this information could be misleading with regards to the required mitigation effort.	Noted. The Executive Summary has been completely redrafted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
45797	4	43	4	43	The SPM provides a range for the peak year (2020-25). Please be consistent.	Noted. The Executive Summary has been completely redrafted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
54765	4	43	4	43	Sentence is not clear and doesn't flow well after preceding sentence. Should be reworded and placed to follow sentence beginning on line 44, "For scenarios with a likely chance of limiting warming to 2°C ..."	Noted. The Executive Summary has been completely redrafted.	Government of United States of America	U.S. Department of State	United States of America
60337	4	43	4	43	Add timing of net-zero CO2 to the sentence "Scenarios lower than 1.5oC most scenarios reach net-zero GHG around 2075."	Noted. The Executive Summary has been completely redrafted.	Niklas Höhne	NewClimate Institute	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
75729	4	43	4	43	"Scenarios lower than 1.5 oC reach net zero GHG around 2075." Sentence must be rephrased.	Noted. The Executive Summary has been completely redrafted.	Alfred Ahenkorah	Regulatory	Ghana
75987	4	43	4	43	Both net zero CO2 and net zero GHG are useful concepts. But be careful to use this in a way that is not confusing to the reader.	Noted. Thanks for the comment.	Jan Fuglestedt	CICERO	Norway
79849	4	43	4	43	Suggest revising "Scenarios lower than 1.5oC", missing words.	Noted. The Executive Summary has been completely redrafted.	Madoka Yoshino	United Nations University Institute for the Advanced Study on Sustainability	Japan
83141	4	44	4	44	To avoid confusion, you should already here indicate that "likely/67%" is your interpretation of the upper end of the Paris LLTG (i.e. "well below 2C"), simply since until recently, "likely/67%" was used for "below 2C". It might sound a little technical, but you do this later in this Executive Summary anyway	Noted. The Executive Summary has been completely redrafted.	Geden Oliver	German Institute for International and Security Affairs	Germany
75555	4	46	4	46	Assignment of confidence is unclear. The statements referred to are descriptive statements about the scenarios that are examined in the chapter. Descriptive statements can only be true or false. If the statement of confidence instead relates to whether what is observed in the scenarios will happen in the real world, this is also very confusing. As stated elsewhere in the summary to this chapter "Pathways are not predictions or forecasts, but rather explorations of plausible representations of the future based on coherent and internally consistent set of assumptions about driving forces." It is therefore unclear what the "confidence" of the pathway results might mean.	Noted. The Executive Summary has been completely redrafted.	Ida Sognaes	CICERO Center for International Climate Research	Norway
1777	4	47	4	47	The chapter refers to "well below 2oC" several times. However, well below is not defined clearly, which it should be to stay in the chapter.	Noted. The Executive Summary has been completely redrafted.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
1781	5	1	5	14	1.5C findings are almost exclusively indicated with 50% likelihood, whereas 2C sometimes is indicated with 66% likelihood. There is no explanation of this in the chapter and no thorough discussion of the issue of likelihoods. It would be very useful to indicate findings for 1.5 and 2C with similar likelihoods and ideally for a range of likelihoods.	Noted. The Executive Summary has been completely redrafted.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
16915	5	1	5	14	¿High/medium or low confidence?	Noted. The Executive Summary has been completely redrafted.	Government of Spain	Area de Estrategias de Adaptacion - Oficina de Cambio Climatico - Ministerio de la Transicion Ecologica	Spain
29319	5	1	5	2	It is not clear which temperature objective (1.5C or well below 2C) is being considered in this sentence: "Scenarios consistent with the Paris Agreement typically reach net zero CO2 emissions around the middle of the century." Since these temperature objectives reach net-zero CO2 at different times, on average, it would be helpful to be more precise.	Noted. The Executive Summary has been completely redrafted.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
37415	5	1	5	2	The statement is inconsistent with previous paragraph that says that a quarter of the scenarios for the 2 deg. C target reach net-zero only by 2100. "Paris Agreement" targets are two - 1.5 and 2 deg. C. The statement as it is, is vague and it is not clear which Paris Agreement target is referred to.	Noted. The Executive Summary has been completely redrafted.	Government of India	Ministry of Environment, Forests and Climate Change	India
45799	5	1	5	2	Please be more specific about the emission paths to net-zero CO2, and whether these paths entail a linear progression or rather a long tail progression. Net-zero dates without this information could be misleading with regards to the required mitigation effort. Please be more specific about the temperature target when referring to the Paris Agreement.	Noted. The Executive Summary has been completely redrafted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
54767	5	1	5	2	Is there a uniform definition throughout AR6 about what "consistent with the Paris Agreement" means? Is this referring to "well below 2°C", or intended to be broadly applicable to both 2°C and 1.5°C?	Noted. The Executive Summary has been completely redrafted.	Government of United States of America	U.S. Department of State	United States of America
61621	5	1	5	5	Nuclear energy is our second largest source of low carbon energy and from a techno-economic and energy-systems point of view is the most promising for significant expansion, since it doesn't rely on additional hardware and other mechanisms to reach high shares in the system, unlike wind and solar that do. It is also the only one with a proven track record of decarbonizing countries without large hydro/geothermal resource (such as France). It seems downright strange and very much against a technological neutrality to leave nuclear energy out from the different pathways, especially as most of the less-proven technologies are mentioned. The four main scenarios in IPCC 2018 SPM have nuclear growing 2-6 times by 2050 and 1.6-2 times already by 2030. It deserves a mention here as well as proper inclusion in the zero-carbon scenarios. Part 1/2	Noted. All statements are based on peer reviewed literature and numbers derive from mitigation pathways coming out of recent runs of Integrated Assessment Models.	Rauli Partanen	Think Atom	Finland

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
61623	5	1	5	5	Part 2/2. Literature on the matter include: Vaillancourt et al., 2008, https://doi.org/10.1016/j.enpol.2008.01.015 ; Brooks, 2012, https://doi.org/10.1016/j.enpol.2011.11.041 ; Apergis et al. 2010, https://doi.org/10.1016/j.ecolecon.2010.06.014 ; Menyah and Wolde-Rufael, 2010, https://doi.org/10.1016/j.enpol.2010.01.024 ; Qvist and Brook, 2015, https://doi.org/10.1371/journal.pone.0124074 ; Baek, 2015, https://doi.org/10.1016/j.apenergy.2015.01.074 ; Horvath and Rachlew, 2016, https://doi.org/10.1007/s13280-015-0732-y .	Noted	Rauli Partanen	Think Atom	Finland
65659	5	1	5	5	Nuclear energy should be included in the list of different options. The choice of including hypothetical technologies such as CCS and CDR but to exclude nuclear is against the technology neutral stand point of IPCC and literature consensus. Several research papers highlight the role of nuclear energy to achieve the mitigation targets (Vaillancourt et al., 2008, https://doi.org/10.1016/j.enpol.2008.01.015 ; Brooks, 2012, https://doi.org/10.1016/j.enpol.2011.11.041 ; Qvist and Brook, 2015, https://doi.org/10.1371/journal.pone.0124074 ; Apergis et al. 2010, https://doi.org/10.1016/j.ecolecon.2010.06.014 ; Menyah and Wolde-Rufael, 2010, https://doi.org/10.1016/j.enpol.2010.01.024 ; Baek, 2015, https://doi.org/10.1016/j.apenergy.2015.01.074 ; Horvath and Rachlew, 2016, https://doi.org/10.1007/s13280-015-0732-y COMMENT CONTINUES	Noted. But we cannot be prescriptive like "nuclear energy should be included". IPCC reports rely on recent peer-reviewed literature.	Eero Hirvijoki	Aalto University	Finland
65661	5	1	5	5	COMMENT CONTINUES; Thangavelu, 2015, https://doi.org/10.1016/j.apenergy.2015.05.087 ; Hong et al., 2014, https://doi.org/10.1016/j.enpol.2014.05.054 ; Hong et al., 2014, https://doi.org/10.1016/j.apenergy.2014.09.062).	Noted.	Eero Hirvijoki	Aalto University	Finland
75557	5	1	5	2	It should be clarified that "scenarios consistent with the Paris Agreement" here refers to the scenarios that are explored in this chapter. It should also be added that these are primarily least-cost scenarios. Otherwise, the statements might be misinterpreted to mean all scenarios consistent with the Paris agreement. It should be clear from the text that the scenarios referred to represent only a sub-set of possible scenarios that are consistent with the Paris Agreement.	Noted. The Executive Summary has been completely redrafted.	Ida Sognaes	CICERO Center for International Climate Research	Norway
76421	5	1	8	36	The Executive summary fails to include the role of nuclear energy in the routes to achieving net zero carbon emissions. This is despite acknowledging its success on page 68 lines 16 to 18. Carbon capture and storage is given a higher priority despite its mediocre performance to date, high costs, prototype status in many applications and huge technical hurdles. Of all the technologies available for a low carbon future, only nuclear energy and hydro have established themselves as being successful on a system levelised cost of electricity basis in actually achieving low emissions. Hydro carries that additional burden of high environmental impacts and large methane emissions in tropical and temperate environs. In the absence of large hydro, wind and solar have a track record of requiring either fossil fuelled backup and/or energy storage with high embedded carbon emissions intensities. Either way grids powered by wind and solar will land on a plateau of significant emissions intensity. This is currently experienced in South Australia and Germany with emissions intensities of 300 gr CO ₂ /kWh, California at 250 gr, Great Britain at 230 gr and Denmark at 170 gr. These values have an uncertainty regarding the upstream methane emissions from their imports. Compare these values with the nuclear reliant jurisdictions of Ontario on 25 gr CO ₂ /kWh, France on 60 gr CO ₂ /kWh and Sweden on 40 gr. In the case of France there is a risk that emissions will increase on the back of a shift to wind and solar caused by increased methane burning. Grids which attempt to use 90 - 100% variable renewable energy with storage and fossil backup are embarking on very high risks of economic and grid failure. Nuclear energy has a proven elegant simplicity.	Noted. The Executive Summary relies on the Chapter, which by its turn rely on peer-reviewed literature on mitigation pathways coming out of Integrated Assessment Models.	Robert Parker	Nuclear for Climate Australia	Australia
82607	5	1	5	6	Should add nuclear to "There are different configurations of a net-zero carbon system, relying more on energy efficiency, renewable energy, carbon-capture-and-storage, reduction of non-CO ₂ emissions or carbon dioxide removal(CDR)"	Noted. Chapter relies 100% in the peer-reviewed literature, and most IAMs do not see nuclear energy as a cost-effective technology to mitigate climate change as compared to most renewable energy technologies.	Jonathan Cobb	World Nuclear Association	United Kingdom (of Great Britain and Northern Ireland)
233	5	2	5	6	There is no mention here of net-zero carbon systems relying on sufficiency. A glaring omission that should be discussed.	Noted.	Kai Kuhnnehn	Konzeptwerk Neue Ökonomie	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
5223	5	3	5	3	Replace "renewables" by "low carbon", in order to include nuclear which is called to play important rôle in many countries.	Noted. Chapter relies 100% in the peer-reviewed literature, and most IAMs do not see nuclear energy as a cost-effective technology to mitigate climate change as compared to most renewable energy technologies.	Michel SIMON	Retraité/ Pdt d'association	France
37597	5	3	5	5	The sentence "There are different configurations of a net-zero carbon system, relying more on energy efficiency, renewable energy, carbon-capture-and-storage, reduction of non-CO2 emissions or carbon dioxide removal (CDR)" ignores established low-carbon technology like nuclear and gives importance to trickster technologies like CCS and CDR. Please use "nuclear and renewable energy" in place of "renewable energy".	Noted. Chapter relies 100% in the peer-reviewed literature, and most IAMs do not see nuclear energy as a cost-effective technology to mitigate climate change as compared to most renewable energy technologies.	Ravi B Grover	Homi Bhabha National Institute	India
69427	5	3	5	4	I would suggest add "electrification" to this list, as it is an important dimension of mitigation pathways to net-zero	Noted.	Cédric PHILIBERT	Institut Français des Relations Internationales	France
79701	5	3			There are different configurations of a net-zero carbon system, relying more on energy efficiency, renewable energy, nuclear energy, carbon-capture and storage.....	Noted.	valerie faudon	SFEN	France
1779	5	4	5	7	Again, the term well below is used. Furthermore, it seems inconsistent with the later parts of the chapter that GHG emissions of 50 GtCO2e in 2030 and percentage range of reductions starting from 0 could be consistent with a well below 2C pathway	Noted. Text has been substantially revised in response to reviewers comments.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
45801	5	5	5	5	Please add "and risks" after "Each of these routes is associated with different challenges...". We are for example referring to the risk of failure to reach the mass deployment of CDR in the second half of the century.	Noted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
15369	5	7	5	23	In these two statements it is not clear whether negative emissions (CDR) are already factored in or not. Please make this explicit. Chapter 2 indicates that we are very close (<10 years) away from exhausting the 1.5C budget. But line 13 here seems to suggest that we still can emit up to 14 GtCO2eq yr-1 by 2050. How does that go together?	Noted. Text has been substantially revised in response to reviewers comments.	Thomas Wiedmann	UNSW Sydney	Australia
17545	5	7	5	23	Issue with uncertainty language around temperature targets. In the ES statement starting line 7: uncertainty language around temp goals is illustrated using likelihood statements (with likely chance, with median chance etc). Meanwhile, in the ES statement starting line 15: the uncertainty is illustrated using probability ranges. Please consider make these consistent. Same comment applies to other relevant statements. Thanks	Noted. Text has been substantially revised in response to reviewers comments.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
17547	5	7	5	23	Can you please follow the same sequence in presenting the information under ES statement starting line 7 and the one starting line 15. Line7 focusing on GHGs: contains annual emissions, emissions reduction rate, for both 2030 and 2050. Meanwhile, the one starting Line 15: only covers annuals emissions for 2030, additionally it covers net zero year. If the statement starting in Line 7 covers net zero year too, then one can compare both next zero GHGs and CO2, and that would reinforce the last statement in the previous page, lines 45-46: that CO2 net zero is earlier than GHGs net zero. Thanks	Noted. Text has been substantially revised in response to reviewers comments.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
17779	5	7	5	23	(3 ES) net zero around 2056 for 1.5 (line 17) compare with around 2050 in SR15 SPM C.1 Don't know how 13-25 GtCO2 in 2030 here compares with 45% fall from 2010 levels by 2030 in SR15 (SPM C.1). (Line 13 has 35-60% fall by 2030 vs 2020, but SR15 C.1 has 10-30% by 2030 comparing vs 2010.) The important thing is that these emissions pathways should be consistent with those in SR15 which are well and widely understood, and that if there are any differences we can explain them, including the apparent change in reference period.	Noted. Text has been substantially revised in response to reviewers comments.	Jonathan Lynn	IPCC	Switzerland

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
29831	5	7	5	14	The formulation here "below 2020 levels" seems slightly odd since in chapter 2 emissions up to 2018 is only used? Please be consistent across the chapters, and we would prefer if the latest emissions estimates could be used throughout the report. Or explain where data stems from, is 2018 based on inventories while 2020 are model output? Please clarify.	Noted. Text has been substantially revised in response to reviewers comments.	Government of Norway	Norwegian Environment Agency	Norway
37417	5	7	5	9	Edit the statement as follows: "Cost-effective model mitigation pathways consistent with limiting temperature change to below 2 °C (with likely chance, C3) are typically associated with GHG emissions of 34 to 56 GtCO ₂ eq yr-1 by 2030 and 14 to 25 GtCO ₂ eq yr-1 by 2050."	Noted. Text has been substantially revised in response to reviewers comments.	Government of India	Ministry of Environment, Forests and Climate Change	India
54769	5	7	5	18	This text uses multiple forms or formats of language to express probability: likely chance on line 8 and median chance on line 11 in the first paragraph, 50% probability on line 15 and 67% probability on line 17 in the second paragraph. All of these are correct but, for an Executive Summary, it may be helpful to stick to one format for this chapter and for the entire document. Also, this first paragraph says "typically associated" on line 8, while the second paragraph says "is associated" on line 18. Standardize the language.	Noted. Text has been substantially revised in response to reviewers comments.	Government of United States of America	U.S. Department of State	United States of America
71263	5	7	5	14	1.5C findings are almost exclusively indicated with 50% likelihood, whereas 2C sometimes is indicated with 67% likelihood. There is no explanation of this in the chapter and no thorough discussion of the issue of likelihoods. It would be very useful to indicate findings for 1.5 and 2C with similar likelihoods and ideally for a range of likelihoods.	Noted. Text has been substantially revised in response to reviewers comments.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
77105	5	7	5	9	Likewise the projection limits to achieve the "2°C" ambition of the Paris Agreement by 2030 and 2050 respectively are so wide as to not inspire any confidence in AR6/WGIII future climate projections.	Noted. Text has been substantially revised in response to reviewers comments.	Jim O'Brien	Expert Reviewer AR6 SOD WG1	Ireland
81153	5	7	5	23	I find it confusing to have two paragraphs with one speaking to GHG emissions with 2 degrees in the headline, and another one speaking to CO ₂ emissions with 1.5 degrees in the headline. Two sets of apples and oranges making a fruit salad. It would be better in my view if those paragraphs were more symmetrical, one on GHG and the other on CO ₂ (but both talking about a range of temperatures), or one para on 1.5 and one para on 2 degrees (and both talking about GHG and then CO ₂ specifically).	Noted. Text has been substantially revised in response to reviewers comments.	Andy Reisinger	Ministry for the Environment	New Zealand
85295	5	7	5	23	Please always present the findings for 1.5°C first, and only then for 2°C. Since the Paris Agreement and SR1.5 the focus has shifted from 2°C to pursuing 1°C.	Noted. Text has been substantially revised in response to reviewers comments.	Kaisa Kosonen	Greenpeace	Finland
10539	5	8	5	8	I suggest you insert "category" in front of "C3"	Noted. Text has been substantially revised in response to reviewers comments.	Philippe Waldteufel	CNRS	France
17541	5	8	5	8	Please consider changing "(with likely chance, C3)" to "(with likely chance)" only. It may confuse the uncertainty language with the categories. Also, the reader at this stage is still not fully versed in the particular categories adopted. If yes, I suggest that the same applies to all other statements in the ES.	Noted. Text has been substantially revised in response to reviewers comments.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
23295	5	10	5	10	We suggest using a reference year for the emissions level that is different from 2020 considering the uncertain impact of COVID-19. An earlier date such as 2018 would be more suitable. Or 2010, noting that SR1.5 used 2010 as a reference year for similar statements	Noted. Text has been substantially revised in response to reviewers comments.	Government of France	Ministère de la Transition écologique et solidaire	France
29833	5	10	5	14	Please consider when referring to scenarios relevant for 1.5C to use formulations such as "stabilizing at" or "limiting to". Try to avoid using the word "below" when referring to 1.5C. This would in our view make the text closer to the formulation in Art. 2 of the Paris Agreement and therefore more relevant. Using the word "below" or "well-below" is more appropriate when referring to scenarios that are relevant to 2C.	Noted. Text has been substantially revised in response to reviewers comments.	Government of Norway	Norwegian Environment Agency	Norway
29835	5	11	5	11	Please consider replacing "(with median chance)" with the more familiar language used for expressing likelihood in the IPCC reports.	Noted. Text has been substantially revised in response to reviewers comments.	Government of Norway	Norwegian Environment Agency	Norway
54771	5	13	5	13	Re-word to be parallel with 2°C wording: delete comma after "2030" and insert "and", and insert "corresponding to" instead of "and" before "reductions".	Noted. Text has been substantially revised in response to reviewers comments.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
50249	5	14			How to interpret 2020 emission levels? Model values (with or without COVID-19 effects?) or real time projections?	Noted. 2020 emission levels are model values and, as such, are typically without COVID-19 effects as most runs in the database were performed before 2019.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
75559	5	14	5	14	Assignment of confidence is unclear. The statements referred to are descriptive statements about the scenarios that are examined in the chapter. Descriptive statements must be either true or false. If the statement of confidence instead relates to whether what is observed in the scenarios will happen in the real world, this is also very confusing. As stated elsewhere in the summary to this chapter "Pathways are not predictions or forecasts, but rather explorations of plausible representations of the future based on coherent and internally consistent set of assumptions about driving forces." It is therefore unclear what the "confidence" of the pathway results might mean.	Noted. Text has been substantially revised in response to reviewers comments.	Ida Sognaes	CICERO Center for International Climate Research	Norway
18075	5	15	5	23	I can't find the detailed discussion (or even the figures) in the main body of the chapter for CO2 pathways referred to in this summary paragraph. Could the authors please ensure that the points in the executive are to be found in the chapter and/or correct the section reference at the end of the paragraph.	Noted. Text has been substantially revised in response to reviewers comments.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
54773	5	15	5	19	Suggest reversing order of 1.5°C and 2°C to maintain a parallel structure throughout summary of discussing 2°C first and 1.5°C second.	Noted. Text has been substantially revised in response to reviewers comments.	Government of United States of America	U.S. Department of State	United States of America
63483	5	15	5	19	This range for the timing of net zero CO2 emissions for limiting global warming to 1.5C with no or limited overshoot - here given as 2045-2070 - will be readily compared to the similar statement in the SPM of IPCC SR1.5 (para C.1; interquartile range given as 2045-2055). Is the much larger range provided here (2045-2070) also the interquartile range based on the updated scenario dataset, or does it represent a wider range of percentiles? The same comment applies to the range provided for net zero CO2 emissions in likely below 2C scenarios.	Noted. Text has been substantially revised in response to reviewers comments.	Government of Canada	Environment and Climate Change Canada	Canada
65285	5	15	5	23	Is there any way this could be written in ways that make sense to the outside world? Or at least to list the 'non-CO2', even if obvious to the writer, it could help the policy maker connect on non-CO2 reductions that support urgent action.	Noted. Text has been substantially revised in response to reviewers comments.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
75051	5	15	5	25	I find it somewhat confusing to report for the 1.5° the budget for 50% probability and the 2.0° for 66% probability. To compare the challenge associated with the targets, it needs to be consistent or you report for both targets both probabilities.	Noted.	Wilfried Rickels	Kiel Institute for the World Economy	Germany
75561	5	15	5	17	The statement in bold should be reformulated to match the sentence in bold in the previous paragraph (line 7-9) in order to clarify that it refers to cost-effective mitigation pathways.	Noted. Text has been substantially revised in response to reviewers comments.	Ida Sognaes	CICERO Center for International Climate Research	Norway
75563	5	15	5	17	Assignment of confidence is unclear. The statement referred to is a descriptive statement about the scenarios examined in the chapter. Descriptive statements must be either true or false. If the statement of confidence instead relates to whether what is observed in the scenarios will happen in the real world, this is also very confusing. As stated elsewhere in the summary to this chapter "Pathways are not predictions or forecasts, but rather explorations of plausible representations of the future based on coherent and internally consistent set of assumptions about driving forces." It is therefore unclear what the "confidence" of the pathway results might mean.	Noted. Text has been substantially revised in response to reviewers comments.	Ida Sognaes	CICERO Center for International Climate Research	Norway
85297	5	15	5	17	Given the well known "IPCC benchmarks" for 1.5°C outlined by the IPCC SR1.5 (i.e. -45 % CO2 cuts from 2010 levels by 2030 and net zero around 2050), many readers will be wondering how these AR6 ranges compare to those SR1.5 benchmarks (which have since become THE science-based benchmarks for Paris Agreement compatible climate action). Given different base years and scopes (CO2 / GHG), a reader might get lost. Please provide an explanation of how the two compare (and in what sense the AR6 provides an updated assessment of the needed 1.5°C compatible emission cuts).	Noted. Text has been substantially revised in response to reviewers comments.	Kaisa Kosonen	Greenpeace	Finland
45803	5	17	5	17	Net zero CO2 does not seem consistent with SPM C2.2.	Noted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
69429	5	18	5	23	Here again there is a shift from gross emissions to net zero which will appear non sequential to the reader	Noted.	Cédric PHILIBERT	Institut Français des Relations Internationales	France
37601	5	19	5	21	The sentence "The use of Carbon Capture and Storage (CCS) plays a very important role in CO2 emissions reduction in the low warming scenarios" should be moderated considering that CCS is yet to be deployed on large scale anywhere.	Noted.	Ravi B Grover	Homi Bhabha National Institute	India
15783	5	20	5	23	"If non-CO2 emissions are reduced rapidly until 2050, the time of net zero CO2 emissions can lag peak warming by 10 years (0-27). The more non-CO2 emissions are reduced until the time of net zero CO2 emissions, the more CO2 emissions can be emitted cumulatively until then." This view is justified in 3.3.2.2 (role of CO2 and other GHG). A significant precision could be added , given chapter 6.7.3 (Energy System Lock-In and Path Dependence) and literature on methane leakage from natural gas industry (see IEA methane tracker annual report, 2021): avoiding development and investment in natural gas industry (both upstream and downstream for final energy use) has two benefits: lower economic lock-in in fossil infrastructure, and lower methane emissions (significant even with the 100-year accounting convention for global warming power).	Noted.	Jean-Michel Trochet	EDF group (French Utility)	France
29837	5	20	5	20	This is the first time non-CO2 emissions are mentioned in Chapter 3. Please consider to explain to the readers which gases or forcers that are included when using this expression. If possible it would also be useful to be informed about which of the non-CO2 gas or forcer that contributes most to future warming. Please consider to include this information in the executive summary of chapter 3, and consider if this is information that also could be included in the Summary for Policymakers.	Noted.	Government of Norway	Norwegian Environment Agency	Norway
63485	5	20	5	23	Can this be stated more simply/plainly? Perhaps something like "if non-CO2 emissions are reduced rapidly until 2050, then the time of net zero CO2 emissions is delayed by X-Y years and the amount of CO2 emitted is larger for a given level of peak warming".	Noted.	Government of Canada	Environment and Climate Change Canada	Canada
71265	5	21	5	21	It is not clear where in the chapter this 10-year lag is explored. Consider deleting it from the Executive Summary. In terms of policy coordination, the idea that the timing of net zero could be delayed because rapid non-CO2 mitigation has been arranged seems quite far-fetched.	Noted.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
44025	5	22	5	23	"The more non-CO2 emissions are reduced until the time of net zero CO2 emissions, the more CO2 emissions can be emitted cumulatively until then." This sentence is not relevant, and it is quite obvious, should be removed	Noted.	Stefano Caserini	Politecnico di Milano	Italy
54775	5	23	5	25	It may be helpful here to clarify that these sentences are referring to meeting temperature targets. For instance, line 23 could end with "while still staying below a given temperature target". Line 24 could also clarify that the reliance talked about is what is needed to meet temperature targets.	Noted.	Government of United States of America	U.S. Department of State	United States of America
29839	5	24	5	36	This para includes findings that are very relevant for policymakers and it is well written and understandable. Please consider including these formulations in the Summary for Policymakers. We suggest to integrate it with the text in SPM section C2, which already discusses some of these findings but in a less understandable way.	Noted.	Government of Norway	Norwegian Environment Agency	Norway
47205	5	24	5	25	Fuzzy way of stating "early-on reductions avert the need for negative emissions technologies"	Noted.	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
1783	5	27	5	28	This seems to contradict lines 11-13, the following two lines are a repetition	Noted.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
29321	5	27	5	28	Similarly, it is not clear which temperature objective (1.5C or well below 2C) is being considered in this sentence: "A temperature limit in line with the Paris climate targets strongly binds near-term emissions developments".	Noted.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
63487	5	27	5	28	The phrase "strongly binds near-term emission developments' is unclear.	Noted.	Government of Canada	Environment and Climate Change Canada	Canada
54777	5	28	5	28	Clarify what is meant by the word "developments". Does this mean mitigation actions?	Noted.	Government of United States of America	U.S. Department of State	United States of America
65287	5	28	5	45	The concept of 'overshoot' is understood by some, but if you could spell out the consequences (as in the SR1.5C), this would help the reader. For example, returning from overshoot may be physically possible but note the consequence to eco-systems that would not survive the overshoot. This is what the SR1.5C helped to do - make real what is at stake in terms of lives and livelihoods - 'humanize' the statistics to reach the heart as well as the mind. Line 38 with the phrase 'climate impacts' is a good place to do this - 'impacts' in terms of human impact/nature impact. We need help to understand what is at stake, what is being lost, with insufficient climate action. FOR line 45 - again, 'below 1.5C', is this different from the 'limit to 1.5C' - unclear and could be a backlash in misunderstanding.	Noted.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
18077	5	30	5	31	Please delete "and net negative CO2 emissions will be required to reduce these risks", because they may not be available at sufficient scale. Thus modified, the sentence will then clearly state the risk of exceeding the temperature target - an important message - and it will become consistent with this in the SPM "Weaker near-term action would place limiting warming to these levels out of reach" (SPM para C1).	Noted.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
43053	5	30		34	However, the large-scale deployment of CDR is problematic: "This requires large-scale deployment of carbon dioxide removal (CDR) options, some of which come with concerns relating to sustainability, impacts on land use and food prices, intergenerational equity issues and risks associated with future performance of these technologies with respect to the use of land and geological storage reservoirs and the permanence of removal."	Noted.	Graeme Taylor	BEST Futures	Australia
83143	5	30	5	30	A qualifier before "chance" should indicate how high this chance actually is	Noted.	Geden Oliver	German Institute for International and Security Affairs	Germany
1785	5	31	5	32	As the following paragraph indicates, reaching the 1.5 LT target is impossible with weaker near term action. Should be specified/text should be clearer.	Noted.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
23297	5	31	5	35	Issues related to societal preferences and acceptability should be added to all these issues around deployment of CDR options	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
23299	5	31	5	31	We suggest to replace "This requires" to "This would require" as the possibility of deploying these options is by no means a given.	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
37599	5	31	5	35	The sentence "This requires large-scale deployment of carbon dioxide removal (CDR) options, some of which come with concerns relating sustainability, impacts on land use and food prices, intergenerational equity issues and risks associated with future performance of these technologies with respect to the use of land and geological storage reservoirs and the permanence of removal" well articulates concerns associated with CDR, but the report places undue emphasis on CDR, while ignoring technologies like nuclear which can be deployed in near-term.	Noted.	Ravi B Grover	Homi Bhabha National Institute	India
45805	5	31	5	32	Please clarify that this would have the stated consequences, only if the condition in the previous sentence were met, and that the scale depends on the level of overshoot. Please reformulate: "Depending on the level of overshoot, this WOULD require large-scale deployment of carbon dioxide removal ..."	Noted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
85137	5	32	5	32	With regard to the many caveats that come with the majority of CDR options and which can be found at various places in the entire report, it seems to be unbalanced to say "some CDR options come with concerns". Please consider to change to "...[CDR options], most of which come with concerns..."	Noted.	Jens Tambke	Umweltbundesamt	Germany
45807	5	35	5	35	An important statement, but the authors should give more guidance on this "weighting", if not here then in a dedicated sub-chapter. As commented giving tangible guidance on the partitioning between emission reduction and (later and more or less) CDR should be a key outcome of this report, taking into account the large uncertainty about the potentials and risks of CDR options. It seems largely lacking in the executive summary level at present.	Noted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
54779	5	35	5	35	Suggest stronger language: the word "can" should be replaced with "must".	Noted.	Government of United States of America	U.S. Department of State	United States of America
5225	5	36	5	36	In addition, industrial development of geological storage will have to gain social acceptance.	Noted.	Michel SIMON	Retraité/ Pdt d'association	France
18079	5	37	5	38	Very important point that should be included in the SPM.	Noted.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
47207	5	37	5	38	Fuzzy way of stating "postponing climate action leads to greater required efforts and resulting impacts"	Noted.	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
61625	5	37	5	38	According to IEA 2019, the easiest and most affordable way to “increase” the availability of low-carbon energy in the short to medium term is to not close existing nuclear power plants (through political decisions like is happening in Germany, Belgium, Switzerland, France) and to facilitate long-term operations of the current nuclear power fleet through access to low-cost financing for plant refurbishment and supportive market design which rewards NPP’s for the value they provide. This should be made clear throughout the report, and especially when it comes to short term failures exacerbating long term mitigation challenges and increasing climate impacts. IEA report available at: https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system .	Noted. IEA reports are very important but we also rely on thousands of peer-reviewed articles.	Rauli Partanen	Think Atom	Finland
71267	5	37	5	38	As the following paragraph indicates, reaching the 1.5 LT target is impossible with weaker near term action. Should be specified/text should be clearer.	Noted.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
43051	5	38		40	Overshoot is likely. “Weak near-term action would require even higher transitions speeds after 2030 and increases the risk of overshooting the target. Overshooting the target entails higher climate impact risks and requires larger CDR deployment to return warming to below the target.”	Noted.	Graeme Taylor	BEST Futures	Australia
23301	5	40	5	41	We suggest to replace "requires larger CDR" to "would require larger CDR" as the possibility of deploying these options is by no means a given.	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
27591	5	42	5	44	Delete "Weak near-term action entails continued build-up of fossil-fuel infrastructure until 2030, making it more costly to replace fossil-fuel related infrastructure thereafter. A carbon lock-in will increase and prolong the societal, economic and political strain of a rapid low-carbon transition after 2030.", as analysis refers to long-term targets.	Noted.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
54781	5	43	5	43	The concept of carbon lock-in is difficult to understand in the Executive Summary without the context provided in the chapter text. Suggest replacing text with a definition, such as: "This long-term infrastructure locks in future carbon emissions, which ..."	Noted.	Government of United States of America	U.S. Department of State	United States of America
11431	5	45	5	45	The figures "49-62 GtCO ₂ -eq" do not tally with the main text (52.4-64.6 GtCO ₂ -eq, P.62, line 6). Please check and revise as appropriate.	Noted.	SAI MING LEE	Hong Kong Observatory	China
17549	5	45	5	45	leading to estimated "GHG" emissions. Same applies to page 6, line 4. Thanks	Noted.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
23303	5	45	5	47	This message is crucial for policy makers and is clearly expressed. Suggestion to keep it as is, and display it in the SPM	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
23305	5	45	5	45	There is a need for harmonization of the emission level consistent with NDCs in 2030: page 62, line 6 of chapter 3 it is written: "If mitigation ambitions as stated in current NDCs are followed until 2030, leading to estimated emissions of 52.4-64.6 GtCO ₂ -eq in 2030" and page 63, lines 14-16 : "The mitigation ambition stated in the current nationally determined contributions (NDCs) under the Paris Agreement are projected to lead to CO ₂ of 36-45 GtCO ₂ emission levels in 2030" in chapter 4, section 4.2.2: "unconditional and conditional NDCs to 59 (55-65) and 56 (52-61) GtCO ₂ -eq, respectively"	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
27589	5	45	5	47	It needs to specify which are the NDCs considered - i.e. if the NDCs submitted until December 2020 were taken into consideration.	Noted.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
44027	5	45	5	45	"If NDCs are followed until 2030" this is not clear. What does it mean "if NDC are followed?": it means that the NDC submitted in 2015 lead to 49-62 GtCO ₂ emission in 2030? Please rephrase	Noted. Text has been revised.	Stefano Caserini	Politecnico di Milano	Italy
62041	5	45	5	45	Do you refer to the unconditional or conditional NDCs ? Please explain. I would also reformulate: if the conditional NDCs are implemented.	Noted.	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands
62043	5	45	5	46	The numbers differ from the Summary of Policy makers. Are the estimates also for the GWPs AR6? Are these conditional or unconditional NDCs.	Noted. Text has been revised.	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands
65507	5	45	5	45	The abbreviation of "National Determined Contributions" (NDCs) is used several times without introducing the whole name.	Noted.	Cristian Chadwick	University of Chile	Chile
80197	5	45	6	2	The statement that staying below 1.5 degrees "not possible" is not accurate given the potential use of SRM. Not mentioning it in the context of risk of insufficient mitigation ambition is misleading by omission and therefore policy-prescriptive. As per SR1.5, "SAI is the most-researched SRM method, with high agreement that it could limit warming to below 1.5°C" (SR1.5, Ch4, Cross-chapter box 10)	Noted.	Kelly Wanser	SilverLining	United States of America
81159	5	45			This will be a very important statement, and the authors need to be transparent about what 'closing date' they apply to NDCs, given that some countries could still update theirs after this draft has been finalised.	Noted.	Andy Reisinger	Ministry for the Environment	New Zealand

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
18081	6	1	6	2	"...emissions would need to be reduced at almost twice the rate of cost-effective mitigation pathways..." I think this needs to specify cost effective pathways beginning action in 2020	Noted.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
18083	6	3	6	9	I think this paragraph would be more helpful framed as "scenarios suggest it is still possible to get on a pathway to 2°C or 1.5°C with concerted action to improve on NDCs before 2030, though this would not be a least-cost outcome." Rather than just a description of what 'accelerated action pathways' are.	Noted.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
47209	6	3	6	4	Fuzzy way of stating "Aligning NDCs to a 1.5C or below 2C pathway requires NDCs to drop another 80% in their estimated emissions by 2030"? (Don't understand this key message)	Noted.	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
60339	6	3	6	9	A 10GtCO ₂ e gap is very low compared to other estimates in the literature. I would have expected a higher number here.	Noted.	Niklas Höhne	NewClimate Institute	Germany
78101	6	3	6	4	'Accelerated action pathway' is a misnomer. It comes from the IAM projects (e.g., ENGAGE) and refers to pathways between NDCs and 1.5°C. Please rephrase, as accelerated action implies Paris compatibility, but these only limit to 2°C.	Noted.	Charlotte Plinke	Climate Analytics	Germany
44029	6	4	6	4	NDC emission levels" What does it mean? Which NDC? The NDC submitted in 2015?	Noted. Text has been revised.	Stefano Caserini	Politecnico di Milano	Italy
69431	6	4			Please spell out NDC as this is its first apparition in this chapter	Noted.	Cédric PHILIBERT	Institut Français des Relations Internationales	France
23307	6	7	6	7	In the part of the sentence "all accelerated action pathways converge to a global mitigation regime" we suggest a clarification on the term "regime" in that case	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
23309	6	10	6	10	In this sentence, for the term "demand", if this is about energy demand, it should be specified. If it entails other things (e.g. goods and services), it should be clarified.	Noted. Text has been revised.	Government of France	Ministère de la Transition écologique et solidaire	France
30653	6	10	6	10	"demand" of what? Energy consumption? Energy service? Please specify.	Noted. Text has been revised.	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
63489	6	10	6	14	Clarify whether energy efficiency improvements are considered here among demand-side mitigation. In cost-effective IAM generated mitigation pathways, it would seem likely that energy efficiency improvements are integral to mitigation pathways. Are demand-side mitigation options not included in pathways referring to things like changes in behaviour, life style, diet, urban form/density etc.?	Noted. Text has been revised.	Government of Canada	Environment and Climate Change Canada	Canada
65289	6	10	6	16	Is there a reason why 'demand side mitigation' pathways are few, when consumption and transformational behavior change (diet, etc) are cited as having significant mitigation contributions?	Noted. Text has been revised.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
65663	6	10	6	15	Specify the "demand-reducing technologies". Also connect this with the historical observation of energy use and GDP growth in developing countries. Add a note on how probable the demand-reduced scenarios are in this light.	Noted. Text has been revised.	Eero Hirvijoki	Aalto University	Finland
74797	6	10	6	12	the line reads, "Mitigation scenarios show reductions in demand from baseline, either due to adoption of demand-driven technologies or through declines in services...." - it is however not immediately clear what demands the sentence refers to. The sentence should be re-written to start as "Mitigation scenarios show reduction in demand in (insert what the demand refers to) from baseline.	Noted. Text has been revised.	Government of Kenya	Kenya Meteorological Service	Kenya
75565	6	10	6	24	Assignments of confidence (seven cases) are unclear. The statements referred to are descriptive statements about the scenarios that are examined in the chapter. Descriptive statements must be either true or false. If the statement of confidence instead relates to whether what is observed in the scenarios will happen in the real world, this is also very confusing. As stated elsewhere in the summary to this chapter "Pathways are not predictions or forecasts, but rather explorations of plausible representations of the future based on coherent and internally consistent set of assumptions about driving forces." It is therefore unclear what the "confidence" of the pathway results might mean.	Accepted. The executive summary statements have been rephrased to make this clearer.	Ida Sognaes	CICERO Center for International Climate Research	Norway
75567	6	10	6	11	"The energy supply sector will undergo changes in terms of size and composition in the 21st century with almost all scenarios" should be changed to "The energy supply sector undergoes changes in terms of size and composition in the 21st century in almost all scenarios". This is a descriptive statement about the scenarios examined in this chapter, and scenarios are neither forecasts nor predictions of the future (as stated elsewhere in the summary of this chapter).	Noted. This sentence has been rephrased in response to this and other comments	Ida Sognaes	CICERO Center for International Climate Research	Norway

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
81161	6	10	6	12	It is striking that this headline does not recognise the role of behavioural and lifestyle choices. Is this meant to be included in "declines in services"? If so, I consider this to be far too negative a characterisation since those who adopt different transport modes or make dietary choices don't necessarily consider those to be reductions in services but perhaps actually an enhancement in active lifestyles etc. This reflects one of the key weaknesses in IAM-based assessment of mitigation options (as such choices are more often embedded in the SSP baseline, rather than an induced mitigation choice that would shift the world from one SSP to another one). Please actively recognise behavioural and lifestyle choices as another discrete demand-side option, since declines in services (which I interpret as making do with less of something that one would actually have wanted and needed) is the least plausible and least feasible demand-side reduction.	Accepted. We have rephrased this statement.	Andy Reisinger	Ministry for the Environment	New Zealand
23311	6	11	6	12	Regarding "mitigation-induced price" we suggest a clarification of what price it is referring to	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
23313	6	12	6	15	This sentence is misleading. If mitigation strategies exploiting potentials based on the reduction of energy demand allow to reduce the dependence on CDR, the pressure on land, and carbon prices, one wonders why there are not more of them in the literature. It should be mentioned that models are still ill-equipped to study changes in behaviour and consumption.	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
29323	6	12	6	14	It is not clear how these two statements fit together. Since IAMs typically allow demand to respond (and usually have final demand in mitigation scenarios that is significantly less than reference), it is not clear why only a limited number of scenarios would show significant potential. "Bottom-up and IAM and non-IAM studies show significant potential for demand-side mitigation; however, a limited number of pathways include these options (high 14 confidence).	Noted.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
51991	6	12	6	12	IAM should be spelled out on first appearance in the chapter.	Accepted	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
65511	6	12	6	12	The abbreviation of "Integrated Assessment Models" (IAMs) is used several times without introducing the whole name.	Accepted	Cristian Chadwick	University of Chile	Chile
69433	6	12			Please spell out IAM as this is its first apparition in this chapter	Accepted	Cédric PHILIBERT	Institut Français des Relations Internationales	France
69435	6	13			Please spell out CDR as this is its first apparition in this chapter	Accepted	Cédric PHILIBERT	Institut Français des Relations Internationales	France
37585	6	14	6	15	The paragraph might be misleading. The carbon price levels in the scenarios with low demand would depend on whether the energy demand is exogeneous or endogeneous. If the energy demand is exogeneous, the carbon price would be low. But, if the demand is reduced endogeneously due to high carbon price, it might not be the case.	Accepted	Young-Hwan Ahn	Sookmyung Women's University	Republic of Korea
1787	6	15	6	16	Can the text be more specific regarding the share of the low warming scenarios for which this is the case?	The text has been significantly revised and improved.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
17555	6	16	7	15	The statements on industry and transport compare IAMs vs sector models. Can the same be done for building and AFOLU? Thanks	Accepted	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
23315	6	16	6	16	In the sentence "The energy supply sector will undergo changes in terms of size and composition in the 21st century with almost all scenarios, including baseline scenarios, transitioning towards non-fossil fuels" we suggest a clarification for the term "changes", change compared to what? This is true for any type of scenario. There are changes even in a laissez-faire case	Accepted. We have revised this sentence in response to this and other comments	Government of France	Ministère de la Transition écologique et solidaire	France
37603	6	16	6	20	The letters in bold use the words "transitioning towards non-fossil fuels", but later on in line 19 it changes to "renewable energy". Why this change? In line 20, a trickster technology like CCS is explicitly included. Please edit to remove this bias against nuclear.	Accepted. We have revised this sentence in response to this and other comments	Ravi B Grover	Homi Bhabha National Institute	India
44031	6	16	6	16	It is quite commonplace that "The energy supply sector will undergo changes in terms of size and composition in the 21st century with almost all scenarios". Please consider what will happen in the first half of the 21st century, this is less obvious and much more relevant for policymakers.	Accepted. We have adjusted the text to focus on 2050 in most cases.	Stefano Caserini	Politecnico di Milano	Italy

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
44033	6	16	6	45	What will happen in the 21st century is not so important for policymakers: I suggest changing all the sentences in this part of the executive summary considering what will happen by 2050, that is far more relevant for policymakers	Accepted. We have adjusted the text to focus on 2050 in most cases.	Stefano Caserini	Politecnico di Milano	Italy
61627	6	16	6	25	According to IPCC 2018 SPM, the 4 main scenarios show a rapid increase of 2-6 times by 2050 and 1.5-2 times by 2030 in nuclear energy production. Nuclear should not be omitted from the list here and from the scenarios themselves (while more unproven technologies such as CCS are included). Literature on nuclear role in achieving climate targets: Vaillancourt et al., 2008, https://doi.org/10.1016/j.enpol.2008.01.015 ; Apergis et al. 2010, https://doi.org/10.1016/j.ecolecon.2010.06.014 ; Menyah and Wolde-Rufael, 2010, https://doi.org/10.1016/j.enpol.2010.01.024 ; Brooks, 2012, https://doi.org/10.1016/j.enpol.2011.11.041 ; Hong et al., 2014, https://doi.org/10.1016/j.enpol.2014.05.054 ; Hong et al., 2014, https://doi.org/10.1016/j.apenergy.2014.09.062 ; Thangavelu, 2015, https://doi.org/10.1016/j.apenergy.2015.05.087 ; Qvist and Brook, 2015, https://doi.org/10.1371/journal.pone.0124074 ; Baek, 2015, https://doi.org/10.1016/j.apenergy.2015.01.074 ; Horvath and Rach-lew, 2016, https://doi.org/10.1007/s13280-015-0732-y .	Noted. The text has been substantially revised in response to reviewer comments. We use "low carbon" in many cases. However, given space limits, we cannot call out each individual carrier.	Rauli Partanen	Think Atom	Finland
65665	6	16	6	25	The hypothetical CCS and BECCS are mentioned to have "a very important role" yet, in Fig. SPM.9, the combined potential of CCS and BECCS is estimated lower and the cost higher than of nuclear. Please explain and correct this inconsistency.	Noted. The text has been substantially revised in response to reviewer comments.	Eero Hirvijoki	Aalto University	Finland
76423	6	16	6	24	While scenarios may show an increase in renewable energy, have they adequately taken into account: a)Very large anticipated cost reductions through the use of smaller nuclear power plants such as the GE's BWRX 300 at \$2,500 - \$3,000 /kw or Nuscale's plant at \$2.850 - \$3,389/kw and short construction times of 19 months? b)Reductions in costs of large scale nuclear power plants through an increase in plant numbers and using more efficient construction techniques as demonstrated by the Korean Chinese and Russian vendors. c)Reductions in capacity factors for all generators on a grid using VRE. This is especially the case with wind and solar which leads to curtailment and zero or negative pricing, d)High cost of storage required to address large energy transfers on a weekly, monthly and seasonal basis. This issue is created by wind variability which can vary up to 100% on a year by year basis. For example, June 2017 in Australia had half the wind intensity of June 2016. e) Has the analysis properly accounted for the very large grid expansions required especially in sparsely populated or underdeveloped regions? Additionally, there are large costs associated with the provision of ancillary services for grid stabilisation which accelerate with an increase in the use of VRE. f)Eventual failure to actually achieve ultra-low carbon generation caused by intermittency, fossil fuel back-up, climatic variability and demands of industry for reliable generation.	Noted. These issues are discussed in Chapter 6	Robert Parker	Nuclear for Climate Australia	Australia
84411	6	16	6	24	The role of nuclear power is not mentioned at all, considering that CCS is given a lot of space this is a bit strange. Large scale nuclear exists, large scale CCS does not.	Partially accepted. We have revised the text substantially. The only mentions of CCS now are as part of CDR (i.e., BECCS and DACCS). However, given space limits, we cannot call out each individual fuel	Mattias Lantz	Uppsala university	Sweden
29369	6	18	6	19	The term "phase out" implies that a quantity eventually reaches zero. Is that the intended meaning? If that is not true in all scenarios, then the term "decline" might apply more generally and therefore be more accurate in this instance. This term is used in other places as well, so the same question applies there. "Scenarios limiting warming to 2°C and 1.5°C show a more rapid increase of renewable energy and a more rapid phase out of coal and other fossil fuel uses (high confidence)."	Partially accepted. We have removed "phase out" and gone with "substantial reductions"	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
43057	6	18		23	For example, CCS will require a high carbon tax to make it cost effective. Nevertheless, many scenarios assume that it will be widely deployed in the near future. The report states that: "The use of Carbon Capture and Storage (CCS) plays a very important role in CO2 emissions reduction in the low warming scenarios; scenarios with more limited shares of CCS require a faster phase out of fossil fuels. The energy supply sector is a large emitter of CO2 in baseline scenarios, but can contribute with large negative CO2 emissions in mitigation scenarios with bioenergy with CCS (BECCS)."	Noted. This text has been substantially revised	Graeme Taylor	BEST Futures	Australia

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
65291	6	18	6	19	Excellent and clear sentence! Scenarios limiting warming to 2°C and 1.5°C show a more rapid increase of renewable energy and a more rapid phase out of coal and other fossil fuel uses (high confidence).	Noted. We have made revisions to this statement in response to other comments, but have tried to retain the clarity and messaging in this particular sentence	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
5227	6	20	6	20	Additionally, the decreased production by fossil fuels will have to be compensated by an increase of controllable production in order to be always able to meet the demand, even in absence of wind or sun. The development of renewable is limited by consequences of intermittent production.	Noted. These issues are discussed in Chapter 6	Michel SIMON	Retraité/ Pdt d'association	France
65293	6	20	6	24	This sentence should be restructured to highlight best practice first, specifically, reducing FF sufficiently rather than slowing FF reduction as enabled by CCS. The P1 Pathway in the SR1.5C had no BECCS - these models should come first. The current sentence as it stands gives argument for FF companies to emphasise CCS over needed rate of FF phasing out. It is important to have clear science in a situation where the main drivers, FF, are financially lucrative, this being a great challenge to acting at the speed needed for a healthy transition. (The use of Carbon Capture and Storage (CCS) plays a very important role in CO2 emissions reduction in the low warming scenarios; scenarios with more limited shares of CCS require a faster phase out of fossil fuels (medium confidence). The energy supply sector is a large emitter of CO2 in baseline scenarios, but can contribute with large negative CO2 emissions in mitigation scenarios with bioenergy with CCS (BECCS)	Accepted. This sentence has been revised	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
69437	6	20	6	24	I would suggest toning down the role of CCS in the energy supply sector in light of the rapid cost reduction of solar PV and wind power. As both technologies are variable and not controllable, there will be a need to complement them with thermal balancing plants, in which the economics of CCS are being made very difficult due to capacity factors getting lower and lower. If CCS is ever to play some significant role in climate mitigation, it will rather be in the industry sector that has processes and plants running full speed 24/7 with in some cases (notably cementmaking) hard-to-suppress process emissions (although more and more electrification based on renewable electricity will permit mitigate or eliminate these emissions). The global average capacity factor of coal plants has already decreased from 61% in 2010 to 53% in 2019 (according to IEA data. in North America, from 69% to 47%; in Europe, from 50% to 38%; in India from 71% to 50%; and even in China from 57% to 53%). In the IEA SDS (WEO 2020) it would go further down to 35% by 2030 and 21% by 2040.	Noted. This text has been substantially revised	Cédric PHILIBERT	Institut Français des Relations Internationales	France
71269	6	20	6	21	Can the text be more specific regarding the share of the low warming scenarios for which this is the case?	Rejected. This text has been removed in response to comments by other reviewers	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
72809	6	20	6	21	CCS does not play a substantive role in all low warming scenarios, e.g., those depending to a large extent on renewable energy. Suggest changing to 'some low warming scenarios'	Noted. This text has been substantially revised	Matthew Gidden	Climate Analytics	Germany
47679	6	22	6	23	It is stated that BECCS can contribute "large negative CO2 emissions" with "high confidence". It is not clear what "large" means, and the high confidence is largely due to the way IAM models deal with BECCS and its tradeoffs. More detailed assessments of BECCS potential have shown that their contributions may be important but limited. This is also described in more detail in the AFOLU chapter. https://www.nature.com/articles/s41558-020-0885-y	Noted. This text has been substantially revised	Vassilis Daioglou	Utrecht University	Netherlands
72811	6	23	6	24	The statement on BECCS needs to be contextualized with given the effect on sustainability dimensions. Further, this statement elides potential dependence on high renewable and zero-carbon technologies as well. It needs to be rephrased.	Accepted. This text has been substantially revised	Matthew Gidden	Climate Analytics	Germany
9661	6	25	6	30	There seems to me some contradiction in the paragraph that line 26 says mitigation potential in IAM for the building sector is limited line 28 says emissions decline by more than 80% in 2100.	Accepted. This text has been revised to clarify	Mustafa Babiker	Saudi Aramco	Saudi Arabia
60341	6	25	6	30	The section on timing of reductions in buildings need to highlight modelling uncertainties upfront to not be misunderstood. The timing per sector is largely determined by the input assumptions of the models. The models used usually have less detailed mitigation options for buildings and transport and therefore project a later net zero year. The fast development of electric vehicles in transport and heat pumps in buildings are often not covered by the models as such exponential growth is difficult to predict. The current section could be interpreted that the transport and building sectors can lean back and that zero emissions is not expected from them.	Accepted. The text has been revised to include these points	Niklas Höhne	NewClimate Institute	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
75569	6	25	6	27	Assignment of confidence is unclear. The statement referred to is a descriptive statement about the scenarios examined in the chapter. Descriptive statements must be either true or false. If the statement of confidence instead relates to whether what is observed in the scenarios will happen in the real world, this is also very confusing. As stated elsewhere in the summary to this chapter "Pathways are not predictions or forecasts, but rather explorations of plausible representations of the future based on coherent and internally consistent set of assumptions about driving forces." It is therefore unclear what the "confidence" of the pathway results might mean.	See response to comment 75565	Ida Sognaes	CICERO Center for International Climate Research	Norway
23317	6	26	6	26	in "the emissions mitigation potential is limited in IAMs pathways" we suggest a clarification on the term "limited".	Accepted. This text has been revised to clarify	Government of France	Ministère de la Transition écologique et solidaire	France
43055	6	26		30	Many experts have questioned the feasibility of key CDR options, such as CCS, BECCS and afforestation. "The vast majority of scenarios that limit warming to 1.5°C or 2°C rely on CDR, used to compensate for positive emissions elsewhere in space or time. Even scenarios without net-negative CO2 emissions can have substantial use of CDR. The predominance of CDR options, such as BECCS and afforestation within 1.5°C and 2°C pathways, have resulted in debates regarding their feasibility, sustainability, and permanence."	Rejected. Unfortunately, it is not clear what suggestion the reviewer is making	Graeme Taylor	BEST Futures	Australia
65509	6	26	6	26	The abbreviation of "Integrated Assessment Models" (IAMs) is used several times without introducing the whole name.	Accepted	Cristian Chadwick	University of Chile	Chile
17551	6	27	6	27	which emissions? I suspect CO2.	Accepted. We have clarified this throughout	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
17553	6	31	6	31	The headline mentions GHGs while the remainder of the statement mentions CO2. Im assuming CO2 in both cases?	Accepted. We have clarified this throughout	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
43257	6	31	6	43	It is not clarified because it is stated that its emission rate is slower than other sectors. It is not clear if it is public or private transport.	Noted. This chapter discusses transport as a whole. A more detailed discussion is in Chapter 10	Government of Chile	Ministry of Environment	Chile
60343	6	31	6	43	The section on timing of reductions in transport need to highlight modelling uncertainties upfront to not be misunderstood. The timing per sector is largely determined by the input assumptions of the models. The models used usually have less detailed mitigation options for buildings and transport and therefore project a later net zero year. The fast development of electric vehicles in transport and heat pumps in buildings are often not covered by the models as such exponential growth is difficult to predict. The current section could be interpreted that the transport and budling sectors can lean back and that zero emissions is not expected from them.	Accepted. The text has been revised to clarify	Niklas Höhne	NewClimate Institute	Germany
75571	6	31	6	43	Assignments of confidence (four cases) are unclear. The statements referred to are descriptive statements about the scenarios that are examined in the chapter. Descriptive statements must be either true or false. If the statement of confidence instead relates to whether what is observed in the scenarios will happen in the real world, this is also very confusing. As stated elsewhere in the summary to this chapter "Pathways are not predictions or forecasts, but rather explorations of plausible representations of the future based on coherent and internally consistent set of assumptions about driving forces." It is therefore unclear what the "confidence" of the pathway results might mean.	See response to comment 75565	Ida Sognaes	CICERO Center for International Climate Research	Norway
85299	6	31	6	37	Please always present the findings for 1.5°C first, and only then for 2°C. Since the Paris Agreement and SR1.5 the focus has shifted from 2°C to pursuing 1°C.	Partially accepted. Where we have mentioned both 1.5C and 2C, we are now discussing 1.5C first	Kaisa Kosonen	Greenpeace	Finland
66829	6	32	6	33	"Absent mitigation efforts" does not seem to make sense to me.	Accepted. This text has been revised	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
74799	6	32	6	32	The second sentence in line 32 (starting with the word "Absent") is not well phrased. - it should be re-phrased as: "With absent mitigation efforts,"	Partially accepted. This text has been revised	Government of Kenya	Kenya Meteorological Service	Kenya
50251	6	34	6	35	Emissions are reduced relative to what (relative to baseline, relative to historic year, ...)?	Accepted. This has been clarified	Matthias Weitzel	European Commission, Joint Research Centre	Spain
23319	6	36	6	36	We suggest to add before the sentence starting with "Reductions": "While some of the scenarios rely more on reduction in other sectors, a quarter of the scenarios compatible with the 1.5°C target suggest transport sector emissions could be reduced by 68% (25th percentile) or more by 2050." This sentence extracted from chapter 10 - Transport provides relevant information showing that some scenarios envisage a deeper reduction by 2050. Furthermore, there is a clear need to better understand why some pathways could reach such level of reduction by 2050 and other only by 2100.	Noted. The text has been substantially revised in response to reviewers comments.	Government of France	Ministère de la Transition écologique et solidaire	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
81029	6	36	6	36	To add before the sentence starting with "Reductions...": "While some of the scenarios rely more on reduction in other sectors, a quarter of the scenarios compatible with the 1.5°C target suggest transport sector emissions could be reduced by 68% (25th percentile) or more by 2050." Reason: 1. Sentence extracted from chapter 10 - Transport. This provides relevant information showing that some scenarios envisage a deeper reduction by 2050. 2. There is a clear need to better understand why some pathways could reach such level of reduction by 2050 and other only by 2100.	Noted. The text has been substantially revised in response to reviewers comments.	Yann BRIAND	Iddri, Sciences Po	France
65295	6	37	6	40	Again, from above, if demand side can have a significant mitigation impact, is there any chance that more demand-side modelling can be completed/included, before the final publication of the AR6?	Noted. We can only assess papers published by October 2021.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
69439	6	37			Fuel switching is an elusive concept, which by the way is not detailed in the Glossary. It can be understood as a switch between different fossil fuels, as this is what it means in the power sector for most stakeholders, namely, switch from coal to natural gas; if this is the case, I very much doubt this will be enough. Or it can be understood more broadly and include biofuels, electricity, power-to-x fuels such as ammonia, methanol and synthetic hydrocarbons, biogas, electricity, hydrogen, etc. Then it would be necessary to use different terms and be more specific. The bulk will probably be accomplished with electricity for ground transportation and short sea shipping, low-carbon ammonia for deep sea shipping, and synthetic kerosene for aviation.	Accepted. We have removed this phrase	Cédric PHILIBERT	Institut Français des Relations Internationales	France
85139	6	37	6	38	Please discuss why the significant demand-side mitigation potential is not adequately included in these pathways. What are the reasons and problems, and, most important: How much would that decrease the need for CDR and CCS?	Rejected. These issues are covered in Section 3.4, the Annex, and Chapter 5	Jens Tambke	Umweltbundesamt	Germany
1789	6	40	6	41	The text could be more specific about up to mid-century and 1.5 vs 2 degrees	Partially accepted. We have revised the text to discuss 2050 in many places	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
29325	6	44	7	5	Does the discussion about industry assume that energy used as industrial feedstocks is part of this sector? This will likely affect the shares of electricity and other energy carriers reported for industry. Please clarify.	No, energy used as industrial feedstock does not affect the industrial energy mix. However, the demand for these non-energy uses is taken into account by IAMs otherwise (e.g. crude oil turning into plastics and therefore implying higher primary energy).	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
47215	6	44	7	5	Section is written in a passive style and uses subjective indicators ("substantially") - could be improved by refraining from writing it in such a way: e.g. " Direct electrification is a key mitigation strategy in mitigation scenarios, expanding electricity demand from X% in 2020 to 61% by 2100 in 1.5C scenarios. Negative emissions are assumed in this sector by the end of the century due to the adoption of CCS applications". Though note that general statements on 'CCS use' in 'industry' are a bit meaningless.	Partially accepted. We have added quantifications, though not the precise phrasing suggested by the reviewer	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
69441	6	44	7	5	It might be useful to introduce a word on low-carbon hydrogen here, as it is likely to play a significant role in this sector, namely to reduce emissions of grey hydrogen in the making of ammonia and methanol, and in replacing fossil fuels as reductants of iron ores in steel making.	Noted.	Cédric PHILIBERT	Institut Français des Relations Internationales	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
71271	6	44	7	26	The role of biomass and AFOLU in these paragraphs needs to be clarified. For example: * is net negative CO2 in the industrial sector due to BECCS or some other technologies? * the paragraph could state more strongly that all scenarios (except possibly the most ambitious demand-side reductions) rely on the AFOLU, either for afforestation/reforestation, or for provision of bioenergy (even if the negative emissions for this are reported in the energy sector). * line 14 on water use and risk of hunger needs to be clarified. Is it saying that pathways with no overshoot are higher risk than those with overshoot? (because of agriculture sector mitigation). If so, it probably should be caveated with a message about whether IAMs are capable of capturing all sectoral measures (similar to disclaimers about IAMs vs sectoral models that exist elsewhere in the chapter). * lines 23-34 regarding "whether AFOLU emissions are positive or negative at the time of net zero" is curious. Surely the relevant point is that the AFOLU sector will be devoted to climate action at this point (hopefully in a sustainable development and nature-friendly way). This would either be due BECCS (so positive AFOLU emissions) or afforestation/reforestation (so negative AFOLU emissions), but this is essentially an accounting difference and a technology choice. However, the centrality of AFOLU to 1.5°C/2°C scenarios is not a choice.	Accepted. The text has been revised to clarify	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
75573	6	44	7	5	Assignments of confidence (four cases) are unclear. The statements referred to are descriptive statements about the scenarios that are examined in the chapter. Descriptive statements must be either true or false. If the statement of confidence instead relates to whether what is observed in the scenarios will happen in the real world, this is also very confusing. As stated elsewhere in the summary to this chapter "Pathways are not predictions or forecasts, but rather explorations of plausible representations of the future based on coherent and internally consistent set of assumptions about driving forces." It is therefore unclear what the "confidence" of the pathway results might mean.	See response to comment 75565	Ida Sognaes	CICERO Center for International Climate Research	Norway
47211	6	46	6	46	Specify 'electrification' by writing 'direct electrification' (e.g. hydrogen would imply indirect)	Accepted.	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
1791	7	2	7	3	There seems to be something missing: "CO2 emissions, the energy supply sector..."	Accepted. This sentence has been revised	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
47213	7	2	7	2	CCS from industry or industrial processes' does not make sense - intends to say that CCS is a policy option for the industry representations in IAMs?	Noted. This sentence has been substantially revised	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
65297	7	2	7	2	The SR1.5C stated that CCS was not yet proven to large scale. If this remains the case, this should be stated in the summary so that the use is not assumed by policy makers as 'a given'. These cautions are important for decision makers to clearly understand current options and consequences of misjudging 'time to act'.	Noted. This sentence has been substantially revised	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
60129	7	4	7	4	deg symbol missing in 1.5	Accepted	Umasankari Kannan	Bhabha Atomic Research Centre	India
65513	7	6	7	6	The abbreviation of "Agriculture, Forestry and Other Land Use" (AFOLU) is used here, without giving the complete name and it has not been introduced in the text before.	Accepted	Cristian Chadwick	University of Chile	Chile
71273	7	6	7	7	The text could be more specific about up to mid-century and 1.5 vs 2 degrees	Accepted. We have revised the text focusing on 2050 in most statements	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
75575	7	6	7	15	Assignments of confidence (three cases) are unclear. The statements referred to are descriptive statements about the scenarios that are examined in the chapter. Descriptive statements must be either true or false. If the statement of confidence instead relates to whether what is observed in the scenarios will happen in the real world, this is also very confusing. As stated elsewhere in the summary to this chapter "Pathways are not predictions or forecasts, but rather explorations of plausible representations of the future based on coherent and internally consistent set of assumptions about driving forces." It is therefore unclear what the "confidence" of the pathway results might mean.	See response to comment 75565	Ida Sognaes	CICERO Center for International Climate Research	Norway
75731	7	6	4	7	It will be important to explain why AFOLU could lead to a net negative CO2 emissions, especially for the politicians.	Noted. This sentence has been removed due to other comments	Alfred Ahenkorah	Regulatory	Ghana
83145	7	6	7	15	Given the role of non-CO2 emission in AFOLU, and the high share of residual emissions coming from AFOLU (esp. enteric fermentation) it would be good to highlight this issue a little bit more here	Accepted	Geden Oliver	German Institute for International and Security Affairs	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11433	7	8	7	8	The source of the statement "Total cumulative AFOLU CO2 emissions vary widely across scenarios, with as much as 415 GtCO2 sequestered between 2010 and 2100 in the most stringent mitigation scenarios" cannot be found in the main text. Please check.	Accepted. The ES has been revised to reflect the underlying text	SAI MING LEE	Hong Kong Observatory	China
50253	7	8	7	8	Can this be expressed as a range for 1.5 and/or 2C scenarios? At least be precise about what "most stringent mitigation scenarios" refer to.	Accepted	Matthias Weitzel	European Commission, Joint Research Centre	Spain
74741	7	9	7	9	It is being proposed that Create IPCC Bank and allocate interest-free bank loans or low-interest loans to countries in the need of financial resources with the aim of constructing, equipping, educating, rehabilitating, equipping with the aim of reducing resources and increasing polluting sinks such as forestry. From land-use change, the forest protection for the prevention, the monitoring and the protection against unintentional disasters such as spontaneous forest fires, the drought, water shortages, floods, erosion, etc. Other factors affecting the climate change been allocated and budgeted. This bank need to be supported from polluting sources in prosperous countries that have not tried to the reduction consumption of fossil fuels for their products.	Rejected. The ES can only include scientific assessment from the underlying chapter and not policy recommendations	Mahnaz Ahmadi Namin	Meteorology Organization of IRAN	Iran
23321	7	10	7	10	We suggest in "AFOLU from 1.5°C and 2°C scenarios" to replace "from" with "in". Otherwise there are too many "from" in the overall sentence.	Noted. This sentence has been substantially revised	Government of France	Ministère de la Transition écologique et solidaire	France
65299	7	11	7	11	Current scientific findings highlight 'restoration' of degraded forests as having a significant positive role. If 'restoration' cannot fit into modelling calculations, then this situation should be noted, so that restoration policy is not overlooked simply because the modelling cannot accommodate.	Noted.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
81163	7	12	7	15	This sentence strikes me as too simplistic, as it gives the impression that the only or main mitigation option for CH4 and N2O emissions from AFOLU is to reduce production, regardless of demand, with increased hunger as a necessary consequence. This is not consistent with the literature, and even where it is, it reflects more the static demand assumptions in IAMs and the blunt application of price instruments as part of modelled pathways, than the actual options to reduce emissions. In addition, IAMs continue to exclude the emerging technologies for deeper reductions in those gases (such as methane and nitrification inhibitors, selective breeding, etc) even though those technologies are no more speculative (for a time horizon of 2050 and beyond) as the deployment of BECCS or DAC at gigatonne/yr scales. These technologies are on the horizon now, and some in the process of commercialisation (e.g. methane inhibitors). Surely this should be relevant when it comes to assessing long-term mitigation outcomes, and should also be reflected in the relevant underlying section of the chapter itself. I understand that there is not enough literature to report actual results, but a brief section recognising the rather significant gap here would be important in my view. I'm hoping that a publication that may be useful in that regard will be forthcoming before the cut-off for acceptance (but this doesn't hinge on one paper, as all the information is available already for an assessment).	Noted.	Andy Reisinger	Ministry for the Environment	New Zealand
85141	7	13	7	15	Please discuss that the "implications for water use and risk of hunger" could be very much decreased when only the production of meat and milk would be (heavily) reduced.	Noted.	Jens Tambke	Umweltbundesamt	Germany
9017	7	14	7	14	Because of change of precipitation pattern which led to increasing runoff and sudden floods and sever damages to economy and environment, suggestion is: to presenting needed approaches for correction of quality of drinking water which is cause of many digestive disease. It was because of entrance of waste water to consumption cycle.	Rejected. Unfortunately we are not sure what the reviewer is suggesting	Behzad Layeghi	IRIMO	Iran
54783	7	14	7	14	Suggest replacing "risk of hunger" with the broader term "food security".	Noted.	Government of United States of America	U.S. Department of State	United States of America
9665	7	16	7	26	The paragraph mentioned differences in net-zero timing across sectors and regions. While examples of sectors are provided, nothing is said about the regional variations in timing of net-zero.	Rejected. Due to space limits we cannot cover everything in the ES	Mustafa Babiker	Saudi Aramco	Saudi Arabia
14935	7	16	7	26	This is a very important but also problematic part of the Chapter 3 assessment, corresponding sections and figures need to be carefully revised. While the assessment and presentation of global net-zero timings resulting from IAM output is rather straightforward, the regional net-zero timings are not. While very early regional net-zero timings of developing regions compared to developed/highly industrialised regions are the result of technology assumptions, above all else controversial AFOLU deployment, this becomes a highly politicised topic and has to be addressed and presented differently, particularly in sections 3.7.4.2, with fundamental implications for the SPM. As results are also influenced by mitigation cost, section 3.6.1.2 has to be checked in this regard as well.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Saint Kitts and Nevis	Department of Environment - Ministry of Agriculture, Marine Resources, Cooperatives, Environment and Human Settlements	Saint Kitts and Nevis

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
75577	7	16	7	26	Assignments of confidence (four cases) are unclear. The statements referred to are descriptive statements about the scenarios that are examined in the chapter. Descriptive statements must be either true or false. If the statement of confidence instead relates to whether what is observed in the scenarios will happen in the real world, this is also very confusing. As stated elsewhere in the summary to this chapter "Pathways are not predictions or forecasts, but rather explorations of plausible representations of the future based on coherent and internally consistent set of assumptions about driving forces." It is therefore unclear what the "confidence" of the pathway results might mean.	See response to comment 75565	Ida Sognaes	CICERO Center for International Climate Research	Norway
85143	7	16	7	26	Some sentences in this paragraph seem to be redundant or even repeat trivial information. Please consider to sharpen.	Accepted	Jens Tambke	Umweltbundesamt	Germany
30655	7	21	7	22	The scenario in which the industrial sector becomes a net negative emitter is one of the few scenarios with extreme assumptions and does not need to be mentioned in the summary. The focus should be on the main message: nearly all show positive industrial sector emissions at the time of net-zero CO2 emissions.	Accepted	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
47217	7	22	7	23	Instead of "Nearly all show positive industrial sector emissions at the time of net-zero CO2 emissions" I would recommend underscoring the required offsets in other sectors to balance out the left-overs from sectors that cannot deliver. Current sentence validates residual emissions in industry and I would prefer to have the semantics here to stress the implications of not solving the issue of residual emissions. (or remove special mention here, as next paragraph emphasizes offsets).	Accepted	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
1793	7	23	7	24	The text indicates that costs would generally be at least as high as benefits. This does not seem to accurately reflect the chapter content.	Noted. The text has been substantially revised in response to reviewers comments.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
18085	7	27	7	28	This reference to "space and time" isn't particularly clear. The use of CDR relates to a) compensating for residual emissions and b) returning, if necessary, from overshoot. Could the authors please consider setting the CDR context in these terms?	Accepted. The text has been revised	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
23323	7	27	7	28	We suggest to add some content about the social acceptability of CCS	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
23325	7	27	7	28	We suggest to specify if CDR would allow for having countries/regions with net negative GHG emissions offsetting countries with net positive GHG emissions	Noted. The text has been substantially revised in response to reviewers comments.	Government of France	Ministère de la Transition écologique et solidaire	France
75579	7	27	7	36	Assignments of confidence (four cases) are unclear. The statements referred to are descriptive statements about the scenarios that are examined in the chapter. Descriptive statements must be either true or false. If the statement of confidence instead relates to whether what is observed in the scenarios will happen in the real world, this is also very confusing. As stated elsewhere in the summary to this chapter "Pathways are not predictions or forecasts, but rather explorations of plausible representations of the future based on coherent and internally consistent set of assumptions about driving forces." It is therefore unclear what the "confidence" of the pathway results might mean.	See response to comment 75565	Ida Sognaes	CICERO Center for International Climate Research	Norway
79105	7	27	7	36	The "vast majority" will be misconstrued as implying validity, but those scenarios' CDR is an artifact of not taking end-use efficiency seriously (doi:10.1088/1748-9326/ab55ab). A striking counterexample, Grüber et al 2018 (doi:10.1038/s41560-018-0172-6, broadly consistent with van Vuuren et al 2018), requires only natural-systems carbon removal and saves many G\$, yet even that wonderful paper is technologically conservative. E.g. it assumes 3L/100km autos in 2010 despite the popular and competitive 1.7L/100km BMW ie (2013–24) and 0.7 (Aptera) and 0.9 (Lightyear) models headed for market in 2021; it applies integrative design (doi:10.1088/1748-9326/aad965) only in buildings, not in vehicles or industry; it greatly understates materials-efficiency opportunities; and its PV growth starts from a far lower baseline, grows slower, and costs much more than actual. It would be correct and helpful to state that most scenarios rely on CDR but some find it unnecessary when cheaper demand-side options, chiefly strong end-use efficiency, are bought instead (a plausible result of competing or comparing those resources against supply-side and CDR investments).	Noted.	Amory B. Lovins	Rocky Mountain Institute; also Adjunct Professor of Environmental & Civil Engineering, Stanford University	United States of America
65465	7	28	7	29	"Even scenarios without net-negative CO2 emissions can have substantial use of CDR (high confidence)", is this generally due to mitigation of hard-to-abate sectors? If so, can that be made explicit?	Noted. Various sectors, beyond those "hard to abate," rely on CDR as well.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
72813	7	28	7	29	The phrase 'Even scenarios without net-negative CO2 emissions can have substantial use of CDR' needs to be contextualized. These scenarios generally result from specific design, for example the proposed 'never below zero' scenarios, and thus the 'high confidence' description is misleading.	Noted. See response above.	Matthew Gidden	Climate Analytics	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
65301	7	31	7	36	Again, is there anyway in the paragraph structure to give more attention, or stress, to the most healthy way forward - Scenarios that include more demand-side mitigation measures and significant reductions in non-CO2 emissions have reduced dependence on CDR (high confidence). Also, it is important for policy makers to know if DACCS is proven to large scale or still an idea. As noted before, with lucrative financial interests at stake with root causes, excuses for delay are easily embraced, and it is important to be clear in the science of what is a real option with knowledge and technology now, rather than making decisions on what might be, if a technology is not yet certain.	Noted. The text has been substantially revised in response to reviewers comments.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
72815	7	34	7	35	The phrase 'the inclusion of DACCS can allow for increased emissions from other sectors compensated by negative CO2 emissions from DACCS' is not specifically correct. DACCS could, for example, compensate for over-dependence on BECCS, which would not necessarily allow for increased emissions elsewhere.	Noted.	Matthew Gidden	Climate Analytics	Germany
78103	7	34	7	35	The reasoning that negative CO2 emissions from DACCS as opposed to BECCS allow for increased emissions from other sectors seems incorrect. Please revise.	Noted.	Charlotte Plinke	Climate Analytics	Germany
17557	7	37	8	8	The statement is quite long, covers methodological issues in the first half, which is not the case in any other statements. I suggest summarising the methodological part of the statement. Could be summarised in a similar fashion to the next statement ("The mitigation costs of many pathways do not consider the benefits of avoided climate change impacts nor co-benefits or co-harms of mitigation action")	Noted.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
18087	7	37	7	41	The first sentence is rather vague and would benefit from being more precise. What exactly do you mean by "global economic activity". Moreover, the framing here is problematic - the basic implication is that mitigation is simply a net cost. You note further on in the paragraph that there may be compensations to this cost (e.g. avoided damages, co-benefits) but the implication that mitigation is a cost in and of itself is potentially misleading. The reality is somewhat more complex and nuanced, see for example Politt and Mecure for a review https://www.tandfonline.com/doi/full/10.1080/14693062.2016.1277685 . I would recommend presenting a more thorough treatment here of the complex economic impacts of mitigation and investment "costs"	Noted. The text has been substantially revised in response to reviewers comments.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
71275	7	37	8	25	These paragraphs imply that, while mitigation requires considerable investment, countries' economic performance will primarily be determined by other factors which far outweigh the % of GDP losses associated with the mitigation scenarios. I.e. all countries are able to continue economic growth while taking ambitious climate action. In addition, countries who delay climate action may gain a competitive in the short-term, but be harmed in the medium-term due to greater stranded asset exposure. These arguments (provided they are supported by the evidence) should be stated more explicitly in the executive summary.	Noted.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
23327	7	41	7	42	The sentence is too long and unclear	Noted. The text has been substantially revised in response to reviewers comments.	Government of France	Ministère de la Transition écologique et solidaire	France
27593	7	44	8	8	It should be mentioned that these arguments do not consider regional aspects, national circumstances and priorities, nor uncertainties and challenges associated with the COVID-19 pandemic.	Noted.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
54785	7	44	8	2	Can this sentence be simplified?	Noted. The text has been substantially revised in response to reviewers comments.	Government of United States of America	U.S. Department of State	United States of America
85145	7	44	7	44	Please discuss why such a complete appraisal does not exist, and what the literature or you as authors consider as prerequisites to overcome this fundamental knowledge gap in the future.	Noted.	Jens Tambke	Umweltbundesamt	Germany
8335	7		8		P7-8 It is disappointing that the authors have not moved beyond the discussion of minimising the 'costs' of climate change. Once again, I must raise the point that there are only guaranteed costs because of the flawed assumptions that underpin the modelling used in the chapter. There is substantial literature in behavioural economics, institutional economics, etc on this.	Noted.	Hector Politt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)
23329	8	2	8	2	We suggest to replace "available scenarios" by "most available scenarios"	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
37587	8	2	8	4	The paragraph might be misleading. The carbon price levels in the scenarios with low demand would depend on whether the energy demand is exogenous or endogenous. If the energy demand is exogenous, the carbon price would be low. But, if the demand is reduced endogenously due to high carbon price, it might not be the case.	Noted.	Young-Hwan Ahn	Sookmyung Women's University	Republic of Korea
7825	8	9	8	14	The information here is quite important to policymakers and should be on the SPM also. There is no information of mitigation cost to GDP in the SPM.	Noted.	Mitsune Yamaguchi	Research Institute for the Innovative Technology for the Earth (RITE)	Japan

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
7827	8	9	8	25	It is essential to show how cost will increase if certain key technologies will not be fully available such as CCS, Negative Emission Technologies (BECCS, DACCS), or limited bioenergy. FYI, these information was shown in AR5.	Noted.	Mitsutsune Yamaguchi	Research Institute for the Innovative Technology for the Earth (RITE)	Japan
9667	8	9	8	25	Why reporting changes in consumption growth rates and not actual consumption compared to baseline as usually being the case in past IPCC assessments. Also because of the policy significance you may need to mention the discount rate (s) used to get to the reported numbers.	Noted.	Mustafa Babiker	Saudi Aramco	Saudi Arabia
16917	8	9	8	14	¿High/medium or low confidence?	Noted. The text has been substantially revised in response to reviewers comments.	Government of Spain	Area de Estrategias de Adaptacion - Oficina de Cambio Climatico - Ministerio de la Transicion Ecologica	Spain
17559	8	9	8	25	Mentioned twice in the statement: The mitigation costs of many pathways do not consider the benefits of avoided climate change impacts nor co-benefits or co-harms of mitigation action	Noted.	Alaa Al Khouardajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
17781	8	9	8	14	(3 ES) losses in GDP in 2050 vs baselines: this means if no mitigation action was undertaken at all? Any other clarifications? Can we (at least as talking points) have examples of similar reductions or foregone growth (post 2008 crash, COVID, Brexit, breakup of USSR – there must be others less sensitive). Can the benefits of avoided impacts and co-benefits/co-harms in lines 13-14 be spelled out or quantified? This is addressed conceptually in the next two sections line 37 onwards and p9 line 3 onwards but no concrete information.	Noted. The text has been substantially revised in response to reviewers comments.	Jonathan Lynn	IPCC	Switzerland
18089	8	9	8	14	Presenting these costs without sufficient context is misleading. As much as anything, they reflect the assumptions and structures of the dominant IAMs. Alternative modelling frameworks provide a different perspective. See Politt and Mecure for a discussion https://www.tandfonline.com/doi/full/10.1080/14693062.2016.1277685 . To quote "We show that model outcomes are mainly determined by their representations of monetary and finance dimensions, and their interactions with investment, innovation and technological change." There needs to be a more nuanced treatment of costs here, otherwise it will simply present mitigation as extremely unaffordable (even if you are noting co-benefits etc elsewhere).	Noted.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
23331	8	9	8	13	This sentence is hard to understand and appears in contradiction with page 8 line 1-2	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
54787	8	9	8	36	The focus here on the costs of mitigation is narrow to the point of being misleading. Contrast this with that of US National Academies of Sciences, Engineering and Medicine (2021): ""The estimated fraction of gross domestic product that the nation would likely spend on energy in a net-zero economy would be smaller than the fraction that the nation has spent on energy in the past, including the past decade (see Chapter 2, Figure 2.3). Studies reviewed in Chapter 2 also estimate total cumulative incremental energy expenditures that average approximately \$300 billion through 2030 -- a roughly 3 percent increase relative to a business-as-usual baseline of approximately \$9.4 trillion (net present values of cumulative total expenditures with a 2 percent real social discount rate). It is important to note that these cost estimates do not capture general equilibrium effects, such as changes in global oil prices. Nor do these cost estimates include impacts of changes in the country's balance of trade, which include both positive and negative factors. Last, several of the policies in Table S.1 are designed to reduce or eliminate adverse impacts of costs on trade-impacted firms and low-income households.""	Noted.	Government of United States of America	U.S. Department of State	United States of America
65303	8	9	8	45	As models that highlight global GDP loss but 'do not consider the benefits of avoided climate change impacts' give an incomplete result to policy makers, IPCC summary findings should list the benefits to emphasise the incomplete information the modelling produces, for example, improved well-being, reduction of suffering, loss of life and eco-system collapse. Current economic approaches are increasingly including well-being as a priority rather than purely GDP/monetary cost. This is improved in 37-45 but could be less complex in sentence structure to really emphasise human/nature benefits.	Noted.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
66831	8	9	8	14	Framing mitigation costs in terms of GDP "loss" has the potential to be misrepresented when there is no quantification of avoided damages in relation to the baseline scenarios in the executive summary. Can this statement be integrated with the analysis of Cross Working Group Box 1? In any case, "investment" rather than "loss" would be a more appropriate term.	Noted.	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
71277	8	9	8	14	Is it possible to state more clearly within the same sentence that the % GDP losses compared to baseline are without considering the benefits of avoided impacts. What are the 'co-harms' of mitigation action? Is there scientific evidence that they exist and could affect GDP (in the same way that air quality improvements might as a co-benefit), or is this simply an effort to appear neutral regarding the fact that any mitigation action (or inaction) has benefits and drawbacks?	Noted. The text has been substantially revised in response to reviewers comments.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
79107	8	9	8	25	The boldface on lines 9–14 seems to contradict the lightface in lines 9–22. Both are correct, but the former doesn't merit implied priority over the latter. The text should be edited to say that whether GDP goes up or down with mitigation, and whether mitigation costs (ignoring benefits) are positive or negative, depends on pace of action and frontloading of investment [and other variables if relevant].	Noted. The text has been substantially revised in response to reviewers comments.	Amory B. Lovins	Rocky Mountain Institute; also Adjunct Professor of Environmental & Civil Engineering, Stanford University	United States of America
85301	8	9	8	25	I question the relevance of providing such precise numbers for estimated GDP losses entailed by 1.5°C and 2°C mitigation pathways, and presenting them as bolded headline findings, when there are so many things that these numbers ignore. Yes, the numbers indicate minor losses, but we're still talking about economic losses rather than gains. And we're still focused on GDP rather than on actual well-being. The paragraph might as well be leading with the bigger picture conclusion - that when economic benefits from avoided climate impacts and co-benefits are accounted for, mitigation can be a welfare-enhancing strategy (see for example section 3.6.2). Or build on the framing in the TS (page 4 lines 43-46) "Recent IAM intercomparisons, with improved representation of system dynamics, show that rapid decarbonization towards net zero emissions (...) is associated with higher economic output in the long term (even aside from the benefits from avoided climate impacts), compared to deferred action."	Noted. The text has been substantially revised in response to reviewers comments.	Kaisa Kosonen	Greenpeace	Finland
11435	8	11	8	11	The figures "1.6% and 3.5%" cannot be reconciled with panel (b) of Figure 3.36. Please check.	Noted.	SAI MING LEE	Hong Kong Observatory	China
11437	8	12	8	12	The figures "2.1% and 4.3%" cannot be reconciled with panel (b) of Figure 3.36. Please check.	Noted.	SAI MING LEE	Hong Kong Observatory	China
45809	8	13	8	15	The last sentence is very important and should be placed as a general constraint >before< stating "losses in global GDP" in various pathways. We suggest adding the findings from section 3.6.2., p. 86, l. 34 ff. to this paragraph in the ES.	Noted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
45811	8	22	8	25	Please replace "optimal" by "cost-optimal"	Noted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
37605	8	26	8	28	Please replace the word "renewable" with "renewable and nuclear".	Noted.	Ravi B Grover	Homi Bhabha National Institute	India
48597	8	26	8	28	The text refers to "a shift away from fossil-fuel generation and extraction and towards renewable energy technologies and efficiency." Shouldn't this be "...towards zero- and low-carbon energy technologies and efficiency"? The report indicates that the IPs indicate growth in nuclear, fossil with CCS, and BECCS, not just renewables.	Noted.	Karl Hausker	World Resources Institute	United States of America
54789	8	26	8	36	Suggest moving this paragraph to come after previous paragraph focused on the energy sector.	Noted.	Government of United States of America	U.S. Department of State	United States of America
61629	8	26	6	28	"In the energy sector, lower global average temperature pathways show increased investments needs, and a shift away from fossil-fuel generation and extraction and towards renewable energy technologies and efficiency." The words "renewable energy technologies" should be substituted with "low-carbon energy technologies" or with "low-carbon renewable and nuclear energy technologies" to be more scientifically accurate and to remain technology neutral.	Noted.	Rauli Partanen	Think Atom	Finland
63491	8	26	8	28	We would suggest that the term renewable should be replaced by 'non-emitting' as the statement does not take into account the non-renewable but also non-emitting technologies, such as nuclear. This comment applies to all instances that compares the opposites of fossil fuels and renewables.	Noted.	Government of Canada	Environment and Climate Change Canada	Canada
65667	8	26	8	28	"In the energy sector, lower global average temperature pathways show increased investments needs, and a shift away from fossil-fuel generation and extraction and towards renewable energy technologies and efficiency." The word "renewable" should be substituted with "low-carbon" for the table 3.6 on page 82 shows a significant annual investiture into nuclear energy as well.	Noted.	Eero Hirvijoki	Aalto University	Finland

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
76425	8	26	8	36	The scenarios modelled have clearly not taken account of the more effective investment in nuclear energy compared to renewables. Grids which include nuclear energy will supply electricity at less than half the cost of those using VRE. The supply will also be more reliable especially during periods of high climatic extremes such as recently experienced in Texas.	Noted. But it is not true that all grids which include nuclear energy will supply electricity at less than half the cost of those using VRE. There are many countries in the world today where VER are, by far, much cheaper than the nuclear energy.	Robert Parker	Nuclear for Climate Australia	Australia
79109	8	26	8	36	The implication that greater mitigation must cost more is almost certainly wrong. Grübler et al 2018 (10.1038/s41560-018-0172-6 and featured in SR1.5) is a strong counterexample on the supply side, where it saves ~\$2–3G\$/y in the later years to 2050 vs baseline, thanks to demand-side investments that are surely several- to many-fold cheaper. Yet it assumes renewable costs markedly above current actuals from BloombergNEF, and doesn't capture the obvious and important market feature of increasing returns because the more renewables we buy, the cheaper they get, so we buy more, so they get cheaper—the opposite of nonrenewable sources in general. Developing countries now dominate renewable investment (FS-UNEP/BNEF annual investment report) and many are rapidly shifting from coal to renewables because they're cheaper; indeed, as BNEF unsubsidized market prices clearly show, especially in e.g. China and India, new renewables beat new fossil in 90% of the world (2H2020) and now or within a few years will beat just their short-run marginal cost. So how can buying more of those cheaper resources increase supply-side investments? If that's just a matter of timing (rush to invest) not intensity, say so. And of course the overall fiscal balance becomes even more favorable when still-cheaper efficient-use investments are considered too.	Noted and agreed.	Amory B. Lovins	Rocky Mountain Institute; also Adjunct Professor of Environmental & Civil Engineering, Stanford University	United States of America
85933	8	26	8	36	Suggest clarification: The authors compare values for mitigation scenarios to values for "baseline scenarios". What baseline scenarios are the authors referring to? No climate-policy baselines? The authors explain in Section 3.2.1 that baseline scenarios are defined in different ways.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
5229	8	27	8	28	Replace "renewable energy " by "Low carbon energies"	Noted.	Michel SIMON	Retraité/ Pdt d'association	France
11439	8	29	8	32	The source of the statement "Increased investment needs in the energy sector for scenarios below 2°C (C3) are, on average, about 3-50% higher than in baselines, and about 50%-65% higher for 1.5°C scenarios (C2 and C1) than baselines (or absolute numbers: 3,780 billion USD2010 yr-1 over 2023-2050 on average for C1 scenarios, 3,370 billion for C2 scenarios, 3,090 billion for C3 scenarios and 2,290 billion for baselines)." cannot be found in the main text. Please check.	Noted. The text has been substantially revised in response to reviewers comments.	SAI MING LEE	Hong Kong Observatory	China
17561	8	29	8	29	3-50%.. Should it be 30-50%? (given the absolute numbers later in the para). Thanks	Noted. The text has been substantially revised in response to reviewers comments.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
51993	8	29	8	29	"on average, about 3-50% higher than"--should be 30, not 3	Noted. The text has been substantially revised in response to reviewers comments.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
5087	8	33	8	34	Explain "R5ASIA" etc. - maybe I'm mistaken but I don't think the abbreviations have been explained beforehand	Noted. The text has been substantially revised in response to reviewers comments.	Lina Hollender	n/a	Germany
30657	8	33	8	34	"R5ASIA, R5LAM, R5MAF and R5REF" is hard to understand. It should be expressed in the name of a region that can be understood in general.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
44035	8	33	8	33	Please explain what R5ASIA, R5LAM, R5MAF 34 R5REF are. This is the executive summary	Noted. The text has been substantially revised in response to reviewers comments.	Stefano Caserini	Politecnico di Milano	Italy

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54791	8	33	8	34	Odd to have R5 in a chapter summary with no explanation.	Noted. The text has been substantially revised in response to reviewers comments.	Government of United States of America	U.S. Department of State	United States of America
23333	8	34	8	35	We suggest a clarification concerning what these regions "R5ASIA, R5LAM, R5MAF and R5REF" are.	Noted. The text has been substantially revised in response to reviewers comments.	Government of France	Ministère de la Transition écologique et solidaire	France
23335	8	36	8	36	We suggest to replace "more-polluting alternatives" by "higher GHG emissions alternatives"	Noted. The text has been substantially revised in response to reviewers comments.	Government of France	Ministère de la Transition écologique et solidaire	France
27595	8	37	9	2	It should be mentioned that regional discrepancies should also be considered, yet the analysis refers to global potential impacts.	Noted.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
23337	8	38	8	39	A more precise reference to this statement would be appreciated	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
23339	8	42	8	43	This sentence is strange. Fortunately, limiting global warming when taking into account the reduction of damage can lead to more well-being and it should lead to improved well-being.	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
54793	8	42	8	43	Suggest moving this important sentence into the bold text at the beginning of this paragraph.	Noted.	Government of United States of America	U.S. Department of State	United States of America
81165	8	43	9	2	This very long sentence is probably correct, but the length makes it difficult to read. It also hides, under the label of "long-term time horizons" the importance of the choice of discount rate and specific choices around how to translate equity considerations into economic quantification. This is actually a really important finding, so more work will be needed (both within the chapter and the executive summary) to be fully transparent about assumptions and limitations regarding this conclusion.	Noted.	Andy Reisinger	Ministry for the Environment	New Zealand
60131	8	44	8	44	disposing nuclear waste is out of place in this statement	Noted.	Umasankari Kannan	Bhabha Atomic Research Centre	India
8337	8				P8 – Given that so many of the conclusions are based on the results from IAMs, the key shortcomings of the IAMs must be included in the executive summary alongside the results [nb same for Section 3.1].	Noted.	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)
65305	9	1	9	11	This is a really important message - can you write it in layperson language? For example, "same order of magnitude as mitigation costs, and under some assumptions even larger." - what does that really mean, what are you actually saying? More simple, plain language would also help UN translators, let alone communicators trying to share these findings with citizens.	Noted. The text has been substantially revised in response to reviewers comments.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
9669	9	3	9	11	How large the trade offs and how do they compare to co-benefits and direct mitigation costs	Noted. The text has been substantially revised in response to reviewers comments.	Mustafa Babiker	Saudi Aramco	Saudi Arabia
30659	9	3	9	4	It would not be possible to make a general statement because the cost of mitigation and the magnitude of co-benefits vary depending on climate goals. Instead of highlighting only co-benefits, trade-offs need to be included in the discussion. In line with Section 3.6.3. we would like to propose that the bold sentence be replaced by the following sentence; Mitigation actions have significant co-benefits and trade-offs with other sustainable development dimensions, beyond climate change	Noted. The text has been substantially revised in response to reviewers comments.	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
54795	9	3	9	11	Unsure that there is the same level of confidence for air quality and diet co-benefits. One would think that the confidence for air quality would be high and that for diet medium or low. Combining these and giving an overall confidence of medium may be obscuring the important, and economically significant, impacts of air quality co-benefits.	Noted.	Government of United States of America	U.S. Department of State	United States of America
71279	9	3	9	4	The text indicates that costs would generally be at least as high as benefits. This does not seem to accurately reflect the chapter content.	Noted. The text has been substantially revised in response to reviewers comments.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
1795	9	5	9	5	Please revise language: "This focus dictates a more global view and on issues"	Noted. The text has been substantially revised in response to reviewers comments.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
17563	9	6	9	7	To avoid duplication with the previous sentence, please consider changing this repeated sentence:"Co-benefits regarding health effects from air quality improvement and from diet change" to "These co-benefits"	Noted.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
1797	9	9	9	9	The sentence is imprecise and the language could be improved	Noted.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
9671	9	12	9	18	Say something about distributional impacts other than employment, e.g. GDP and government revenue losses or gains.	Noted.	Mustafa Babiker	Saudi Aramco	Saudi Arabia
27597	9	12	9	18	It should be mentioned that mitigation policies should be considering core principles of the Convention and the Paris Agreement, in the light of equity and national circumstances, and in the context of sustainable development.	Noted.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
45813	9	12	9	16	The first line (headline statement) is very general and not very substantial. We suggest to use the message starting with the sentence in line 15 "Unmitigated climate change ..." as the headline statement. It is more policy relevant.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
50175	9	12	9	18	This paragraph remains quite vague. Please elaborate on barriers and enabling factors related to distributional effects of mitigation policies, especially in the context of limited financial resources. The way the information is currently presented ("has the potential" / "can be designed") is not useful if the underlying factors are not discussed.	Noted. The text has been substantially revised in response to reviewers comments.	Anna Main	Ministry of Foreign Affairs and Trade	Samoa
65307	9	12	9	18	Here could be added the 'positive contribution of just transition approach to successful transitions', reflecting research findings highlighted in other parts of the AR6.	Noted.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
81871	9	12	9	18	This paragraph remains quite vague. Please elaborate on barriers and enabling factors related to distributional effects of mitigation policies, especially in the context of limited financial resources. The way the information is currently presented ("has the potential" / "can be designed") is not useful if the underlying factors are not discussed.	Noted.	Francella Strickland	Ministry of Foreign Affairs and Trade	Samoa
23341	9	15	9	15	In "reallocatin of jobs across sectors." We suggest to add the percentage of jobs that will be concerned by reallocation.	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
17565	9	19	9	28	The headline focuses on delayed cooperative action, but the remainder of the statement focuses on distributional implications and transfers with no elaboration on the delay aspect. Please reconsider the focus, thanks. In fact, this delay aspect comes stronger in the following statement (lines 29-33)	Noted.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
50177	9	19	9	28	This is a crucial paragraph which should be further elaborated. Given the focus on cost-optimal assessments throughout the report, the gap in global cooperation needs to be more prominently discussed.	Noted.	Anna Main	Ministry of Foreign Affairs and Trade	Samoa
65309	9	19	9	28	Your leading sentence for this paragraph ought to be line 24 - 'Together with co-benefits, the aggregate economic benefits of mitigating climate change outweigh costs in most regions.'	Noted.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
65311	9	19	10	22	This last section helps us focus on 'cost/benefit' in relation to human and nature impacts of ambitious, effective and fair mitigation. If you have the data, could some of these human/ecosystem impacts be better integrated in the areas on 'economic impact', because the current separate 'silos' understate the 'cost' we would face, including cosystem collapse and human lives.	Noted.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
71281	9	19	9	28	Placeholder international cooperation comment Consider limiting the scope of this paragraph to findings directly supported by the evidence considered in this chapter, given that Chapter 14 is dedicated to international cooperation.	Noted.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
81873	9	19	9	28	This is a crucial paragraph which should be further elaborated. Given the focus on cost-optimal assessments throughout the report, the gap in global cooperation needs to be more prominently discussed.	Noted.	Francella Strickland	Ministry of Foreign Affairs and Trade	Samoa

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
29327	9	21	9	22	This statement is unclear, since a uniform carbon price would harmonize marginal costs across regions. Does "higher mitigation costs" refer to total mitigation costs, or costs as a share of GDP, or something else? Please clarify. "Pathways with uniform carbon values show higher mitigation costs in more carbon-intensive and poorer regions."	Noted.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
51995	9	25	9	25	"outweigh costs in most regions." Should be, "outweigh costs in most regions in the long-term."	Noted.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
27599	9	26	9	28	Delete "The efficiency-sovereignty trade off can be resolved by allowing for partly differentiated regional carbon prices (low confidence).", as this is not a policy-neutral statement.	Noted.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
54797	9	26	9	26	The transfers discussed here are from wealthy nations to less wealthy nations; however, the topic of the paragraph may imply that the transfers are from less carbon-intensive nations to more carbon-intensive nations. Clarify.	Noted.	Government of United States of America	U.S. Department of State	United States of America
8339	9	28			P9 – line 28. The whole chapter sidesteps the issue of policy. I understand that policy is outside the IPCC's remit even though it is what policy makers need to know about. This line goes further however in equating 'policy' with carbon pricing. This is potentially highly misleading and, again, I fear stems from the over-reliance on models based on pricing instruments.	Noted.	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)
60739	9	29	9	33	Willingness of governments in developing countries to agree and implement ambitious mitigation is observed to highly dependent on conditionalities (i.e., access to technology and finance) but this key finding on what is necessary to achieve sustainable development goals in the longer term could induce policymakers to find ways and means beyond conditionalities to achieve mitigation targets.	Noted.	Lourdes Tibig	Climate Change Commission, Philippines	Philippines
23343	9	32	9	33	One of the main message from the WG2 report was that none of the mitigation pathways limiting global warming to 2°C/1.5°C allows for reaching all of the SDGs. This sentence seems to provide a different message. A harmonization would be needed.	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
71283	9	32	9	33	This statement is important and should feature more prominently, both in this chapter and SPM. Especially if the evidence underpinning the high confidence label is solid.	Noted.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
9673	9	34	9	41	Are there trade-offs in relation to food and biodiversity from large scale deployment of renewables?	Large scale deployment of any technology can lead to trade-offs in relation to food and biodiversity.	Mustafa Babiker	Saudi Aramco	Saudi Arabia
54799	9	34	9	35	This bold sentence neither appears worthy of being a key message, nor does it serve as an adequate lead-in to the rest of the paragraph. The framework being helpful is not the important takeaway; the trade-offs are. Suggest rewriting bold text or moving the non-bold text in this paragraph into the following paragraph.	Noted. The text has been substantially revised in response to reviewers comments.	Government of United States of America	U.S. Department of State	United States of America
44037	9	35	9	36	"...include food and biodiversity, which come under pressure from large-scale CDR deployment" please be specific: which large scale CDR? This is not true in principle. I would specify "which come under pressure from some large-scale CDR deployment" The large scale deployment of ocean alkalinity enhancement could counteract ocean acidification and thus, on the contrary, could benefit ocean health and thus food and biodiversity	Noted.	Stefano Caserini	Politecnico di Milano	Italy
17569	9	37	9	37	"affordability/access" to "affordability and access"	Noted.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
23345	9	40	9	40	We suggest that after "economic prosperity and employment" should be added "food security and biodiversity". The deployment of certain CDR's can also have co-benefits with food and biodiversity. Reforestation (as opposed to afforestation), especially if done through natural regeneration with indigenous species, will have co-benefits on biodiversity. Agroforestry can also have co-benefits with food production, depending on the synergies between the trees and the food crops, and on whether the trees planted also produce food. In both cases, it depends both on the precise ways in which the CDR is deployed.	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
23347	9	41	9	41	We suggest that after "regions" should be added "and the precise details of the CDR deployment". Reforestation (as opposed to afforestation), can have cobenefits with biodiversity if done through natural regeneration with indigenous species. The fact that the details of deployment matter should be reflected.	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
54801	9	44	9	44	Suggest replacing text with something more specific, such as: "Policies should be designed such that they protect against increases in ..."	Noted.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
17567	9	45	9	45	"access/affordability. To "access and affordability"	Noted.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
17783	10	1	10	12	(3 ES) useful point, same as comment on Ch 2 p7 lines 19-20 above	Noted.	Jonathan Lynn	IPCC	Switzerland
29017	10	1	10	5	BECCS is singled out as the only negative example. This section could benefit from more balance, such as mentioning positive interactions of BECCS with SDGs or mentioning negative interactions of other mitigation options such as afforestation.	Noted.	Jasmin Kemper	IEAGHG	United Kingdom (of Great Britain and Northern Ireland)
37607	10	1	10	5	Achieving many SDG dimensions with lower energy use is hypothetical and is based on assumptions that cannot be realised. Large quantities of BECCS have associated difficulties like increase in water stress as mentioned at s. no. 1.	Noted.	Ravi B Grover	Homi Bhabha National Institute	India
54803	10	1	10	1	Define "previously thought". Does this mean in comparison to AR5?	Noted. The text has been substantially revised in response to reviewers comments.	Government of United States of America	U.S. Department of State	United States of America
60741	10	1	10	5	A key message to policymakers , especially in the light of being able to address SDG dimensions and still using low-energy and land-based resources	Noted.	Lourdes Tibig	Climate Change Commission, Philippines	Philippines
85935	10	1	10	2	Suggest clarification: "Decent living standards ... are achievable at lower energy use than previously thought." Would be useful to clarify what is meant by 'decent living standards', and how these compare to those currently enjoyed by people in developed countries.	Noted.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
17571	10	6	10	9	This is an important contribution, could you please expand and elaborate.	Noted.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
54805	10	6	10	10	Suggest cutting lines 6-9 and including text at the end of the bold sentence on line 11 to capture the idea: "particularly in the next 2-3 decades".	Noted.	Government of United States of America	U.S. Department of State	United States of America
23349	10	10	10	10	We suggest to add social dimensions to "Institutional and economic feasibility" as follows : "Institutional, social and economic feasibility challenges"	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
54807	10	16	10	24	These two paragraphs could be combined and focused on the immediate actions and broad portfolios of mitigation strategies that ameliorate feasibility concerns.	Noted.	Government of United States of America	U.S. Department of State	United States of America
37609	10	21	10	23	A broad portfolio of mitigation strategies has to include nuclear and the report has a bias against nuclear. It requires heavy editing to remove the bias against nuclear.	Noted. Chapter 3 relies completely on the assessed, peer-reviewed literature.	Ravi B Grover	Homi Bhabha National Institute	India
61631	10	21	10	23	"Scenarios relying on a broad portfolio of mitigation strategies are more resilient". This important conclusion, which is well founded in both science and holds from a risk-mitigation point of view, is lacking elsewhere in the report and the scenarios. If (and when) this holds true, why does Chapter 4 analysis include so many research that exclude nuclear and CCS by designing, therefore representing (by definition) a higher risk, higher cost and slower mitigation pathways than inclusive pathways? Given the diffusion of nuclear technology is more feasible from techno-economic, land-use and material-flow perspectives than renewable energy alternatives, it would be prudent to include similar "enhanced development and rapid diffusion of renewables" -assumption for nuclear as is included for renewables for example in Chapter 1, Box 1.1, Table 1). The riskier, non-inclusive scenarios seem to receive much more detailed discussion than is warranted due to their increased risks for the climate mitigation efforts.	Noted.	Rauli Partanen	Think Atom	Finland
65669	10	21	10	23	"Scenarios relying on a broad portfolio of mitigation strategies are more resilient". From this acknowledged risk-mitigation point-of-view, please explain why the analysis especially in Chapter 4 includes research that a priori excludes nuclear and CCS as a viable technology and thus imposes an unnecessary risk to climate mitigation. If broad portfolios are recognized why do the Illustrative Pathway scenarios <2-Ren and 1.5-Ren include a priori assumptions of "enhanced development and rapid diffusion of renewables" (Chap 1, Box 1.1, Table 1) but no such assumption is enabled for nuclear? If scientific consensus exists regarding the non-optimality (and even the non-feasibility) of the so-called 100% renewable scenarios, why are these nevertheless discussed in so much detail? Revise accordingly.	Noted. The text has been substantially revised in response to reviewers comments.	Eero Hirvijoki	Aalto University	Finland
8341	10	22			P10 – line 22 It is a strange definition of 'strategy' to talk about varying technologies! The strategy should be how to bring about desired change, which means policy. Are any political scientists involved in the chapter? Sentences like this would definitely benefit from targeted expertise.	Noted.	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
14937	11	1			In order to fully establish a link between assessed pathways to temperature targets and the Paris Agreement, more information on the long-term temperature goal of the Paris Agreement has to be provided here. Most importantly, it has to be clearly laid out what the observed temperature record is that is applied here (according to ANNEX C p43, it is 0.84°C between 1850-1900 and 1995-2014, to be updated with WGI FGD estimate). This is crucial information that allows the AR6 pathways to be put into perspective and compared with the AR5. This effort should be closely coordinated with Chapter 1 which currently lacks a clear comparison between IPCC reports.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Saint Kitts and Nevis	Department of Environment - Ministry of Agriculture, Marine Resources, Cooperatives, Environment and Human Settlements	Saint Kitts and Nevis
75733	11	1	11	1	Reference must be made to "this chapter" because we are dealing with Chapter 3.	Editorial	Alfred Ahenkorah	Regulatory	Ghana
54809	11	3	11	8	Could cut this section. It is unclear to what text the "more global view" on line 5 is referring. More global than what? Also, "long-term" on line 3 should be defined. What does long-term mean? Because this concept of the "long-term" arises multiple times throughout the chapter, a definition would be helpful.	Taken into account. The paragraph aims at providing an overview of the section. The "global view" refers to the integrated perspective as opposed to the sectoral perspective. We will improve clarity on this.	Government of United States of America	U.S. Department of State	United States of America
75581	11	4	11	4	"the required short- and medium-term system changes" should be changed to "cost-effective short- and medium-term system changes" given that most pathways compute cost-effective ways of meeting given targets. The word "required" implies more absolute bounds, which is not the focus of the scenario literature.	Taken into account.	Ida Sognaes	CICERO Center for International Climate Research	Norway
71285	11	5	11	6	Please consider revising the language as the sentence is difficult to understand: "This focus dictates a more global view and on issues"	Taken into account. Clarity will be improved.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
51997	11	9	11	9	"change requires to reduce CO2 emissions to"--should read "change requires a reduction..."	Editorial	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
52017	11	9			Stabilizing temprature changes requires to reduce all GHGs not just CO2. This needs to be captured in the section.	Partially accepted. GHGs were mentioned in the previous paragraph. In the second paragraph, we focus on CO2 specifically. The authors will consider adding a sentence on GHGs here. Anyway, this issue is explored in other sections of this chapter.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
54811	11	9	11	9	Change "to reduce" to "reducing".	Editorial	Government of United States of America	U.S. Department of State	United States of America
61573	11	9	11	14	It is recommended to include an information box or discussion in the section about what it means to apply a 'net zero CO2' vs 'net zero GHG emissions' concept as a target. The discussion should be scientifically sound and unbiased. These terms have the potential to be politicised so it is necessary for the IPCC to provide clear discussions on what it means to apply these terms, including the advantages and disadvantages. Clarity should be provided on what the difference is for implementing mitigation depending on which term is used. What activities may or may not be affected? What are the advantages/disadvantages of a 'net-zero CO2' or 'net-zero GHG emissions' target?	Accepted. The FGD will include a box on this subject (net-zero CO2 and net-zero GHG).	Kent Buchanan	Department of Environmental Forestry and Fisheries	South Africa
71287	11	9	11	9	Replace "to reduce" with "reducing"	Editorial	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
73005	11	9			Change: "Stabilising global average temperature change requires to reduce CO2 emissions...", to: "Stabilising global average temperature change requires reducing CO2 emissions..."	Editorial	Larry Edwards	Larry Edwards Environmental Consulting	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
75989	11	9	11	14	In this para you use net zero CO2, balance and carbon neutrality. I suggest you clarify very early which concept you use and how. A small box listing the concepts net zero CO, net zero GHG, carbon neutrality and GHG neutrality with pointer to glossary, could be useful. Since you also mention "balance" you may say that this is open for interpretations and then what you use in this chapter. Two relevant references Rogelj et al., 2015 (ERL) and Fuglestvedt et al., 2018.	Accepted. The FGD will include a box on this subject (net-zero CO2 and net-zero GHG).	Jan Fuglestvedt	CICERO	Norway
78335	11	9	11	9	The use of the term "temperature change as opposed to "global warming" led to some clumsy language in this chapter. Especially when it's just "temperature" that is meant as here!	Taken into account. Clarity will be improved.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
81167	11	9	11	14	These sentences are confusing, and give the impression that the 'balance of emissions and removals' apply to CO2 only. This is sharpened by the sentence that says "...increasing body of literature on net-zero CO2 emissions pathways that avoid temperature overshoot and hence do not rely on net negative CO2 emissions". Reaching net-zero GHG emissions inevitably relies on the net negative CO2 emissions since no single pathway achieves zero non-CO2 emissions. Please ensure this para correctly presents the relative role of CO2 and non-CO2 gases in the context of the 'balance' and their different roles in temperature outcomes (which ideally would cross-reference a more detailed discussion in the yet-to-be-written box on net-zero emissions).	Accepted. The FGD will include a box on this subject (net-zero CO2 and net-zero GHG).	Andy Reisinger	Ministry for the Environment	New Zealand
63493	11	10	11	12	These lines seem to interpret the "emissions balance" language of Article 4.1 of the Paris Agreement in terms of carbon neutrality. This kind of interpretation should be avoided. Text should refer to the separate concepts of carbon neutrality (net zero carbon emissions) and GHG neutrality (net zero GHG emissions).	Accepted. The FGD will include a box on this subject (net-zero CO2 and net-zero GHG).	Government of Canada	Environment and Climate Change Canada	Canada
83151	11	10	11	11	While the informed reader might be able to detect that you are talking about two different net-zero concepts here, it might be better - given the prominence of this message - if you weave "CO2" and "GHG" in here to make clearer that carbon neutrality is not the same as the PA balance requirement (and if you keep the latter as a quote - which would mean you'd only need to add "of greenhouse gases" - you probably need to indicate where it is from)	Accepted. The FGD will include a box on this subject (net-zero CO2 and net-zero GHG).	Geden Oliver	German Institute for International and Security Affairs	Germany
1799	11	19	11	26	This is a very good argument why the chapter should refrain from using "well below"	Taken into account	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
85937	11	21	11	40	Suggest it may be useful to explain why the Illustrative Pathways have been introduced and why they are needed in addition to the SSPs.	Partially accepted. This is better discussed in sections 3.2 and 3.3. Anyway, we will try to improve clarity here as well	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
50089	11	37	11	37	"central role" is not appropriate	Taken into account. Rephrasing will be considered	Masahiro Sugiyama	University of Tokyo	Japan
30673	12	18	12	19	As described in Annex C on page 43, the use of multiple emulators will improve the understanding of the uncertainties involved in the scenario classification process. Although SOD is based on a single emulator, we expect that the final assessment is based on multiple emulators, and that confidence levels in SPM sections C1 and C2 are to be considered carefully.	Taken into account. Three emulators will be used for the FGD. MAGICC, FaIR and CICERO-SCM. MAGICC is used as a basis. The other two are used to get uncertainty ranges.	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
75991	12	19	12	19	To my knowledge the calibrated emulators are not used in WGII.	Noted.	Jan Fuglestvedt	CICERO	Norway
48183	12	22	13	8	As with Section 3.1.3 on the Illustrative Pathways (IPS) theme, consider incorporating the contents of Section 3.1.3 into Section 3.2.5 and expanding and elaborating on the contents of Box 3.1.	Taken into account. The suggested structure will be considered by the authors	Yang Wang	Beijing Climate Center	China
54813	12	22	12	27	The header suggests the section talks about complementary uses, but the text sets up a false contradiction. Specifically, removing text from lines 25 and 26 like "on the one hand" and "in addition to" would help clarify that these ideas are not in opposition to one another.	Accepted. We will rephrase it.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
14939	12	25			The number of illustrative pathways increased from 5 in the FOD to 11 in the SOD. Importantly, all pathways of the FOD led to net-zero emissions at the end of the century. The usefulness of illustrative pathways reduces with the number of them (see comment below).	Accepted. For the next round, there will be a lower number of IPs (now called IMPs - Illustrative Mitigation Pathways).	Government of Saint Kitts and Nevis	Department of Environment - Ministry of Agriculture, Marine Resources, Cooperatives, Environment and Human Settlements	Saint Kitts and Nevis
50623	12	37	13	8	There is also a box on IPs in chapter 1, it could be referenced here.	Taken into account, but Ch1 is the introduction. As such, it should have a reference to Ch3, not the opposite. A reference to Ch1 here might be unnecessary.	Anne Marie Treguier	CNRS	France
63495	12	37	13	8	Box 3.3 on the Illustrative Pathways: In chapter 1 of the WGIII report, there is also a Box on the illustrative pathways (Box 1.1, page 1-21). In that Box, it states that all but one of the 11 IPs are based on SSP2. This seems important information about the IPs to include in this Box in Ch. 3 as well. Additionally, a rationale for this decision would be helpful given that the 11 IPs are characterized as sampling from and representative of the broad scenario space. If all share the same socio-economic background, how does this sample the scenario space?	Accepted. It will be made clear that SSP2 is the assumption for most IPs. For the second part of the comment, the authors will consider adding this rationale. However, it is worth noting that SSP2 is the basis for many scenarios in the database.	Government of Canada	Environment and Climate Change Canada	Canada
75993	12	37	13	8	The box on IPs is useful. But it would also be good with a couple of sentences about what the IPs don't do / are not. (e.g., not recommendations, predictions, not most likely)	Accepted. These limitations will be made clear.	Jan Fuglestedt	CICERO	Norway
75995	12	37	13	8	It would be very useful if you say how IPs align with the set of core scenarios used by WGI; i.e. in terms of ranges for temperature outcomes.	Taken into account, but a better explanation of the association of IPs with temperature levels is already provided in 3.3.	Jan Fuglestedt	CICERO	Norway
78337	12	37	13	8	11 is a lot for a scenario set - could be described in terms of 4 levels of climate ambition with "alternate" scenarios at higher levels of ambition.	Accepted.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
54815	12	38	12	39	The text implies that the literature only depicts baseline or Paris Agreement pathways. Suggest editing to convey that the literature includes such pathways.	Taken into account.	Government of United States of America	U.S. Department of State	United States of America
79833	12	39			"pathways consistent with the Paris Agreement"- as it is an important concept for this chapter, it will benefit having some explanation on what this means.	Taken into account.	Madoka Yoshino	United Nations University Institute for the Advanced Study on Sustainability	Japan
85939	12	44	12	44	Consider explaining the term "transformative pathways". How are they different to other pathways? Is the use of the term "transformative" in the WGIII report consistent with its use in the WGII report?	Taken into account. We will consider better explaining the term.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
37611	13	2	13	4	Why not include pathways that focus on nuclear such as given by Berger et al. 2017, a reference which has been cited in this chapter.	Chapter 3 is built mostly on IAMs, where nuclear energy is not normally seen as a least-cost mitigation option for power generation.	Ravi B Grover	Homi Bhabha National Institute	India

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
61633	13	2	13	5	"These pathways illustrate the implications of a focus on renewable energy such as solar and wind; reduced energy demand; reliance on biomass, other supply-side measures; strategies that avoid net-negative carbon emissions, and gradual strengthening." The IPs <2-Ren and 1.5-Ren include a priori assumptions of "enhanced development and rapid diffusion of renewables". There should be a scenario with similar assumptions for nuclear, given that literature contains a multitude of scenarios where nuclear plays a fundamental role and mitigates the acknowledged risks of more hypothetical scenarios. Part 1/2	Considering the concerns of nuclear energy, the authors chose not to have an IP focussing exclusively on this technology. Still, in some IPs, nuclear power plays an important role. Also, it is worth noting that the scenario database includes several high-nuclear scenarios.	Rauli Partanen	Think Atom	Finland
61635	13	2	13	5	Part 2/2. Literature to previous point include for example: Vaillancourt et al., 2008, https://doi.org/10.1016/j.enpol.2008.01.015 ; Apergis et al. 2010, https://doi.org/10.1016/j.ecolecon.2010.06.014 ; Menyah and Wolde-Rufael, 2010, https://doi.org/10.1016/j.enpol.2010.01.024 ; Brooks, 2012, https://doi.org/10.1016/j.enpol.2011.11.041 ; Hong et al., 2014, https://doi.org/10.1016/j.enpol.2014.05.054 ; Hong et al., 2014, https://doi.org/10.1016/j.apenergy.2014.09.062 ; Thangavelu, 2015, https://doi.org/10.1016/j.apenergy.2015.05.087 ; Qvist and Brook, 2015, https://doi.org/10.1371/journal.pone.0124074 ; Baek, 2015, https://doi.org/10.1016/j.apenergy.2015.01.074 ; Horvath and Rach-lew, 2016, https://doi.org/10.1007/s13280-015-0732-y .	Considering the concerns of nuclear energy, the authors chose not to have an IP focussing exclusively on this technology. Still, in some IPs, nuclear power plays an important role. Also, it is worth noting that the scenario database includes several high-nuclear scenarios.	Rauli Partanen	Think Atom	Finland
65671	13	2	13	2	"These pathways illustrate the implications of a focus on renewable energy such as solar and wind; reduced energy demand; reliance on biomass, other supply-side measures; strategies that avoid net-negative carbon emissions, and gradual strengthening." The IPs <2-Ren and 1.5-Ren include a priori assumptions of "enhanced development and rapid diffusion of renewables". Why is there no scenario with equivalent assumptions on nuclear? Literature contains a multitude of scenarios where nuclear plays a fundamental role and mitigates the acknowledged risks of more hypothetical scenarios (see my previous comments for the references). Revise and include an Illustrated Pathway scenario which explores the enhanced development and rapid diffusion of nuclear energy.	Considering the concerns of nuclear energy, the authors chose not to have an IP focussing exclusively on this technology. Still, in some IPs, nuclear power plays an important role. Also, it is worth noting that the scenario database includes several high-nuclear scenarios.	Eero Hirvijoki	Aalto University	Finland
84421	13	2	13	2	"renewable energy" change to "renewable and nuclear energy", or "nonfossil energy"	Partially accepted. The referred IP focus specifically on solar and wind. This will be better explained in the next draft.	Mattias Lantz	Uppsala university	Sweden
54817	13	10	24	5	Section 3.2, especially 3.2.1, is very long but also very well written. The full text of Section 3.2.1 would be very helpful as an FAQ, allowing the authors to condense chapter narrative.	Thank you. Taken into account. This will be considered	Government of United States of America	U.S. Department of State	United States of America
74787	13	10	39	44	It seems that while the scenarios by Johansson et al (2020=are discussed in the text the related scenarios are missing in the database. Please add the scenario to the database or contact the modeling team so that the scenario can be added.	Noted.	Daniel Johansson	Chalmers	Sweden
75997	13	19	13	20	You say that scenarios generally are not predictions nor forecasts. I think more useful if you say "in IPCC" rather than "generally".	Dropped "generally"	Jan Fuglestedt	CICERO	Norway
23351	13	20	13	20	"generally" seems unnecessary here	Dropped "generally"	Government of France	Ministère de la Transition écologique et solidaire	France
65515	13	22	13	22	The abbreviation of "Integrated Assessment Models" (IAMs) is used here, without givin the complete name and it is introduced for the first time in page 15.	First usage of IAM now written in full	Cristian Chadwick	University of Chile	Chile

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
14837	13	23	13	24	A comprehensive multi-target backcasting approach, which combines the strengths of MCA, nexus approaches and backcasting, can have the potential to ensure system resilience and sustainability and support a transition to zero GHG emissions. van der Voorn, T., Svenfelt, Å., Björnberg, K.E. et al. Envisioning carbon-free land use futures for Sweden: a scenario study on conflicts and synergies between environmental policy goals. Reg Environ Change 20, 35 (2020). https://doi.org/10.1007/s10113-020-01618-5	Noted	Tom van der Voorn	Institute of Environmental Systems Research	Netherlands
80387	13	29	13	29	There is stream of works spurred by the paper Battiston, S., Mandel, A., Monasterolo, I., Schütze, F., Visentin, G., Mandel, Antoine Monasterolo, I., ... Visentin, G. (2017). A Climate stress-test of the financial system. Nature Climate Change, 7(4), 283–288. https://doi.org/doi:10.1038/nclimate3255 which makes use of IAM scenarios to derive assessments of financial risk along mitigation pathways. A selection of IAM scenarios are currently used by the Network for Greening the Financial System as a basis for transition risk analysis in the context of financial risk (NGFS. (2020). NGFS - Network for Greening the Financial System - Guide to climate scenario analysis for central banks and supervisors 2020. https://www.ngfs.net/sites/default/files/medias/documents/ngfs_guide_scenario_analysis_final.pdf). Limitations arising from the fact that IAM do not contain a description of the financial system have been examined and partially addressed in Battiston, S., Monasterolo, I., Riahi, K., & van Ruijven, B. (2020). Climate mitigation pathways need to account for the ambivalent role of finance. Ssrn 3748041.	Thanks for pointing this out. Including this example would then lead the reader to wonder why other examples are not included. I think this example is best elaborated on in the Finance chapter, and keeping this section more focused and general.	Stefano Battiston	University of Zurich	Switzerland
85941	13	30	13	30	Consider changing the sub-heading to either "baseline scenarios" or "reference scenarios" given that they are the same thing.	Changed to "reference scenarios"	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
23353	13	31	13	31	In the sentence "There are different types of scenarios that have distinct roles in a scenario analysis", we suggest to replace "in a scenario analysis" by "in the analysis"	Sentence removed	Government of France	Ministère de la Transition écologique et solidaire	France
9857	13	36		38	As a consequence, There will be many baseline scenarios based on many policies on sectors.	Paragraph improved to clarify	Government of Indonesia	Ministry of Environment and Forestry	Indonesia
47387	13	39	13	41	This article may also be useful in this context: https://doi.org/10.1088/1748-9326/abcd2	Reference included later in paragraph	Takeshi Kuramochi	NewClimate Institute	Germany
80371	13	40	13	43	As it is, this paragraphs seems to suggest some optimism about the current policies in terms of reaching the Paris targets. Is this the message? For instance, the passage seems odd with the finding of the SR1.5 (2018), which stated that the gap is increasing. Could the authors clarify? While there is certainly "some" effect of the current policies, could the paragraph mention the order of magnitude of such an effect with respect to the 2C carbon budget?	The text now provides more nuance and explanation	Stefano Battiston	University of Zurich	Switzerland
81211	13	42			It's not just current policies that are having an effect, but simply declining technology costs. I.e. even if policies were reversed, coal would still be more expensive than renewables in many countries. This is stated in the Box but is worth adding here by adding "current policies and declining costs of low-carbon technologies are having an effect".	A few references to technology are now included	Andy Reisinger	Ministry for the Environment	New Zealand
63497	13	43	13	44	As written, it sounds as though this sentence has assessed that strong feedbacks are becoming less likely. Perhaps this is not what is intended. It might read better to say that "high concentration and warming levels are becoming less likely unless strong feedbacks are assumed."	This paragraph now provides more clarify	Government of Canada	Environment and Climate Change Canada	Canada
75999	13	43	13	44	More explanation would be useful here.	This paragraph now provides more clarify	Jan Fuglestedt	CICERO	Norway
85943	13	43	14	2	Are the authors referring to RCP 8.5 and/or SSP 5-8.5? If yes, consider stating this.	This paragraph now provides more clarify	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
23355	14	4	14	5	In the sentence "There is relatively little literature analysing the evolution of baseline emissions in a world with climate policies in the post-2030 period." we suggest to replace "of baseline emissions in a world with climate policies" with "of baseline emissions incorporating elements of climate policies"	Reworded to clarify	Government of France	Ministère de la Transition écologique et solidaire	France
2337	14	5	14	11	there are many scenarios besides IEA, perhaps you can add in here that there are other authoritative scenarios that include IRENA (e.g. Global Renewables Outlook), Shell, BP, etc. By the way, IEA WEO looks until 2040, whereas others go to 2050 or beyond.	Yes, the point was to just give examples, not be exhaustive.	Nicholas Wagner	International Renewable Energy Agency (IRENA)	Germany
54819	14	8	14	10	It is unclear what "more stylised" means.	Reworded to clarify	Government of United States of America	U.S. Department of State	United States of America
76001	14	14	14	14	You may mention what constraints that are added; e.g., RF	RF is now mentioned in several different places	Jan Fuglestedt	CICERO	Norway

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
76003	14	14	14	14	What you write here about Baseline scenario may seem contradicting to what you write on page 13, line 32. There you say counterfactual. But here baseline scenarios are presented containing existing policy. I think this just needs some more explanation of the use of the term; see glossary	Text has tried to clarify	Jan Fuglestedt	CICERO	Norway
78339	14	16	14	17	I think it needs to be clear that the operational method for hitting a given level of climate change has generally been to constrain cumulative net emissions over the 21c. This choice has implications for overshoot etc.	Text has tried to clarify, but the literature remains unclear	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
10541	14	18	14	18	I believe the colour should be blue, rather than red	Addressed	Philippe Waldteufel	CNRS	France
23357	14	19	14	19	The sentence "This thus allows a temporarily overshoot of the target, attractive in to find pathways to aggressive mitigation targets." is unclear. It looks like words are missing.	Text has been improved	Government of France	Ministère de la Transition écologique et solidaire	France
54821	14	19	14	19	Change "temporarily" to "temporary".	Changed	Government of United States of America	U.S. Department of State	United States of America
66833	14	19	14	19	"Attractive in to find pathways" needs rewording	Reworded	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
83153	14	19	14	25	It could be mentioned that 'overshoot' as such might be unavoidable for 1.5C, and was an issue left open by the Paris Agreement, with the "end-of-century" benchmark introduced by IAMs already being an additional constraint (see Ricke et al. 2017 https://www.nature.com/articles/s41598-017-14503-9 and Geden/Löschele 2017 https://www.nature.com/articles/s41561-017-0026-z). Also make sure to distinguish between "overshoot" and "peak and decline" (see Glossary definition for overshoot/temperature overshoot)	References added along with some text	Geden Oliver	German Institute for International and Security Affairs	Germany
63501	14	20	14	21	Is it primarily/only the literature on 1.5C and 2C scenarios that have become dominated by overshoot pathways (vs high GW level scenarios). Should this be specified?	This is a problem in higher warming levels to, but since temperature is still rising by 2100, the peak and decline profile does not (yet) appear. It perhaps complicates the discussion to introduce this new layer.	Government of Canada	Environment and Climate Change Canada	Canada
52019	14	21	14	22	This section emphasizes on the important role CDR will play. This needs to be reflected in the SPM as well.	Noted	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
65389	14	21	14	25	Would it be possible to include in this section some reference to the climate impacts of overshooting? In policy and communication audiences, the concept/impacts of overshooting often needs explaining. Suggest including a reference, or pointer towards WGI Chapters (or literature) which assess the impacts of overshoot on the climate system as a whole - not just temperature. E.g. impacts on more latent earth system changes like ice sheets, and following sea level rise - what about ocean acidification?	I have discussed with WG1, and there is nothing really concrete. Some implications could perhaps be drawn from Chs 4, 5, and 11, but it would essentially require doing some analysis. Nothing in the way of assessment to refer to.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
3945	14	26			end of the line: change "in" by "is"	Fixed	Rosa M Poch	ITPS and UdL	Spain
8343	14	26			P14 line 26. The scenarios usually follow least-cost pathways because it is the only thing that the IAMs can handle – why not just say this in the text? Yes, policy does not follow least-cost pathways but the text is missing the main point, that people do not minimise costs in the real world. The results from the models can therefore be misleading. Social, political and institutional constraints are implicitly included in the parameters in macro-econometric models such as E3ME, and in the FTT modelling by J-F Mercure.	This is now mentioned a bit more specifically	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)
54823	14	26	14	26	"in" should be "is"	Fixed	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
5009	14	30	14	30	For the reference "Brutschin et al." the year is missing	Will be fixed when full details available	Tiziana Susca	Italian National Agency for New Technologies, Energy and Sustainable Economic Development	Italy
65673	14	30	14	30	Given the uncertainties of assumed cost reductions of wind, solar, battery storage, CCS, and electrolyzers, the list in the parenthesis, namely "(social, political, institutional)", should include also the word "temporal".	I added "evolving" to help point this out	Eero Hirvijoki	Aalto University	Finland
65519	14	31	14	31	The reference "Brutschin et al." is missing the year.	Will be fixed when full details available	Cristian Chadwick	University of Chile	Chile
83159	14	31	14	33	maybe refer to ch13 and 14 here, or add some non-scenario literature. The "not always" might be read as euphemism	Link added	Geden Oliver	German Institute for International and Security Affairs	Germany
8345	14	35			P14 line 35 – as noted in the executive summary comments, this sentence needs a comment about how technology change comes about, i.e. the policy inputs that enable change. Unfortunately, 'getting the prices right' is not sufficient.	Text on this added, with reference	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)
37613	14	35	14	44	It is ironical that key elements include technologies that are not deployed on large scale, but the report as a whole gives a cold shoulder to nuclear energy.	Noted	Ravi B Grover	Homi Bhabha National Institute	India
43079	14	36		42	The report should call for the urgent development of an integrated strategy involving rapid emissions reductions, the large-scale deployment of a wide range of CDR technologies to draw down carbon, and the use of SRM to prevent dangerous temperature overshoot. "The most important step is reducing and avoiding (positive) emissions by means of energy and material efficiency, low and zero carbon energy sources, changes in behaviour, and other abatement measures (e.g., Carbon Capture and Storage (CCS), technology change, or non-CO2 emission measures). Second, measures that lead to Carbon Dioxide Removal (CDR) to remove carbon dioxide from the air (such as afforestation, Bioenergy with CCS, or Direct Air Capture). An additional aspect, not prevalent in mitigation pathways, but with a growing literature is solar radiation modification (SRM) to reduce temperature by deliberate intervention to incoming solar radiation."	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Graeme Taylor	BEST Futures	Australia
63499	14	36	14	44	This would be a good place to also introduce the conclusions highlighted in the ExSumm page 6 lines 10-12 about the paucity of mitigation scenarios addressing demand. Since gains in energy and material efficiency are clearly integral to all mitigation paths, the reduction in demand presumably refers to reduced per capita consumption. An explanation here would be suitable and helpful.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Canada	Environment and Climate Change Canada	Canada
63503	14	36	14	44	There is still a lot of learning to do in various communities about CDR and how it differs from what was previously considered "enhancement of sinks" and treated as part of mitigation. Would this paragraph be a good place to address these terminology issues and explain whether there are any fundamental differences between measures to enhance sinks in modelled emissions paths vs measures to achieve CDR, or is it primarily a matter of scale?	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Canada	Environment and Climate Change Canada	Canada
76005	14	36	14	36	Add "differing" before "characteristics" ?	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Jan Fuglestedt	CICERO	Norway
5089	14	39	14	40	It would be nice to have an example here for non-CO2 emission measures	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Lina Hollender	n/a	Germany
9859	14	40		40	CDR should be explained earlier in line 22, or include in the Glossary	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Indonesia	Ministry of Environment and Forestry	Indonesia
23359	14	40	14	40	We suggest to replace "Second, measures that lead to" with "Second step corresponds to"	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of France	Ministère de la Transition écologique et solidaire	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
83155	14	40	14	40	Change to "measure that remove carbon dioxide from the air..." and then probably add the rest of the glossary definition of CDR "and durably store it..."	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Geden Oliver	German Institute for International and Security Affairs	Germany
65391	14	41	14	41	Can you include other 'nature based solutions' in the examples of CDR technologies? Or an explanation of NbS/natural climate solutions in the overall chapter. As companies/nations continue to commit to nature based carbon removal, confusion remains on what/how these could work, so this would be a helpful explainer for policy/communication. Either include here, or point to places in the report where it is discussed.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
81213	14	41	14	44	Please make explicit that SRM is NOT a mitigation option (it does not reduce emissions or enhance sinks). SRM only limits SOME of the climate consequences of emissions but not others. Also please include a cross-reference to further discussion of this in Chapter 14, including the cross-WG box on SRM located in that chapter.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Andy Reisinger	Ministry for the Environment	New Zealand
83157	14	41	14	41	CCS needs to be mentioned with DACCS as well, otherwise it's not CDR (or only with very long-term utilization)	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Geden Oliver	German Institute for International and Security Affairs	Germany
74801	14	43	14	44	Reduce temperature by deliberate intervention to incoming solar radiation (discussed in 3.4) The solar radiation discussion to be incorporated in 3.4	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Kenya	Kenya Meteorological Service	Kenya
83161	14	43	14	44	since SRM is not broadly "discussed" in 3.4, please also refer to ch14, where there is now a cross-WG box on SRM	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Geden Oliver	German Institute for International and Security Affairs	Germany
76007	14	46	14	46	"it" seems missing before "is"	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Jan Fuglestvedt	CICERO	Norway
83163	14	46	14	46	I guess all GHG scenarios show reducing emissions to zero is hard, and for some emission sources elimination is impossible	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Geden Oliver	German Institute for International and Security Affairs	Germany
83165	15	1	15	2	What is the meaning of "at least" here. Do Holz et al. 2018 show complete elimination for non-CO2? If not, then maybe better "but only for CO2 emissions"	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Geden Oliver	German Institute for International and Security Affairs	Germany
9869	15	3	16	16	<p>Modelled emission pathways compatible with the Paris Agreement.</p> <ul style="list-style-type: none"> The need for integrated assessment models (IAMs) for long-term goals. IAMs are generally driven by economics and can have a variety of characteristics such as partial or general equilibrium, myopic or perfect foresight, be based on optimisation or simulation, have exogenous or endogenous technological change, amongst many other characteristics. Some IAMs have an impressive level of regional and sectoral detail, for questions that require higher levels of granularity at the local scale specific region and sector models may be better suited. Refer to Annex C (CGE Model) <p>Indonesia already using Input Output (IO) model, such as ExSS by using GAMS and CGE as approach to develop pathways for estimating emission in the First NDC, Updated NDC and Long-term-strategy (LTS) documents.</p>	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Indonesia	Ministry of Environment and Forestry	Indonesia

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
30675	15	3	15	3	In addition to Rogelj (2018a), please consider citing MacDougall et al. (2020) Biogeosciences, 17, 2987-3016, 2020, https://doi.org/10.5194/bg-17-2987-2020 . They used the CMIP6 model suite to show that the warming ceases on average when emissions are reduced to zero.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
52021	15	4	15	6	The statement shows importance of CDR in removing residual emissions and should be included in the discussion in the SPM.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
63505	15	4	15	6	Could be reworded to say "...mitigation scenarios that first exceed a given target before returning to it (overshoot), and this requires additional CDR to sustain net negative CO2 emissions, which is required to lower global temperature after an overshoot." (italics = suggested additions to text).	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Canada	Environment and Climate Change Canada	Canada
48095	15	5	15	5	Stating that "this requires additional CDR" to sustain net negative CO2 emissions is a false promise. Net negative CO2 emissions can be obtained by reducing emissions of biomass burning, halogens, N2O, and non-energy CH4 on top of converting all energy to clean, renewable energy. There is no need for synthetic CDR. In addition, please clarify what type of CDR you are referring to. Direct Air Capture (DAC) is always an opportunity cost, even after all energy is converted to 100% renewables, as discussed here, because it always increases air pollution and mining while hardly reducing carbon. Jacobson, M.Z., The health and climate impacts of carbon capture and direct air capture, Energy and Environmental Sciences, 12, 3567-3574, doi:10.1039/C9EE02709B, 2019. Reforestation, or natural CDR is beneficial.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Mark Jacobson	Stanford University	United States of America
23361	15	6	15	6	In the sentence 'some recent scenarios... CO2 emissions', it would be useful to precise what these 'additional constraints' refer to (what kind of constraints? it is not clear)	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of France	Ministère de la Transition écologique et solidaire	France
65393	15	6	15	7	Could you list some of the additional constraints in recent scenarios? I know it is specified in the figure, but could you say that in general the trade-offs are that low-overshoot scenarios has higher short-term cost, but lower long-term costs? Or is this an incorrect statement?	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
23363	15	7	15	7	In the sentence "limit the net negative CO2 emission" it would be useful to precise what it refers to (is the potential of net CO2 emissions that is limited? what kind of limit?).	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of France	Ministère de la Transition écologique et solidaire	France
23365	15	7	15	8	The sentence "but this lead to different trade-offs between residual emission, CDR and costs" and the figure (fig 3.1) put the spotlight of trade off on costs, while negative emissions technologies (CDR) are almost non-existent today and present even greater challenges than cost issues.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of France	Ministère de la Transition écologique et solidaire	France
63507	15	11	15	12	In this introductory text about key features of mitigation scenarios, it would be helpful to also address the difference and timing of gross negative CO2 emissions vs net negative CO2 emissions, at least to make the basic point that amounts of total CDR are larger than those indicated by net CO2 emission values and deployment begins earlier.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Canada	Environment and Climate Change Canada	Canada
9861	15	12		12	The label of fig a and b are not clear. It is difficult to link the left figure with the right one	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Indonesia	Ministry of Environment and Forestry	Indonesia
51999	15	12	15	12	I'm unable to read the font on these tables and the color for the lightest font is impossible to discern	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
65521	15	12	15	18	Figure 3.1 in letter d it says "migitation" instead of "mitigation".	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Cristian Chadwick	University of Chile	Chile
65523	15	12	15	18	Figure 3.1 does not have the letters a and b in the figure, which makes its reading somewhat difficult.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Cristian Chadwick	University of Chile	Chile
65525	15	12	15	18	Figure 3.1 although Figure d is illustrative, the lack of values in the vertical axis makes it harder to read. Could some illustrative values be added?	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Cristian Chadwick	University of Chile	Chile
47433	15	13			Neither of the two pathways consistent with a temperature increase of 1.5°C shown in this figure reaches net-zero. It has to be noted that this is not in line with Article 4 of the Paris agreement. Please consider this issue when further developing a stylised figure.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Saint Lucia	Department of Sustainable Development - Ministry of Education, Innovation, Gender Relations and Sustainable Development	Saint Lucia
50439	15	13	15	13	Missing (a) and (b) labels in the diagram	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Hoy Yen Chan	ASEAN Centre for Energy	Malaysia
63509	15	13	15	13	Figure 3.1: This figure is very helpful. We look forward to seeing the planned schematic (as indicated in the Figure caption). In that regard, given that Table SPM.1 in the SPM shows that the median timing of net zero GHG emissions in 1.5C pathways is around 2075, we would suggest the planned schematic show a pathway more consistent with the SPM 1.5C pathway descriptions. Neither of the paths here show that net zero GHG emissions are reached even by 2100. It would also be helpful in the final schematic to show both the net GHG emissions line and the net CO2 emissions line. And possibly also illustrate that LUC emissions are currently positive. This would make clear the two fold challenge to first reduce LUC emissions to zero, and then negative.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of Canada	Environment and Climate Change Canada	Canada
54825	15	14	15	18	A more stylized version of this figure would be very welcome. Panels a and b are difficult to match with the ips and panel d should perhaps not be a line graph if it is not quantitative.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Government of United States of America	U.S. Department of State	United States of America
31523	15	15	15	16	I suggest changing "conventional" and "alternative" to a more descriptive terminology, it is not clear from context why one would be "conventional" and not the other.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Robert Gieseke	Independent	Germany
85147	15	18	15	18	Please consider not to stylise the figure, but to keep the concrete information. Please add absolute numbers for the annual GDP "losses" in sub-plot (d). Perhaps it is possible to compute mean values from more than one model?	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Jens Tambke	Umweltbundesamt	Germany
4881	15	19	15	19	Caption: "This scenario is based on one model, but a simpler stylised figure will be developed." I hope this will show an envelope of all models.	This section was greatly reduced in length and migrated into the Illustrative Pathway section	Harry Saunders	Carnegie Institution for Science, Global Ecology Group, Stanford, USA	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
75061	15	20	17	16	This discussion of the strengths and limitations of IAMs for modelling mitigation scenarios omits some key references, including: Stern and Stiglitz (in review), which provides a wide-ranging critique of current IAMs; Pye et al. (2018), which highlights the weaknesses of critical model assumptions that are highly influential in driving the energy pathways in the scenarios generated by IAMs; McCollum et al. (2020), which shows how energy system modellers systematically tend not to explore extremes and that the SSPs (used in the IPCC scenarios) do not capture the full range of plausible future socio-economic and political developments. Stern, N. and Stiglitz, J. (in review) The economics of immense risk, urgent action and radical change: towards new approaches to the economics of climate change. Journal of Economic Methodology; Pye et al. (2018) Assessing qualitative and quantitative dimensions of uncertainty in energy modelling for policy support in the United Kingdom. Energy Research & Social Science 46: 332-344. McCollum D et al. (2020) Energy modellers should explore extremes more systematically in scenarios. Nature Energy 5: 104–107. https://doi.org/10.1038/s41560-020-0555-3	Some of these references have been included, also in previous sections	Robert Ward	London School of Economics and Political Science	United Kingdom (of Great Britain and Northern Ireland)
76141	15	20			I found this section very useful and interesting. It would strengthen the chapter if these considerations can be somewhat more integrated where relevant later in the chapter.	Noted	Jan Fuglestedt	CICERO	Norway
78341	15	20	17	16	It is right to spell out the utility of IAMs in this section, but more reflection on the limitations would also be appropriate. Not just what the controversial topics are, but also the arguments made (and refutations if these can be referenced).	Attempts made to do this, within the limited space	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
79111	15	20	17	16	Trenchant but uncited critiques of nearly all IAMs' underscoping and sketchy analysis of end-use efficiency options (e.g. doi:10.1088/1748-9326/ab55ab including its SM) should be addressed, and more general critiques of IAMs cited in that paper should be more thoroughly discussed. Also important to treat is the serious problem that IAMs evolve—in culture, methodology, and assumptions—far slower than the energy system is changing (see e.g. speed examples in doi:10.1088/1748-9326/abc3f2), then the flow through consensus processes like IPCC adds more lags, then informing policymakers adds more, then changing policy adds more, so the entire process at best is far behind market realities and at worst (and arguably in reality) is falling further behind. Despite all the excellent talent and commendable effort reflected in the 1,065 scenarios assessed in Ch 3, none come close to reflecting state-of-the-art understanding of end-use energy and materials efficiency potentials, and none fully reflect renewables' current and prospective market prices.	Citations added in the section	Amory B. Lovins	Rocky Mountain Institute; also Adjunct Professor of Environmental & Civil Engineering, Stanford University	United States of America
81215	15	20			The "need for" IAMs seems somewhat prescriptive and pre-empts the conclusion. I would recommend rephrasing this important section to "The role and utility of IAMs", as this implies a more open mind towards the limits of utility. Overall though, I congratulate the authors for including this section and would urge them to (a) expand this further, and (b) ensure the core insights from this section flow through into other parts of the report. Right now this section recognises some critical issues around IAMs, but this is not picked up consistently in other parts of this chapter where results are reported without obvious awareness of those issues and limitations, and where model design or input assumptions might be driving the outputs. The chapter would be strengthened significantly if the IAM (and other) model results were always reported throughout the chapter with a clear view of the extent to which input assumptions and model design may drive some of the outcomes, and where models deliver genuinely important new and additional insights. Note that the approved outline for this chapter requests authors to cover "Methods of assessment, including approaches to analysis of mitigation and development pathways" - this requires in my view a critical assessment of those methods. Section 3.2.2 is a useful start but it needs to go significantly further in my view to do justice to this mandated component of the chapter. I offer more specific suggestions on how this could be done in separate comments.	The title of the section is changed. Though, unfortunately not really enough space to expand further	Andy Reisinger	Ministry for the Environment	New Zealand

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
81217	15	20	17	16	Section 3.2.2: This section contributes an essential part of this chapter, which is an assessment of the design features, utility and limits to the utility or interpretation of IAM results. However, as it stands this section provides really only an enumeration of the issues rather than an assessment. I consider that such an assessment is critical to (a) increase confidence in the results and proper use of IAM outputs to inform policy, and (b) because such an assessment is mandated in my view by the first bullet point of the approved outline for the chapter. I would urge the authors to expand this section and give it more structure so it can actually assess the issues rather than just name them. Broad areas include (a) assumptions about mitigation potentials in IAMs and how they compare with bottom-up studies, which after all drive relative sector and regional mitigation in IAM pathways; (b) the (limited) ability of IAMs to model endogenous demand changes (especially outside the energy sector), including and in particular those arising from shifts in behaviours and lifestyles (i.e. those where it is difficult to assign a mitigation cost that connects with the economic architecture of most IAMs); (c) the fact that IAMs are driven primarily by global cost-effectiveness, with some moderate constraints around land- and water-use, but fundamentally no consideration of equity principles (see e.g. Klinsky and Winkler 2018 doi:10.1098/rsta.2016.0461); (d) the linked issue of discounting which drives reliance on costly technologies and their speculative large-scale deployment late in the century such as BECCS (not that discounting is wrong - but it's not transparent how much this matters); and (e) broader definitions of 'sustainability' are not generally integrated into IAMs but are critical for a perception of feasible policy spaces and pathways. All of those points have substantial literature but currently this section only flags the existence of some relevant papers - it does not provide an assessment. My recommendation is to expand this section, break it into relevant subsections (perhaps along points a-e above), and provide a proper, if still brief, assessment of those points. The key take-home from this would not be a criticism of IAMs, but an increased confidence in their proper use based on a fuller and more robust understanding of their inputs and limitations.	Noted.	Andy Reisinger	Ministry for the Environment	New Zealand
76009	15	21	15	22	This sentence is unclear; i.e. "The problem"	Removed	Jan Fuglestedt	CICERO	Norway
27601	15		15		Figure 3.1., the vertical axis of graph (d) should be labelled.	Removed	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
54827	16	3	17	16	This section on IAMs should be shortened. Lines 29 through 45 should be cut entirely. The list of jargon terms in lines 3 through 14 could be moved to an FAQ or glossary. This entire section has a rather defensive tone in support of IAMs which may not build confidence in IAMs for a non-technical reader. Suggest cutting out the extensive caveating and the discussion of theoretical controversy. Line 10 on page 17 makes it sound like the information is difficult to explain, not that the concerns are being addressed or that issues are being fixed or improved.	Noted. Though, many other reviewers suggested to lengthen. Though, this section will be of similar length due to length constraints	Government of United States of America	U.S. Department of State	United States of America
5091	16	11	16	11	what do you mean by "value-judgements"? Judgements by whom?	Removed	Lina Hollender	n/a	Germany
23367	16	11	16	11	At the beginning of the line, we suggest to replace "also" by "however"	Removed	Government of France	Ministère de la Transition écologique et solidaire	France
81219	16	11			It's not just value judgements, but also simplifications, assumptions and interpretations of process-based information, questions about which mitigation options to include (and how to drive them if it is difficult to assign a simple economic cost to them, i.e. where cultural values and possible shifts in such values play a key role).	Removed	Andy Reisinger	Ministry for the Environment	New Zealand
23369	16	13	16	13	In the sentence "Each IAM has advantages and disadvantages, and the model structure and type may shape the types of questions IAMs can address in addition to the IAM outcomes." we suggest to cut "In addition to the IAM outcomes"	Removed	Government of France	Ministère de la Transition écologique et solidaire	France
235	16	16	16	20	Compared to which other models are IAM "ideal" and "most suited"? How can you make such a statement when the text then goes on to acknowledge all the shortcomings of IAMs. How can you make such a statement without discussing the pros and cons of different model types?	Section 3.2. Sentence has been changed to avoid this issue.	Kai Kuhnne	Konzeptwerk Neue Ökonomie	Germany
23371	16	17	16	18	We suggest to change "questions related to short- and long-term trade-offs," with "questions related to short- versus long-term trade-offs"	Changed	Government of France	Ministère de la Transition écologique et solidaire	France
81221	16	25			"somewhat" strikes me as a distinct understatement, especially since some demand-side responses are driven not by economics but by societal values and hence are difficult to incorporate as endogenous mitigation responses into the economic structure of IAMs. They can and some have been explored by making different scenario assumptions, but this strikes me as far removed from the way supply-side options are modelled in IAMs.	Word removed and more references added	Andy Reisinger	Ministry for the Environment	New Zealand
23373	16	26	16	26	We suggest to change "needed to be coupled with other tools" with need to be coupled with other tools"	Phrase removed	Government of France	Ministère de la Transition écologique et solidaire	France
76011	16	26	16	28	Could you give examples of other tools?	Phrase removed	Jan Fuglestedt	CICERO	Norway

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
45815	16	29	17	16	While it is acknowledged that integrated models necessarily have limited complexity and need to use assumptions (cf. chapter 1, Annex C, and elsewhere in this report) there is evidence, mentioned repeatedly throughout the whole WGIII AR6-draft, that most mitigation scenarios, even the Illustrative Pathways, underestimate certain key mitigation potentials, but, on the other hand, many models promote the role of BECCS to an extent beyond feasibility limits (see e.g. Chapters 3.7, 6.4, 12.3 and 12.7 or Vaughan and Gough, 2016). This should be commented upon more prominently in the report and the SPM to ensure that no misleading respective policies are derived from these models. With respect to benefits for or conflicts with other SDG, desirable and not desirable CDR-options or other mitigation measures (cf. concept in Chapter 1.36) should generally be distinguished. The existence of alternative pathways or research gaps should be clearly stated. Please see also Vaughan, N.E., Gough, C., 2016, Expert assessment concludes negative emissions scenarios may not deliver, Environ. Res. Lett. 11, 095003, doi:10.1088/1748-9326/11/9/095003,	This point is discussed earlier in Section 3.2 in relation to models and assumptions.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
65395	16	34	16	37	Could you define "apparent". Could you also list examples, or a cumulative number, on how much AR5 RCP scenarios relied on BECCS? I.e "In the United States, projections generally suggest a high degree of deployment, with real growth beginning in 2020 and median cumulative reductions from BECCS reaching approximately 60 billion tonnes of carbon dioxide equivalent (GtCO2e) for the 2010–2100 period," (Galik, 2020)	Changed to "large scale deployment", and hopefully the references clarify this	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
76013	16	35	16	35	Re "limited insight": It may also be argued that this has triggered attentions and discussion.	Phrase removed	Jan Fuglestvedt	CICERO	Norway
23375	16	39	16	39	We suggest to cut "amount of" in "There are now many amount of transparent databases".	Phrase removed	Government of France	Ministère de la Transition écologique et solidaire	France
47681	16	39	16	42	Another database with a lot of input data for energy conversion technologies has been made available as part of the EMF-33 project. See the supplementary data of the following paper: https://link.springer.com/article/10.1007/s10584-020-02799-y	Cited	Vassilis Daioglou	Utrecht University	Netherlands
54829	16	39	16	39	Delete "amount of"	Phrase removed	Government of United States of America	U.S. Department of State	United States of America
76015	16	39	16	39	Something wrong with language here	Phrase removed	Jan Fuglestvedt	CICERO	Norway
45817	16	46	17	9	This highly important discussion regarding the economic paradigm, discount rate, ethical consideration of IAMs especially with regard to the derived extend of CDR in the scenario needs further elaboration and not just a short mentioning in this chapter. In general, this chapter seems to be imbalanced in that it contains much more justification for the use of IAM than explanation of the caveats and downsides. In addition, the information on the advantages and limitations of IAMs are scattered across chapter 3. Please revise.	Hopefully this comment is address through the changes throughout the section	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
47683	16	46	17	16	This discussion is very important. A recent paper, part of the EMF-33 study, attempted to understand the results of IAM projections (specifically the deployment of bioenergy and BECCS) as a function of technology cost assumptions, and assumed technology portfolio. The results were mixed, showing that technology deployment does not depend on (highly uncertain) technology cost assumptions, but rather the broader energy and land system representation. Important determinants include feedstock costs, the availability and costs of alternative mitigation options for different end-uses (including energy efficiency), the availability of CDR and potential payments, the speed with which large scale changes in the makeup of energy conversion facilities and integration can take place, and the relative demand for different energy services. https://link.springer.com/article/10.1007/s10584-020-02799-y	Noted.	Vassilis Daioglou	Utrecht University	Netherlands
10543	17	1	17	1	"tendency a" is probably spurious	Removed	Philippe Waldteufel	CNRS	France
29329	17	1	17	2	Please provide citation to the peer-reviewed literature for Carton et al, 2019.	It is peer reviewed	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
54831	17	1	17	1	The word "a" after "tendency" does not fit in the sentence.	Removed	Government of United States of America	U.S. Department of State	United States of America
54833	17	1	17	1	"to prefer" instead of "a preference for"	Removed	Government of United States of America	U.S. Department of State	United States of America
8347	17	2		5	P17 lines 2-5. In my opinion, this passage represents a selective view of the literature. It is pretty questionable whether assuming optimising behaviour 'approximates' real-world behaviour (at best poorly, as behavioural economics tells us) but the key issue is it does it in a way that biases towards certain outcomes. There is a single reference that optimisation may be close to reality but no mention of entire schools of economics and behavioural science that suggest otherwise. Failing that, just look at the data – the energy system and everything else are clearly not in an optimised world!	The sentence was rewritten to reflect this	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
23377	17	2	17	2	We suggest to change "The cost optimisation paradigm" with "The cost minimisation paradigm"	Changed to least cost, as used elsewhere	Government of France	Ministère de la Transition écologique et solidaire	France
50255	17	5	17	5	It sounds strange that the discount rate (in IAMs) has received attention "recently", as this has been discussed for quite some years or even decades, especially in a cost-benefit analysis context.	True. Recently analysed in the mainstream IAM community	Matthias Weitzel	European Commission, Joint Research Centre	Spain
78343	17	5	17	9	Chapter 1 notes that appropriate discount rates may be 2-3%. Can you spell out 5% general usage and the implications?	It was mentioned in the second part of the sentence, but this was reworded to make the point more clear	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
81223	17	7			This would benefit from a lot more unpacking. Discounting doesn't favour CDR as such, it favours delay of more costly actions (whether they are CDR or gross reductions). It just so happens that BECCS is not cheap and hence is ramped up mainly later in the century (but not all CDR is expensive, and the CDR that is not used right away). But more importantly, discounting is strongly linked with target formulation, i.e. whether one uses an end-of century target and hence accepts a large overshoot the higher the discount rate, or whether IAMs adopt a "not to exceed" target where discounting still matters but is not that far into the future. This single sentence easily deserves a couple of paragraphs if not also a figure to clarify those points (and perhaps also discuss how many scenarios are not using end-of-century targets but not-to-exceed targets or simply "before end of century" targets.	Noted.	Andy Reisinger	Ministry for the Environment	New Zealand
37023	17	14	17	16	If the IAMs are based on different methodology, how the comparison is possible?	I guess this is the point of model intercomparisons, to show what is comparable and not	Arun kumar Nayak	Bhabha Atomic Research Centre Trombay Mumbai	India
37025	17	14	17	16	What is the validity of the models?	Hopefully the cited literature gets to this point	Arun kumar Nayak	Bhabha Atomic Research Centre Trombay Mumbai	India
37027	17	14	17	16	Is there some uniform methodology or guidelines to be followed for IAMs?	No, not outside of the protocols for model intercomparisons	Arun kumar Nayak	Bhabha Atomic Research Centre Trombay Mumbai	India
45819	17	14	17	16	A very fitting and important quotation. However, it is our strong impression that exactly this required "careful interpretation" and amendment by other qualitative information is not sufficiently provided throughout this chapter and this report, e.g. when total figures of the whole scenario data base is given. Especially when such figures, ranges, medians of the ensembles are used in executive summary statements, more framing on the possible biases due to omitted factors (like excluding the cost of avoided climate change) needs to be given, in the ES of this chapter, the TS and most importantly in the SPM.	Noted, attempts have been made to address this more holistically across Ch3	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
72411	17	16	17	16	(Compare comment on Chapter 1 46-line 25 above): In addition to the IAM-critiques mentioned here, I would encourage adding a version of Steve Keen's critique, not least because systematically addressing the methodological questions raised here and elsewhere will strengthen the WG3 analysis: "Fundamental critiques of Nordhaus and the data used to calibrate IAMs raise the question whether neoclassical economics can reliably inform climate economic models and policy. Economists made their own predictions of damages, using three spurious methods: Assuming that about 90% of GDP will be unaffected by climate change, because it happens indoors; using the relationship between temperature and GDP today as a proxy for the impact of global warming over time; and using surveys that diluted extreme warnings from scientists with optimistic expectations from economists. Nordhaus in particular misrepresented parts of the scientific literature to justify using a smooth function to describe the damage to GDP from climate change. Correcting for these errors makes it feasible that the economic damages from climate change are at least an order of magnitude worse than forecast by economists, and may be so great as to threaten the survival of human civilization (Keen 2020)."	I have put in a few mentions of damages in an earlier section now, but much of Keen's work is on cost-benefit analysis. In any case Section 3.6 will cover this in a little more detail.	Paul Maidowski	Fletcher School, Tufts; independent researcher	Germany
54835	17	17	17	17	The use of the term "scenarios" in this section may be confusing to readers. The SSPs are pathways, not scenarios, to distinguish them from integrated scenarios including emission pathways and socioeconomic development pathways.	Some instances of "scenario" removed	Government of United States of America	U.S. Department of State	United States of America
54837	17	17	17	17	The introduction to this section can be shortened considerably because it overlaps with subsequent text. For example, it is now clear why the introduction provides multiple sentences discussing sources of scenarios, but the section later gives inclusion criteria for the scenarios considered. It would be clearer to have that information in one place.	Yes, overlaps dealt with	Government of United States of America	U.S. Department of State	United States of America
75063	17	17	19	2	This discussion of the scenarios should note that the majority are produced by IAMs that are created and used by three European institutions: Potsdam Institute for Climate Impacts Research, IIASA and the PBL Netherlands Environmental Assessment Agency.	Probably could not get away with that...	Robert Ward	London School of Economics and Political Science	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
50091	17	18	17	19	Another related issue is model democracy (Knutti 2010, https://doi.org/10.1007/s10584-010-9800-2)-- all models are treated (almost) equally, though the vetting process has been introduced.	This issue is discussed later in the section	Masahiro Sugiyama	University of Tokyo	Japan
81207	17	18			I presume that "unlikely" is not a probabilistic assessment and hence the word should not be used. Might be useful to say this quite forcefully, with "very high confidence"?	Deleted	Andy Reisinger	Ministry for the Environment	New Zealand
73007	17	22			The noted "ensemble of opportunity" presented by the available "scenarios" should be expanded for use throughout the chapter by retroactively including scenarios that are "qualitative narratives" (see 3-13 at 15 to 17) which were effectively excluded by the limited invitation to submit scenarios (see Annex C at II.3.1). Retroactive inclusion is justified because "scenarios in the literature may come from ... businesses and stakeholders" as well as the being invited from organized science and governments (3-17 at 23-30). This is important because "individual scenarios in grey literature may be overlooked even though they play greater weight in a policy context" (3-17 at 23-30) and "the submission process may be a barrier for some analysts" (3-27 at 40-42). With climate change there is too much at stake to overlook potentially important scenarios. For example, no scenarios are included that take an emergency based rather than temperature-target-based approach.	Some of these points are now further outlined, and mentioned again when discussing the statistical distribution of different scenarios.	Larry Edwards	Larry Edwards Environmental Consulting	United States of America
81225	17	23	17	24	This is a correct and important observation, but to be an assessment, it needs more detail: are there types of long-term mitigation pathways that are discussed in other literatures but that are systematically not explored in IAMs and that could therefore imply an inherent bias in IAM results? In some other part of the chapter, the degrowth literature is mentioned - are there other conceptualisations of long-term mitigation that systematically fall outside the space explored in the IAM database assembled for the AR6?	I am not sure of a systematic assessment of the scenario literature, to give an idea of what literature may be excluded. But narratives, degrowth, etc, are obvious ones. Some additional clarifications are added to highlight this.	Andy Reisinger	Ministry for the Environment	New Zealand
65397	17	29	17	30	Could you list some of the scenarios in grey lit that play a significant part in decision making? E.g. Shell's Sky Scenario, or the IEA WEO? Is there any research on how these scenarios have influenced policy makers, instead of scenarios originated within scientific communities?	I did not want to mention specific examples, as it may appear to imply that some particular industry scenarios have more weight than others. But, the examples you give are good examples.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
54839	17	31	17	42	This section would benefit from more citations.	Section now reduced in length	Government of United States of America	U.S. Department of State	United States of America
66825	17	32	17	32	CMIP = Coupled Model Intercomparison Project. Consider also citing Eyring et al. 2016 (https://gmd.copernicus.org/articles/9/1937/2016/)	Text removed	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
81209	17	37			Model intercomparisons can only tell us about robustness if we assume that input assumptions and model design is sufficiently diverse. This may not always be the case, depending on what the question is whose answer we want to test for its robustness. This should be recognised more clearly.	Correct. This was rephrased to be more nuanced.	Andy Reisinger	Ministry for the Environment	New Zealand
1801	18	1	18	2	Avoid well below	Removed	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
54841	18	1	18	7	Strongly recommend cutting this figure. It neither conveys helpful information nor clarifies the text. It also appears to be inaccurate, as it suggests that the scenarios from individual scientific studies assessed by the IPCC is equal in number to the scenarios from model intercomparisons assessed by the IPCC.	Figure removed	Government of United States of America	U.S. Department of State	United States of America
23379	18	2	18	5	We suggest to consider the political and technical documents produced by governments or NGOs. In Latin America, for example, 100RC (the foundation 100 Resilient Cities) has published mitigation plans for a large number of cities; Similarly, CAF (Andean Corporation of Promotion) with AFD (French Development Agency) and aid from the European Union published analyzes of the vulnerability of cities to climate change, accompanied by an adaptation plan, etc. There are also many examples in the fields of agriculture and biodiversity. All of this is in Spanish and is outside the strictly scientific scope of this report, although these reports are produced by scientists. An analysis by country of these multiple experiences should be proposed to the IPCC.	Figure removed	Government of France	Ministère de la Transition écologique et solidaire	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
76017	18	8	18	8	I am not sure if "intecomparison" is the right way to describe SSPs. They are a very important element in doing intercomparison, but I dont think they can be called this as such.	Changed to development	Jan Fuglestedt	CICERO	Norway
54843	18	12	18	12	The citation used on the line is from 2017, but the SSP narratives were developed much earlier than this. Check citation.	This is from the SSP Special Issue, which was published in 2017 when all articles were available. The article actually appeared online in early 2015!	Government of United States of America	U.S. Department of State	United States of America
76019	18	17	18	17	The recent paper by O'Neill et al in NCC om the use of the framework could be cited here.	Cited	Jan Fuglestedt	CICERO	Norway
76021	18	24	18	24	The SSP/RCP matrix has not been explained. May need some words earlier.	This discussion was avoided in the interests of space	Jan Fuglestedt	CICERO	Norway
78345	18	24	18	24	"combination" rather than "mapping" which suggests something else?	Section deleted	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
54845	18	25	18	25	Not all of the SSPs will ever be compatible with all of the RCPs.	Section deleted	Government of United States of America	U.S. Department of State	United States of America
66835	18	27	18	28	"Check..." I presume you will check!	Section deleted	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
1803	18	28			It would be useful to explain the link between the SSPs and the IPs more clearly	Section deleted	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
65399	18	28	18	33	Would it be possible to make reference to the five scenarios WGI focuses on here? Could you for example reference to Box 1.1 in WGIII Chapter one, where it states that the only scenario overlapping with WGI is SSP2-4.5? The messaging can be confusing to policy/communications audiences who have read in WGI that the 1.5 will be reached in the near-term (2021-2041) in the considered SSP2 and SSP1 scenarios. If assume are talking about reaching 1.5 end of century - as it is the chapter goal - but could you specify it in this statement?	Section deleted	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
66837	18	28	18	28	RCP1.9. I see this a few places in the literature to refer to 1.9 W/m2 / 1.5C consistent mitigation scenarios, but I don't like it. To my mind RCP scenarios specifically refer to the four representative pathways considered in AR5. In the SSP matrix there are many different IAM/SSP pathways that are capable of reaching different prescribed forcing levels (SSP1-1.9, SSP2-1.9 for each IAM, and probably several of the non-SSP deep mitigation scenarios) so it is not uniquely defined. More correctly, it's a 2100 forcing level.	Section deleted	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
54847	18	32	18	32	It would be helpful to have an explanation of the SSP-RCP scenarios, particularly the reasons why they were developed and a short summary of how they were created.	Section deleted, but reference made to WG1	Government of United States of America	U.S. Department of State	United States of America
12603	18		18		I think the Figure is misleading because the intersection between Scenarios from MIP and from individual studies is an empty set	Figure removed	valentina bosetti	boconni	Italy
20455	19	1	19	1	Missing reference Jr 2020?	Fixed	Jordi Solé	Universitat Rovira i Virgili	Spain
54849	19	1	19	2	Suggest using more formal language here, or being more specific. If these scenarios need updating at some unknown point of time, should a reader imply that the scenarios are not trustworthy and should not be used here?	It is now mentioned that the scenarios are becoming outdated, and this will be picked up in the scenario vetting (next section).	Government of United States of America	U.S. Department of State	United States of America
80375	19	1	23	30	Section 3.2.4 should in my view address a fundamental issue: GDP is widely recognised to be insufficient to describe well-being. If the purpose of IAM scenarios is to provide a tool to support decision making about climate mitigation, to what extent is the limited focus on GDP going to bias the judgement of decision makers? Moreover, the authors should explain for how many of the considered scenarios the variable GDP takes into account the economic losses due to the impact of climate change and if it does so under which damage function and interest rate. As we know, they can vary by an order of magnitude or more.	These issues are discussed elsewhere in the report	Stefano Battiston	University of Zurich	Switzerland

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
81205	19	1	19	2	They do indeed need updating - the chapter should make clear to what extent has this updating happened in the AR6 scenario database; has there been a cut-off applied for grossly out-of-date assumptions? How different from most recent global emission values for CO2 and CH4 are the emissions for 2020 in the IAM scenarios? This is an important comparison that should be easy to make and would provide useful information about the realism of present-day assumptions (as this matters e.g. for the cumulative emissions to net-zero CO2, but also for relative rates of reduction necessary to remain within a given temperature limit).	It is now made clear that the SSPs do not make a core part of the WG3 assessment, for this reason.	Andy Reisinger	Ministry for the Environment	New Zealand
37591	19	3	24	4	For clarity and consistency, if possible, it is better to use the same way of categorising scenarios in section 3.2.4 and classifying the illustrative pathways in section 3.2.5. Or at least, I would like to see some links between categorising scenarios in section 3.2.4 and classification of the IPs in section 3.2.5.	This is explained better in the IP section now	Young-Hwan Ahn	Sookmyung Women's University	Republic of Korea
76023	19	9	19	9	Please add "WGIII" after "AR6"	Added	Jan Fuglestedt	CICERO	Norway
78347	19	12	19	24	Some of the material here might be better in AnnexC. This stands as an example.	Removed	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
76025	19	19	19	19	Please add "WGIII" after "AR6"	Added	Jan Fuglestedt	CICERO	Norway
78349	19	27	19	27	Must specify and explain vetting criteria	Annex C	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
83587	19	28	19	28	Have not all scenarios been vetted, but not all of them made the cut? Maybe reword this sentence.	Reworded	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
54851	19	33	19	33	What is the level (or range) of bias correction that needs to be applied?	No automated bias correction was applied, but each section in Ch3 considered this in the assessment	Government of United States of America	U.S. Department of State	United States of America
63511	19	33	19	34	This states "that some level of bias correction should be applied to correctly interpret the scenario characteristics". Was this done, then, in the analysis presented in Ch. 3?	No automated bias correction was applied, but each section in Ch3 considered this in the assessment	Government of Canada	Environment and Climate Change Canada	Canada
76027	19	33	19	34	Re bias correction: You may point to where this is followed up.	No automated bias correction was applied, but each section in Ch3 considered this in the assessment	Jan Fuglestedt	CICERO	Norway
83167	19	33	19	34	Is bias correction applied or not?	No automated bias correction was applied, but each section in Ch3 considered this in the assessment	Geden Oliver	German Institute for International and Security Affairs	Germany
66839	19	34	19	34	It's not clear whether this bias correction is merely a recommendation or whether this actually occurred.	No automated bias correction was applied, but each section in Ch3 considered this in the assessment	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
30661	20	1	20	5	Figure 3.3 shows that most of the scenarios are the result of the European modeling teams. There is a large regional imbalance of the modeling teams, so it needs to be shown that there is no bias in the results. For example, REMIND is characterized by a tendency to have large renewable energy deployment. It would be necessary to show this will not affect the overall assessment.	No automated bias correction was applied, but each section in Ch3 considered this in the assessment	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
37615	20	1	20	3	It will be useful for readers to know as to which of these models account for intermittency of renewables, lack of system inertia of solar PV and other characteristics of renewables.	This is in Annex C	Ravi B Grover	Homi Bhabha National Institute	India
65527	20	1	20	5	Figure 3.3 and 3.4 says "Vetted scenarios in database (n=1065)", but the text in page 19, line 27 says that 1065 scenarios passed the vetting, and hence were not vetted. I am not sure if the figure should have said "Non-vetted scenarios in database (n=1065)" or "Vetted scenarios in database (n=597)", but it seems it has an error. Note, the 597 is the subtraction of the total received scenarios and the ones that passed the vetting process.	This will be updated with the new database	Cristian Chadwick	University of Chile	Chile

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
65675	20	1	20	3	Figure 3.3., The scenario modeling tools such as REMIND lack the temporal and spatial resolution to account for the variable production of solar and wind and the realistic demand profiles on hourly basis (REMIND manual, https://www.pik-potsdam.de/en/institute/departments/transformation-pathways/models/remind/remind16_description_2015_11_30_final). This approach is questionable, and may lead to underestimation of costs and overestimation of emission reduction from these technologies (Rinkjoeb et al., 2020, https://doi.org/10.1016/j.energy.2020.118377). Is the hourly variation of wind, solar, and demand included in the analysis that results in the Illustrated Pathway scenarios? If not, at least one of the scenarios should then focus on a case that includes a higher share of dispatchable low-carbon energy, e.g., nuclear energy, to avoid the uncertainty risks associated with the variable renewable technologies and their modelling. Revise the scenarios accordingly.	This is in Annex C	Eero Hirvijoki	Aalto University	Finland
81203	20	1			Figure 3.3: the stunning dominance of REMIND model runs warrants a discussion - to what extent might specific assumptions in the REMIND model skew not just percentiles but even the median of reported results? How do the REMIND results compare to the results from all other models for key variables and scenarios? This is an issue for such ensembles of opportunity that needs to be covered in the assessment.	No automated bias correction was applied, but each section in Ch3 considered this in the assessment	Andy Reisinger	Ministry for the Environment	New Zealand
4149	20	6	24	4	With absence of illustration of the relationship between the seven temperature categories (C1-C7), eleven Illustrative Pathways (IPs) and 11 specific scenarios (e.g. <2-SUP, <2-Ren etc), readers can hardly understand their internal logistics and relationship between them. Suggestion: 1) In Table 3.1, add a column to elucidate the relationship between the seven temperature categories (C1-C7), eleven Illustrative Pathways (IPs) and 11 specific scenarios. 2) In Figure 3.5, split the vertical “Warming level” from four rows to seven rows, referring to the seven temperature categories (C1-C7). 3) In Figure 3.6, add explanations to each 11 scenarios, elucidate which temperature category (C1-C7) and which 11 IPs they are in line with. And we suggest to add some explanations and literature reference for those 11 scenarios, so reader can better understand the relationships between the 11 scenarios-7 temperature category-11 IPs. For example, regarding the fifth scenario (in second row, second column), “MESSAGEix-GLOBIOM_GEI_SSP2_..._Ic_50” scenario comes from the MESSAGEix-GLOBIOM model, refers to <2-Ren IPs, in line with C3 (>67% below 2°C) (GEIDCO, IIASA, WMO, 2019). Reference: GEIDCO, IIASA, WMO, 2019: Research Report on Global Energy Interconnection for Addressing Climate Change. Beijing: China Electric Power Press.	The IPs are now updated and hopefully better explained	Changyi Liu	GEIDCO	China
80373	20	6	20	9	"To assess the implications of scenarios for climate policy, the vetted scenarios were classified into different categories along the dimensions of population, GDP, energy, temperature, technology shares, and cumulative emissions (Table 3.1). ". Could the authors explain why no dimension related to the impact of climate change along the trajectory is considered?	This is only included by some modelling groups, and is assessed in section 3.6	Stefano Battiston	University of Zurich	Switzerland
37029	20	10	20	11	If the number of scenarios does not provide higher probability, what is the implication?	This is more clearly explained now	Arun kumar Nayak	Bhabha Atomic Research Centre Trombay Mumbai	India
37031	20	10	20	11	Significance of the scenarios not defined	This is more clearly explained now	Arun kumar Nayak	Bhabha Atomic Research Centre Trombay Mumbai	India
12605	20		20		Isn't the dataset heavily biased towards a single model? Isn't this prone to critique?	Yes. Each section deals with this in its assessment	valentina bosetti	bocconi	Italy
31521	21	1	21	14	I suggest clarifying the naming of the climate models to only call them “emulators” when explicitly used with a calibration from output of more complex models. They have not always been explicitly developed as emulators, but can rather be used in such a way, see also Nicholls et al. (2020), section 3.1 Model configuration. Hartin et al. (2015) also states that “SCMs such as MAGICC [...] are also used as emulators of more complex ESMs”. A way to phrase this could be to say that in the report, simple climate models are called climate emulators when they are calibrated to outputs from more complex models.	The word emulators was decided to be used, and this is not really the section to get into these details. Perhaps Annex C.	Robert Gieseke	Independent	Germany
47729	21	1	21	1	Mean temperature, surface air temperature,	Clarified	Yulizar Yulizar	Universitas Pertamina	Indonesia
47731	21	1	21	1	max/ min temperature?	Clarified	Yulizar Yulizar	Universitas Pertamina	Indonesia
66841	21	1	21	14	This is a huge improvement compared to AR5 and SR1.5, and really helps ensure that the results presented in this chapter are consistent with the assessment in WG1 and that the emulators are cross-validated against each other (which was an SR1.5 issue). I know a huge amount of work has gone into this and the results will be very valuable.	Noted	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
78351	21	3	21	14	Annexe C?	Text is much shorter now	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
31221	21	8	21	14	It is not sufficient to calibrate the emulators against complex climate models only. The emulators should also be consistent with new insights into other lines of evidence, such as historical warming, effective radiative forcing, climate sensitivity, and carbon cycle sensitivity.	This is discussed in WG1	Junichi Tsutsui	Central Research Institute of Electric Power Industry	Japan
17573	21	15	21	16	"between" duplicated	Fixed	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
54853	21	15	21	15	Delete "between"	Fixed	Government of United States of America	U.S. Department of State	United States of America
73015	21	15			There is a missing word in this phrase: "was established between to ensure".	Fixed	Larry Edwards	Larry Edwards Environmental Consulting	United States of America
76029	21	15	21	15	You may delete first instance of "between"	Fixed	Jan Fuglestedt	CICERO	Norway
76031	21	18	21	18	"... and a source of historical emission to improve": Can you explain more?	Section removed to Annex C	Jan Fuglestedt	CICERO	Norway
71289	21	23	21	26	This will be a good improvement	Section removed to Annex C	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
71291	21	26	21	28	To do this further granularity than simply below 2C with 67% chance and 50% chance might be needed for a possible interpretation of the well below goal of the Paris Agreement.	Section removed to Annex C	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
81199	21	26			"targets" -> "outcomes". I hope nobody has a 'target' of warming of 3 degrees.	Section removed to Annex C	Andy Reisinger	Ministry for the Environment	New Zealand
81201	21	28			To avoid any accusation of science being policy-prescriptive, you might want to add at the end of the sentence "...", although this interpretation is ultimately a judgement to be made by governments."	Section removed to Annex C	Andy Reisinger	Ministry for the Environment	New Zealand
10545	21	30	21	30	Concerning the population, a particularly significant case would be the "SDG met need" scenario, as termed by Vollnet et al (https://doi.org/10.1016/S0140-6736(20)30677-2), which assumes that the SD Agenda for 2030 has been wholly implemented, with as a result a world population in 2100 of about 6,2 billions. This is significantly lower than SSP1.	Noted	Philippe Waldteufel	CNRS	France
30663	21	30	22	2	Table 3.1 shows that the temperature scenarios are divided into seven detailed categories. However, there are no meaningful implications to be gained by dividing the scenarios into smaller categories, which in turn makes it more difficult to understand. It would be better to classify the temperature scenarios into about four levels.	This is something decided by the author team and TSU	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
45821	21	30	21	30	Table 3.1, the labelling of cumulative negative emissions, e.g., up to 300 GtCO2 as "low", could be very misleading. Based on which scientific method is this categorisation selected? The approach needs please to be explained, e.g. as a footnote to the table. It should be clearly stated that a label "low" does not correspond to any judgement on the realism or feasibility of this scenario. Furthermore, please mention if the numbers refer to gross or net cumulative negative emissions.	Noted	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
50093	21	30	21	30	I don't quite understand the table heading "Category." It should be variable, perhaps.	Changed to variable	Masahiro Sugiyama	University of Tokyo	Japan
54855	21	30	21	30	It's unclear whether the categories were created from the data available in the SSPs, or if the categories were based on some percentage +/- the SSP2 mean value.	Clarified	Government of United States of America	U.S. Department of State	United States of America
65529	21	30	22	2	In the footnote, there is a reference to multiple SCMs. The abbreviation SCMs is used three or four times in the chapter, the full name is given in page 21 line 2 "Simple Climate Model", but the abbreviation is not presented there.	SCM removed	Cristian Chadwick	University of Chile	Chile
72163	21	30			I'd like to suggest some revisions to the scenario categorisation done. The so-called 1.5°C high-OS pathways are likely to exceed 1.5°C. They should thus not be labelled 1.5°C. The fact that they are below 1.5°C in 2100 has not policy relevance – that time frame is purely the outcome of conventions in modelling. I suggest to delete this category altogether.	This is something decided by the author team and TSU	Carl Schleussner	Climate Analytics	Germany
72165	21	30			The naming convention in 1.5 and 2°C pathways fails to illustrate the fact that there's in fact an interdependency between warming level and probability. Specifically I suggest to include a 'very likely' (90%) below 2°C category. This resembles a plausible interpretation of the PA formulation of 'holding warming to well below 2°C' – a strengthening of the Cancun language of 'below 2°C' that was commonly interpreted as likely (66%) below 2°C. Clearly, there are different interpretations of the PA language. But it has been argued that well below 2°C might be best interpreted as "very likely" below 2°C (see e.g. Schleussner et al. 2016 (10.1038/nclimate3096) or Schleussner et al. 2019 (10.1088/1748-9326/ab56e7) and such an interpretation should be also represented in the IPCC report.	This is something decided by the author team and TSU	Carl Schleussner	Climate Analytics	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
72167	21	30			The 50% below 2°C scenarios shouldn't be called 'below 2°C' (see also Table 3.2) They are as likely as not 2°C. Could for example be called 2°C median warming or something.	This is something decided by the author team and TSU	Carl Schleusner	Climate Analytics	Germany
23381	21		22		The lines 'high CCS' and 'high efficiency improvemnt' are empty. We suggest a clarification whether it is a typo and if not if it means that there are no representative scenario.	This is now filled in	Government of France	Ministère de la Transition écologique et solidaire	France
27603	21		22		Table 3.1, to be specified whether there were no scenarios with "High CCS" and "High efficiency improvement". At present, the respective cells remain blank.	This is now filled in	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
29333	22	1	22	1	Table 3.1. There is no value provided for the number of scenarios with "high CCS". Also, it would be good to clarify if this is for electricity CCS only or CCS generally.	This is now filled in	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
50441	22	1	22	1	Suggest adding notes to indicate the acronym of "OS", otherwise full spell of overshoot	Written in full	Hoy Yen Chan	ASEAN Centre for Energy	Malaysia
78353	22	1	22	1	This is different from the low O/S definition SR 15 "Pathways limiting median warming to below 1.5°C in 2100 and with a 50–67% probability of temporarily overshooting that level earlier, generally implying less than 0.1°C higher peak warming than Below-1.5°C pathways". Is <1.6 the criterion, or the outcome of applying the SR15 definitiion? Need to be clear and explain if the method has moved on.	Noted.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
83169	22	1	22	1	"negative emissions" should be changed into "carbon dioxide removal" or "net negative emissions", depending on what the numbers are about	CDR to be used throughout	Geden Oliver	German Institute for International and Security Affairs	Germany
81197	22	2			Table 3.1: It would be useful to add another note to this table that makes clear that the median across the ensemble of scenarios within each category doesn't necessarily match the headline temperature characterisation. I.e. the median temperature of all scenarios in the C3 category is NOT 66% probability remaining below 2 degrees, since some scenarios in this category are lower (but not quite low enough to fit into C2 or C1). This may also help people understand the probabilities given in Table 3.2 (see my related comment on temperature outcomes for that table).	Noted.	Andy Reisinger	Ministry for the Environment	New Zealand
50443	22	4	22	4	Suggest adding (IPs)	The IPs have been reworked in this version	Hoy Yen Chan	ASEAN Centre for Energy	Malaysia
71293	22	4			It would be useful to explain the connection and differences between the SSPs and the IPs more clearly	The IPs have been reworked in this version	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
80377	22	5	24	30	Section 3.2.5 should mention that the IP scenarios do not contain a descriptipn of the financial system. This is an important limitation that needs to be acknowledged because, as discussed in Chapter 15, in reality the financial system cannot be assumed unconditionally to support the mitigation pathways. Indeed, if the decision makers in the financial system do not understand the risk of unmitigated climate change they will not adjust their risk perception across low/high carbon activities. Further, unless they understand the risk of a late and sudden transition they will postpone to reallocate capital. This can be a problem for the consistency of the IP that achieve 1.5C or 2C. For instance, if along the pathway the financial system does not adjust risk perception, the reallocation of capital needed to scale up the low carbon technologies is in fact not there and the scenario becomes inconsistent. This issue has been examined in Battiston, S., Monasterolo, I., Riahi, K., & van Ruijven, B. (2020). Climate mitigation pathways need to account for the ambivalent role of finance. Ssrn 3748041.	The IPs have been reworked in this version	Stefano Battiston	University of Zurich	Switzerland
80379	22	5	24	30	In Section 3.2.5 I would suggest the authors to highlight more clearly that all the IP assume some form of CDR. There is no clarity among the public about this. It is important to clarify the following: i) if the CDR technologies that are assumed to have a role in the IPs exist already, and if not, what is the gap and what is the confidence level in the assumption ii) if the CDR technologies assumed in the model could have adverse environmental impacts. Is there a scientific consensus on their safety? Which ones could be problematic?	The IPs have been reworked in this version	Stefano Battiston	University of Zurich	Switzerland
80381	22	5	24	30	In Section 3.2.5 I would suggest the authors to explain what IP do and do not in relation to projected impacts. At the moment, it does not emerge if and how the various IP differ along the dimensions of risks, which are critical for policy makers and businesses to make decisions. The goal to presents IP in a neutral way, which I understand, should not come to the detriment of clarity on the fact that they present different risks (sure, across several types of risks). It should be mentioned, at least as an example, the risks highlighted by WGII in 4C pathway such as IP1 in particular in terms of well-being, social unrest and conflicts.	The IPs have been reworked in this version	Stefano Battiston	University of Zurich	Switzerland

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
80383	22	5	24	30	I would invite the authors to discuss in Section 3.2.5 the following issue. Across SSPs and IP there is great level of details in the assumptions about by the evolution of technologies, policy environment and even geopolitics several decades in the future. In contrast, there is no description of the impact of climate change on well being, social unrest, migration, which are in fact described in WGII. I find this striking. Why are IPs so precise about aspects that are largely unpredictable because they depend un human behaviour, and so vague about impacts which, conditioned to a temperature level or path, climate scientists are at least able to model. I remember the argument that IP can be connected to corresponding impacts but this should be done in another context and by other people. But I remain unconvinced by this argument because policy makers will read these IP as they are. What if their perception and their decisions get biased by the fact the impact dimension is not even mentioned? After all, there is no prescriptive element in mentioning the impacts. They seem far less uncertain than the future of international coalitions. Therefore, I would invite the authors to discuss this point in the section and explain what is the intended use of the IP in relation to impacts.	The IPs have been reworked in this version	Stefano Battiston	University of Zurich	Switzerland
54857	22	7	22	13	The text is unclear. Why keep the same illustrative pathways for the AR6 when the policy questions differ from SR1.5?	That was a misunderstanding, hopefully the text is better now	Government of United States of America	U.S. Department of State	United States of America
50625	22	11	22	12	WGI chapter 1, section 1.6 (Scenarios) may be referenced here. Also, note that WGI assessment relies not only on CMIP6 but on multiple lines of evidence. This is very important to mention here, because the CMIP6 ensemble includes a larger number of members with unlikely high Equilibrium Climate Sensitivity, compared with CMIP5. This problem is fully taken into account in the assesement of future global temperatures made in WGI, chapter 4, which does not rely on CMIP6.	Reworded	Anne Marie Treguier	CNRS	France
54859	22	11	22	11	Should be "on" CMIP6.	Reworded	Government of United States of America	U.S. Department of State	United States of America
65401	22	11	22	11	Copy-edit: AR6 WG1 relies on (not of) CMIP6. In general, it would be great if this sentence could be expanded. As it is crucial to a policy/communications audience to know how WG1 results have been found, and how they rely on results from the CMIP6. Maybe a short explanation on exactly which of the SSPs WG1 asses are. Is there a review paper that can reference "scenarios from the literature" or can you reference the IAMC database?	Reworded	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
76035	22	12	22	12	"using scenarios from the SSP/RCP matrix": See WGI for a better description	WG1 referenced	Jan Fuglestvedt	CICERO	Norway
76033	22	16	22	18	Is "storyline" and "narrative" used interchangeably, or do they have different meanings?	Illustrative Pathway section rewritten, taking all comments on board	Jan Fuglestvedt	CICERO	Norway
54861	22	17	22	17	More explanation is needed as to how the dialogue was used to select storylines, including how the process was designed to avoid bias.	Illustrative Pathway section rewritten, taking all comments on board	Government of United States of America	U.S. Department of State	United States of America
8247	22	29	28	39	When discussing the mitigation effort if non-government and subnational stakeholders, I would suggest to also mention how policies have and might influence their role (and also ease the access to data on this subject). E.g the EU non-financial reporting directive (NFRD), requires larger corporations to report on environmental protection, social responsibility etc.	Illustrative Pathway section rewritten, taking all comments on board	Frida Zahlander	DanChurchAid	Denmark
37617	23	1	23	17	There is no illustrative pathway with a focus on nuclear. Considering that time available to take action is too short, excessive reliance on technologies that are yet to be proven on a large scale can be catastrophic. Please think afresh and remove bias against nuclear.	Illustrative Pathway section rewritten, taking all comments on board	Ravi B Grover	Homi Bhabha National Institute	India
54863	23	2	23	2	What characteristics and what criteria were used to select the characteristics? Similar question on modeling frameworks.	Illustrative Pathway section rewritten, taking all comments on board	Government of United States of America	U.S. Department of State	United States of America
14941	23	3	23	15	The usefulness of illustrative pathways reduces with the number of them. Are these pathways at all indicative of the wider set they are 'illustrating'? Why are so many 1.5C pathways infused with residual fossil fuel CO2? Instead of a range of non-PA compatible pathways, it would be of particular importance to design target pathways consistent with the Paris agreement which are somehow indicative statistically across a range of core indicators.	Illustrative Pathway section rewritten, taking all comments on board	Government of Saint Kitts and Nevis	Department of Environment - Ministry of Agriculture, Marine Resources, Cooperatives, Environment and Human Settlements	Saint Kitts and Nevis

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
27607	23	3	23	15	It should be elaborated on whether scenarios based on the NDCs consider the submissions made until the end of December 2020.	Illustrative Pathway section rewritten, taking all comments on board	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
50627	23	3	23	15	From a cross-working group perspective, it would be interesting to know if any of the IPs comes "close" (in term of radiative forcing in 2100) to one of the "SSPx-y.y" used in CMIP6/ScenarioMIP and assessed in WGI (see WGI chapter 1, section 1.6)	Illustrative Pathway section rewritten, taking all comments on board	Anne Marie Treguier	CNRS	France
78105	23	3	23	17	There are major issues with the selection of illustrative pathways. First, the number of illustrative pathways is too extensive. Second, the key underlying assumptions as well as outcomes of the illustrative pathways need to be pointed out. Which of these pathways is in line with the Paris agreement? By attributing these to temperature targets, they seem in line with the Paris agreement - however, this masks the fact that they are not necessarily in line with Article 4. Please separate them clearly! Also, please clearly state which of this pathways meets both climate and development goals - only 1.5SP? If so, why?	Illustrative Pathway section rewritten, taking all comments on board	Charlotte Plinke	Climate Analytics	Germany
76037	23	5	23	5	What is meant by "similar mitigation effort" ? In terms of costs, cumulative CO2...?	Illustrative Pathway section rewritten, taking all comments on board	Jan Fuglestvedt	CICERO	Norway
63513	23	7	23	8	Table 3.1 identified categories C1 and C2 both as 50% chance of GW <1.5C by 2100. This text implies there is an IP with a 67% chance of achieving 1.5C. Flagging this potential inconsistency.	Illustrative Pathway section rewritten, taking all comments on board	Government of Canada	Environment and Climate Change Canada	Canada
61637	23	8	23	11	Two of the chosen illustrative pathways are mentioned to focus explicitly on renewable electricity and electrification (<2-REN and 1.5-Ren). Why is renewable energy (a problematic umbrella term in itself) lifted on their own platform with focus scenarios, while other low-carbon energy sources are not treated similarly? Especially nuclear energy, as it has many highly beneficial features such as reliability, dispatchability, the ability to produce high quality process heat for industry, low materials use and small land footprint compared to wind, solar, hydro and bioenergy, would more than deserve focus scenario of its own. This would be extremely valuable, as nuclear energy's problems are often political and reports like the AR6 has a big effect on what politicians see as feasible pathways forward. Further, for this reason, it would be irresponsible to leave out such a potent and promising technology as nuclear energy.	Illustrative Pathway section rewritten, taking all comments on board	Rauli Partanen	Think Atom	Finland
65677	23	8	23	11	The scenarios <2-REN and 1.5-Ren explore "enhanced development and rapid diffusion of renewables". What differences exactly does this impose a priori on the treatment of nuclear and renewables. Are there a priori assumed differences? If yes, then revise the scenario to have equal a priori assumption regarding "enhanced development and rapid diffusion". After all, the target is a low-carbon energy system, not one which dismisses one technology.	Illustrative Pathway section rewritten, taking all comments on board	Eero Hirvijoki	Aalto University	Finland
5231	23	11	23	11	after "renewable", add "and nuclear"	Illustrative Pathway section rewritten, taking all comments on board	Michel SIMON	Retraité/ Pdt d'association	France
50257	23	13	23	14	It is unclear at this point what characterizes a "shifting pathway", this should be briefly explained.	Illustrative Pathway section rewritten, taking all comments on board	Matthias Weitzel	European Commission, Joint Research Centre	Spain
15563	23	15	23	17	Figure 3.5: I think it would be a valuable information to know how many scenarios are embodied by each Illustrative Pathways so we can better interpretate the following Figure 3.6 on next page	Illustrative Pathway section rewritten, taking all comments on board	Lucas Desport	MINES ParisTech, Total	France
45823	23	15	23	16	Figure 3.5: seems to be similar to the Box 1.1 Fig. 1, but with different ordering of the scenarios and better text for the scenario features, at least for the SUP scenarios. Make sure only one version is used in all chapters. We also suggest to use self-explaining and consistent names for all scenarios.	Illustrative Pathway section rewritten, taking all comments on board	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
48185	23	15	23	16	It is suggested to establish a corresponding relationship between 11 specific temperature rise scenarios (such as < 2-REN, 1.5-REN, etc.) and "Illustrative Pathways" (IP1-IP11) and 7 groups of "temperature rise classification" (C1-C7) in Figure 3.5.	Illustrative Pathway section rewritten, taking all comments on board	Yang Wang	Beijing Climate Center	China

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54865	23	15	23	17	What is the y-axis in this figure?	Illustrative Pathway section rewritten, taking all comments on board	Government of United States of America	U.S. Department of State	United States of America
30665	23	16	24	4	It is not reasonable to include only one SSP1 scenario; it should focus only on SSP2 or include other SSP3, SSP4, and SSP5 scenarios. Also, with 11 scenarios in total, it becomes complicated and difficult to understand (Figure 3.6). It would be easier to communicate intuitively if the number of illustrative scenarios is limited to three or four.	Illustrative Pathway section rewritten, taking all comments on board	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
54867	23	16	23	16	Provide the warming level for each illustrative pathway.	Illustrative Pathway section rewritten, taking all comments on board	Government of United States of America	U.S. Department of State	United States of America
85945	23	16	23	17	Figure 3.5 would be greatly improved by the addition of numerical labels next to each of the warming level 'bars', as is done for Figure 1 in Box 1.1, Chapter 1, Page 22.	Illustrative Pathway section rewritten, taking all comments on board	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
23383	23		23		We suggest to put this Figure 3.5 in vertical, so as to ensure an immediate understanding of 3.6, which is not self-understandable	Illustrative Pathway section rewritten, taking all comments on board	Government of France	Ministère de la Transition écologique et solidaire	France
27605	23		23		Figure 3.5, the warming level should be specified (i.e. degrees C).	Illustrative Pathway section rewritten, taking all comments on board	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
79113	24	0	24	4	Fig 3.6 is visually excellent but needs an easy-to-read color legend to interpret.	Illustrative Pathway section rewritten, taking all comments on board	Amory B. Lovins	Rocky Mountain Institute; also Adjunct Professor of Environmental & Civil Engineering, Stanford University	United States of America
17575	24	1	24	1	Figure 3.6 is not readable. Please consider 2 panels (graphs) per row.	Illustrative Pathway section rewritten, taking all comments on board	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
48187	24	1	24	1	It is suggested to add tables or detailed descriptions in words to the 11 "Illustrative Pathways" in Figure 3.6, and add corresponding references ⁴ to indicate which model and group of scenarios each "Illustrative Pathways" comes from, which specific temperature rise scenarios corresponds to, and which "temperature rise category" (C1-C7) it belongs to.	Illustrative Pathway section rewritten, taking all comments on board	Yang Wang	Beijing Climate Center	China
52001	24	1	24		The graph font is unreadable.	Illustrative Pathway section rewritten, taking all comments on board	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
63515	24	1	24	1	Figure 3.6: This Figure will be a key reference figure for appreciating differences across the 11 Illustrative pathways. Can the positive emissions from LUC sector be shown on these (in the time period up to when they switch to negative emissions)? (As was done in Figure SPM3.b in the SR1.5 SPM).	Illustrative Pathway section rewritten, taking all comments on board	Government of Canada	Environment and Climate Change Canada	Canada
65403	24	1	24	2	Please include clear titles on the graphs. The writing is too small, making the figures very hard to follow.	Illustrative Pathway section rewritten, taking all comments on board	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
78107	24	1			While this figure clearly shows that not of all these pathways reach net zero, this still needs to be pointed out more clearly. Displaying the NBZ pathways along with other pathways should not be retained if it is not clearly displayed how these are not in line with Article 4. Also, the reader may wonder why historical emission patterns are not consistent across pathways - please revise.	Illustrative Pathway section rewritten, taking all comments on board	Charlotte Plinke	Climate Analytics	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
14943	24	2			The NBZ pathway category is highly problematic as is and has to be reassessed by the authors. How can a pathway that builds on huge amounts of negative emissions to offset more than 10Gt CO ₂ eq of remaining fossil CO ₂ emissions and never reaches net zero in the 21st century be presented alongside actual 1.5°/2°C pathways without a qualifier that this pathway group is not compatible with the Paris agreement? While there is value in discussing these pathway options, they have to be clearly separated from pathways that would actually be able to meet the PA.	Illustrative Pathway section rewritten, taking all comments on board	Government of Saint Kitts and Nevis	Department of Environment - Ministry of Agriculture, Marine Resources, Cooperatives, Environment and Human Settlements	Saint Kitts and Nevis
78355	24	6	40	0	I found the structure and messaging of this very important Section 3.3 quite confusing. I think it needs a clearer storyline to pick through the warming levels and the IPs. The potential power of the IPs is not fully exploited. They were presumably chosen for a reason and to convey a message. What are these messages?	We will have a look at the structure and the integration of the IPs	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
54869	24	8	24	11	Could cut this section as it is repetitive.	Done	Government of United States of America	U.S. Department of State	United States of America
54871	24	12	27	12	This section is a review reporting that author X said aa and author Y said bb. Synthesize the evidence into a short summary.	We have looked at the text; improved it somewhat - but also feel it is ok - given the word constraint	Government of United States of America	U.S. Department of State	United States of America
60765	24	13	24	13	We know from Einstein that production of energy is not possible. But we can transform energy.	Done	Manfred Treber	Germanwatch	Germany
71295	24	13	24	14	Add aquatic dimension (e.g. land and water use (change)).	Compared to other sources relatively small. Did not change	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
1805	24	29	24	31	Good idea!	Txs	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
237	25	2	25	5	Compared to which other models are IAM "ideal" and "most suited"? How can you make such a statement without discussing the pros and cons of different model types?	Section 3.2. Sentence has been changed to avoid this issue.	Kai Kuhnhehn	Konzeptwerk Neue Ökonomie	Germany
239	25	2	25	5	If economic growth is such an important determinant of emissions, why is it not discussed in detail, i.e. what are its benefits, how can they be achieved without economic growth? What policies would be needed to reduce economic activity without social hardships.	More useful if discussed in Chapter 1	Kai Kuhnhehn	Konzeptwerk Neue Ökonomie	Germany
1809	25	2	25	3	It should also be mentioned, that there are few 1.5C scenarios with no or low overshoot.	Not sure why this is mentioned here	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
54873	25	10	25	10	A comprehensive assessment reflects the range of views in the literature. Provide the justification for only assessing the reference scenarios.	Done	Government of United States of America	U.S. Department of State	United States of America
54875	25	13	25	14	This sentence repeats one on page 19, line 1. Delete one of the instances.	Did not find it - but most likely indirectly dealt with via other edits	Government of United States of America	U.S. Department of State	United States of America
76039	25	13	25	13	Language can be improved (2 x still)	Done	Jan Fuglestedt	CICERO	Norway
66843	25	14	25	14	relatively	Corrected	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
20179	25	24	25	25	Something's not right in this sentence ('expect are')	Corrected	Nikas Alexandros	National Technical University of Athens	Greece
54877	25	24	25	24	Replace "are" with "a"	Corrected	Government of United States of America	U.S. Department of State	United States of America
65405	25	24	25	24	"SSPs expect a (not are) faster drop in fertility"	Corrected	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
75067	25	28	26	2	There needs to be a discussion here about the extent to which the scenarios take into account how growing climate change impacts might affect economic growth. In some cases, models wrongly assume no impacts of climate change on growth. See Stern and Stiglitz (in review). The economics of immense risk, urgent action and radical change: towards new approaches to the economics of climate change. Journal of Economic Methodology.	Texted added as well as reference to 3.5	Robert Ward	London School of Economics and Political Science	United Kingdom (of Great Britain and Northern Ireland)
17577	25	29	25	29	Covid GDP drop (5%) requires a reference, e.g. https://www.imf.org/en/Publications/WEO/Issues/2020/06/24/WEOUpdateJune2020	Comment added	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
50259	25	29	25	29	Can "in the last decades" be expressed more precisely?	Yes done.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
75065	25	29	25	32	The potential impacts of the COVID-19 pandemic on future growth rates of economic growth are grossly understated. While it is possible that they will revert to the trend, it is also possible that the pandemic will continue for many years due to the emergence of new variants, and that growth will continue to be weakly positive or negative. In addition, the long-term economic impacts of the pandemic in 2020-21 might have long-term consequences for economies through markedly higher debt leading to reductions in investment levels and sluggish growth.	Reference added to the Covid box. Current text simply says something on expected LT growth by leading organisations.	Robert Ward	London School of Economics and Political Science	United Kingdom (of Great Britain and Northern Ireland)
54879	25	38	25	38	Many would argue that equity issues are more important. Regardless, if they are at least as important, perhaps this topic should be moved earlier in the section or at least to the beginning of this paragraph.	As emission driver, income is more important - and we only have a limited amount of words. See no option to change this much.	Government of United States of America	U.S. Department of State	United States of America
241	25	41	25	46	If economic growth is such an important driver and than the fact that degrowth literature is not represented in the SSPs is a major blind spot. This blind spot should be discussed and pointed out much more vigorously.	Not necessarily. Depends on how relevant this option is for decision-making and the size of the literature. Will check with Chapter 1 if they do more.	Kai Kuhnnehn	Konzeptwerk Neue Ökonomie	Germany
65407	25	42	25	44	Can you include a short justification to why the degrowth literature is not represented in the SSPs? I.e. not enough available data? No through scenarios?	It an emerging issue and IAMs have mostly taken a different take on this focusing not so much on reduction of activities as measured in monetary indicators, but focusing on reducing physical flows (e.g. low energy demand; demand-side changes). We made sure to indicate this better in the text.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
65531	25	46	25	47	The parenthesis inside the parenthesis are not needed in the reference "(e.g. Grubler et al. ..."	Txs, Result of my reference manager. Will be corrected at a much later stage.	Cristian Chadwick	University of Chile	Chile
1807	25				C3: This is the only place where it becomes clear what is meant by "well below". It is debatable whether below 2C with 67% likelihood qualifies as well below and it seems a weakness to suggest this.	We removed references to well below	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
62045	26	1	26	1	Figure 3.7: Perhaps include historical trend in these figures, or mention in the legend that the historical trends match well with UN, OECD and IEA scenarios. A brief explanation why the SSP projections differ with the historical trends would be welcome.	Done	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
81195	26	3			Figure 3.7: population: the panel suggests that there is a significant bias in population assumptions in IAM scenarios. Given that population is an important element in emission projections, I feel this needs a proper discussion in the text to clarify whether and to what extent this matters. The same goes, in the opposite direction, for GDP growth. Those two might well cancel each other out but this deserves a proper assessment which I cannot find right now in the text.	There already was text. Let me know if that wasn't insufficient. But also realize that the word bias is wrong. There is no reason to assume that UN is better	Andy Reisinger	Ministry for the Environment	New Zealand
82517	26	7	26	8	The report was talking about IEA's World Energy Outlook 2020 in the previous pages, but the figure 3.7 is referring the 2019 version. It will be better to update the data to 2020 version and use the latest data in the entire chapter.	Will do.	Jinsun Lim	International Energy Agency	France
49	26	12	27	1	"In the literature, several researchers discuss the possibility of decoupling material and energy demand from economic growth, mostly in developed countries (Kemp-Benedict, 2018)". Comment: The word 'decoupling' should be defined / clarified. By this is mean to define the difference between absolute and relative decoupling. This is a key distinction in the literature, for example see Heun et al. 2018 who state "The simultaneous increase of GDP and decrease of primary energy consumption is called "absolute decoupling" [5]. "Relative decoupling" occurs when total primary energy consumption grows, but less quickly than GDP." Reference: Heun MK, Brockway PE. Meeting 2030 primary energy and economic growth goals: Mission impossible? Appl Energy. 2019 Oct;251:112697.	Agree	Paul Brockway	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
54881	26	12	26	13	The chapter would benefit from an expansion of this section and more citations. Suggest looking into work done by Raworth.	Will do - but also check with the lifestyle chapter	Government of United States of America	U.S. Department of State	United States of America
51	27	1	27	3	"In the scenario literature this is reflected by scenarios with a very low demand for final energy based on increased energy efficiency and/or less energy-intensive lifestyles (e.g. SSP1 and the LED scenario) (Grubler et al. 2018; van Vuuren et al. 2018)". Comment: This should be clarified that the increased effect of energy efficiency is outwith the historical record, where Energy-GDP have remained tightly relatively coupled: from 1971 GDP has grown at 4.0%/year, final energy has grown at 2.1%/year. ref Heun et al paper referenced in comment above). The systematic review on decoupling completed by Haberl et al 2020 also demonstrates the historical record of relative decoupling, not absolute decoupling. (Haberl H, Wiedenhofer D, Virág D, Kalt G, Plank B, et al. A systematic review of the evidence on decoupling of GDP, resource use and GHG emissions, part II: Synthesizing the insights. Vol. 15, Environmental Research Letters. Institute of Physics Publishing; 2020.)	Please note that anything related to mitigation scenarios will be at odds with history	Paul Brockway	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
83147	27	7	27	28	I'm not sure how "vast majority" is meant or will be read, but section 3.4. gives the impression it can't be more than a handful, and those might even be CO2 only scenarios. If so, I'd suggest a stronger wording here	Changed	Geden Oliver	German Institute for International and Security Affairs	Germany
65413	27	13	29	15	Could you please in this section make clearer links to the temperature estimates and outcomes in WG1? I understand that WG1 bases its outcomes on complex climate simulations (CMIP6 results) and asses only five SSPs (WG1, Chapter 4, page 26, line 3). But even the use of a different baseline temperature for reporting results (WG1 uses 1995-2014 to report results), while in WG3 you refer to the 2 and 1.5 targets (assuming from pre-industrial levels), can be confusing to a lay audience. WG3 explains well its choices and methods - i.e. reduced complexity model calibrated to WG1 - but to a lay/policy audience a more explicit discussion of how the WGs differ, and an expert view on how to judge temperature outcomes, would be incredibly helpful.	This is now handled in a dedicated box as well as in Annex C.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
60767	27	19	27	22	The sentence " In fact, for scenarios in the category that avoid temperature overshoot for the 1.5oC scenario, GHG emissions are reduced already to almost zero by 2050. Typically, CO2 emissions reach net zero about 20 years before total GHG emissions reach net zero." should be included in the SPM	It is - and text has been made consistent	Manfred Treber	Germanwatch	Germany
65409	27	19	27	21	Are you talking about ONLY scenarios that avoid temperature overshoot? Or are you referring to the classification "C1" per the table and Figure 3.8. In which it says no/or low overshoot?	Corrected	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
23385	27	21	27	22	"CO2 emissions reach net zero about 20 years ..." and in page 4 the range is "5-25 years". Although not contradictory, this sentence seems to be much more precise. We suggest the same figure should appear page 4 (possibly with the range added after)	Done	Government of France	Ministère de la Transition écologique et solidaire	France
76041	27	21	27	21	It would be useful if you somewhere explain why there is this difference in timing, and what it is sensitive to.	Added	Jan Fuglestedt	CICERO	Norway
37619	27	22	27	23	Is it desirable to consider scenarios having net CDR?	There is discussion on this already further in the section	Ravi B Grover	Homi Bhabha National Institute	India
9077	27	23			What does 'net CDR' mean? Net-negative emissions?	Rephrased	Xunzhang Pan	China University of Petroleum, Beijing	China

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54883	27	27	27	32	Suggest clarification that, on line 28, estimates indicate RESPONSES to the COVID-19 pandemic reduced CO2 emissions. It would also help to provide the baseline from which they were reduced. From the previous year? From expected 2020 emissions levels? The authors may have also meant working far from home, not living far from home. Many more studies are coming out on this subject every day, so this may be a place to allow some new citations.	Updated	Government of United States of America	U.S. Department of State	United States of America
71297	27	27	27	39	Some of the text in this box could already be updated if cutoff dates permit. This includes the final estimate of the drop in CO2 emissions in 2020 due to COVID-19 (slightly lower than the 7% mentioned) and references to studies of the recovery packages + longer term trends. The UNEP Emissions Gap Report 2020 could e.g. be referenced.	Update	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
75069	27	27	27	39	This box grossly understates the potential impact of the COVID-19 pandemic, which may continue for many more years if new variants emerge that are resistant to current vaccines. In addition, the impact of the pandemic in 202-21, which has resulted in high levels of public debt, may undermine investments in the transition to low-carbon economies, fundamentally affecting emissions pathways in the coming decades. Hence the IAM outputs that form the basis for this assessment may quickly prove to be irrelevant.	Updated	Robert Ward	London School of Economics and Political Science	United Kingdom (of Great Britain and Northern Ireland)
79115	27	27	27	39	Overlooked in Box 3.2 is the important discussion of whether, as documented in doi:10.1088/1748-9326/abc3f2, the pandemic fundamentally altered the evolution of the global energy system by crushing 2020 demand while renewables and EVs kept accelerating so they now meet and can continue to meet all demand growth, condemning fossil fuels and CO2 to permanent decline, i.e. shifting fossil fuel and CO2 peaks back to 2019 as many respected analysts now believe. We don't yet know for sure whether that's true, but its possibility is vital to note, especially since it accelerates self-reinforcing capital flight (id.).	I would not attribute all of that to Covid - but clearly we can see signs of new dynamics. In general this is acknowledged at several places in the chapter. We have also rephrased text in the Covid box.	Amory B. Lovins	Rocky Mountain Institute; also Adjunct Professor of Environmental & Civil Engineering, Stanford University	United States of America
52003	27	29	27	30	"working from home, but maybe also living further from home" Should be, "working from home, but maybe also living further from work"	Thanks	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
15745	27	30	27	30	"but maybe also living further away from home" what does this mean?	Thanks	Sara Budinis	International Energy Agency	France
16919	27	30	27	30	¿living further away from "home" or from "workplace"?	Thanks	Government of Spain	Area de Estrategias de Adaptacion - Oficina de Cambio Climatico - Ministerio de la Transicion Ecologica	Spain
54885	27	30	27	30	Assume authors mean living farther away from "work", not living farther away from "home".	Thanks	Government of United States of America	U.S. Department of State	United States of America
71299	27	30	27	30	Presumably the authors mean "living further away from work", not "living further away from home".	Thanks	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
76043	27	30	27	39	"... but maybe also living further away from home" is unclear to me	Thanks	Jan Fuglestedt	CICERO	Norway
83149	27	34	27	36	Does DACCS not partly substitute BECCS or afforestation when included in scenarios? Here it sounds as if its inclusion simply allows for more residual emissions	Rephrased	Geden Oliver	German Institute for International and Security Affairs	Germany
76045	27	38	27	39	Please add pointers to where covid 19 is discussed; e.g. box in ch1. It would also be very good if you add pointers to WGII and WGI (i.e. box in WGI Ch6).	Done	Jan Fuglestedt	CICERO	Norway
17579	27	39	27	39	Could you please specify "elsewhere"? With regards to detailed discussion of Covid recovery policies.	Done	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
23387	27	39	27	39	In the sentence "the impacts of the covid... elsewhere in the report", a precision about the section(s) in the report would be needed	Done	Government of France	Ministère de la Transition écologique et solidaire	France
50261	28	1			This figure is very busy, especially at low levels with overlapping ranges and Ips. Maybe ranges in 2100 (and/or 2050) can be made more explicit by adding a right panel as in Fig. 3.9?	There are now less IPs	Matthias Weitzel	European Commission, Joint Research Centre	Spain

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54887	28	1	28	4	For Figure 3.8, is IPCC still using "Kyoto Gases" as a universal term? Suggest instead "all six major GHGs".	Has been done	Government of United States of America	U.S. Department of State	United States of America
62047	28	1	28	5	Figure 3.8: An explanation for the difference between the full and reported range would be welcome. Which criteria is used for the filtering?	See description in 3.2 and Annex C	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands
62049	28	1	28	5	Figure 3.8: There is still a wide range in 2000 and 2010 and 2015 emissions, which go beyond the presented uncertainty ranges in earlier Chapter of the IPCC. Would it be further filter out the scenarios, based on two criteria: (i) emissions should not go beyond the uncertainty range of the historical emissions, as presented in the earlier IPCC Chapters. (2) filter out emissions pathways that do not show an increase in global emissions for the period 2010-2020. Pathways that reduce their emissions already before 2020 are unrealistic (for pre-COVID studies). This filtering would reduce the uncertainty ranges of the 2030 emissions as presented in the summary, and would lead to more robust estimates. This approach is adopted in the UNEP Emissions Gap report, and leads to more realistic 2030 and 2050 global emissions goals.	This is done actually. You are referring to the full range which is deliberately added just to show the full literature and therefore there is no filtering.	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands
62051	28	1	28	5	Figure 3.8: SSP1-19 pathways seems to show global emissions already declining between 2010-2020, and seems to go beyond the presented range.	SSP1-1.9 was created some years ago. But it is an official scenario	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands
62053	28	1	28	5	Figure 3.8: Please indicate which GWPs are used?	Text was added	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands
78109	28	1			Thank you for this figure, very useful. Also clearly shows that even with only 7 IPs, they cannot be clearly distinguished. Please make sure that the number of illustrative pathways is reduced to those actually "illustrative" across a range of indicators.	We reduced them.	Charlotte Plinke	Climate Analytics	Germany
66857	28	2	28	2	Suggest harmonization of scenario categorization colours across WG3 or at least this chapter (see comment on fig. 3.16). There are also SSP scenario colours used across WG1.	We will harmonise the colours. This was already done for the C categories.	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
54889	28	3	28	3	Figure 3.8 needs units on the y-axis.	Done	Government of United States of America	U.S. Department of State	United States of America
17583	28	6	28	18	Box 3.3 on RCP8.5 merits more detailed discussion given the attention RCP8.5 attracted in the literature and in social media. Example papers could be: https://www.nature.com/articles/d41586-020-00177-3 https://www.nature.com/articles/s41560-020-0555-3 https://link.springer.com/article/10.1007/s10584-019-02500-y https://iopscience.iop.org/article/10.1088/1748-9326/aab53e/meta https://www.journals.uchicago.edu/doi/10.1086/698910?mobileUi=0& https://www.nature.com/articles/s41558-018-0293-8 https://iopscience.iop.org/article/10.1088/1748-9326/aaa494 https://www.sciencedirect.com/science/article/pii/S1674927818300376?utm_source=TrendMD&utm_medium=cpc&utm_campaign=Advances_in_Climate_Change_Research_TrendMD_1 https://www.pnas.org/content/116/3/759 https://iopscience.iop.org/article/10.1088/1748-9326/abcc29	Some references added- but many are broadening the topic too much.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
23391	28	6	28	6	We recommend that the title of box 3.3. should precise 'the likelihood of high-end emission scenario has decreased since AR5'	Agree with the content, but it is a style choice whether titles have messages.	Government of France	Ministère de la Transition écologique et solidaire	France
76049	28	6	28	18	It is useful that you have a box on this. But I think this issue deserves some more reflections. The last sentence on changes in sources and possibility of high sensitivity. I suggest you elaborate a bit more on this. Please have a look at what is written about these aspects in WGI Ch1.	We added references	Jan Fuglestedt	CICERO	Norway
78111	28	6	28	18	Very useful, deserves even to be a cross-working group box. Placement would be even more suitable in other places of AR6 than here.	We added references	Charlotte Plinke	Climate Analytics	Germany
81193	28	6	28	18	This box is very useful, but perhaps one or two sentences too brief. It should include a specific cross-reference to WGI to substantiate the statement that RCP85-type climate outcomes can also be reached with lower emissions but high climate sensitivity and feedbacks. Also in line 17, it's not just feedbacks on natural emission sources, feedbacks can also amplify warming from anthropogenic sources. In line 18, clarify or expand that while high-end emission scenarios have become (significantly) less likely, high-end climate change scenarios (about 4 degrees) are well within the range of outcomes from baseline scenarios and even at the upper end of category C6.	Thanks	Andy Reisinger	Ministry for the Environment	New Zealand

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54891	28	7	28	18	Wording in this text box is inaccurate or could convey inaccuracies to non-technical readers. Suggest replacing "indicate" on line 8 with "represent". On line 9, do not use the term "baseline". Suggest replacing with "high emissions scenarios". On line 16, the word "emerge" may be confusing to non-technical readers; suggest replacing with "could also occur".	Thanks	Government of United States of America	U.S. Department of State	United States of America
66845	28	9	28	9	Could say that RCP6 and RCP4.5 are more appropriately weak- and moderate-ambition mitigation scenarios than baselines - they do include some climate policy unlike RCP8.5	Have added a similar conclusion now	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
76047	28	13	28	13	"as" is missing after "such"	Thanks	Jan Fuglestedt	CICERO	Norway
43371	28	15	28	15	The term "relatively high" does not describe the scenario in the most promising way.	Removed relatively.	BEATRIZ BECCARI BARRETO	Politecnico di Milano	Brazil
63517	28	15	28	18	This statement seems to contradict what WGI communicated about the higher climate sensitivity of the CMIP6 generation of climate models. While it may be more straightforward to conclude that higher emission scenarios are now less likely given policy developments; is the 'less likely' assessment of strong climate feedbacks and high climate sensitivity equally robust? Does this need a cross-reference to WGI?	We discuss the consistency in detail in Annex C	Government of Canada	Environment and Climate Change Canada	Canada
50629	28	16	28	18	There are a few references on this issue of RCP8.5 and uncertainty in carbon feedbacks in WGI, chapter 1, section 1.6.1.4 that could be cited here.	We referred here to direct literature referenes	Anne Marie Treguier	CNRS	France
83589	28	18	28	18	Maybe include: "and their median climate projections might also materialize when following a lower emissions path"?	Thanks	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
65411	28	21	28	22	Could you make a more detailed reference to where you can find an explanation in WG1?	Done	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
76051	28	23	29	1	"and further increase will happen after 2100": Please check. From figure, C7 and C6 are still increasing, while the other are flat or decreasing. I think you need to add more nuances here; especially it depends on what the emissions will be after 2100.	Changed	Jan Fuglestedt	CICERO	Norway
25047	28	24	28	32	CSI activities have been transferred to the GCCA, we suggest replace CSI by GCCA. Moreover GCCA represent now 40% of world capacity	Unfortunately, I don't understand the comment	Claude Lorea	GCCA	Belgium
23389	28		28		It seems it is table 3.2 and not 3.3	Corrected	Government of France	Ministère de la Transition écologique et solidaire	France
27609	28		28		Figure 3.8, please specify unit of data presented in the vertical axis (i.e. for emissions).	Done	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
76059	29	1	29	15	It would also be useful if you explain that the starting point in terms of warming level is based on the assessed present warming from WGI.	Added	Jan Fuglestedt	CICERO	Norway
76053	29	3	29	3	I think you could add "<0.1)" after "small overshoot".	Added	Jan Fuglestedt	CICERO	Norway
76055	29	3	29	3	From table 3.1 it is not clear that the max overshoot in C2 is 0.2, as given in the text here.	Corrected	Jan Fuglestedt	CICERO	Norway
63521	29	8	29	9	this line says the bars to the right of the graph in Figure 3.9 portray the full uncertainty range, but then this is defined as this 17th to 83th range. Unclear. Figure caption describes these bars as portraying the 5th-95th percentiles.	Corrected	Government of Canada	Environment and Climate Change Canada	Canada
85303	29	8	29	20	These full scenario ranges (including maximum warmings associated with different scenario types) should also be included in the SPM when presenting the scenario categories.	Noted.	Kaisa Kosonen	Greenpeace	Finland
63519	29	10	29	10	"small climate model" = emulator? Or simplified climate model?	Changed to reduced complexity	Government of Canada	Environment and Climate Change Canada	Canada
76057	29	11	29	11	"not covered by all models": Which type of models are you thinking of here?	Noted.	Jan Fuglestedt	CICERO	Norway
1811	29	12	29	14	Seems to contradict page 25 line 16-17	Not sure what is meant	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
81191	29	16			Figure 3.9: the figure caption should make clear that the probability range is for the 'ensemble of opportunity' of scenarios in the WGIII database - right? i.e. it is not an assessment of probability of outcomes in the real world. It should be close, but it is conceptually not the same. And please use the same percentile range here as in Table 3.2 - either 5-95%, or 10-90%. Having different percentiles in different places seems needlessly confusing.	Thanks	Andy Reisinger	Ministry for the Environment	New Zealand

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
83591	29	16	29	19	full scenario range seems offset relative to scenario categories (see historical period).	Thanks.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
62055	29	17	29	19	Figure 3.8: What is the impact of the harmonisation on the temperature increase projections? The pathways presented in Figure 3.8 show a range in historical emissions, whereas Figure 3.9 is based on harmonisation.	Noted.	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands
63523	29	17	29	19	Please clarify what the bolded lines and shaded areas are in the left hand panel. Presumably the bolded lines are the 50th percentile lines for each scenario category. What range is represented by the shaded areas?	Added	Government of Canada	Environment and Climate Change Canada	Canada
71301	29	18	29	18	Why does the figure show the scenarios for 50% probability when most of the text refers to 67% for the 2C scenarios	Good question. The 67th percentile is often used as interpretation of a serious effort to reach a goal. It is however a bit odd to show 67th percentile outcomes. We have now added these to the bars.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
63525	29	21	29	21	Would it be possible to add to this section on non-CO2 GHGs an illustration of how methane and N2O and possibly BC emissions change in the C1-C3 pathways. Figure 3.10 shows end of century emissions only. In the text (page 30, lines 14-15), there is a statement that emissions for methane and N2O decline by about 50% across many scenarios, but not further than this due to technological and/cost constraints. This would be useful to see as a time series.	Noted.	Government of Canada	Environment and Climate Change Canada	Canada
64269	29	21	31	12	Short-lived climate pollutants, in particular methane, can indeed play a substantial role for short-term climate change and should be considered as one of the most accessible and cost-effective options to increase our carbon budget before 2050. In that context, the potential of satellites to monitor the evolution of methane emissions and improve the accuracy of estimates should be emphasized. The IEA, the world reference for energy related statistics, updated its Methane Tracker in January 2021, incorporating data on large-scale methane leaks detected by satellite (https://www.iea.org/reports/methane-tracker-2021). The European Commission is also considering integrating satellite data in its upcoming methane legislation and in the work of the future International Methane Emissions Observatory (https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12581-Proposal-for-a-legislative-act-on-methane-leakage-in-the-energy-sector). The taskforce on national greenhouse gas inventories already mentioned the potential for satellite technologies in their 2019 Refinement of 2006 Guidelines (see in particular section 6.10.2 in Volume 1, chapter 6: https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/1_Volume1/19R_V1_Ch06_QA_QC.pdf), highlighting the role satellites can play for verification by providing fully independent data.	Do not think this is the right place given limited word space	Christian Lelong	Kayrros	United Kingdom (of Great Britain and Northern Ireland)
81183	29	21			Section 3.3.2.2: I would consider it extremely useful to have an overview table of emission characteristics of IPs, similar to the table contained in the SPM of SR15 Figure 3b. This provides a much more easily accessible way of extracting reduction rates than e.g. Figure 3.10 can provide. Within the chapter it would be well worthwhile using a full page on this (or several pages in the appendix, but with a clear reference to its existence here). Such a table would be a good place to provide both 10-90 percentile as well as interquartile ranges.	This is done in 3.2	Andy Reisinger	Ministry for the Environment	New Zealand
71303	29				The scenarios C1-C7 are not explained in table 3.3, but in table 3.1. Same goes for other figures, where table 3.3 is referred to.	Corrected	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
83173	30	1	30	1	please use "carbon dioxide removal is introduced", to distinguish between net negative emissions and gross CDR	Sentence not found	Geden Oliver	German Institute for International and Security Affairs	Germany
76061	30	4	30	10	I understand that the main point of fig 3.10a is to show magnitude of emissions in 2100. I wonder if it is worth trying to show these emissions as normalized to the current emission (or for start year).	I think the absolute emissions is better.	Jan Fuglestedt	CICERO	Norway
83175	30	4	30	6	Panel b: would it be possible in include a line indicating net emissions?	We are also showing the difference between net and gross emissions later	Geden Oliver	German Institute for International and Security Affairs	Germany
83177	30	4	30	6	Panel b: it his really CO2 only - and if so, why not GHG? Why energy positive/negative? This is not the only sector beyond AFOLU and would need to be explained	Not all GHGs because it is cumulative;	Geden Oliver	German Institute for International and Security Affairs	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
83189	30	4	30	6	Panel b: what do the pos/neg AFOLU values represent? Gross values throughout the period, or simply cumulated annual balances (with positive values for some years and negative values for some more)? If the latter, this should probably be mentioned somewhere	Cumulated annual balances. Added to the caption.	Geden Oliver	German Institute for International and Security Affairs	Germany
76063	30	7	30	7	Fig 3.10b: The caption says "Cumulative CO2 emissions". For clarity you can say over which time spane.	Added	Jan Fuglestvedt	CICERO	Norway
1813	30	9	30	10	Please reconsider the wording. The figure seems to show that low end scenarios require higher net negative to stay within temperature limits and limit overshoot. However, the sentence seems to have broader implications and doesn't really illustrate the tradeoff between near term action and the rest	Reworded a bit	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
65415	30	14	30	14	Could you list some examples of "technical reductions measures". I.e. stopping methane gas leaks from oil and gas, remove deliberate flaring, cover tropical mega-city landfills with soil, reduction in industrial cattle farming, reduction in biomass burning (etc.)	Done	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
75129	30	19	30	26	This sections seems to adopt the perspective that short-lived climate forcers consist only components with warming impact on climate (i.e. similarly to the use of the term SLCFs in some literature), and neglects to recognize cooling components. For instance, line 20 says "i.e. methane and black carbon", while it should rather be "e.g. methane and black carbon" in my opinion (in any case, as there are other heating SLCF like ozone as well). I feel that at the minimum a sentence acknowledging co-emissions of this other group of SLCFs is needed. Similarly to BC, the exact role of reductions in cooling aerosols is still discussed in the literature, and depends on uncertainty in the radiative forcing and in recent trends in SO2 emissions, as well as on the type of scenario and emission perturbation considered. Examples of the latter include Shindell and Smith 2019 (doi:10.1038/s41586-019-1554-z) and Samset et al. 2018 https://doi.org/10.1002/2017GL076079 . However, even if cooling components are not strong enough to cause a spike in global warming in realistic scenarios as estimated by Shindell and Smith, their impact can be such that the benefit from mitigation measures in certain sectors can be substantially lower than if only heating SLCFs and GHGs are considered (e.g. Lund et al. 2020 https://doi.org/10.5194/esd-11-977-2020). Another argument to more broadly cover SLCFs is that sulfate aerosols are much more abundant than BC and cleaning up the air for air quality purposes inevitably implies reducing also these cooling aerosols.	Text was added	Marianne Tronstad Lund	CICERO Center for International Climate Research	Norway
75131	30	19	30	21	I'm a bit puzzled that such a strong statement is only supported by one reference which is no longer exactly new. Perhaps more of the substantial bulk of literature on this topic could be considered, including perspectives on the role of SLCFs for e.g. peak warming and the role of timing of the emission reductions? Should this section also mention rate of climate change?	Added new text	Marianne Tronstad Lund	CICERO Center for International Climate Research	Norway
65417	30	20	30	26	Could you reference this discussion to WG1 Chapter 6 for further review on SLCF?	Added	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
86213	30	20	30	21	BC has been found (WG1 Chapter 6 section 6.4.2) to have a lower than thought effect, I suggest to rephrase "can be" by "have been thought to be".	Added	Sophie Szopa	LSCE	France
65501	30	21	30	26	The remaining carbon budget of 310 (390,500) GtCO2 needs clearer definition. Is this carbon budget from 2020? Fo readers ease could you directly reference this to WG1, Chapter 5?	Cannot find text	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
65057	30	22	30	26	Smith et al. 2020c is not cited accurately. The sentence starting with "In the literature" is proposed to change to: "In the literature, there has been an active discussion on the exact climate contribution of SLCF focused policies – mostly based on assumptions on possible reductions and the continuing uncertainty in the radiative forcing and impact of black carbon on global warming" (Rogelj et al. 2014; Smith et al. 2020c).	Text was rewritten	Valentin Foltescu	Climate and Clean Air Coalition Secretariat, UNEP	India
86215	30	22	30	26	This aspect are discussed in WG1 chapter 6, section 6.6.3, please consider to add a reference. (It's consistent anyway regarding the less that thought importance of BC). However CH4 reduction still appears very relevant both for climate and air pollution, could be good to mention it here.	Reference added	Sophie Szopa	LSCE	France
75133	30	26	30	26	More relevant literature for the weak temperature response to BC seen in recent studies: Takemura and Suzuki 2019 (https://doi.org/10.1038/s41598-019-41181-6) and Stjern et al. 2017 (https://doi.org/10.1002/2017JD027326)	Thanks	Marianne Tronstad Lund	CICERO Center for International Climate Research	Norway
76065	30	27	30	27	You may add "emission" before "metric"	Added	Jan Fuglestvedt	CICERO	Norway
71305	30				The scenarios C1-C7 are not explained in table 3.3, but in table 3.1.	Corrected	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
78357	31	1	31	5	Any chance of mentioning global damage potential which has an economic logic and is cited in Chapter 2	Added	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
83179	31	1	31	1	It's not the policies but the accounting (which might influence the actual policymaking, or not). Better to refer to the Paris rulebook decision on use of GWP100 (see glossary on metrics or the metrics box in ch2)	Added	Geden Oliver	German Institute for International and Security Affairs	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
1815	31	3	31	6	Worth mentioning the carbon budgets for 2 and 1.5 degrees as well and if possible be more specific than "typically around 20 years later"	Text on 20 years changed.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
76067	31	4	31	4	Please add "change" after "temperature"; i.e., Global Temperature Change Potential	Added	Jan Fuglestedt	CICERO	Norway
29841	31	5	31	12	Text is missing from the paragraph, and it is not stated for which metric reduction of SLCFs are highly valuable. Please consider to explain better why you say that mitigating CH4 in the near term has little value by applying GTP. What is this in contrast to and what time frame are you assuming?	We changed the text somewhat. More detailed considerations are found in the cross-chapter box on metrics	Government of Norway	Norwegian Environment Agency	Norway
65535	31	5	31	5	There is one parenthesis that is not needed (different number of parenthesis being opened and closed).	Corrected	Cristian Chadwick	University of Chile	Chile
81185	31	5	31	7	This sentence needs re-phrasing - the value for the climate of reducing short-lived gases is always the same (it's a function of physics only), the metric only changes the apparent value of such reductions from an emissions pricing or trading perspective. But the physical properties and hence the consequences for the climate of emission reductions are unchanged.	Added	Andy Reisinger	Ministry for the Environment	New Zealand
5011	31	7	31	8	The sentence looks weird. The authors write "Clearly, the timing of reductions across different gases does not only have consequences for climate consequences but also the co-". Do the author mean co-consequences? If yes, I would suggest to add consequences or whatever the author mean	Corrected	Tiziana Susca	Italian National Agency for New Technologies, Energy and Sustainable Economic Development	Italy
23393	31	7	31	8	The sentence 'Clearly, the timing... but also the co-' is not complete.	Corrected	Government of France	Ministère de la Transition écologique et solidaire	France
27611	31	7	31	9	Sentence is incomplete.	Corrected	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
63529	31	7	31	8	There is an incomplete sentence, which makes it very difficult to follow what the paragraph is communicating.	Corrected	Government of Canada	Environment and Climate Change Canada	Canada
1817	31	8			It is confusing that the scale only goes to 2.6 while the text says 3 degrees or less	Corrected	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
10547	31	8	31	8	"but also the co-"	Corrected	Philippe Waldteufel	CNRS	France
17581	31	8	31	8	co-"benefit"?	Corrected	Alaa Al Khourdjie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
52023	31	8			"Co-" missing the rest of sentence	Corrected	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
65419	31	8	31	8	co- (what?). Missing word.	Corrected	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
71307	31	8	31	8	Incomplete sentence ("co-")	Corrected	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
76069	31	8	31	8	Something wrong with language here	Corrected	Jan Fuglestedt	CICERO	Norway
76071	31	9	31	9	Is this addressed in chapter 1? Please check	Corrected	Jan Fuglestedt	CICERO	Norway
81187	31	9	31	11	It would be useful to expand on this to clarify how much emission pathways differ under different metrics. There are some misconceptions that emission pathways would look fundamentally different if we adopted e.g. GTP100, but most studies have shown that under stringent (well below 2 degree and 1.5) targets, almost any metric that gives short-lived gases a value greater than zero will result in rapid abatement. This is due to the shape of abatement cost curves for methane in most IAMs and rapidly rising carbon prices (e.g. Harmsen et al 2019). Also a cross-reference to Box 2.2 would be useful here since this box presents an assessment of how global abatement costs change with different metrics.	Added	Andy Reisinger	Ministry for the Environment	New Zealand

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54893	31	11	31	12	Phrase "emissions are often so much reduced in scenarios leading to a smaller contribution of non-CO2 to warming than it is today" needs to be re-worded for clarity.	Sentence removed	Government of United States of America	U.S. Department of State	United States of America
76073	31	11	31	11	Something wrong with language here	Sentence removed	Jan Fuglestedt	CICERO	Norway
54895	31	14	31	14	The use of the word "imply" is inaccurate and conveys a greater amount of uncertainty than is supported by the literature. Suggest replacing "imply that there is a" with "demonstrate that".	Thank you for the suggestion - but we believe that the current text is accurate	Government of United States of America	U.S. Department of State	United States of America
1819	31	15	31	15	above 40% seems illogical as it has to be 40-70% for 2 degrees	Left text unchanged	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
66849	31	15	31	15	Also WG1 Chapter 5. The original papers on this go back to 2009 (Allen et al. 2009 https://www.nature.com/articles/nature08019 ; Matthews et al. 2009 https://www.nature.com/articles/nature08047) as well as the cited Meinshausen one	Added	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
1821	31	17	31	18	can be further nuanced: it is particularly the 1.5 and the no or low overshoot scenarios that rely heavily on CDR. Or alternatively: the lower temperature increase and overshoot, the more CDR needs to be deployed for the scenarios to achieve the PA temperature targets	Text was further elaborated so we believe it is now fine.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
65537	31	18	31	19	There are a couple of parenthesis that are not needed.	Removed	Cristian Chadwick	University of Chile	Chile
65421	31	20	31	21	Please reference the statement on how reducing non-CO2 forcings can impact the carbon budget. Maybe the 1.5 report; Rogelj et al. 2018a?	Added	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
66847	31	22	32	12	SLCFs: see also Chapter 6 of WG1. Metrics: see chapter 7 Section 7.6, WG1. In fact, in general on CO2-eq calculations throughout this chapter, while changes will be imperceptible on the resolution of plots it would be fully consistent to use new AR6 values (WG1 Table 7.15 and Chapter 7 Supplementary Material Table 7.SM.7)	Yes - this is done. And reference added	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
65423	31	23	31	23	to add support that a box comparing cumulative CO2 emissions and carbon budgets as assessed in WG1 would be a really helpful addition to a lay/policy audience.	Thanks. Box was added	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
76075	31	23	31	24	Yes, this box will be very useful. You may consider involving WGI authors as CA	Thanks. Box was added. Also thank you for your help in creating it.	Jan Fuglestedt	CICERO	Norway
83593	31	23	31	24	Happy to provide a discussion of this.	Thanks. Box was added. Also thank you for your help in creating it.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
30677	31	24	31	24	Although it may be unavoidable that this box has not been in time for SOD, this contents would be critical for the confidence of C2 section and Table SPM.1 in SPM. Completed box contents in FGD should be reviewed by not only governments but also experts.	Thanks. Box was added	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
45825	31	24			A placeholder for possible box comparing cumulative CO2 emissions and carbon budgets as assessed in WG1 is inserted in Chapter 3. We encourage the authors to include this box explaining the different concepts assessed in WG1 and WG3 but also the associated uncertainties, as this is particularly relevant for understanding the remaining carbon budgets and timing of net-zero emissions.	Thanks. Box was added	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
63527	31	24	31	24	We support the proposal to include a box comparing remaining carbon emission budgets in WGI assessment and WGIII assessment. This is a potential source of confusion (eg. In the current draft SPM) and a targeted Box that addresses this would be a good to have (including, for example, the difference between remaining carbon budgets for 'no exceedance' vs overshoot scenarios).	Thanks. Box was added	Government of Canada	Environment and Climate Change Canada	Canada
76925	31	24	31	24	That "possible box" would likely be an extremely useful addition to the report in terms of policy relevance. I hope that it can be produced and thank you for considering it. Efforts should be done to explain the key differences between the concepts used in the two groups (how does WGI SOD SPM.2 table 3 compares to WGIII SOD table 3.2?).	Thanks. Box was added	Philippe Marbaix	Université catholique de Louvain	Belgium

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
81189	31	24			Such a box would strike me as very useful - key elements in my view being (a) the RCB is not a geophysical quantity but depends on assumptions and human choices (around non-CO2 emissions), (b) the RCB is uncertain, (c) scenarios assessed in WGIII cover a wider range than the assumption to calculate median values for the RCB in WGI, and (d) the ensemble of scenarios in the WGIII database in specific categories does not lead to the same outcomes as the 'headline' outcome in WGI (i.e. WGI "well below" is precisely 66% probability of limiting warming to 2 degrees, whereas category C3 in WGIII is a whole bunch of scenarios that remain somewhere below 2 degrees with 66% probability and above 1.5°C in 2100. But overall I think it would be good to show how the uncertainties swallow up any differences in median numbers.	Thanks. Box was added	Andy Reisinger	Ministry for the Environment	New Zealand
85149	31	24	31	24	The proposed box comparing with emissions and budgets from WG1 would be very helpful and much appreciated.	Thanks. Box was added	Jens Tambke	Umweltbundesamt	Germany
65547	32	1	38	12	Such a long paragraphs can most likely be divided in two, making the reading easier.	Done	Cristian Chadwick	University of Chile	Chile
72819	32	1	32	6	The temperature metric here shown (66%) is inconsistent with the scenario classification for 1.5C scenarios (50%). It would be useful to show both metrics.	Understand the point. But we use multiple metrics in the classification. As people in the end understand the median warming best - we decided to stick with this.	Matthew Gidden	Climate Analytics	Germany
54897	32	3	32	3	Clarify if the two columns of graphs in Figure 3.11 have different y-axes.	They do not have different axis	Government of United States of America	U.S. Department of State	United States of America
1823	32	5	32	6	Are they really all well below 2? Also confer earlier comments about the use of well below	We don't use the term well below. But the data shown is indeed consistent with the categorisation based on likely.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
76077	32	9	32	9	"The so-called peak emission budget": Please explain more and adjust to consistent wording for the concepts (cumulative to net zero etc)	Corrected	Jan Fuglestedt	CICERO	Norway
78359	32	9	32	9	Please do not bring in new terminology in an already confused area (peak emission budget!). And its zero emissions not peak emissions.	Corrected	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
76079	32	11	32	11	target --> targetS	Corrected	Jan Fuglestedt	CICERO	Norway
65425	32	12	32	19	For the energy-system negative emissions originate from BECCS, but what about for AFOLU?	Reforestation; afforestation	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
76081	32	13	32	14	It is not easy to read the contribution of net negative CO2 emissions in the lower panels	We hope it is better now.	Jan Fuglestedt	CICERO	Norway
37621	32	18	32	19	Please also add relationship of BECCS to water stress as mentioned at s. no. 1.	Added	Ravi B Grover	Homi Bhabha National Institute	India
43061	32	20	33	5	All CDR options require more R&D: "For C1 and C2, the tight carbon budgets imply in many scenarios more CDR use and thus a larger role from BECCS. Creating net negative emissions can thus be an important part a mitigation strategy, in order to offset remaining emissions or to compensate for emissions earlier in time. As indicated above, there are different ways to achieve this, including re-and afforestation and BECCS (as often covered in IAMs) but also ocean fertilisation, soil carbon enhancement and direct air capture. With exception of reforestation, these options have not been tested at large scale. Moreover, the reliance on CDR in scenarios has been discussed given possible consequences of land use for BECCS and afforestation in terms of biodiversity loss and food security, the reliance on uncertain storage potentials and the risks of possible temperature overshoot."	Added	Graeme Taylor	BEST Futures	Australia
17585	32	21	32	24	Does that include DACs?	Rephrased	Alaa Al Khourdjie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
65427	32	21	32	24	Could you expand on this sentence, as without further explanation it seems to contradict your previous statement (page 30, line 1-2), that in C1 immediate climate constraints implies that longer term negative emissions are less relevant? Is there a percentage of C1 scenarios that have high NETs? or are you discussing only short term?	Rephrased	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
63531	32	22	32	24	C1 scenarios: text states that around 800-1000GtCO2 net positive cumulative emissions remain (i.e. cannot be mitigated). Can this range be compared to the allowable estimated remaining carbon budget for limiting GW to 1.5C (WGI estimate) which would help elucidate the scale of CDR required?	Text added	Government of Canada	Environment and Climate Change Canada	Canada
76083	33	1	33	16	you may consider adding a reference to SRCCL here,	Added	Jan Fuglestedt	CICERO	Norway

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
23395	33	2	33	2	It would be useful to introduce in this sentence the chapter number or sections in the report where socio-technico issues concerning ocean fertilisation, soil carbon enhancement and direct air capture are discussed.	Added	Government of France	Ministère de la Transition écologique et solidaire	France
63533	33	2	33	2	Add 'potentially' before this list of other CDR options. In particular, using ocean fertilization as an approach should not be implied to be simply a matter of not having yet been tested at scale, but limited by other considerations as well (including permanence of the carbon stored).	Added	Government of Canada	Environment and Climate Change Canada	Canada
37623	33	3	33	6	Please also add water stress also as a consequence.	Done	Ravi B Grover	Homi Bhabha National Institute	India
65429	33	3	33	16	As per my earlier comments, could you please expand on the "risks of possible temperature overshoot". I.e. what impacts could this have on the overall climate system - not just temperature. It would also be great if you could be a bit more quantitative in some of the statements: e.g. "even in strategies with net negative CO2 emissions, the emission reduction via more conventional mitigation measures (efficiency improvement, decarbonisation of energy supply) is much larger than the negative CO2 emission contribution". What do scenarios with high CDR look like in terms of overall CO2 removed by end of century, for example.	Done	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
83181	33	3	33	3	Please use ocean alkanisation here instead of ocean fertilization and refer to ch 12.3, where both concepts are discussed (but OA much more than OIF)	Added	Geden Oliver	German Institute for International and Security Affairs	Germany
19885	33	4	33	4	Revise "Moreover...." as follows: "Moreover, the reliance on CDR in scenarios has been discussed given possible consequences for sustainable development overall (Honegger et al., 2020) and particularly of land use for BECCS and afforestation in terms of biodiversity loss and food security, the reliance on uncertain storage potentials and the risks of possible temperature overshoot (Venton 2016; Peters and Geden 2017; Smith et al. 2016b; van Vuuren et al. 2017; Anderson and Peters 2016)." Reason: Literature on CDR implications for sustainable development should be covered. New reference: Honegger, M., Michaelowa, A., & Roy, J. (2020). Potential implications of carbon dioxide removal for the sustainable development goals. Climate Policy, 1-21.	Added	Axel Michaelowa	University of Zurich	Switzerland
23397	33	7	33	9	In the sentence "in the case of BECCS,... to certain areas", It is not clear what certain areas mean. Does it refer to regions in the world. Please be more precise.	Rephrased	Government of France	Ministère de la Transition écologique et solidaire	France
63535	33	7	33	9	Unclear text. "net negative effects" - is this meant to be 'net negative carbon emissions (i.e. net CDR)? The phrase negative effects could be misinterpreted to be referring to other environmental effects associated with bioenergy. What does the phrase "carbon debt" refer to in the context of CDR from BECCS?	Did not find	Government of Canada	Environment and Climate Change Canada	Canada
81181	33	7	33	10	Please expand on this and make clear to what extent IAMs fully capture these temporal dynamics (I'm not sure that all of them do, depending on their degree of complexity and detail).	Added	Andy Reisinger	Ministry for the Environment	New Zealand
78361	33	8	33	9	And can you whether carbon debt is taken into account in IAMs?	Added	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
1825	33	9			Brown legend seems to be missing	Check	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
17587	33	11	33	11	mission => emissions strategies, also please elaborate that these alternative strategies are LED	E added	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
66851	33	11	33	11	mission = emission	E added	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
83595	33	12	33	12	Shouldn't this be: Rogelj et al, nature, 2019 (new scenario logic for meeting the paris agreement...)?	Txs	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31223	33	13	33	16	In this context, the following literature may be cited. Tsutsui, J., H. Yamamoto, S. Sakamoto, and M. Sugiyama, 2020: The role of advanced end-use technologies in long-term climate change mitigation: the interlinkage between primary bioenergy and energy end-use. Climatic Change, 163, 1659-1673, https://doi.org/10.1007/s10584-020-02839-7 . It is a modeling study on interlinkage between primary bioenergy and energy end-use. The results indicate that while improving end-use efficiencies consistently decrease policy costs for a wide range of carbon budgets, the value of BECCS availability in terms of cost reduction is crucial only in a limited range of lower budgets.	Added	Junichi Tsutsui	Central Research Institute of Electric Power Industry	Japan
83183	33	13	33	13	Please also refer to ch12, where the DACCS, EW and OA/OIF are discussed in more detail	Added	Geden Oliver	German Institute for International and Security Affairs	Germany
52025	33	14	33	16	Break down impact of each conventional measure vs. negative co2 emissions in order to understand which conventional measures have the most contribution.	Added	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
8087	33	17	33	21	Please revise paragraph. The relation to figure 3.11 is unclear (the figure does not show CDR directly).	Removed complete paragraph; was repetitive	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
75583	33	17	33	17	"CDR can especially be an effective component" should be changed to "CDR can especially be a cost-effective component", since most scenarios compute cost-effective pathways ("effectiveness" has broader connotations related to for instance political feasibility than "cost-effectiveness", which in any case is more accurate here).	Changed	Ida Sognaes	CICERO Center for International Climate Research	Norway
83185	33	20	33	20	Please use "net negative emissions" instead of "net CDR"	Changed	Geden Oliver	German Institute for International and Security Affairs	Germany
30667	33	22	33	24	In this section, carbon neutrality and climate neutrality are not discussed with a clear distinction. There is a 10- 20 years difference between the year of net zero CO2 emissions and the year of net zero GHG emissions for the 1.5°C and 2°C targets. Therefore, the two concepts should be clearly distinguished.	Rephrased	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
76085	33	22	33	44	The text here to some extent clarifies part of the concepts related to Art4 and GHG balance. As suggested in an earlier comment, I think this chapters needs a short and clear presentation of the related concepts net zero CO, net zero GHG, carbon neutrality and GHG neutrality. The chapter will benefit from a consistent use of these concepts. You may also link this to Art4 and "balance" there and mention that this is open for interpretations (e.g. Rogelj et al., 2015 and Fuglestedt et al, 2018) and then say what you use. (I also suggest you also continue avoid using the more ambiguous concept "climate neutrality")	Rephrased	Jan Fuglestedt	CICERO	Norway
83597	33	22	34	19	The discussion of the timing of net zero emissions should include a discussion of how the net-zero timing depends on near-term emissions levels. That information can then help to interpret how emissions reductions ranges in 2030 relate to range of net zero timings for a given scenario category.	Added text	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
83187	33	23	33	26	This sounds like "carbon neutrality" and "net zero GHG" were the same - please distinguish more clearly	Rephrased	Geden Oliver	German Institute for International and Security Affairs	Germany
85947	33	23	33	23	Reference should be "reaching a balance of sources and sinks of GHG emissions in the second half of this century".	Not changed.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
52027	33	24			The emphasize on the balance of Sources and Sinks reflects the importance of removal aspect which is not emphasized in some parts of the report. This should be also emphasized in the SPM.	There is currently a lot of emphasis on removal in Section 3.3	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
81179	33	25	33	26	This sentence is confusing: the preceding sentence talks about the remaining carbon budget and this by definition implies that net-zero (CO2) emissions are reached. But then this sentence says that this is also referred to as carbon neutrality or as GHG neutrality - as if that were optional one or the other label. Please make very clear that the remaining carbon budget applies only to CO2 emissions, but its value is linked to net-zero CO2 emissions (but it is not linked to GHG neutrality, as that is a separate goal and concept). It might be useful to clarify that (at a stretch), a quantity akin to the remaining carbon budget can be defined and calculated for long-lived GHGs more generally, but make equally clear that it does not apply to all GHGs (as some of them are short-lived). Perhaps include a cross-reference to chapter 2 box 2.2 on GHG metrics since that box discusses which metrics are suitable for including short-lived GHGs in remaining carbon budget calculations.	Text is rephrased	Andy Reisinger	Ministry for the Environment	New Zealand

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
50263	33	26	33	41	Potentially add (or refer to) the term "climate neutrality" which the EU interprets as GHG neutrality, as the EU's "net zero" target refers to this.	We have now avoided all neutrality wording	Matthias Weitzel	European Commission, Joint Research Centre	Spain
78363	33	26	33	26	Need to be absolutely clear about net zero C or net zero GHG	I think the text is clear now	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
75585	33	29	33	31	The statement "Figure 3.12 shows that there is a strong relationship between the temperature target and the carbon budget, but also albeit somewhat weaker also with the net zero year (see also Tanaka and O'Neill, 2018)" should be specified by adding "in the scenarios explored" or "in the scenarios in the AR6 database" or "in cost optimal scenarios" (or similar). Otherwise, the impression is given that this is a general climate finding. Naturally, the net zero year only matter so much, because it is the shape of emissions reductions that determines cumulative emissions, which we know from climate science is what matters to temperature increase. And the timing of net-zero in these pathways is determined by the solution algorithm in the IAMs that are used to generate the pathways, which again are determined by socio-technical variables. The scenarios depict primarily cost-effective pathways towards given climate targets, they are not designed to explore what is and isn't physically possible given a climate target.	Rephrased	Ida Sognaes	CICERO Center for International Climate Research	Norway
16921	33	30	33	30	"but also albeit somewhat weaker also with the net zero year". Confusing redaction.	Has been rephrased	Government of Spain	Area de Estrategias de Adaptacion - Oficina de Cambio Climatico - Ministerio de la Transicion Ecologica	Spain
54899	33	30	33	30	This phrase "... but also albeit somewhat weaker also ..." is not clear as written. Authors should clarify if this means that there is still considerable uncertainty about when net-zero needs to be achieved even if the temperature target and corresponding cumulative carbon budget is known.	Has been rephrased	Government of United States of America	U.S. Department of State	United States of America
71309	33	31	33	33	"certainly there is no overshoot of the target". It is not clear what this means or how it relates to the rest of the sentence.	Has been rephrased	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
54901	33	33	33	33	Suggest semicolon begin this phrase, and that it instead read (if this is what the authors meant), "certainly the Paris Agreement does not explicitly mention the possibility of overshooting the target."	Has been rephrased	Government of United States of America	U.S. Department of State	United States of America
63537	33	33	33	35	The text here emphasizes that emissions of non-CO2 gases can have a strong influence on the remaining carbon emission budget and the timing of net zero carbon emissions. And yet, earlier in this chapter the point was made that most scenarios reduce emissions of CH4 and N2O by about 50% and not much further due to technological or other constraints. Again, it would be helpful to understand better to what extent mitigation of non-CO2 emissions varies across scenarios, perhaps with a graph showing a time series for emissions of these substances in different scenarios.	So the points are not inconsistent. The carbon budget does increase for lower non-CO2 emissions... but at the very low levels, on average, non-CO2 does not reduce further if one only implements technical measures. It is possible to reduce CH4 further via lifestyle change as explained in the text.	Government of Canada	Environment and Climate Change Canada	Canada
5013	33	34	33	34	Please correct: "the Figure also show ..." in "the Figure also shows ..."	Corrected	Tiziana Susca	Italian National Agency for New Technologies, Energy and Sustainable Economic Development	Italy
23399	33	34	33	34	When referring to the figure in this line please indicate which figure is mentioned	Corrected	Government of France	Ministère de la Transition écologique et solidaire	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
16923	33	35	33	37	Confusing drafting	Reworded	Government of Spain	Area de Estrategias de Adaptacion - Oficina de Cambio Climatico - Ministerio de la Transicion Ecologica	Spain
60769	33	35	33	37	The sentence "The global average warming limit of 1.5°C (50% probability) implies carbon neutrality around 2040-2060 should very high overshoot (> 0.2°C) be avoided " should be included in the SPM	Quite a bit on this is now in the SPM	Manfred Treber	Germanwatch	Germany
63539	33	35	33	37	Recommend rephrasing: replace "should very high overshoot be avoided" with "in scenarios with no or limited overshoot".	Has been rephrased	Government of Canada	Environment and Climate Change Canada	Canada
65431	33	35	33	37	Could you refer to WGI here? Reminding readers of how you have used different ways to calculate final temperature outcomes? Potentially referring to the box comparing cumulative CO2 emissions and carbon budgets as assessed in WG1	Have referred to the Section	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
75587	33	35	33	37	The statement "The global average warming limit of 1.5°C (50% probability) implies carbon neutrality around 2040-2060 should very high overshoot (> 0.2°C) be avoided. Holding warming below 2°C (66% probability) implies carbon neutrality around 2050-2080" should be specified by adding "in the scenarios explored" or "in the scenarios in the AR6 database" or "in cost optimal scenarios" (or similar). Otherwise, the impression is given that this is a general finding and that 1.5°C is impossible if carbon neutrality happens before 2040 or after 2060 (and that 2°C is impossible if carbon neutrality happens before 2050 or after 2080). The scenarios assessed in this chapter depicts cost-effective pathways towards given climate targets. They do not explore the bounds of what is and isn't possible when it comes to the relationships between emissions and temperature outcomes.	Reworded	Ida Sognaes	CICERO Center for International Climate Research	Norway
17589	33	36	33	36	This is the first instance (I spotted) where "very high" instead of "high" OS is used. Both are referring to the same warming OS, but the use of "very" might be confusing.	Reworded	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
54903	33	39	33	39	Insert "of" after "use"	Added	Government of United States of America	U.S. Department of State	United States of America
9079	33	43			An allocation on equity might result in different carbon neutrality years'. Please give more discussions or provide the results of carbon neutrality years from the perspective of equitable allocations. Otherwise, delete it.	We think the addition is important. However, there is simply little room to go into detail. We did a reference.	Xunzhang Pan	China University of Petroleum, Beijing	China
14945	33	43	33	44	This assessment should take into account Fyson, C. L., Baur, S., Gidden, M., & Schlessner, C. F. (2020). Fair-share carbon dioxide removal increases major emitter responsibility. Nature Climate Change, 10(9), 836-841.	Added	Government of Saint Kitts and Nevis	Department of Environment - Ministry of Agriculture, Marine Resources, Cooperatives, Environment and Human Settlements	Saint Kitts and Nevis
54905	33	43	33	44	The phrase "allocation on equity" is unclear. Clarify or define.	Reprased	Government of United States of America	U.S. Department of State	United States of America
72821	33	43	33	44	The statement 'An allocation on equity might result in different carbon neutrality years.' Can be defended and quantified by citing the results in Fyson et al 2020 (https://www.nature.com/articles/s41558-020-0857-2%22%20/t%20%22_blank).	Added	Matthew Gidden	Climate Analytics	Germany
78113	33	43	33	44	Counter question: How could an allocation based on equity not result in different neutrality years? This statement is not sufficient, please see comment on Figure 3.12 below.	Reprased; and figure removed	Charlotte Plinke	Climate Analytics	Germany
50179	34	1			This figure seems to suggest that Latin America needs to reach net-zero CO2 and Kyoto gases well ahead of other regions. How do considerations of fairness and equity relate to this fact? If this is based on cost-optimality only (as mentioned on p.33 l.41), the underlying assumptions should be more clearly displayed, or the regional part of this figure should be deleted.	Reprased; and figure removed	Anna Main	Ministry of Foreign Affairs and Trade	Samoa
50265	34	1			Maybe showing ranges more clearly (as in figure 3.9) would better substantiate the 20 year difference. From the IPs, this difference is not obvious, e.g. for the non-NBZ pathways, this difference appears to be much less. If there is a clear difference between NBZ pathways and other pathways, then the 20 years as an average would emerge from the relative number of NBZ and other scenarios in the data base - in this case if might be necessary to calculate the value for NBZ and other pathways separately.	So the difference also emerges from the Table. Hope that helps.	Matthias Weitzel	European Commission, Joint Research Centre	Spain

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
50267	34	1			It is unclear that the C1-C2 and C3 ranges represent in panels c and d. Do they refer to global ranges?	It is not so clear to me why it is unclear.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
78115	34	1			This figure cannot be retained as it currently stands and crucially shows the importance of discussing integrated assessment models more comprehensively (beyond section 3.2.2) - why is there no section on assumptions, shortcomings, limitations? AIM (1.5 Sup and 1.5 NBZ) clearly has a regional bias for net-zero in Africa balanced by additional allowed emissions in OECD. Showing these regional net-zero timing resulting from cost-optimal scenarios and based on assumptions on afforestation and economic growth is at very high danger to be misunderstood, as well as to come across policy-prescriptive. The sentence "An allocation on equity might result in different neutrality years." (p.33, l.43) is far from sufficient. Please delete this figure, or complement by a comprehensive analysis of carbon neutrality years under different equity approaches.	Reprased; and figure removed	Charlotte Plinke	Climate Analytics	Germany
81177	34	1			Figure 3.12: It is odd that net-zero CO2 is achieved between 2055 and 2070 in the 1.5 degree scenarios shown, but the 10-90 percentile range in the database is 2045-2070. This needs some explanation/comment in my view regarding what those scenarios are representative of and what they are not (i.e. why are those two marker scenarios shown and not others?)	I think the inconsistencies have been solved in further updates of the numbers	Andy Reisinger	Ministry for the Environment	New Zealand
81875	34	1			This figure seems to suggest that Latin America needs to reach net-zero CO2 and Kyoto gases well ahead of other regions. How do considerations of fairness and equity relate to this fact? If this is based on cost-optimality only (as mentioned on p.33 l.41), the underlying assumptions should be more clearly displayed, or the regional part of this figure should be deleted.	Reprased; and figure removed	Francella Strickland	Ministry of Foreign Affairs and Trade	Samoa
83191	34	1	34	1	panels c/d: unclear what light grey numbers mean	If we keep the Figure more explanation will be added	Geden Oliver	German Institute for International and Security Affairs	Germany
83193	34	1	34	1	panels c/d: unclear why the light shades ranges for C1-C2 and C3 cover exactly the same timeframes. Shouldn't they appear later in d?	If we keep the Figure more explanation will be added	Geden Oliver	German Institute for International and Security Affairs	Germany
63541	34	2	34	4	Figure caption is incomplete and is not sufficient to enable readers to interpret this complex 4-panel graphic sufficiently.	If we keep the Figure more explanation will be added	Government of Canada	Environment and Climate Change Canada	Canada
65435	34	2	34	2	Figure 3.12: Could you include a reference to where in the text (or literature) individual regional netzero timings are discussed?	Reprased; and figure removed	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
75589	34	5	34	7	The timing of carbon neutrality does not determine the peak cumulative CO2 emissions alone: the shape (trajectory) of emissions will be equally important and you can in principle have neutrality later but with cumulative emissions lower, and neutrality earlier with cumulative emissions higher, depending on the trajectory. While there might be a relationship in the scenarios explored (in which case it should be clarified that this is the case), this is not a physical or logical necessity. It is also not clear from the table referred to (3.2) that this is the case.	Section removed	Ida Sognaes	CICERO Center for International Climate Research	Norway
73019	34	7	34	18	These sentences make climate policy involving CO2 and non-CO2 species sound like a zero-sum with an objective of taking temperature rise up to a prescribed limit (1.5oC or 2oC). Content should be added to say that this only illustrates some relationships, but that the objective must be to minimize temperature rise.	Hope current text is better.	Larry Edwards	Larry Edwards Environmental Consulting	United States of America
63543	34	11	34	19	These lines are difficult to follow. Aerosol cooling has not yet been mentioned in this chapter. Some context needs to be provided. Lines 13-14 say that non-CO2 emissions can play a role in limiting peak warming, but then the second half of the sentence says that the smaller the residual non-CO2 emissions are at the time of carbon neutrality, the larger the carbon budget can be. That is a different message. Are these not 2 different things? 1. if non-CO2 emissions are lowered further and the carbon emissions remain the same, then peak warming can be lowered, OR 2. For a given peak warming, if residual non-CO2 emissions are lower, then the remaining carbon emission budget can be larger. Lines 16-19 again stress the potential for non-CO2 emissions to impact the remaining C budget but little concrete information has been provided in this chapter up to here on emission paths for non-CO2 emissions over the century under different categories of scenarios. Adding this information would be useful.	Reworded	Government of Canada	Environment and Climate Change Canada	Canada
5015	34	14	34	14	"can plays.." should be amended into "can play.."	Txs	Tiziana Susca	Italian National Agency for New Technologies, Energy and Sustainable Economic Development	Italy

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
9873	34	14	36	16	Sectoral issue studies model based on IPCC category, as follows: <ul style="list-style-type: none"> • Energy supply: Energy resources transformation (e.g., electricity generation, refineries, etc.) • Buildings (Residential and commercial buildings, military) • Transportation (Road, rail, aviation, and shipping) • Industry (IPPU) • AFOLU • Other CDR (CDR options not included in individual sectors, e.g. direct air CCS, enhanced weathering) • Cross-sector (Supply and demand, bioenergy, timing of net zero, other interaction among others). 	Not sure this is made for the right section	Government of Indonesia	Ministry of Environment and Forestry	Indonesia
73017	34	14			The phrase should be either "can play" or "plays".	Txs	Larry Edwards	Larry Edwards Environmental Consulting	United States of America
83599	34	17	34	17	In AR6 WG1 Ch5 Section 5.5.2.2 we now say +220 GtCO2 variation due to non-CO2 scenario uncertainty.	Txs	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
1827	34	45	34	45	emissions	Txs	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
1829	34	46	34	48	This seems a bit meager. Could more references/examples be added? There should be a wide range to choose from. Furthermore, the first sentence seems broader, i.e. economic impacts on emissions. Here, references to COVID-19 studies would be highly relevant.	Txs	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
71311	34		34		The cumulative emissions axis is not very informative since the values for the IPs are so close together. Suggest replacing panel with something that better illustrates the trade-off between short-term action and CDR. E.g. X-axis cumulative CDR 2010-2100: Y-axis 2050 emissions (% reduction below 2010). Also, change the colour. Use lighter/whiter shades for the non-IP results, so that the IPs stand out more.	We reduced the number of IPs. That at least helped.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
18091	35	1	35	3	The 'Temperature change 50% probability' and 'Likelihood of staying below' columns are quite confusing, as it is very easy to conflate these probabilities with the percentage chance of limiting warming to a given level by 2100, which is defined as 50% or 67% depending on the pathway in question. It would help to rename the latter column as 'Likelihood of staying below temperature at peak warming', and the 'temperature change 50% probability column could be removed entirely.	We understand the problem. However, we believe that the different numbers are useful.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
29335	35	1	35	1	Table 3.2. It is difficult to reconcile some of these values with those reported in SR15. For example, the P67 2C budget in SR15 was 1170 GtCO2. Should that be compared with 872 GtCO2 here? If so, what explains the large difference? Also, it would be helpful to compare to the budgets reported in WG1 and explain any differences.	We added a box to explain difference between information in Table 3.2 and carbon budgets. We also added text to explain differences between table and SR1.5	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
62057	35	1	35	2	Table 3.2: the results are presented relative to 2020 levels. I could not read to which footnote it refers, and what you assume for the 2020 emission, as the figures gives quite a range of emissions (see Figure 3.8 for the different C-groups). Are you assuming a constant global 2020 emissions? I would recomend not to present the results relative to 2020 emissions, as the 2020 emissions are much lower due to the COVID implications. I would use 2019 emissions levels.	Yes - this is solved.	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands
71313	35	1	35	1	This table is one of the most important in the report and is likely to be the most influential. In the final draft: 1) please make an effort to explain any changes in these pathways compared to their equivalents in SR1.5 Table 2.4; 2) please provide some commentary on how this table should be interpreted in light of the WG1 report in particular: a) WG1's choice to switch back to GSAT as the preferred measure (rather than GMST in SR1.5 b) the apparent finding from WG1 that the world is 0.1°C / roughly one decade closer to the 1.5°C threshold than previously thought - not because the world is actually warmer than thought but due to reassessment of the historical reference period.	So the issues you raise now are, as far as space allows, addressed	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
81171	35	1			Table 3.2: Is the likelihood in the last column really fully consistent with WGI? The WGI SOD found that warming from 1850-1900 to 1995-2014 was 0.68-1.0°C. It also states that warming under RCP19-SSP1 would be 0.5-1.1°C above 1995-2014. The latter is a 5-95 percentile rather than 10-90 percentile, but still it seems slightly odd to me that the probability of remaining below 2 degrees should be as high as 96% across the set of scenarios. Perhaps this is because of an internal skew in the scenarios in the C1 group, and of course WGI has made further updates to its temperature assessment - but please double check that these probabilities fully match those that one might infer from WGI, using consistent confidence intervals. In addition, the relevant footnote should make clear that the probabilities are for the "ensemble of opportunity" of scenarios in each category, not for the 'headline outcome' (i.e. category C3 is for scenarios that limit warming to 2 degrees with 66% probability, but exceed 1.5 degrees with more than 50% probability. The footnote (or somewhere in the main text) it should be made clear that it is the collection of individual scenarios, if each is weighted the same in this ensemble, give in aggregate an 80% chance of remaining below 2 degrees (is my understanding correct?) This means this percentage value could be different if some modelling groups had submitted more scenarios that happen to land closer to the 66% threshold, or lie just outside the 1.5 threshold. In other words, the number tells us little about the real world and is simply descriptive of the distribution of scenarios within that category in the database - this needs to be made crystal clear.	The numbers are consistent... as far as the emulators are consistent with WG1 data. The latter is discussed in the carbon budget box and in Annex C.	Andy Reisinger	Ministry for the Environment	New Zealand
81173	35	1			Table 3.2: It is difficult to interpret the "cumulative CO2 emissions to net-zero" when scenarios don't reach net-zero (on average). I think it is misleading to give numbers based on a (undisclosed) subset of scenarios within each category that happen to meet net-zero even though the median does not. I think it would be more consistent and transparent to at leave the median number blank (as is done in the column on "emissions milestones"). For those scenarios that report neither the median nor the 10-90 percentile to reach net-zero CO2 (C6, C7, baseline), the values for cumulative CO2 emissions to net-zero should also be left blank, even if there are a few scenarios that do reach net-zero nonetheless. The information conveyed in these cells should be consistently about the full ensemble set with each category, not a sub-set of scenarios that meet the category definition in a particular regard but may be only a tiny fraction of the number of scenarios that describe this category in other regards.	We agree that there are problems. We did indicate the % of scenarios reaching net zero	Andy Reisinger	Ministry for the Environment	New Zealand
81175	35	1			Table 3.2: The table title needs to also refer to GHG emissions, not just CO2. Plus it needs to make clear that the quantitative results are for the scenarios in the IPCC database and hence contingent on this ensemble of opportunity - if different groups had submitted different scenarios, most of those numbers would be different (not fundamentally, but in some cases perhaps non-trivially; see also my comment on the probabilities listed in the last column). This doesn't invalidate the results, but it is important to help readers interpret the specific ranges given.	It is now in the title	Andy Reisinger	Ministry for the Environment	New Zealand
83601	35	1	35	3	This table could be further strengthened and made more policy relevant by including the level of gross CDR until net zero CO2 and net zero GHG emissions are achieved. Currently, the perception exists with many that CDR is only something that plays an important role once we want to reach net negative emissions. The provision of these two additional indicators can show that even to reach net zero CO2, a sizeable amount of gross CDR will be required (and thus planned for in near-term policies if that net-zero level is to be achieved).	We included it in the figures	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
83647	35	1	35	3	First, congratulation to this most important and excellent table of great use for climate policy making. There is much progress on the categories/bins for the global emissions pathways. However, I find the terminology still too close to be policy prescriptive and for sure not clear enough. The PA uses "well below", and Table 3.2 uses "below". First I doubt this is mathematically correct as \leq is IMHO not the same as $<$. Secondly, in the policy making context I read/hear often just "below" when citing the PA Art.2, which is of course not correct, but makes then the terminology of this table identical to such misunderstandings. As the difference when net-zero needs to be reached may amount up to 2 decades with an understanding of "well below 2°C" (PA) as being the 1.5°C limit for the majority of Parties to the UNFCCC (state 2015), the difference between "well below 2°C" and "below 2°C" is far from trivial in a policy context. I therefore urge authors to consistently use new terms such as "less or equal to" or some similar wording, but please not the unclear "below". The categories then would read e.g. "Less or equal 2°C" or "Likely less or equal to 2°C" or "Less or equal 3°C" etc.	I think we solved it by now.	Andreas Fischlin	IPCC Vice-chair WGII, ETH Zurich	Switzerland
83663	35	1	35	3	The later date by which net-zero CO2 is to be reached compared to previous IPCC assessments needs some explanation, so that the finding is not misunderstood as if there would be now more time left for action. I understand that this shift comes rather from the fact that mitigation has not progressed as assumed in previous estimates for this date. I understand this correctly then a prominent explanation is needed along those lines.	Explanation has been added	Andreas Fischlin	IPCC Vice-chair WGII, ETH Zurich	Switzerland
359	35	2	35	3	The IPCC report on 1.5 degree global warming indicated emission pathways "giving at least 50% probability based on current knowledge of limiting global warming to below 1.5°C ". Scenarios meeting this criteria should be shown here for consistency reasons and because many organizations and countries have set climate target consistent with remaining below 1.5 degree global warming.	So the categorisation is similar to SR1.5	Bastien Girod	ETH Zurich	Switzerland

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
14947	35	2			The scenario logic underlying some of these pathways is problematic in particular in relation to overshoots. More nuance is required to inform policy makers. The high-OS category 1.5°C is unlikely to limit warming to 1.5°C and should thus be deleted, as was done in SR1.5. In IPCC terms, the low-OS category is "as likely as not" to limit warming to 1.5°C. Thus, implying by its name that there will be an overshoot is incorrect. A more appropriate name would be "as likely as not below 1.5°C". In a second step, peak warming and end-of-century warming should be separated. Several 1.5°C pathways achieve median end-of-century warming levels of much below 1.5°C (1.25°C on average). Achieving such levels after peak warming around 1.6°C obviously requires a lot of negative emissions and the discussion around these negative emissions has negatively affected the discussion around 1.5°C. The choice of including such strongly declining temperatures in the same pathway category that does not require them is misleading and highly policy-prescriptive. It is thus suggested to separate out two pathway categories: one with a 50% change of being <1.5°C in 2100 after allowing for 0.1°C overshoot in the 21st century, and an additional, separate category that's likely (66%) below 1.5°C in 2100 with no or low OS before.	So the categorisation is similar to SR1.5	Government of Saint Kitts and Nevis	Department of Environment - Ministry of Agriculture, Marine Resources, Cooperatives, Environment and Human Settlements	Saint Kitts and Nevis
47435	35	2			In the SR1.5, high-overshoot pathways were removed from the illustrative pathways for the compelling reason that the probabilities of eventually returning to 1.5°C are too low to justify a 1.5°C label. This rationale and the risk of providing misleading information on potential future options still very much holds for WGIII AR6. Please reconsider the inclusion of high-overshoot pathways, it is strongly recommended to also remove the category in this assessment.	So the categorisation is similar to SR1.5	Government of Saint Lucia	Department of Sustainable Development - Ministry of Education, Innovation, Gender Relations and Sustainable Development	Saint Lucia
50181	35	2			The Paris Agreement temperature goal of 'well below 2°C' reflects a strengthening of the "below 2°C" language. If understood correctly, the "below 2°C" used here is only "as likely as not" to limit warming to 2°C in terms of probabilities (50%). To fully capture the strengthened Cancun language, we would suggest to add a "very likely below 2°C" (90%). This would also allow to remove the high-overshoot 1.5°C category that was already dropped in SR1.5 because of too high peak warming and too low probability of actually returning to 1.5°C by 2100. Please revisit the categorisation.	We do not define well below. We have 3 categories that could be interpreted in the context of Paris (C1-C3)	Anna Main	Ministry of Foreign Affairs and Trade	Samoa
78365	35	2	35	2	This table needs reviewed for clarity. Apparent discrepancies between the cumulative emission columns (which are explainable) need addressed. And use of P50 v P67 is also worth considering.	Table has been improved	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
81877	35	2			The Paris Agreement temperature goal of 'well below 2°C' reflects a strengthening of the "below 2°C" language. If understood correctly, the "below 2°C" used here is only "as likely as not" to limit warming to 2°C in terms of probabilities (50%). To fully capture the strengthened Cancun language, we would suggest to add a "very likely below 2°C" (90%). This would also allow to remove the high-overshoot 1.5°C category that was already dropped in SR1.5 because of too high peak warming and too low probability of actually returning to 1.5°C by 2100. Please revisit the categorisation.	We do not define well below. We have 3 categories that could be interpreted in the context of Paris (C1-C3)	Francella Strickland	Ministry of Foreign Affairs and Trade	Samoa
83195	35	2	35	3	This is an excellent table, especially with the columns for CO2 and GHG net zero years, and the post-2030 reduction values, the temperature change values and the cumulative net negative emissions. On the top my wishlist for additional information would be cumulative gross CDR, to highlight that a considerable additional amount is needed in any category. If it's not possible to put these numbers into the table, could they be given somewhere else in chapter 3, and could a footnote highlight that the net negative values don't equal gross CDR values because of CDR's additional (and in fact not so far away) function to counterbalance residual emissions? This could also be done by calculating/showing residual emissions vs. removals until the time of net zero for different scenario classes - either in the table or elsewhere	We included it in the figures	Geden Oliver	German Institute for International and Security Affairs	Germany
85151	35	2	35	3	Please consider to give an indicative value for the global mean temperature change that could occur for the 104 baseline scenarios (second column).	We have no special indication for baseline scenarios	Jens Tambke	Umweltbundesamt	Germany
18093	35	13	35	13	Can CO2 emissions be presented here as well as all GHG (as was done in SR1.5)	There are clearly limits to what fit in the table. CO2 is mostly there for budget and netzero	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
9081	35				Table 3.2 is very good. However, all 1.5C/2C scenarios show peak CO2 emissions by 2020-2025 which are difficult to be achieved in reality. If we use the results in the table to guide future mitigation, will the required efforts (e.g. the requirements of 2050 reductions or net-negative emissions) be underestimated? This point should be remarked.	Text added	Xunzhang Pan	China University of Petroleum, Beijing	China
52005	35		35		The chart is unreadable.	Will be better in final version	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
73009	35				Table 3.2 is difficult to read because of the small type size, and the footnotes even more so. In the table, I suggest reducing the amount of horizontal whitespace as much as possible, to allow a larger type size. In the Emissions Milestones columns, save horizontal space by making the parenthetical dates like this: ('20 - '25). In the footnotes section, use two or three columns, to avoid excessive horizontal whitespace in order to allow a bigger type size.	Will be better in final version	Larry Edwards	Larry Edwards Environmental Consulting	United States of America
243	36	2	37	16	This whole paragraph on “mitigation strategies” does not mention efficiency let alone sufficiency, depicting the inability of IAMs to properly incorporate these strategies.	IAMs do capture efficiency; the examples are selected for illustration - so we will now also include efficiency.	Kai Kuhnnehn	Konzeptwerk Neue Ökonomie	Germany
76413	36	2	36	19	This section goes straight to the use of renewables as the exclusive source of low carbon energy. Life Cycle Assessments of materials consumption from the US Quadrennial Technology Review 2015 show hugely greater materials required per kilowatt hour generated from wind or solar PV as the source compared to nuclear energy. Apart from concrete, and considering just metals, solar needs 55 times as much as nuclear or gas combined cycle, and wind 11.6 times as much. The difference is less compared with coal. Not only do these materials cost money, but they have CO2 implications. Further, if we add the GHG LCA's for batteries, additional transmission and backup generators the materials intensities of renewable could well be 30 to 100 times that of nuclear energy. A World Bank report in 2020 said that if relying on wind, solar and energy storage for limiting climate change “A low-carbon future will be very mineral intensive because clean energy technologies need more materials than fossil-fuel-based electricity generation technologies,” or nuclear technology. In particular, by 2050, “large relative increases in[annual] demand of up to nearly 500 percent are estimated for certain minerals, especially those concentrated in energy storage technologies, such as lithium, graphite, and cobalt,” as well as other minerals such as neodymium, aluminium, copper, chromium and molybdenum “either to build their structures or frames, or as components in the technology used to generate electricity, such as the PV cells in solar PV and magnets or motors in wind turbines.” The increased aluminium production in particular will give rise to substantial CO2 emissions. To date, no nation has made significant GHG reductions using wind and solar alone. All have relied to various degrees on fossil fuel backup with greenhouse gas intensive methane being the main source. This growth has been quite evident in the EU and the USA.	Chapter 6 on energy sector has more detail on nuclear and renewable energy sources. We will add reference to this chapter.	Robert Parker	Nuclear for Climate Australia	Australia
65539	36	3	36	19	I think this paragraph refers to Figure 3.13, if that is so, then it should have a reference to the Figure. The document in its current version does not have it.	Added	Cristian Chadwick	University of Chile	Chile
23401	36	4	36	6	a reference to the figure 3.13 is missing here	Added	Government of France	Ministère de la Transition écologique et solidaire	France
50269	36	4			Be explicit in stating that the share of renewables refers to primary energy	Added	Matthias Weitzel	European Commission, Joint Research Centre	Spain
65433	36	6	10	36	For these statements "In the majority of the scenarios reaching low greenhouse targets, a considerable amount of CCS is applied. Moreover, as noted before, scenarios consistent with the targets of the Paris Agreement typically rely significantly on net-CDR." could you possibly pull out some quantitative numbers from Figure 3.13 (lower panels)?	Done	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
75591	36	6	36	8	The statement "The share of renewables, for instance, needs to be around 20-50% for scenarios reaching global average temperature change of 2.5oC, clearly above 40% for scenarios reaching 2oC and 1.5oC" should be changed to "The share of renewables, for instance, is around 20-50% in scenarios reaching global average temperature change of 2.5oC, and clearly above 40% for scenarios reaching 2oC and 1.5oC." Because the scenarios explored depict primarily cost optimal pathways to given target, rather than explore all possible pathways, "need" (such as absolute and minimum levels of shares of renewables implied by a given target) is not demonstrated by these scenarios.	Agreed, reformulated	Ida Sognaes	CICERO Center for International Climate Research	Norway
71315	36	7	36	7	there seems to be an 'and' missing between 2C and clearly	Rephrased	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
37625	36	8	36	13	Please add uncertainties and assumptions associated with 100% renewable scenarios. Please also add publications that propose nuclear energy as a silver bullet (Brook, B. W., T. Blees, T. M. L. Wigley and S. Hong, 2018, Silver buckshot or bullet: Is a future “energy mix” necessary? Sustainability, 10, 302; doi:10.3390/su10020302.)	We added text on nuclear	Ravi B Grover	Homi Bhabha National Institute	India

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
45827	36	8	36	10	As stated in section 3.9. a statistical interpretation of model results is likely to be misleading. Pointing out to the high number of models using CCS and CDR should be assessed accordingly. Therefore, it should be clearly and prominently stated that the reliance on CCS and CDR in the models is not to be interpreted as a real need and thus cause claims for enabling policies. There are some explanations in the remainder of this paragraph supporting this, yet they are not sufficiently clear. More critical discussions on CDR-deployment, its efficiency and possible alternative sustainable development pathways are cited throughout the whole WGIII AR6-draft (e.g. Chapter 3.3.2.2, p. 33, lines 3-13, Chapter 3.7.7).	Reformulated	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
71317	36	9	36	10	can be further nuanced: it is particularly the 1.5 and the no or low overshoot scenarios that rely heavily on CDR. Or alternatively: the lower temperature increase and overshoot, the more CDR needs to be deployed for the scenarios to achieve the PA temperature targets	Rephrased	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
17591	36	10	36	19	Please refer to Box 6.6 "100% Renewables in Net-Zero Energy Systems" in Chapter 6 for a detailed discussion on this issues	Added	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
48097	36	10	36	12	Please cite some of the additional global studies that have found 100% clean, renewable energy feasible: (1) Jacobson, M.Z., and M.A. Delucchi, A path to sustainable energy by 2030. Scientific American, November 2009; (2) Jacobson, M.Z., and M.A. Delucchi, Providing all global energy with wind, water, and solar power, Part I: Technologies, energy resources, quantities and areas of infrastructure, and materials, Energy Policy, 39, 1154-1169, doi:10.1016/j.enpol.2010.11.040, 2011; (3) Delucchi, M.Z., and M.Z. Jacobson, Providing all global energy with wind, water, and solar power, Part II: Reliability, System and Transmission Costs, and Policies, Energy Policy, 39, 1170-1190, doi:10.1016/j.enpol.2010.11.045, 2011; (4) Jacobson, M.Z., M.A. Delucchi, Z.A.F. Bauer, S.C. Goodman, W.E. Chapman, M.A. Cameron, Alphabetical: C. Bozonnat, L. Chobadi, H.A. Clonts, P. Enevoldsen, J.R. Erwin, S.N. Fobi, O.K. Goldstrom, E.M. Hennessy, J. Liu, J. Lo, C.B. Meyer, S.B. Morris, K.R. Moy, P.L. O'Neill, I. Petkov, S. Redfern, R. Schucker, M.A. Sontag, J. Wang, E. Weiner, A.S. Yachanin, 100% clean and renewable wind, water, and sunlight (WWS) all-sector energy roadmaps for 139 countries of the world, Joule, 1, 108-121, doi:10.1016/j.joule.2017.07.005, 2017; (5) Jacobson, M.Z., M.A. Delucchi, M.A. Cameron, and B.V. Mathiesen, Matching demand with supply at low cost among 139 countries within 20 world regions with 100% intermittent wind, water, and sunlight (WWS) for all purposes, Renewable Energy, 123, 236-248, 2018; (6) Jacobson, M.Z., M.A. Delucchi, M.A. Cameron, S.J. Coughlin, C. Hay, I.P. Manogaran, Y. Shu, and A.-K. von Krauland, Impacts of Green New Deal energy plans on grid stability, costs, jobs, health, and climate in 143 countries, One Earth, 1, 449-463, doi:10.1016/j.oneear.2019.12.003, 2019.	Citation added. But most in this list were a bit old.	Mark Jacobson	Stanford University	United States of America
52029	36	13	39	19	Possibility of 100% renewable energy systems must be based on robust scientific evidence. Rephrase the statement.	The text has clear limitation; and also refers now to Chapter 6	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
1831	36	14	36	14	how is large-scale defined?	There might be a problem with the line number. Cannot find it	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
29341	36	14	36	19	More references should be added to this discussion. Also, it appears somewhat contractictory ("there is clear debate" vs "it is possible"). "In the literature, there is a clear debate on whether it is possible to achieve a 100% renewable energy system by 2050. This critically depends on assumptions made on future system integration, system flexibility, storage options and the ability to also supply high-temperature functions and specific mobility functions with renewable energy. The range of studies published showing 100% renewable energy systems show that it is possible to design such systems in energy system models."	We added more references. We believe there is no contradiction. Last sentence deliberate add the wording "in the context of energy system models"	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
78367	36	14	36	17	reference to Chapter 6	Added	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
5233	36	17	36	19	Shocking!! Yes some studies claim that a 100% rewable is feasible, and more or less honestly recognises that the economic consequences have to be evaluated, as well as the social acceptance, the consequences in term of energy precarity, etc.. Many other studies establish that this a lure, an unrealistic target, what is confirmed recently by IEA (Fatih Biro)The sentence as written in the draft is unacceptable.	There is further information in the chapter on energy supply	Michel SIMON	Retraité/ Pdt d'association	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
61639	36	17	36	19	"The range of studies published showing 100% renewable energy systems show that it is possible to design such systems in energy system models". The mere ability of designing something in a model does not mean it is prudent to do it, especially when moving from "possible to put in a model" into implementation in real, physical world, where climate mitigation eventually needs to happen. This statement should therefore be accompanied with sentence like: "such scenarios, however, imply significant additional risks with respect to achieving the climate targets and are projected to be more expensive than systems that allow also for nuclear and CCS." Part 1/2	We agree that there is a difference between model-based scenarios and the real world. We hope that the text reflects is. More information can be found in the chapter on energy supply. In general there is strong evidence that at least at reasonable penetration levels, investments on renewable energy is very cost-effective.	Rauli Partanen	Think Atom	Finland
61641	36	17	36	19	Part 2/2. See IEA, 2021, https://www.iea.org/reports/conditions-and-requirements-for-the-technical-feasibility-of-a-power-system-with-a-high-share-of-renewables-in-france-towards-2050 ; Lehtveer and Hedenus, 2014, https://doi.org/10.1080/13669877.2014.889194 ; Hong et al., 2014, https://doi.org/10.1016/j.enpol.2014.05.054 ; Hong et al., 2014, https://doi.org/10.1016/j.apenergy.2014.09.062 ; Lehtveer and Hedenus, 2015, https://doi.org/10.1016/j.esr.2014.11.003 ; Zappa et al, 2018, https://doi.org/10.1016/j.apenergy.2018.08.109 ; Pfenninger and Keirstead, 2015, https://doi.org/10.1016/j.apenergy.2015.04.102 ; Sepulveda et al., 2018, https://doi.org/10.1016/j.joule.2018.08.006	Txs	Rauli Partanen	Think Atom	Finland
65679	36	17	36	19	"The range of studies published showing 100% renewable energy systems show that it is possible to design such systems in energy system models". Accompany this with the sentence "Such scenarios, however, imply significant additional risks in achieving climate targets (IEA, 2021, https://www.iea.org/reports/conditions-and-requirements-for-the-technical-feasibility-of-a-power-system-with-a-high-share-of-renewables-in-france-towards-2050), and are more expensive than systems that allow also for nuclear and CCS (Lehtveer and Hedenus, 2014, https://doi.org/10.1080/13669877.2014.889194 ; Hong et al., 2014, https://doi.org/10.1016/j.enpol.2014.05.054 ; Hong et al., 2014, https://doi.org/10.1016/j.apenergy.2014.09.062 ; Lehtveer and Hedenus, 2015, https://doi.org/10.1016/j.esr.2014.11.003 ; Zappa et al, 2018, https://doi.org/10.1016/j.apenergy.2018.08.109 ; Pfenninger and Keirstead, 2015, https://doi.org/10.1016/j.apenergy.2015.04.102 ; Sepulveda et al., 2018, https://doi.org/10.1016/j.joule.2018.08.006)".	Thanks for the references.	Eero Hirvijoki	Aalto University	Finland
84423	36	17	36	19	"The range of studies published showing 100% renewable energy systems show that it is possible to design such systems in energy system models." There are also a number of studies pointing out the challenges with a 100% renewable energy system, and that complementing it with nuclear power would make it easier to phase out fossil fuels.	The text already had some limitations added; we added a bit more text and references.	Mattias Lantz	Uppsala university	Sweden
48599	36	20	36	21	It seems that not all IPs appear on all graphics in Fig. 3.13. Also readability and understanding might be improved by lightening the colored dots and making IP icons bolder so they stand out more.	We improve the graphs; moreover we reduced the number of IPs. We also only show the IPs relevant for each figure.	Karl Hausker	World Resources Institute	United States of America
83197	36	20	36	24	Would it be possible to show not only total net negative emissions but also total CDR? This would not only avoid the misunderstanding that this is the same, but also show that the difference (in Gt CO ₂) is substantial	Has been added	Geden Oliver	German Institute for International and Security Affairs	Germany
45597	36	21	36	21	I think it is more interesting to give total negative emissions than just the net negative emissions, as the first one is a better indicator of the total removal effort.	Has been added	Kornelis Blok	Delft University of Technology	Netherlands
45599	36	21	36	21	I find the unit (MtCO ₂ /b\$)/yr somewhat difficult to interpret. Isn't it possible to give it as a percentage of the current carbon intensity?	Done	Kornelis Blok	Delft University of Technology	Netherlands
78117	36	21			Again, this figure (which is useful per se) calls into question the illustrative pathways. It appears none of the highlighted pathways are particularly indicative of their grouping/category.	Hope it is improved now	Charlotte Plinke	Climate Analytics	Germany
9675	36	25	37	3	The fact that there are alternative mitigation strategies consistent with Paris agreement (net zero emissions) and that different strategies can lead to very different energy systems with fossil fuels contributing 30% (NBZ) in 2100 and in others contributing as low as 5% (REN) in 2100 is important and worth emphasis in both the SPM and executive summary of the chapter.	Thanks. We will make this point.	Mustafa Babiker	Saudi Aramco	Saudi Arabia

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
85949	36	26	36	26	Suggest text in brackets should be "and reach net-zero emissions".	Text was reworded	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
71319	36		36		The title of Panel a (mean decarbonisation rate) and the y-axis metric (MtCO ₂ /\$billion)/yr is confusing. This is a measure of mitigation cost effectiveness?	Agree. Has been improved	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
27613	37	5	37	6	Delete "Oil phases out in the second half of the century in nearly all scenarios.", as this is not evident using Figure 3.14 (see Oil w and w/o CCS).	Txs. We have formulated the sentence somewhat.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
37627	37	6	37	8	The paper by Berger et al. says that nuclear production will reach 60% of Total Final Consumption by 2100. Please check the figure of 20%. The statement should imply that nuclear power should be a part of the strategy as it is a proven technology.	Rephrased	Ravi B Grover	Homi Bhabha National Institute	India
61643	37	6	37	7	"Also nuclear power can be part of a mitigation strategy, although its contribution does not reach more than around 20% of total TPES even in high-nuclear scenarios (see also Berger et al. (2017))." This needs to be rephrased, as the results from (Berger et al., 2017) have not been addressed correctly. Berger et al, (2017) use the scenario tool MESSAGE and conclude that, by 2100, nuclear would provide a capacity of 20 TWe – a more than 40-fold increase from today's levels. The scenario satisfies the IPCC targets and mitigates the risks associated with assuming CCS expansion at needed scales. These results urgently need to be communicated in the IPCC report and not demoted with a dismissive "(see also Berger et al., 2017)".	Only a very few scenarios indicate a large role for nuclear. In contrast, most scenarios show a large role for renewables. The text should be reflective of these observations. Still we have rephrased the text somewhat consistent with your points	Rauli Partanen	Think Atom	Finland
65687	37	6	37	8	"Also nuclear power can be part of a mitigation strategy, although its contribution does not reach more than around 20% of total TPES even in high-nuclear scenarios (see also Berger et al. (2017))." The results from (Berger et al., 2017) have not been addressed correctly. Berger et al, (2017) use the scenario tool MESSAGE and conclude that, by 2100, nuclear would provide a capacity of 20 TWe. The scenario satisfies the IPCC targets and, better yet, mitigates the risks associated with the yet hypothetical expansion of CCS. These results urgently need to be communicated in the IPCC report and not demoted with a dismissive "(see Berger et al., 2017)". Revise accordingly and acknowledge the potential of nuclear correctly.	Only a very few scenarios indicate a large role for nuclear. In contrast, most scenarios show a large role for renewables. The text should be reflective of these observations. Still we have rephrased the text somewhat consistent with your points	Eero Hirvijoki	Aalto University	Finland
76415	37	6	37	8	High nuclear scenarios explored to date do not include the rapid deployment of small nuclear power plants such as the GE BWRX300 or Nuscale. Both are available for near term deployment and unlike variable renewables use existing grids. Unlike renewables they are not reliant upon the expensive and materials intensive deployment of additional transmission, ancillary services or backup generating systems or storage options. The 20% projection for the potential for a strong nuclear energy roll out need a strong revision - they are wrong.	We reworded the text, but please note that most of the scientific literature is more optimistic on renewables than on nuclear as reflected in the text.	Robert Parker	Nuclear for Climate Australia	Australia
78233	37	6	37	8	Misrepresented fact - The paper by Berger et al. says that nuclear production will reach 60% of Total Final Consumption by 2100. The figure of 20% should be corrected and the statement should be rephrased to indicate inclusion of nuclear power as it is a proven technology.	We have now better reflected that study	Reetesh Chaurasia	Department of Atomic Energy, Government of India	India
78491	37	6	37	8	Also nuclear power is part of almost all mitigation strategies. Its contribution reaches up to 20% of total TPES in high-nuclear scenarios...	Indeed, nuclear is often part of the mitigation strategy but smaller compared to other options.	Tomaž Žagar	Faculty for Energy Technology, University of Maribor	Slovenia

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
82609	37	6	37	8	Suggest revising to "Also nuclear power is a part of many mitigation strategies, although its contribution does not reach more than around 20% of total TPES even in high-nuclear scenarios (see also Berger et al. (2017))". The data presented in figure 3.16 clearly supports this. The current language "can be part of a mitigation strategy" is too weak	We strongly disagree. Studies earlier have emphasized that excluding nuclear from the portfolio has much less impact than excluding renewables	Jonathan Cobb	World Nuclear Association	United Kingdom (of Great Britain and Northern Ireland)
84417	37	6	37	8	"Also nuclear power can be part of a mitigation strategy, although its contribution does not reach more than around 20% of total TPES even in high-nuclear scenarios (see also Berger et al. (2017))." 20% for an individual power source is not negligible, the sentence should be rephrased.	The text was rephrased	Mattias Lantz	Uppsala university	Sweden
65541	37	7	37	8	There are a couple of parenthesis that are not needed.	Rephrased	Cristian Chadwick	University of Chile	Chile
72913	37	8	37	8	The quote "Berger et al." is problematic for two reasons. First it is an outlier with extreme and unrealistic views on the potential contribution of nuclear power, clearly at odds with most other scenarios, both pro or critical of nuclear power (e.g. Berger and co-authors suggest a goal of 20 000 GW of nuclear or a 50 fold factor, meaning that every year in the next 50 years we should build the equivalent of the whole present stock of world nuclear reactors!). Second, the authors are not energy modellers but come from other fields such as climate or biology. Finally, figure used for costs are outdated (e.g. solar costs from 2010!)	Yes. It was reworded	Antoine BONDUELLE	EE-Consultant	France
29337	37	9	37	10	Figure 3.14. It would be helpful to show both 1.5C and 2C scenarios in this figure.	This is done by the climate categories	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
61645	37	9	37	10	Figure 3.14: It seems extremely unlikely and even biased to see unproven and according to Figure SPM.9 more expensive CCS (whether it be with bioenergy or fossil fuels) have much higher shares than the already proven and globally cost-effective nuclear energy. Why is this? Is nuclear constrained somehow in the scenarios, and if yes, what value do such scenarios have for effective climate mitigation? Such constraints are often born from political bans and discrimination, but it is not the mandate of IPCC to enforce ineffective and harmful climate policies by presenting them as the main pathways forward. Indeed, IPCC should stick to technology neutral scenarios as much as possible and give the politicians and people the full information, instead of enforcing current biases against nuclear in a circular argument of "nuclear is not popular so let's hide it from the scenarios so it will also remain unpopular."	According to most literature nuclear is simply too expensive for significant expansion. There are some alternative views and we have reflected on this.	Rauli Partanen	Think Atom	Finland
61647	37	9	37	10	Figure 3.14. Despite the climate and energy policies of the last 30 years of climate negotiations, primary energy consumption has grown at roughly 2% per year, and electrification of final energy use has progressed at 2%-points per decade. This means almost a doubling of primary energy use by 2050. Assuming significant, even reversing, changes to this trend while the majority of people are still struggling at much lower living standards and energy use than citizens of developed world is both risky and arrogant towards the growing population in the developing world. Scenarios that properly account for the desire of the developing world to develop need to be presented, perhaps modelling an unconstrained new supply from nuclear energy (see e.g. Brooks, 2012, https://doi.org/10.1016/j.enpol.2011.11.041 ; Qvist and Brook, 2015, https://doi.org/10.1371/journal.pone.0124074 , and Berger et al., 2017, doi:10.1504/ijgei.2017.080766).	We reflect the scientific literature that, in general, does not expect a large role for nuclear	Rauli Partanen	Think Atom	Finland
65681	37	9	37	10	Apart from one Illustrated Pathway scenario (ModAct) displayed in Figure 3.14, the primary energy consumption in 2050 is projected to be equal or less than the 600 EJ in 2020. The final energy use displayed in Figure 3.7, however, indicates that, with a confidence of 95%, the final energy use will be a minimum of 500 EJ and expected to more than 600 EJ (all of the SSP scenarios, apart from one, assume over 600 EJ). Please explain how it is possible produce more than 600 EJ of final energy with less 600 EJ of primary energy. In this light, I question the feasibility of the illustrated pathway scenarios 1.5-Sup, 1.5-NBZ, 1.5-Ren, 1.5-LD, and 1.5-SP as highly improbable. Consequently, the emphasis of the chosen Illustrative Pathway scenarios should be shifted to be more realistic.	These scenarios were selected by the assessment, consistent with the 1.5 deg C target. See also energy demand chapter for more information on the potential for energy demand	Eero Hirvijoki	Aalto University	Finland
65683	37	9	37	10	In Figure 3.14: Please explain the learning curves which enable coal and gas CCS to dominate over nuclear by 2050. Have there been any sensitivity analysis with respect to the assumptions? This seems to be in conflict with the Figure SPM.9 where CCS and BECCS are seen to be more expensive than nuclear and to have smaller mitigation potential.	Most assessments find a relatively small role for nuclear as a result of costs.	Eero Hirvijoki	Aalto University	Finland
65685	37	9	37	10	In Figure 3.14: Since 11 different Illustrative Pathway scenarios were chosen, display all of them for better comparison. Why were the rest left out?	We reduced the number of IPs	Eero Hirvijoki	Aalto University	Finland

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
84425	37	9	37	10	Several of the IPs show a decrease in energy use that does not correlate with other information, for instance in Fig 3.16 where the mean value for the C1 scenarios in 2100 is at about the same level as today. Surely one or a few suchs IPs could be shown, but in the light of the distributions shown in Fig 3.16 they do not seem very representative, and therefore the question is what they will illustrate.	IP-LD and IP-SP are indeed not very well represented in the literature, but still assessed to be important mitigation strategies	Mattias Lantz	Uppsala university	Sweden
5093	37	11	37	11	You refer to emission origins in 2010 - wouldn't it be better to use more up-to-date data? Or is this just a typo as in Figure 3.14 you present 2020 values.	Corrected.	Lina Hollender	n/a	Germany
78235	37	11	37	12	Unspecific - word "so-called" should be removed w.r.t the developed countries and UN classification report may kindly be used to infer details. Ref: https://unstats.un.org/unsd/mi/worldmillennium.htm	Reworded	Reetesh Chaurasia	Department of Atomic Energy, Government of India	India
27615	37	13	37	15	Delete "According to the projections shown in Figure 3.15, the the share of developing countries emissions further increases to about 70% by 2050, with especially strong emission growth in the Middle East and Africa region.", as for example Figure 3.15 does not include emissions for the Middle East region.	Removed	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
9083	37	15			In the scenarios in the literature, emissions are typically almost equally reduced across the regions' needs references.	Seen in Figure; now pointed out.	Xunzhang Pan	China University of Petroleum, Beijing	China
23403	37	15	37	16	In the sentence "In the scenarios in the literature, emissions are typically almost equally reduced 16 across the regions." we suggest a clarification about the reduction, equally reduced compared to what? Is it compared to current levels?	Projected level in the absence of climate policy	Government of France	Ministère de la Transition écologique et solidaire	France
23405	37	18	37	18	in the legend of figure 3.15 "Emissions by region (including 5-95th percentile range)" please precise the year	Thanks - is done now.	Government of France	Ministère de la Transition écologique et solidaire	France
62059	37	19	37	19	Figure 3.15: I would recomend not to present the results relative to 2020 emissions, as the 2020 emissions are much lower due to the COVID implications.	Changed	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands
14949	38	1			This is an extremely important section as it should directly address concerns surrounding the rapidly decreasing potential of so-called Nature Based Solutions (NBS) in the mitigation context, as ecosystem services will break down rapidly with ongoing warming. A thorough discussion is needed here on the risks of relying too much on this mitigation measure for meeting climate targets. The resulting revised assessment should also be reflected in the ES so that it can be elevated further to the SPM.	In addition to this section, there is also text in the individual "sector chapters"	Government of Saint Kitts and Nevis	Department of Environment - Ministry of Agriculture, Marine Resources, Cooperatives, Environment and Human Settlements	Saint Kitts and Nevis
29339	38	1	39	45	There are many useful references in this section, but it is not clear what the takeaway is for mitigation.	We have reduced the Section - to make it more concise.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
48189	38	1	39	44	Please add some assessments on the impact of climate change on the carbon budget.Supporting documents: Liu, Z., Ballantyne, A.P., Poulter, B., Anderegg, W.R.L., Li, W., Bastos, A., Ciais, P., 2018. Precipitation thresholds regulate net carbon exchange at the continental scale. Nat. Commun. 9 (1), 3596. https://doi.org/10.1038/s41467-018-05948-1 . Zhang, Y., Goll, D., Bastos, A., Balkanski, Y., Boucher, O., Cescatti, A., Collier, M., Gasser, T., Ghattas, J., Li, L., Piao, S., Viovy, N., Zhu, D., Ciais, P., 2019. Increased global land carbon sink due to aerosol-induced cooling. Glob. Biogeochem. Cycles 33 (3), 439–457. https://doi.org/10.1029/2018GB006051 .	There reference seems too much "WG1" style. But we added a more generic comment and a reference to WG1	Yang Wang	Beijing Climate Center	China
76087	38	1			Important section. Please check what WGII and WGI (Ch12) are writing about this and insert links.	Checked but did not find direct links	Jan Fuglestedt	CICERO	Norway
66853	38	2	38	2	It is important to mention that most (all?) IAM scenario pathways do not consider these feedbacks from climate on energy demand and emissions projections.	Added	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
27617	38	6	38	10	The sentence needs to be edited.	Edits were made	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
65543	38	6	38	9	There are a couple of parenthesis that are not needed. In particular when references are added in the e.g.	Txs	Cristian Chadwick	University of Chile	Chile
7687	38	7	38	29	in arid and semi-arid mid latitude areas , increasing of temperature lead to increasing consumption of hydro electric energy , which noting to deficit of precipitation and water resources, applying clean energy in these areas will be necessary, including nuclear, sun and wind energy which have lowest environmental pollution and they are economic.	Did not understand comment	Leila Rashidian	Meteorological	Iran

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
7729	38	7			in arid and semi-arid mid latitude areas , increasing of temperature lead to increasing consumption of hydro electric energy , which noting to deficit of precipitation and water resources, applying clean energy in these areas will be necessary, including nuclear, sun and wind energy which have lowest environmental pollution and they are economic.	Did not understand comment	Leila Rashidian	Meteorological	Iran
9007	38	7	38	7	in arid and semi-arid mid latitude areas , increasing of temperature lead to increasing consumption of hydro electric energy , which noting to deficit of precipitation and water resources, applying clean energy in these areas will be necessary, including nuclear, sun and wind energy which have lowest environmental pollution and they are economic.	Did not understand comment	Behzad Layeghi	IRIMO	Iran
9677	38	9	38	9	There is a typo: the word "upward" is missing	Sentence was reowred	Mustafa Babiker	Saudi Aramco	Saudi Arabia
17593	38	9	38	9	"leading to both and". Missing word "upward" presumably	Sentence was reowred	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
5095	38	19	38	21	Explain mechanism behind chaning energy demands of lower/higher latitudes	Reworded	Lina Hollender	n/a	Germany
17595	38	31	39	12	On CO2 fertilisation: it might help the reader to cross reference chapter 7: section 7.2.2.5 and Cross Chapter Box 5	Added a more generic reference to Chapter 7	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
71321	38	31	38	31	How about the aquatc sphere?	Not much literature available.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
76089	38	31			Please check consistency with WGI CH5 and WGII and insert references	We added a ref to the land chapter	Jan Fuglestvedt	CICERO	Norway
23407	38	36	38	36	We recomand for this sentence to add the following reference : "Mima, S., & Criqui, P. (2015). The costs of climate change for the European energy system, an assessment with the POLES model. Environmental Modeling & Assessment, 20(4), 303-319.", as it gives an evaluation for the EU electricity sector of the impact of climate change on electricity demand and supply.	Added	Government of France	Ministère de la Transition écologique et solidaire	France
54907	38	38	38	48	While this is good information, suggest keeping the text in this section more closely tied to just the mitigation potential, not the specific impacts on crop yields.	We agree - took text out.	Government of United States of America	U.S. Department of State	United States of America
70173	38	38			Kim et al. 2017). Additional research suggests that mean annual temperatures of 25.4C or above results in sharp decreases in the longevity of tropical trees (Locoselli, et al 2020). https://doi.org/10.1073/pnas.2003873117	Now refered to Chapter 7 for more detail	Rayner Andersen	Department of Fisheries and Oceans	Canada
31617	38	39	38	46	We developed a model which couples land surface physics, ecosystems, water management, crop growth, and land use change (Yokohata et al. 2020). We found that the declines in crop yields results in increases in cropland area. Because of the increase in cropland area, water demands is also increases due to the expansion of irrigated cropland. We also found that the excluding CO2 fertilization can increase the cropland area because of decrease in crop yield. Yokohata T, Kinoshita T, Sakurai G, Pokhrel Y, Ito A, Okada M, Satoh Y, Kato E, Nitta T, Fujimori S, Felfelani F, Masaki Y, Iizumi T, Nishimori M, Hanasaki N, Takahashi K, Yamagata Y, Emori S (2020) MIROC-INTEG-LAND version 1: A global bio-geochemical land surface model with human water management, crop growth, and land-use change. Geosci. Model Dev., 13, 4713–4747, https://doi.org/10.5194/gmd-13-4713-2020	Now refered to Chapter 7 for more detail	Tokuta Yokohata	National Institute for Environmental Studies	Japan
65545	38	46	38	47	Is says "Studies that exclude CO2 fertilisation tend have more negative...", while it should say "Studies that exlude CO2 fertilisation tend to have more negative...". The word "to" is missing.	Text was taken out.	Cristian Chadwick	University of Chile	Chile
65437	39	1	39	2	Please could you specify which land-related GHG you are referring to?	Text has been made more generic and we refer to Chapter 7 now for more details.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
5017	39	11	39	11	Substitut "does..." with "do..." or delete it	Txs	Tiziana Susca	Italian National Agency for New Technologies, Energy and Sustainable Economic Development	Italy
75735	39	14	39	14	There is a "large amount of " literature	Don;t understand the comment	Alfred Ahenkorah	Regulatory	Ghana
23409	39	20	39	28	The two paragraphs are not very clear. For example, it is not easy to understand what mechanisms are at play in the assessments of climate impacts on emissions concerning sea-level rise in the second paragraph.	Hope the rewrite has made this clearer.	Government of France	Ministère de la Transition écologique et solidaire	France
75737	39	25	39	25	There is	Don;t understand the comment	Alfred Ahenkorah	Regulatory	Ghana

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54909	39	29	39	29	Because of the placement of this header at the very end of Section 3.3, it could appear that this is a synthesis of the entire 3.3 section, not just 3.3.3. Suggest clarification in the header text.	We removed the header	Government of United States of America	U.S. Department of State	United States of America
75739	39	30	39	30	There is ...	Don't understand the comment	Alfred Ahenkorah	Regulatory	Ghana
76091	39	30	39	31	Is the confidence statement here linked to that there is a limited number of studies? That is a bit strange, and not needed, I think.	Totally reworded the paragraph.	Jan Fuglestedt	CICERO	Norway
76417	39	40	39	42	While existing nuclear thermal plants may have reduced output in hotter periods, new plants can have larger condensers installed to compensate for this impact. They can also be sited at coastal locations where the impacts are minor. This paragraph failed to mention that hotter temperatures reduce solar PV output. There was no mention of the types of events that the polar vortices have on wind and solar output especially in the USA. In general nuclear thermal plants are more resistant to the impacts of climate extremes than are wind and solar generators.	Thank you. Given the size of the section we have not included this.	Robert Parker	Nuclear for Climate Australia	Australia
9085	40	1			This section includes many numbers and information. For the whole section, is it possible to add a table to summary key indicators of the transformations under 2C/1.5C, such as primary energy mix, electricity mix, end-use electrification rate, phasing-out time of conventional coal power plants, deployments of CCS and BECCS. Such table will help understand the required efforts clearer.	Noted. We have not added a table in the interest of space, but have reduced the numbers in the text to make this easier to read.	Xunzhang Pan	China University of Petroleum, Beijing	China
9871	40	5	40	8	Integrating sectoral analysis into systems transformations. <ul style="list-style-type: none"> • Sectoral studies typically include more detail and additional mitigation options compared to IAM pathways. However, sectoral studies miss potential feedback and cross-sectoral linkages that are captured by IAMs. Additionally, since IAMs include all emissions sources, these models can be used to identify pathways to a particular climate target. • For these reasons, the amount of mitigation observed in each sector in an IAM may differ from the potential mitigation in sectoral studies. Given the strengths and limitations of each type of model, IAMs and sectoral models are complementary, each providing an important perspective on mitigation. 	Noted. This is consistent with the current text	Government of Indonesia	Ministry of Environment and Forestry	Indonesia
50095	40	14	40	14	Please harmonize the examples of CDR with Chapter 12 (i.e., include ocean-based approaches, direct air carbon capture and STORAGE, rather than SEQUESTRATION)	Accepted. We have coordinated with Chapter 12	Masahiro Sugiyama	University of Tokyo	Japan
54911	40	14	40	16	For the military emissions included in the "Other" category of Table 3.3, what do those emissions include? Fuel use? Navigation? Logistics? Training? Military emissions transcend just buildings and infrastructure construction.	Accepted. Most models use data from the IEA. This is the ONONSPEC category which states "Military fuel use for all mobile and stationary consumption is included here (e.g. ships, aircraft, road and energy used in living quarters) regardless of whether the fuel delivered is for the military of that country or for the military of another country." We have added more information to the table	Government of United States of America	U.S. Department of State	United States of America
7731	40	18		19	One of high challenge world areas are Middle East and mid latitude which are oil producers which is cause of increasing of CO2 in atmosphere. It must be provided causes of decreasing consumption of fossil fuels and increasing clean energy in these areas.	Accepted. The energy supply subsection discusses energy transitions towards lower fossil fuel energy systems.	Leila Rashidian	Meteorological	Iran
9009	40	18	40	18	One of high challenge world areas are Middle East and mid latitude which are oil producers which is cause of increasing of CO2 in atmosphere. It must be provided causes of decreasing consumption of fossil fuels and increasing clean energy in these areas.	See response to comment 7731	Behzad Layeghi	IRIMO	Iran

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
12007	40	18	40	18	Some reference to marine based negative emissions techniques should be added for completeness of coverage (i.e., much of global capacity for enhanced sinks lies not on land but in the oceans. See GESAMP 2019. High Level Review of a Wide Range of Proposed Marine Geoengineering Techniques. GESAMP Reports and Studies. Joint Group of Experts on the Scientific Aspects of Marine Environment Protection.	Noted. These are discussed in the section on other CDR	Paul Rouse	Carnegie Climate Governance Initiative (C2G) - The Carnegie Council for Ethics and International Affairs	United Kingdom (of Great Britain and Northern Ireland)
29351	40	18	40	18	There is no discussion in this section or elsewhere of how electricity and liquids are produced. Given the discussion of end uses (buildings, transport, industry), it seems odd not to discuss how electricity and liquids production transform. Could this be included in the supply section or as additional subsections? Unless it is discussed in a different chapter for the same scenarios, it would be helpful to know how the electricity mix changes and how liquids production changes (total, as well as share of oil, biomass, BECCS, other).	Partially accepted. We have added some information, but more detail is provided in Chapter 6	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
14875	40	19			Primary energy increases in all scenarios? That seems to be an incorrect statement, as some scenarios show declining reliance on primary energy (as contrasted with useful energy).	Noted. The text has been revised to reflect the figure	Felix Creutzig	MCC Berlin & TU Berlin	Germany
50271	40	19			This section might also discuss briefly the decarbonization of the electricity sector, as this is a necessary condition for decarbonizing other sectors as mentioned in the following sub-sections. Also the shift within the energy supply sector might be mentioned here, as decarbonization scenarios rely more on electricity and hydrogen (hydrogen is shown in figure 3.18) than e.g. fossil fuel supply and processing.	Accepted. We have added information on electricity (both total and mix).	Matthias Weitzel	European Commission, Joint Research Centre	Spain
1833	40	24	40	26	Are peak emissions in 2020 realistic? Should this be considered in the selection of scenarios?	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
43037	40	28		30	"In order to meet the Paris targets, most scenarios require emission to peak in 2020 (Ch 3, p. 35 diagram), with CO2 emissions from energy supply reaching net-zero between 2030 and 2060." This is unlikely given current policies.	Rejected. Unfortunately, we are not sure what text this comment is addressing. The page/line mentioned does not say anything about emissions peaking	Graeme Taylor	BEST Futures	Australia
45829	40	28	40	31	Here again the results taken from the model set can be biased - as commented upon already in section 3.3. The high representation on CCS or CDR might be model driven (see discussions and explanations given in sections 3.3 and 3.9). Assessment of respective mitigations pathways should be done with care and results not be seen as need for CCS/CDR-deployment. Alternatives have please to be analysed more thoroughly instead throughout chapter 3 also considering recent and more detailed modelling approaches.	Accepted. We have revised this subsection in response to this and other comments. We have also included information from other modeling approaches where applicable.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
23411	40	29	40	31	This sentence suggests that in the second approach only negative emission sources like BECCS are used. We therefore recommend a clarification	Accepted. This sentence has been revised.	Government of France	Ministère de la Transition écologique et solidaire	France
23413	40	29	40	29	In the sentence "Two different approaches to 1.5°C are possible", please mention that they are to some extent complementary	Accepted. This sentence has been revised.	Government of France	Ministère de la Transition écologique et solidaire	France
29019	40	29	40	31	What about hybrid approaches?	Accepted. This sentence has been revised.	Jasmin Kemper	IEAGHG	United Kingdom (of Great Britain and Northern Ireland)
29343	40	29	40	31	These two options are not mutually exclusive, which could be implied by how the sentence is stated. "Two different approaches to 1.5°C are possible: (1) low carbon energy sources, including renewable energy, nuclear, fossil fuel with CCS and (2) negative emissions sources, like BECCS."	Accepted. This sentence has been revised.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
17597	41	1	41	2	In previous sections (e.g. page 33, line 36) net-zero years CO2 between 2040-260.. It is stated here 2030-2060 here	Noted. This sentence is about net zero for energy supply emissions only, not total emissions.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
23415	41	3	41	18	The figures for nuclear energy could be detailed in the text (only Baseline scenarios figures are included in page 40 line 24, and the Figure 3.16 is difficult to read).	Rejected. We have limited space. More discussion on energy systems are in Chapter 6.	Government of France	Ministère de la Transition écologique et solidaire	France
23417	41	3	41	12	We recommend to use a table complemented with simplified comments in plain words to replace this paragraph because it is difficult to read as it is	Partially accepted. We have revised the text to be easier to read.	Government of France	Ministère de la Transition écologique et solidaire	France
65441	41	3	41	3	Does 'these scenarios' refer to C1? Staying below 1.5? Please specify.	Accepted. This sentence has been revised.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
76419	41	3	41	31	The results shown in Figure 3.16 and the text including the CCS projections are the result of extremely high-risk scenarios. On page 68 lines 16 – 18 the highest performing decarbonisation scenarios which occurred in France and Sweden are outlined. Both were heavily reliant on nuclear energy. The example of Ontario could also be included. In the fullness of time the jurisdictions provide low-cost energy compared to regions that have tried to deploy high levels of renewables, especially wind and solar. The risks to achieving low emissions with the scenarios outlined in this report are: 1. Carbon capture and storage is proceeding only slowly with some 26 operational projects capturing up to 40Mt of CO2/yr. Significant operational issues lay ahead including reliability of operations, significant corrosion issues and energy demand. In the power sector, nuclear energy is significantly lower in cost – Ref Projected Costs of Generating Electricity – 2020 Edition, International Energy Agency. 2. Wind and solar with battery storage have significant Life Cycle Emissions. For solar plus batteries this of the order of 150 gr CO2/kWh. When supported by gas generators, additional transmission and ancillary services there is no reasonable prospect of achieving ultra low emissions. 3. Materials intensity of very high levels of material consumption in VRE systems will result in long term high lifecycle emissions that will prevent targets being met. This is already quite evident in Germany and the Australian State of south Australia. 4. As demonstrated in Germany, Denmark, California and in the Australian states of South Australia and Western Australia, VRE results in high retail costs of electricity despite low prices from the individual generators. Costs of subsidies, transmission, ancillary services, curtailment and support of standby generators and low system capacity factor combine to drive up costs. 5. Analysis of the Australian grid shows that for deep decarbonisation scenarios, a system that includes nuclear energy will have retail costs less than half those of a system that excludes it. Similar key findings were made in "The Cost of Decarbonisation : System Costs with High Shares of Nuclear and Renewable. OECD/NEI publication 7299.	Noted. Due to space limits, this section can only describe energy transitions in the pathways assessed. Issues related to feasibility are discussed in Section 3.8 and Chapter 6 provides more information on the challenges associated with scaling up different options.	Robert Parker	Nuclear for Climate Australia	Australia
78369	41	3	41	12	This text with all the numbers is virtually unreadable. It's all in the figure, just summarise high-level messages?	Accepted. We have removed the numbers from the text.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
65439	41	6	41	8	For Natural Gas scenarios: is it possible to include a short explanation on why scenarios that see high gas demand differ from those with low? I.e. do high gas demand scenarios rely more on CCS, for example? I see that is stated in line 23-34, but maybe you could move this up for clarity?	Noted. We have substantially revised the text in response to other comments.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
5235	41	10	41	10	please specify at the end of line : "renewable and nuclear energies"	Rejected. This isn't universally true in the scenarios. For this sentence to be correct, we need to discuss the two fuels separately.	Michel SIMON	Retraité/ Pdt d'association	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
9679	41	10	41	12	Why non-biomass energy contribution on average is less under 1.5c compared to 2c? Does that mean 1.5c on average results in lower overall energy supply in 2050?	Noted. This is due in part to sample bias. There is a different set of models & socioeconomic assumptions in the 1.5C bin than in the 2C bin.	Mustafa Babiker	Saudi Aramco	Saudi Arabia
54913	41	12	41	12	Only 33% electrification in the transportation sector for the most stringent mitigation scenarios seems very low, especially considering the chapter says that demand continues to grow. It would be nice to have a statement on other fuel switching that is seen in the various models and how the different fuel use breaks down by transportation mode.	Partially accepted. We have added information on natural gas use in transportation. However, due to space limits, we cannot go into detail by mode. This information is included in Chapter 10	Government of United States of America	U.S. Department of State	United States of America
30669	41	13	41	18	In Figure 3-16, only the C-1 scenario has a distinctive behavior. It is necessary to explain why this is the case.	Noted. This figure has been updated and C1 looks less distinctive	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
48601	41	13	41	14	Regarding Fig 3.16, as in Fig 3.13, it would be helpful to also show the IP icons on this figure. Ditto for Fig 3.17 and 3.18	Partially accepted. We have added a figure with IP indicators.	Karl Hausker	World Resources Institute	United States of America
45593	41	14	41	14	Would be useful to add similar graphs for natural gas and bio-energy (as the development is much less obvious than for e.g. non-bio renewables and coal).	Partially accepted. We have added bioenergy and added a table with additional indicators	Kornelis Blok	Delft University of Technology	Netherlands
48191	41	14	41	18	It is suggested to change "coal" to "fossil energy", or to list coal, oil and gas separately in Figure 3.16.	Accepted.	Yang Wang	Beijing Climate Center	China
66855	41	14	41	14	Is there a consistent colour scheme for scenario categorization across WG3? For example fig. 3.8 uses a different colour scheme. Also applies to fig 3.18, 3.19 and several other figures in this section. Fig. 3.34 uses a different scheme again. (Otherwise, great plots)	Accepted.	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
14877	41	15			The figure 3.16 would profit from higher resolution on the lower ranges (visuals dominated by outliers).	Accepted.	Felix Creutzig	MCC Berlin & TU Berlin	Germany
45595	41	15	41	18	Given that this is all primary energy, what is the convention used to represent primary energy in the case of nuclear? If the regular convention is used that in the case of nuclear it is thermal energy input, and in the case of solar and wind it is electricity output, then it is good to mention that in the caption.	Accepted. We are using direct equivalent.	Kornelis Blok	Delft University of Technology	Netherlands
61649	41	15	41	18	There were roughly 1000 vetted scenarios in the screened 1600 scenarios. In how many of the screened studies was nuclear constrained a priori, making the scenario more a "modelling exercise" than a serious, technology neutral scenario? In literature, one often encounters a study which assumed a priori no construction of new nuclear for one reason or another. Indeed, if nuclear is allowed with reasonable assumptions, it often fills a large share of the scenario, as in Nelson et al, 2014, https://www.osti.gov/servlets/purl/1163655 where the "new nuclear" scenario was the only technologically neutral one. Scenarios which leave important technologies such as nuclear energy out should be excluded and the statistical analysis repeated.	Noted. The discussion of the scenario database and vetting process is in Section 3.2.	Rauli Partanen	Think Atom	Finland
65689	41	15	41	18	There were roughly 1000 vetted scenarios in the screened 1600 scenarios. In how many of the screened studies was nuclear constrained a priori? In literature, one often encounters a study which assumed a priori constrains on new nuclear, and they appear to be present in the current draft as (see, e.g., Breyer et al. 2019ab in Chapter 12). The a-priori-constrained studies should be excluded from the vetted scenarios and the statistical analysis repeated.	See response to comment 61649	Eero Hirvijoki	Aalto University	Finland
37629	41	19	41	19	It seems that scenarios where CCS plays an important role have been selected. What about selecting scenarios where nuclear plays an important role.	Noted. We are reporting on the set of scenarios submitted to the AR6 database. We have not selected for scenarios that match any particular criteria. We have clarified this in the text.	Ravi B Grover	Homi Bhabha National Institute	India

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54915	41	19	41	31	Is the projected need for both CCS and BECCS feasible?	Accepted. We have added a short sentence on feasibility and referred the reader to Section 3.8 which discusses feasibility in more depth	Government of United States of America	U.S. Department of State	United States of America
37631	41	25	41	25	It seems that scenarios where BECCS plays an important role have been selected. What about selecting scenarios where nuclear plays an important role.	See response to comment 37629	Ravi B Grover	Homi Bhabha National Institute	India
15747	41	28	41	29	"Higher BECCS is associated with higher fossil fuel demand, which requires more BECCS to compensate for those emissions." This sounds like an endless loop, I would suggest to rephrase it a little bit, or to give more details	Accepted. This has been rephrased	Sara Budinis	International Energy Agency	France
52033	42	1	42	3	The scenarios cover hydrogen use from renewable and nuclear, but neglects other sources such as Blue Hydrogen. Include other options/sources.	Noted. This sentence has been revised in response to other comments. More detail on hydrogen can be found in Chapter 6	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
65443	42	1	42	3	Could you expand a little bit on the hydrogen section? How much is from nuclear, how much from RE? Is there still a significant amount of hydrogen derived from fossil fuel source (as today)? Maybe this could be added to Figure 3.18	Rejected. Because of space limits, we cannot expand this discussion. More information on the energy system is available in Chapter 6.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
1835	42	20	42	21	This seems highly relevant for all sectors. Has it been considered to contrast the IAMs with bottom up assessments more generically?	Accepted. We are now comparing IAM results to sector models in most subsections of Section 3.4	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
28659	42		42		Figure 3.17 - the C7 scenario seems to be on outlier from the rest, with much non-CCS coal, gas and biomass. Could be explained here? The text about Figure 3.17 on p41 is otherwise clear.	Noted. The C7 category includes a lot of high emissions, non-mitigation scenarios.	Tim Dixon	IEAGHG	United Kingdom (of Great Britain and Northern Ireland)
30671	43	1	43	4	In Figure 3-18, only the C-1 scenario has a distinctive behavior. It is necessary to explain why this is the case.	See response to 30669	Government of Japan	Climate Change Division - Ministry of Foreign Affairs	Japan
7691	43	5	43	8	because of increasing temperature in developed cities with abundant structures and towers and also asphalted avenues, the green roof plan must be noticed for decreasing albedo.	Partially accepted. Added a sentence on green roofs and energy efficiency, but literature is not conclusive.	Leila Rashidian	Meteorological	Iran
9011	43	5	43	5	because of increasing temperature in developed cities with abundant structures and towers and also asphalted avenues, the green roof plan must be noticed for decreasing albedo.	Partially accepted. Added a sentence on green roofs and energy efficiency, but literature is not conclusive.	Behzad Layeghi	IRIMO	Iran
23419	43	9	43	10	Concerning the sentence "Scenarios with lower temperature changes project smaller increases in total final energy use in buildings", we suggest to explain the two counteracting effect: more heating in temperate or cold region but less air conditioning everywhere	Taken into account. This sentence has been reformulated to avoid misunderstanding that climate impacts play a role here. These insights are only about mitigation, not about impacts or adaptation	Government of France	Ministère de la Transition écologique et solidaire	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
50273	44	4			The energy intensity is expressed per unit of GDP. The consequences of choosing this indicator (rather than an activity level, which arguably is hard to find and/or might not be reported) should at least be discussed, as this not only depends on energy efficiency of buildings, but also on the composition of GDP (e.g. share of industry, services, etc.). This applies also - potentially even more so - for Figures 3.21 and 3.22.	Noted. While we agree that the indicator of GDP is not ideal for the buildings sector, it is the best available indicator with the given dataset, as floor space (which would have been a better intensity indicator) is barely reported in the scenarios.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
1837	44	5	44	15	Very interesting discussion. Would be great to have more discussion throughout the chapter regarding the strengths and weaknesses and the overall feasibility of the IAM assumptions (see also later comments on the feasibility section)	Accepted. We have added more discussion on IAMs	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
85049	44	8	45	4	Clarification needed. Text and chart refer to the lower share of 'gas' or 'gases' versus electricity in final energy demand in the Building Sector. Is 'gases' inclusive of biogas and hydrogen, or just fossil methane? If the former, the work implies that electrification will be a more widespread/successful strategy for building decarbonisation than clean gas substitution. If this is the case, it would be worth bringing this judgment out more explicitly and assigning a confidence level to it. Intense national debates on policy and standards regarding building gas use will be influenced by this section and maximum clarity (including any qualifications or limitations in the modelling) would be helpful.	Accepted. Final energy consumption of gases includes natural gas, biogas and coal-gas. Hydrogen is reported separately. The text has been revised to reflect this.	Tennant Reed	Australian Industry Group	Australia
1839	45	16	45	26	There is a huge discussion around the land use and food and energy nexus + behavioural change that could be more directly referred to here, e.g. as a cross chapter reference. It is also relevant in the demand side discussion.	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
65549	45	20	45	20	The reference "Edelenbosch et al." is missing the year.	Accepted. References have been corrected	Cristian Chadwick	University of Chile	Chile
29345	46	1	46	1	In the transport section, it would be helpful to have a figure (similar to buildings - Fig 3.20) that shows how different energy carriers change (electricity, liquids, gases, H2)	Accepted. We have made the figures consistent between the three demand sectors, adding shares of fuels to the transport figures.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
14879	46	4			The figure 3.21 looks like that the transport sector is based on outdated assumptions in model runs. Models of logistic technological change suggest that EV adoption could be high enough to drive out fossil-fuel based vehicles in 2035-2040 from markets and 2050 from the roads. That's doesn't seem to be reflected, as indicated in the bottom right panel. Also, the negative emissions from the transport sector appear to be based on a theory that electrification is not gonna happen. While this is a theoretical plausibility, this thought experiment dominates the visuals. Even more, the negative emission pathways in the transport sector are not explained in the text. Suggest to delete the negative emissions component from the figure. If there is an argument that this should nonetheless be considered, insert a sentence in the main text to explain this option.	Accepted. We have updated the figure to the latest database and the negative emissions pathways no longer appear in the figure. We have also added a panel on shares of electricity in transport.	Felix Creutzig	MCC Berlin & TU Berlin	Germany
23421	47	10	47	10	Concerning the percentage 58%, we recommend to specify the base year	Noted. We have added the base year whenever % changes are reported.	Government of France	Ministère de la Transition écologique et solidaire	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
79117	47	11	47	13	I'll comment on the Transport chapter (and don't know how changes there feed back to Ch 3 or higher-level summaries), but I'm surprised to see only 23–43% electrification in the 1.5° scenarios. There's now (March 2021) such a strong business case for electrifying autos that e.g. VW, the world's biggest automaker, expects half its 2030 US and China auto sales to be electric, and >70% in EU, while GM says it'll stop making fueled autos by 2035 and Volvo by 2030, and many govts will ban new fueled autos by various dates 2025–40. Tesla's Semi Class 8 electric truck also shows a powerful business case, extendable to medium trucks. Vehicle/grid interactions powerfully reinforce electrification: e.g. The Mobility House (Zürich) earns ¥1000 per automotive battery pack (in inventory or in or retired from an active vehicle) whose 10, soon 13, ultimately 21 services the firm can sell to the grid; this will of course saturate, but the market is immense. It's also now clear that electric airplanes will take short- and some medium-haul markets, while green hydrogen will win intercontinentally. Shipping, led by Maersk, is demonstrating and intends to shift to renewably-made NH3 or LH2. Buses, trains, and 2–3-wheelers are rapidly electrifying. What transport is left? The IAMs' story of only ~1/3 transport electrification told here is seriously outdated; it seems only the bottom-up studies, some showing complete decarb possible by 2050, got it right (47:17). This merits more pointed discussion.	Accepted. We have added some text on electrification, comparing to sectoral studies.	Amory B. Lovins	Rocky Mountain Institute; also Adjunct Professor of Environmental & Civil Engineering, Stanford University	United States of America
71323	47	14	47	18	This seems highly relevant for all sectors. Great to contrast the IAMs with bottom up assessments for all sectoral insights	Accepted. We have added comparisons to sectoral studies in all subsections	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
85051	47	19	47	31	The note here about the limitations of IAM transport assessment would be a good place to add the observation that the COVID-19 pandemic has highlighted the significant scope for telework and communications technology to substitute for a share of transportation services.	Rejected. In the interest of space, we have not added information on this here, as this chapter is focused on long-term	Tennant Reed	Australian Industry Group	Australia
78371	47	25	47	31	As I recall, in AR5 BU and TD were said to get similar answers. If this conclusion has changed, should flag.	Accepted. Whether BU & TD agree depends on the sector, study, and time frame. We have adjusted the text to be clearer and have elevated some comparisons to the executive summary.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
81031	47	26	47	26	After "Creutzig et al. 2016", add another reference: "Julien Lefèvre , Yann Briand , Steve Pye , Jordi Tovilla , Francis Li , Ken Oshiro , Henri Waisman , Jean-Michel Cayla & Runsen Zhang (2020): A pathway design framework for sectoral deep decarbonization: the case of passenger transportation, Climate Policy, DOI: 10.1080/14693062.2020.1804817"	Accepted	Yann BRIAND	Iddri, Sciences Po	France
29347	48	1	48	1	In the industry section, it would be helpful to have a figure (similar to buildings - Fig 3.20) that shows how different energy carriers change (electricity, coal, biomass, liquids, gases, H2)	Accepted. We have made the figures consistent between the three demand sectors, adding shares of electricity and gas to the industry figures.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
65445	48	1	49	38	Could you be more specific about defining "industry". I can find references to steel, ammonia, plastics and pulp throughout the report, but there is no coherent outline to what is being referred to exactly.	Noted. We have a table at the beginning of the section defining all sectors.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
7693	48	11	48	19	decreasing fossil fuel of factories and increasing of nuclear fuels in factories to decrease of CO2 issue from factories.	Rejected. Unfortunately, I do not know what is being suggested by this comment.	Leila Rashidian	Meteorological	Iran
9013	48	11	48	11	decreasing fossil fuel of factories and increasing of nuclear fuels in factories to decrease of CO2 issue from factories.	Rejected. Unfortunately, I do not know what is being suggested by this comment.	Behzad Layeghi	IRIMO	Iran

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
47245	48	12	48	14	In light of discussing aggregate public scenarios in the AR6DB, I find it a bit weird to handpick 2 specific (IMAGE) studies here that look into more subsectoral trends (van Ruijven and Daiglou) - especially as these studies have never been part of a MIP that have been collected in AR6 DB collection. I am in favour of highlighting the high variety in subsectoral responses, particular in terms of mitigation strategies. Ideally consolidate or merge this with CH11(Industry) authorship.	Rejected. IPCC assess all available literature published since AR5, which includes many papers and scenarios that are not included in the AR6 database. IMAGE is one of the few models that includes industrial sector detail, so its papers appear in this subsection.	Mariësse van Sluiseveld	PBL Netherlands Environmental Assessment Agency	Netherlands
15751	48	20	48	22	If this refers to baseline scenarios then it should be moved to the previous paragraph	Noted. We have clarified that this sentence is referring to mitigation scenarios	Sara Budinis	International Energy Agency	France
71325	48	20	48	23	The concept of energy conservation versus energy efficiency was introduced and discussed by Lebot et al. in 2004, Lebot, B., P. Bertoldi, and P. Harrington. 2004. Consumption versus efficiency: Have we designed the right policies and programmes? In Proceedings of the ACEEE 2004 Summer Study on Energy Efficiency in Buildings. Washington: American Council for Energy Efficient Economy. More recently the same topic as been further analysed by Ruzzenenti F., Bertoldi P. (2017) Energy Conservation Policies in the Light of the Energetics of Evolution. In: Labanca N. (eds) Complex Systems and Social Practices in Energy Transitions. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978-3-319-33753-1_7 . It is recommended to cite Ruzzenenti and Bertoldi.	Rejected. This sentence is about quantitative mitigation pathways in the industrial sector in the future. The suggested citation is focused on more conceptual issues and on the past.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
72305	48	20	48	23	The concept of energy conservation versus energy efficiency was introduced and discussed by Lebot et al. in 2004, Lebot, B., P. Bertoldi, and P. Harrington. 2004. Consumption versus efficiency: Have we designed the right policies and programmes? In Proceedings of the ACEEE 2004 Summer Study on Energy Efficiency in Buildings. Washington: American Council for Energy Efficient Economy. More recently the same topic as been further analysed by Ruzzenenti F., Bertoldi P. (2017) Energy Conservation Policies in the Light of the Energetics of Evolution. In: Labanca N. (eds) Complex Systems and Social Practices in Energy Transitions. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978-3-319-33753-1_7 . It is recommended to cite Ruzzenenti and Bertoldi.	Rejected. This sentence is about quantitative mitigation pathways in the industrial sector in the future. The suggested citation is focused on more conceptual issues and on the past.	bertoldi paolo	europaen commission	Italy
9015	48	42	48	42	developing woods strips in arid and semi-arid areas specially in western Iraq because of prevention of soil erosion and dust storms.	Rejected. Unfortunately, I do not know what is being suggested by this comment.	Behzad Layeghi	IRIMO	Iran
52035	49	1			CCS for industrial applications can result in significant CO2 emission reductions. This has been introduced in many sections of the report as well and should be emphasized in SPM as it provides alternatives for decision makers.	Noted. CCS is discussed in this section as suggested by the reviewer. The content in the SPM is being revised to address the comments made there.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
47219	49	2	49	4	It warrants to mention here that the chemical sector representation in Diaoglou et a. (2014) has >no< technology representation (and therefore no CCS technology representation). It is a purely feedstock substitution model. So obviously, the potential is much lower as it does not take any technological innovations for production into account. Upcoming work by van Sluiseveld et al (in review with minor revs, submitted before the cutoff date) shows updated industry representations of the Daiglou and van Ruijven representations in the IMAGE framework (rendering the chemical sector and steel sector carbon emissions free with specially designed scenarios). van Sluiseveld, M.A.E. and de Boer, H.S. and Daiglou, V. and Hof, A.F. and van Vuuren, D.P. (in review, minor revs and submitted before cutoff date) " A race to zero - assessing the position of heavy industry in a global net-zero CO2 emissions context"	Partially accepted. We will add the van Sluiseveld citation. However, given space limits, we cannot add detail on the differences between the two papers.	Mariësse van Sluiseveld	PBL Netherlands Environmental Assessment Agency	Netherlands

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
10445	49	3	49	3	In line 3, after "... availability of CCS, with larger potential reductions in the steel sector..." , could you please add "and the cement industry (Sanjuán et al.)"? Reference: Sanjuán, M.A.; Argiz, C.; Mora, P.; Zaragoza, A. Carbon Dioxide Uptake in the Roadmap 2050 of the Spanish Cement Industry. <i>Energies</i> 2020, 13, 3452. https://doi.org/10.3390/en13133452	Accepted.	Aniceto Zaragoza	Oficemen	Spain
11601	49	3	49	3	In line 3, after "... availability of CCS, with larger potential reductions in the steel sector..." , could you please add "and the cement industry (Sanjuán et al.)"? Reference: Sanjuán, M.A.; Argiz, C.; Mora, P.; Zaragoza, A. Carbon Dioxide Uptake in the Roadmap 2050 of the Spanish Cement Industry. <i>Energies</i> 2020, 13, 3452. https://doi.org/10.3390/en13133452	Accepted.	PEDRO MORA PERIS	UNIVERSITY	Spain
44039	49	3	49	4	please also cite the cement sector, which will be one of the main users of CCS	Accepted.	Stefano Caserini	Politecnico di Milano	Italy
44041	49	5	49	14	Although Chapter 4 already deal with mitigation and development pathways in the near- to mid-term, I suggest providing here information about 2050. They could be informative, just to more easily compare the figure for the distant 2100 with mid-term values	Noted. We have removed most of the numbers from the text to make it more readable.	Stefano Caserini	Politecnico di Milano	Italy
47221	49	5	49	5	Does ' final energy' entail gross energy here (reflecting both energy and non-energy demand), or does it reflect only the energy needs for energy uses?	Accepted. We have clarified this in the text.	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
47225	49	9	49	9	Direct electrification or also including indirect electrification routes? (e.g. on-site electrolysis)	Accepted. We have clarified this in the text.	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
47223	49	11	49	11	Please be aware that in the current industrial decarbonisation debate this is a really weird conclusion (with large steel producers converting to H-DRI / green steel production processes, etc)	Noted.	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
15753	49	12	49	14	The reported range for CO2 capture in industry seems small - the IEA has recently reported CO2 capture in 2070 for the industrial sector to be equivalent to around 3,000 Mt in 2070, for a climate scenario in line with the Paris agreement, therefore way above what reported here in the text (max = to 600 Mt/year). Reference: ETP 2020 Special Report on Carbon Capture Utilisation and Storage: CCUS in clean energy transitions https://www.iea.org/reports/ccus-in-clean-energy-transitions)	Noted. The numbers have been updated.	Sara Budinis	International Energy Agency	France
15755	49	12	49	14	' CCS (0 to 5.4 Gt captured)" this seems more in line with the upper range I would expect for industry (see previous comment)	Noted. The numbers have been updated.	Sara Budinis	International Energy Agency	France
29349	49	15	49	16	Would it be possible to comment on industrial feedstocks? Is this represented separately in the models? Does demand for feedstocks continue to increase and does the energy continue to be provided by liquids? "The representation of the industry sector is very aggregate in most IAMs, with only a small subset of models disaggregating key sectors such as cement, fertiliser, chemicals, and iron and steel."	Accepted. We have added a sentence on feedstocks	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
47227	49	15	49	17	Cited references can be supplemented with IAM studies that have included a more integrated subsectoral focus, such as: Napp, T.A., Few, S., Sood, A., Bernie, D., Hawkes, A., Gambhir, A., 2019. The role of advanced demand-sector technologies and energy demand reduction in achieving ambitious carbon budgets. <i>Applied Energy</i> 238, 351-367. van Sluisveld, M.A.E. and de Boer, H.S. and Daiglou, V. and Hof, A.F. and van Vuuren, D.P. (in review, minor revs and submitted before cutoff date) " A race to zero - assessing the position of heavy industry in a global net-zero CO2 emissions context"	Accepted	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
71327	49	15	49	21	Very interesting discussion. Would be great to have more discussion throughout the chapter regarding the strengths and weaknesses and the overall feasibility of the IAM assumptions	Accepted. We have added more discussion.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
85055	49	15	49	21	This would be a good place to include and cross-reference the conclusions in Chapter 11 page 11-5 lines 5-11 about missing effective mitigation options and potential overestimation of mitigation costs.	Accepted.	Tennant Reed	Australian Industry Group	Australia

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
79119	49	17	49	21	Excluding materials efficiency and circular economies is extraordinarily important. You should cite the Energy Transitions Commission's pathfinding 2018 Mission Possible (augmented by Making Mission Possible, Sep 2020) showing that both heavy transport and industrial process heat can be globally fully decarbonized by 2050 at modest cost (a small fraction of 1% of GDP). RMI's in-press April 2021 technical synthesis and MIT Sloan Management Review's June 2021 in-editing business-strategy paper (both by A B Lovins and extensively reviewed, the former provided to WG3 in Nov 2020) show such decarbonization should actually be profitable in private internal cost, thanks partly to options ETC overlooked or greatly overscoped for saving upwards of half the cement and steel, either through tedious conventional incremental improvements or through an uncounted alternative solution space—materials-efficient structural design and business models that reward it. Without mentioning such findings, few readers will realize that not just circularity but materials efficiency make all the difference between substantial and zero industrial CO2 in 2050—a or the dominant emissions term in most long-run scenarios. Thus 47:17–21 needs flashing red lights and a summary section of its own. In essence, it says the whole industrial analysis misses in IAMs, and greatly understates even in bottom-ups, an unexpected but well-documented term that can decarbonize global industry completely by 2050 at modest to negative cost—dependent, of course, on decarbonizing electricity, a vibrant trend reinforced by bidirectional lock-in with competitive advantage in the end-use sectors (featured in my Sloan Mgt Rev paper). Surely this merits major emphasis.	Partially accepted. We have added some additional context around what is missing in IAMs. However, given page limits, we cannot add as much detail as suggested and have referred the reader to Chapter 11.	Amory B. Lovins	Rocky Mountain Institute; also Adjunct Professor of Environmental & Civil Engineering, Stanford University	United States of America
47229	49	19	49	19	" may" can be removed, industrial representation should be emphasized as a caveat here that needs an urgent research focus. Particularly in light of current developments, these technology pathways are reflective of what was the norm a decade ago. The industry itself has moved forward incredibly - with current breakthrough technologies and strategies not represented in these scenarios. Linkages to circularity and material stocks are indeed a big caveat - also an underscored limitation in Ch. 11.	Accepted	Mariëse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
15757	49	33	49	35	Please refer to the latest publications if possible - 2015 IEA ETP is now outdated	Noted. The paper cited compares to 2015 IEA ETP and we cannot change the underlying literature. However, given space limits, we have removed this note on IEA.	Sara Budinis	International Energy Agency	France
47231	49	33	49	33	The authors should consider the relevance of emphasizing the difference of two >dated< scenario studies in a rapidly changing field of discussion. Next to potentially looking into 2 different policy realities in these studies which could have affected the different outcomes (van Ruijven did a random ctax study), the debate in the IEA ETP work has also shifted to an overall focus on CCS in the cement sector.	Accepted. We have revised this sentence to deemphasize.	Mariëse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
23423	49	36	49	36	We suggest to replace the term "the industry" with "in most energy intensive industries".	Accepted	Government of France	Ministère de la Transition écologique et solidaire	France
47233	49	36	49	38	Authors should emphasize the representational capacity in models: Its not just the long-lived nature of capital stock in these models that dictate the restricted mitigation potential - it is also the lack of a policy/emissions objective for industry in models, lack of representation of maintenance cycles for capital intensive assets (e.g. relining of BFs every 20 years, could be a window of opportunity to switch), underestimation of cost improvements for breakthrough innovations, lack of low-carbon materials or material substitution etc. All these together result in a very conservative picture of capital turnover. To name a few, see also CH.11 (industry)	Noted. This sentence is about the effects of delayed action and not why capital turnover in general.	Mariëse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
23425	49	39	49	39	Section 3.4.5 does not rely on the same scenarios framework used elsewhere in the report, which reduces somewhat its significance. Results from scenarios of low demand (1.5-LD) or without net negative emissions (1.5-NBZ or <2-NBZ) would have greatly enriched the analysis.	Accepted. This section has been revised to be more consistent with the rest of the chapter.	Government of France	Ministère de la Transition écologique et solidaire	France
24905	49	39	53	24	The discrepancies in land CO2 fluxes between IAM and GHGIs (and the possible way forward) as described in Ch 7.2.2.5 and in Cross-chapter Box 5 in chapter 7 is very relevant also for this chapter. An explicit reference to this box is needed in this ch 3.4.5. Furthermore, I encourage authors to consider adding in the text some additional information on the medium/long-term implication of box 5 in ch 7. These implications are potentially relevant - i.e. . the "remaining GHG budget" as perceived by countries could be reduced when IAMs' results are made "comparable" to country GHGI and climate plans - but not well know yet.	Accepted. We have added text and a reference to Chapter 7 + the box.	Giacomo Grassi	Joint Research Centre, European Commission	Italy
83603	49	39	50	23	This discussion could be further strengthened by also highlighting the gross land-use fluxes in CO2. These are never shown, but even if only for a couple of scenarios, they would provide really interesting insights for readers. For example, to understand that gross CDR is something that one needs to count on and plan for, even to simply reach net zero CO2 levels (in the AFOLU sector, or more economy-wide).	Rejected. Unfortunately, we don't have the necessary data in the database to do this comprehensively.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
7695	49	40	49	45	developing woods strips in arid and semi-arid areas especially in western Iraq because of prevention of soil erosion and dust storms.	Rejected. Unfortunately, we are not clear on what the reviewer is suggesting	Leila Rashidian	Meteorological	Iran
23427	49	41	49	41	The ter1 "mitigation" should be replaced with "CDR" or "sequestration" for purposes of consistent terminology. I interpret "mitigation" in the highlighted text to refer to carbon withdrawals from land use. If this is correct, "mitigation" does not come across as sufficiently distinct from "emissions reductions".	Partially accepted. We have updated the terminology to be clearer; however, this specific sentence was revised in response to other comments.	Government of France	Ministère de la Transition écologique et solidaire	France
23429	49	41	49	43	Concerning Figure 3.23a it doesn't seem clear that most of the emission reductions come from forest-related measures. We suggest a clarification about the point in time that this comment refers to. The situation is completely different before and after 2050. Cumulatively over the period, it seems that most of the emission reductions come from the BECCS.	Noted. We have replaced this figure in response to other comments on this section	Government of France	Ministère de la Transition écologique et solidaire	France
23431	49	41	49	42	Concerning the term "emissions reduction", it should somehow be clarified that this regards net emissions reductions, for instance by adding "net" before "emissions reductions", or alternatively by adding "and sequestrations" after "emission reductions"	Partially accepted. We have updated the terminology to be clearer; however, this specific sentence was revised in response to other comments.	Government of France	Ministère de la Transition écologique et solidaire	France
29021	49	41	49	44	Aren't they only reported as a memo item, not being counted in the country's emissions total, because they are already counted as harvesting emissions in the origin country's AFOLU?	Noted. We have revised this text and the approach to bioenergy in this section in response to other comments	Jasmin Kemper	IEAGHG	United Kingdom (of Great Britain and Northern Ireland)
52039	50	1	50	2	Modelled pathways for AFOLU must realistically include Fossil Fuel CCS not just BECCS.	Noted. Most modelled pathways do include fossil fuel CCS. This is discussed in the sections on energy supply and industry.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
65447	50	1	50	3	This is a really interesting and crucial point. Can it be expanded? What about regenerative agriculture? Soil sequestration? How do these findings fit with the general term 'nature-based-solutions'?	Accepted. We have added additional information	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
65553	50	9	50	23	Figure 3.23 a has a black line, but it does not say what it is. Most likely it is the net CO2eq. per year, but it is not clear. A legend is needed or an explanation in the caption at least.	Noted. We have replaced this figure in response to other comments on this section	Cristian Chadwick	University of Chile	Chile
65555	50	9	50	23	Figure 3.23 b could have a "Wourld" bar, just as figure c.	Noted. We have replaced this figure in response to other comments on this section	Cristian Chadwick	University of Chile	Chile
65557	50	9	50	23	Figure 3.23 has some Figures titles that are slightly cut by the figures, making it a bit difficult to read.	Noted. We have replaced this figure in response to other comments on this section	Cristian Chadwick	University of Chile	Chile

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
83199	50	9	50	23	This is a very good figure/approach because it is not CO2 only and therefore better represents the challenges in the AFOLU sector. It is confusing (and downplaying the challenge) that removals from BECCS are accounted towards AFOLU and not energy. There might be good reasons for that, but then the whole chapter (and probably the whole report) should use the same accounting approach	Noted. We have replaced this figure in response to other comments on this section	Geden Oliver	German Institute for International and Security Affairs	Germany
14881	50	10			Panel C: should y-axis unit be Gt, not Mt? Double check.	Noted. We have replaced this figure in response to other comments on this section	Felix Creutzig	MCC Berlin & TU Berlin	Germany
14883	50	10			High reliance on BECCS in models. Later it becomes clear that there are also other CDR options. Yet, model statistics continue to focus on BECCS, mostly because it had been the first CDR option implemented. Arguably, because it's the logical continuation from CCS and from having bioenergy in the model. In that sense, it's a path dependent results of models, not a more or less plausible option compared to other CDR options. Yet, the visuals imply that only BECCS deserves explicit attention. That's a message a substantial part of the non-IAM literature on CDR does not agree with. See e.g. the systematic reviews on NETs in ERL. See also p. 24 of Chapter 12.	Noted. This figure has been completely revised and does not include BECCS anymore. BECCS is covered in other subsections	Felix Creutzig	MCC Berlin & TU Berlin	Germany
24907	50	11	50	23	Please add "The AFOLU CO2 estimates in this figure are not necessarily comparable with country GHG inventories (see Chapter 7)".	Partially accepted. We have revised this figure, but have added a note in the caption of the new figure showing AFOLU CO2	Giacomo Grassi	Joint Research Centre, European Commission	Italy
1841	50	32	50	32	More specific coverage of mitigation potentials by sectors would be interesting	Rejected. Mitigation potential by sector is covered in Chapter 12	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
1843	50	39	50	39	The IPs were introduced many pages ago and need a bit of elaboration/recap here for the reader to be able to follow them. This includes the figure 3.32, where a clearer denomination of the five IPs is needed	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
1845	51	2			Does 'supply' mean energy supply? Be clearer. Same goes for other figures.	Partially accepted. This particular figure did not include the word "supply", but we have clarified it in all figures that did	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
65559	51	3	51	10	Figure 3.24 b could have a "World" bar, just as figure c.	Noted. We have replaced this figure in response to other comments on this section	Cristian Chadwick	University of Chile	Chile
54917	51	5	51	5	Figures 3.23 and 3.24 could potentially be combined into one.	Noted. We have replaced this figure in response to other comments on this section	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
1847	51	6	51	9	The link between the IPs and the entire scenario data base is unclear. The text jumps from one to the other without explanation	Noted. The link between the IPs and the database is described earlier in the chapter	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
23435	51	15	51	24	We suggest to add to this paragraph the following elements : the avoided impacts on agriculture if mitigation starts earlier and the long-term effect of late mitigation depend very much on assumptions about the deployment potential of the BECCS.	Accepted	Government of France	Ministère de la Transition écologique et solidaire	France
78373	51	15	51	15	That's the WG I definition of mid-term. Wg III is 2030-50	Accepted. We have fixed this.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
85053	51	15	51	18	There are a couple of errant extra words here. Line 15: remove "the" from "...the moving mitigation earlier...". On line 17-18, remove the second "in" in "...However, the carbon price increases in the mid-term in when mitigation starts earlier."	Accepted	Tennant Reed	Australian Industry Group	Australia
23433	51	16	51	17	We recommend a clarification about how can irrigation and fertiliser use be reduced while agricultural intensification increases.	Noted. This text has been removed due to space limits and other comments on this subsection	Government of France	Ministère de la Transition écologique et solidaire	France
45831	51	18	51	24	Please include the potential effects on biodiversity as well, as biodiversity might be affected by a long-term increase of demand for land (see chapter 7).	Accepted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
65449	51	18	51	19	"In addition, land pressure increases due to increased bioenergy deployment, leading to higher food prices, lower food demand and a higher risk of hunger" can you reference this statement?	Noted. This subsection has been revised in response to this and other comments. References have been added.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
86765	51	18	51	19	The production of some types of bioenergy do not hamper food security as it is based on food residues, having no effect on food prices and hunger as they do not compete with food supply. We suggest the following wording (added language in capital letters and deleted wording between brackets): "In addition, IN SOME CASES land pressure increases due to increased bioenergy deployment (,leading to higher food prices, lower food demand and a higher risk of hunger)".	Noted. This subsection has been revised in response to this and other comments.	Government of Argentina	Ministry of Environment and Sustainable development of Argentina	Argentina
9681	51	19	51	21	Shifting mitigation earlier also increases carbon price and mitigation costs in the short term -- so there is a trade off between short and long term as indicated in table 3.4 that needs to be mentioned in the text	Accepted.	Mustafa Babiker	Saudi Aramco	Saudi Arabia
37749	51				This statement "In addition, land pressure increases due to increased bioenergy 19 deployment, leading to higher food prices, lower food demand and a higher risk of hunger." deserves some clarification. It is not a new observation that there is considerable reliance on BECCS embedded in this (and previous) reports. But the practicalities of these proposed "solutions" remains undemonstrated, and the outlook appears more complex than might be desired. See here, for example (with the appropriate link to the original reference:): https://www.newscientist.com/article/2270227-carbon-negative-crops-may-mean-water-shortages-for-4-5-billion-people/	Noted. This subsection has been revised in response to this and other comments.	Robert Buhr	Green Planet Consulting Ltd.	United Kingdom (of Great Britain and Northern Ireland)
8089	52	1	52	7	Table 3.4: Please check and revise table. Only forest protection is included here, what about afforestation / reforestation?	Noted. We have replaced this table in response to other comments on this section	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
24909	52	2	52	5	Please add "The AFOLU CO2 estimates in this table are not necessarily comparable with country GHG inventories (see Chapter 7)".	Partially accepted. We have revised this figure, but have added a note in the caption of the new figure showing AFOLU CO2	Giacomo Grassi	Joint Research Centre, European Commission	Italy

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
50097	52	2	52	7	Table 3.4 is unclear about the statistical test used (t-test?), and the sample size is missing.	Noted. We have replaced this table in response to other comments on this section	Masahiro Sugiyama	University of Tokyo	Japan
29023	52	6	52	7	-800 US\$2010/t CO2 as a carbon price?	Noted. We have replaced this table in response to other comments on this section	Jasmin Kemper	IEAGHG	United Kingdom (of Great Britain and Northern Ireland)
54919	52	6	52	7	The format of this table makes it difficult to decipher.	Noted. We have replaced this table in response to other comments on this section	Government of United States of America	U.S. Department of State	United States of America
1849	52	10	52	10	economy-wide needs more elaboration	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
17599	52	11	52	11	Please double check the numbers of per hectare estimates.	Accepted. These numbers have been corrected.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
23437	52	17	52	21	The large difference between the IAM estimates and the National GHG inventories suggests that IAMs may overestimate the potential of forest carbon sequestration in the EU and UK. The question is therefore more about the reliability of IAMs projections - what influence can this have on the results? - rather than about the location of afforestation/reforestation activities.	Noted. We have revised this section, removing the discussion of forest carbon in regions and adding a discussion on comparing models to inventories.	Government of France	Ministère de la Transition écologique et solidaire	France
23439	53	1	53	1	in the sentence "For example, afforestation rates in the EU and UK were approximately", I didn't notice that this has been defined as a country grouping EU + UK would be more explicit. Maybe replacing the plural "afforestation rates ... were" by a singular would help	Noted. We have removed this in response to other comments.	Government of France	Ministère de la Transition écologique et solidaire	France
6019	53	12	53	24	The report says "eventually the carbon sink in AFOLU will saturate..." While this has been established for labile carbon stocks both above and below ground, it has not been established for recalcitrant stocking below ground (biochar, bio-oils, pyrolytic carbon, etc.) which take molecular forms less subject to normal soil organic matter degradation processes Application rates of 90t/ha are recommended for degraded soils (Omulo, Biochar Potential in Improving Agricultural Production in East Africa, DOI: 10.5772/intechopen.92195 2020) and while yield benefits may decline above annual applications of 165 t/ha (Rondon M, Lehmann J, Ramirez, J, Hurtado M., Biological nitrogen fixation by common beans (<i>Phaseolus vulgaris</i> L.) increases with bio-char additions. <i>Biology and Fertility of Soils</i> . 2007;43:699-708), at the avoided emissions market value of \$87.5/t CO2e, adding biochar would be economically beneficial to farmers whether beneficial or non-beneficial of greater crop yield. (Filiberto, David M., and John L. Gaunt. "Practicality of biochar additions to enhance soil and crop productivity." <i>Agriculture</i> 3, no. 4 (2013): 715-725. DOI: 10.3390/agriculture3040715). Tree crops have been grown with biochar amendment of 18500 t/ha (Ogawa, M., Okimori, Y. & Takahashi, F. Carbon Sequestration by Carbonization of Biomass and Forestation: Three Case Studies. <i>Mitig Adapt Strat Glob Change</i> 11, 429–444 (2006) DOI:10.1007/s11027-005-9007-4). Field cabbages have been grown in 100% biochar substrate. (Nanjing Agricultural University). An annual application of 100 t biochar/ha would yield ~62tC/ha sequestered after 100 years for each year the practice continued. (Ilan Stavi (2013) Biochar use in forestry and tree-based agro-ecosystems for increasing climate change mitigation and adaptation, <i>International Journal of Sustainable Development & World Ecology</i> , 20:2, 166-181, DOI: 10.1080/13504509.2013.773466). While saturation of labile C is well documented, the assumption of a similar saturation level for recalcitrant C applied to AFOLU is, for now, unwarranted.	Noted.	Albert Bates	Global Village Institute	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
8091	53	12	53	24	Please revise this paragraph. The rather static view on sink capacity of terrestrial vegetation and soil neglects the ties to other sectors and biomass use is attributed to these other sectors. Besides, limitations in the modelling framework(s) employed here may restrict the field of view in this regard. For example, sustainable forest management systems with a high share of timber harvested and being used in (long-living) products with a high potential to substitute fossil fuel intensive materials are an old, proven example of CCU. The challenge is thus to broaden the view from the mere in situ carbon stocks to the annual net carbon sequestration including CCU. AFOLU can thus even contribute to carbon reduction targets even when the balance in AFOLU is zero. This may not show up properly in IAM and this may lead to inferior analyses and sub-optimal recommendations.	Partially accepted. This paragraph has been revised in response to this and other comments.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
23441	53	12	53	13	We suggest that in the sentence "Finally, there is high agreement that terrestrial vegetation and soil have a finite capacity to accumulate carbon stocks", the time dependent dynamics of the process be more explicit	Accepted. We have revised this paragraph.	Government of France	Ministère de la Transition écologique et solidaire	France
23445	53	12	53	24	Concerning this paragraph, non CO2 emissions reduction could be discussed as well	Partially accepted. More discussion of AFOLU non-CO2 has been added to this subsection	Government of France	Ministère de la Transition écologique et solidaire	France
24911	53	12	53	24	This paragraph is useful and clear. I suggest (here or elsewhere) to add few additional words of caution on the capacity of IAMs to represent forest-related dynamics. For example (taken from Grassi et al. in review): "IAMs include simplified and/or incomplete representations of land-use change and management (Popp et al. 2017), including the role of forest management in promoting biomass expansions and thickening (Kauppi et al. 2020) and the impact of forest demography (Pugh et al. 2019)". I also suggest a reference to Chapter 7.2.2.5 and to cross-chapter box 5 within this chapter 3.4.5. REFS: Popp, A. et al. Land-use futures in the shared socio-economic pathways. Glob. Environ. Chang. 42, 331–345 (2017). Kauppi, P. E. et al. Carbon benefits from Forest Transitions promoting biomass expansions and thickening. Glob. Chang. Biol. 26, 5365–5370 (2020). Pugh, T. A. M. et al. Role of forest regrowth in global carbon sink dynamics. Proc. Natl. Acad. Sci. U. S. A. 116, 4382–4387 (2019).	Accepted. We have revised this paragraph.	Giacomo Grassi	Joint Research Centre, European Commission	Italy
85305	53	12	53	18	This is a key finding, with high policy relevance. It should be reflected in the SPM, or at least in the Technical Summary.	Noted. We have added this to the chapter's executive summary	Kaisa Kosonen	Greenpeace	Finland
23443	53	15	53	15	In the sentence "The timescale to reach saturation...", we suggest to clarify what happens after saturation	Accepted.	Government of France	Ministère de la Transition écologique et solidaire	France
65313	53	18	53	21	This is a really important point - it should be in the summary, because it is not widely understood and NBS are being viewed as a substitute for mitigating anthropogenic drivers, which is of serious concern.	Noted. We have added this to the chapter's executive summary	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
14885	53	25			The chapter appears to report results in proportion to IAM papers dealing with technologies. But that is IAM phenomenology. Because of higher potential for technological learning in technology intensive CDR options, such as DACCS, and more importantly, the potentially highly destructive effects of large-scale BECCS, more attention on non-land-based CDR is warranted.	Noted. The chapter is assessing the literature on mitigation in long-term pathways. We can only assess what has been published.	Felix Creutzig	MCC Berlin & TU Berlin	Germany
45833	53	25	53	47	This subsection does not refer to the complicated scale-up of CDR options that needs to be mentioned when presenting mitigation pathways that include CDR. Please revise.	Partially accepted. We have added a sentence referring the reader to Chapter 12 where these issues are discussed.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
84413	53	28	53	41	Regarding the article by Realmonte et al. (2019), please note the important exchange with Chatterjee and Huang (2020) (https://doi.org/10.1038/s41467-020-17203-7) and Ralmonte et al. (2020) (https://doi.org/10.1038/s41467-020-17204-6) regarding the need for life cycle analyses and evaluations about whether DACCS will be worth the effort or not.	Noted. This information is included in Chapter 12, which goes into more depth on individual options.	Mattias Lantz	Uppsala university	Sweden
74805	53	33	54	6	consider correcting inconsistent in-text reference style in chapter-4	Accepted. References will be formatted during the copy edit	Government of Kenya	Kenya Meteorological Service	Kenya

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
6017	53	34	53	34	The report says "Only a small number of studies and pathways include other CDR options." While biochar is mentioned in the AFOLU context in the preceding section and in Chapter 7 at 7.4.3.2 on pages 79-80, since 2017 the total number of papers published on biochar has more than tripled from 17000 to >57000, and a substantial fraction relate to non-agricultural, non-forestry, hence "other CDR" applications. See, e.g.: Bates and Draper, Burn: Using Fire to Cool the Earth (Chelsea Green: 2019) which projects a potential for non-AFOLU biochar CDR at >40 GtCO ₂ -1y. See too: Roychand, R, S Patel, P Halder, S Kundu - Journal of Building, (2021) "Recycling Biosolids as Cement Composites in Raw, Pyrolysed and Ashed Forms: A Waste Utilisation Approach to Support Circular Economy." Elsevier. https://www.sciencedirect.com/science/article/pii/S2352710221000553 ; Q. Hu, J. Jung, D. Chen, et al., Biochar industry to circular economy, Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2020.143820 .	Noted. This section (like the chapter as a whole) is focused on long-term mitigation pathways. Estimates of potential in a given year are reported in Chapter 7.	Albert Bates	Global Village Institute	United States of America
19883	53	34	53	47	Please insert after "other CDR options.": "While most modeling studies focus on conventional BECCS, a rapidly growing number of studies is examining variants of BECCS (waste biomass burning with CCS) and other CDR options that are being considered for pilot activities (enhanced weathering, biochar, soil carbon enrichment, enhanced forest carbon stocks, using wood in construction, or accelerated mineralization in cement) (Honegger et al. 2020, Plaza et al. 2020)". Reason: This section overlooks a rapidly growing body of (non-modeling) literature on diverse CDR options other than conventional BECCS. New references: Honegger, M., Michaelowa, A., & Roy, J. (2020). Potential implications of carbon dioxide removal for the sustainable development goals. Climate Policy, 1-21. Plaza, M. G., Martínez, S., & Rubiera, F. (2020). CO ₂ Capture, Use, and Storage in the Cement Industry: State of the Art and Expectations. Energies, 13(21), 5692.	Rejected. CCS in the cement sector is covered in the industry subsection. The discussion on effects of individual CDR options on sustainability is covered in Chapter 12.	Axel Michaelowa	University of Zurich	Switzerland
15759	53	35	53	35	"up to 37 GtCO ₂ yr-1 in 2100" this level of capture and storage from the air seems extremely optimistic (for reference: the IEA Sustainable Development Scenario for 2070 has DACCS capture equivalent to less than 300 Mt/year, source: https://www.iea.org/reports/ccus-in-clean-energy-transitions). Under which circumstances would it be possible to deploy DACCS to this level of capture? What would this mean in terms of energy, emissions and land footprint?	Accepted. We have added information on what this level of deployment means.	Sara Budinis	International Energy Agency	France
63545	53	40	53	47	Lines 40-41 and 46-47 both refer to deployment levels of non AFOLU CDR options as being dependent in part on the strength of carbon cycle feedbacks. Ideally, a bit more explanation could be provided here about how the strength of these feedbacks influence the efficacy of CDR. If space is limited, then perhaps a cross reference to the WGI report would be suitable, assuming this topic is covered by WGI.	Accepted. We have added a reference to WGI	Government of Canada	Environment and Climate Change Canada	Canada
20181	53	41	53	42	See also: - Babacan, O., De Causmaecker, S., Gambhir, A., Fajardy, M., Rutherford, A. W., Fantuzzi, A., & Nelson, J. (2020). Assessing the feasibility of carbon dioxide mitigation options in terms of energy usage. Nature Energy, 5(9), 720-728.	Accepted. We have added this citation	Nikas Alexandros	National Technical University of Athens	Greece
70133	53	43			(Creutzig et al. 2019). A range of studies has shown that DACCS powered by fossil fuels would likely result in net-positive emissions, contrary to the desired results (National Academies of Sciences, 2019) https://cmi.princeton.edu/wp-content/uploads/2019/12/Pacala-NAS-study-2019.pdf	Partially accepted. We have added this citation, but did not use the phrasing suggested by the reviewer	Rayner Andersen	Department of Fisheries and Oceans	Canada
84415	53	43	53	43	Not sure if it fits well exactly here, but here is an interesting paper going through the feasibility for DACCS with new and existing nuclear power plants, using the waste heat. Dmitry Grishchenko and Pavel Kudinov, "Feasibility study for coupling of Nuclear Power Generation with Green House Gas capture", Proceedings of ICAPP 2020, 15-19 March 2020 – Abu Dhabi (UAE), Paper 20537. https://scienceforsustainability.org/papers/AGW/mitigation/CDR/DAC_coupling_with_NPPs.pdf This is also investigated for the Sizewell C nuclear power plant.	Noted. Thank you for the suggestion, but this section is on the deployment of CDR options in mitigation pathways. Feasibility is discussed in Section 3.8	Mattias Lantz	Uppsala university	Sweden
54921	53	45	53	45	"... find that CO ₂ removal is spread options ..." Unclear what this means.	Accepted. There were some words missing. The sentence now reads "CO ₂ removal is spread across available options"	Government of United States of America	U.S. Department of State	United States of America
78375	54	1	61	37	In my view, 3.4.7 is higher level than the other material in Section 3.4 and could come earlier. It includes aggregate IP and warming level insights. Even in 3.3?	Accepted. We have moved this to the beginning of section 3.4	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
63547	54	4	54	9	In this introductory paragraph about demand side mitigation, please clarify whether or not energy efficiency improvements are part of the parcel of demand-side mitigation options excluded from current models. This is unclear and it would help to be specific about this. It would also be helpful to give a few examples of what is being considered in scenarios that explicitly look at additional demand side options. Is this a reference to changes in behaviour and lifestyle and to urban form etc? As written the text in this and subsequent paragraphs is very generic.	Accepted. We have clarified this.	Government of Canada	Environment and Climate Change Canada	Canada
1851	54	7	54	8	Suggest to also reference the UNEP Emissions Gap Reports here.	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
53	54	8	54	9	The exclusion of some demand-side options in IAMs is noted. But on the other hand, so too is the adequate inclusion of energy rebound in the IAMs following demand-side interventions, and this should be acknowledged in the passage of text, i.e. yes you need more demand side options in IAMSA, but you also need more / a better inclusion of rebound too in teh models, to avoid them being too optimistic in terms of energy reductions. REF: Brockway P. E., Sorrell S.R., Semieniuk G., Heun M.K., Court V. (2021) Energy efficiency and economy-wide rebound effects: a review of the evidence and its implications, Renewable and Sustainable Energy Reviews. In review.	Accepted. We have added this citation	Paul Brockway	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
3973	54	8	54	9	The exclusion of some demand-side options in IAMs is noted. But on the other hand, so too is the adequate inclusion of energy rebound in the IAMs following demand-side interventions, and this should be acknowledged in the passage of text, i.e. yes you need more demand side options in IAMs, but you also need more / a better inclusion of rebound too in teh models, to avoid them being too optimistic in terms of energy reductions. REF: Brockway P. E., Sorrell S.R., Semieniuk G., Heun M.K., Court V. (2021) Energy efficiency and economy-wide rebound effects: a review of the evidence and its implications, Renewable and Sustainable Energy Reviews. Available at: https://doi.org/10.1016/j.rser.2021.110781	See response to comment 53	Paul Brockway	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
23447	54	13	54	14	We suggest a clarification concerning the meaning of "demand side" for AFOLU	Accepted. We have clarified the concept of demand-side in this section	Government of France	Ministère de la Transition écologique et solidaire	France
65561	54	13	54	13	There is a reference that says "Creutzig et al. (Creutzig et al. 2016)", but I think it should be written as "Creutzig et al. (2016)".	Accepted	Cristian Chadwick	University of Chile	Chile
1853	54	14	54	16	Again, the issue of the chosen probabilities and why 50% is chosen for 1.5 versus 66% for 2 degrees Celsius	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
83903	54	16	54	20	For balance with these references showing additional potential for curbing energy demand, the recent study by Semieniuk et al. (2021) discusses reasons to do in particular with industrialization of developing countries why energy demand may be higher than depicted by certain modeling exercises that abstract from how economic growth is achieved. This also reinforces and expands on the point made earlier by Steckel et al. (2013). I recommend citing these two studies, full references for which are: Semieniuk, G. et al. (2021) 'Plausible energy demand patterns in a growing global economy with climate policy', Nature Climate Change, Accepted M. https://doi.org/10.1038/s41558-020-00975-7 Steckel, J. C. et al. (2013) 'Development without energy? Assessing future scenarios of energy consumption in developing countries', Ecological Economics, 90, pp. 53–67. doi: https://doi.org/10.1016/j.ecolecon.2013.02.006 .	Accepted. We have added these citations	Gregor Semieniuk	University of Massachusetts Amherst	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
1855	54	19	54	21	Is it possible with slightly higher overshoot? And can the 'strongly increase challenges to stay below 2°C' be specified more?	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
37589	54	19	54	20	The paragraph might be misleading. The carbon price levels in the scenarios with low demand would depend on whether the energy demand is exogenous or endogenous. If the energy demand is exogenous, the carbon price would be low. But, if the demand is reduced endogeneously due to high carbon price, it might not be the case.	Accepted. This has been removed	Young-Hwan Ahn	Sookmyung Women's University	Republic of Korea
245	54	21	54	27	Why is the lack of proper incorporation of efficiency and sufficiency not an exclusion criteria for scenarios? It is widely agreed that efficiency is a major strategy to reduce emissions and any scenario that can not represent this perpetuates the wrong notion that there is no way around large scale negative emission technologies.	Rejected. The paragraph says that not all scenarios include strong demand-side reductions, not that models don't include efficiency. Some of these are explicit design choices to understand the implications of high versus low demand.	Kai Kuhnnehn	Konzeptwerk Neue Ökonomie	Germany
71329	54	21	54	21	The IPs were introduced many pages ago and need a bit of elaboration/recap here for the reader to be able to follow them. This includes the figure 3.25, where a clearer denomination of the five IPs would be helpful	Rejected. In the interest of space, we cannot repeat information covered elsewhere in the Chapter	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
1857	54	36	54	38	This statement is difficult to follow in terms of where it comes from.	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
1859	55	1	55	4	formatting issue	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
1861	56	1			The figure can be improved, e.g. by giving a bit more space and prominence to the 2020-2030 time period, etc. The overall message one gets from looking at it is that 1.5 is truly mission impossible. Another issue is whether the figure should look at the entire range of 1.5 to 2 degrees as the PA relevant range?	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
1863	56	10	56	10	Here you have 66% probability, which I find more relevant than 50% as alluded to in previous comments.	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
65315	56	10	56	21	Again, the findings on reduced demand leading to reduced need for BECCS, etc (and their consequences at large scale to biodiversity, food security, etc, etc) need to be spelled out more clearly in the summary. Policy makers need clear language to best understand the opportunities they have today to influence transformation, sustainable demand rather than leave young and future generations with fewer, more dangerous and risky options.	Accepted. We have revised the executive summary	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
63549	56	16	56	18	The wording here is rather odd: "while the other pathways show positive emissions compensating for gross negative emissions..". Consider rephrasing as "while the other pathways have limited or no net negative emissions due to similar magnitudes of gross negative CO2 emissions and positive CO2 emissions". It might also be useful to elaborate here that in some such scenarios (e.g. 1.5C-NBZ), there is limited net negative CO2 emissions due to both large positive and large negative emissions balancing out (after 2050), whereas in other scenarios (e.g. 1.5C-LED), the limited/no net negative CO2 emissions is achieved by a balance between small residual positive emissions and small gross negative emissions.	Noted. This text and the figure were removed, as they were redundant with information in Section 3.2	Government of Canada	Environment and Climate Change Canada	Canada
17601	57	1	57	1	In Figure 3.26: the "NDC" panel label should be "Modest Action"?	Noted. This figure has been removed since it was duplicative of one in Section 3.2, but we have revised all IP labels.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
29353	57	1	57	1	What is included in supply in Fig 3.26? Is this only electricity, with emissions from liquids shared out to end uses? If so, it might be clearer to change the label from "supply" to "electricity". Alternatively, or in addition, more explanation could be provided in the caption.	Noted. This figure has been removed since it was duplicative of one in Section 3.2, but supply was referring to energy supply	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
65563	57	1	57	4	Figure 3.26 has several subplots empty. Why is this? It is not clear, also each row or column of subplots have a meaning? This issues makes it difficult to read.	Noted. This figure has been removed since it was duplicative of one in Section 3.2	Cristian Chadwick	University of Chile	Chile
83203	57	1	57	4	Assuming that "supply" is mainly/only energy (supply) you should get "energy" somewhere into the figure legend (here and in other IP-related figures), otherwise readers will be confused	Noted. This figure has been removed since it was duplicative of one in Section 3.2, but supply was referring to energy supply	Geden Oliver	German Institute for International and Security Affairs	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
79121	57	7	57	9	There's an important missing sentence after this, saying that some stringent mitigation scenarios (starting with Grubler et al 2018) do not require net negative emissions from energy supply—only from natural systems—because they more seriously examine end-use efficiency, resulting in lower energy-system and mitigation costs.	Accepted.	Amory B. Lovins	Rocky Mountain Institute; also Adjunct Professor of Environmental & Civil Engineering, Stanford University	United States of America
1865	57	17	57	29	Also relevant to refer to UNEP Emissions Gap Reports here	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
23449	57		57		Concerning figure 3.26. It would be useful to take the same names of IP as in figure 3.5.	Noted. This figure has been removed since it was duplicative of one in Section 3.2, but we have revised all IP labels.	Government of France	Ministère de la Transition écologique et solidaire	France
71331	57				Suggest to change 'supply' to energy supply to make the figure more reader friendly. Same goes for other figures. Furthermore, the figure is difficult to grasp with the blank elements	Accepted. This figure has been removed since it was duplicative, but we have implemented these suggestions on all other figures.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
1867	58	1			This is a potentially very interesting figure, but needs to become clearer and the legends need revision (get rid of the MES-GLOB, IMAGE, etc. and clearly indicate what these are and why they are considered specifically rather than as part of the overall scenario data base (refer to the IPs))	Rejected. It appears the reviewer is not looking at the SOD version of this Chapter. This comment does not align with the text cited and unfortunately we are not sure what text this comment is addressing.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
29355	58	1	58	1	Please clarify the term "supply" in Fig 3.27.	Noted. This figure was redesigned.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
65565	58	1	58	8	Figure 3.27 has in the horizontal axis the scenarios, and the only reference to the scenarios is Section 3.2, making it a bit difficult to properly read. The Figure would be easier to read if it also had the subsection, a specific table or figure for the reader to go and understand the Scenarios.	Noted. This figure was redesigned.	Cristian Chadwick	University of Chile	Chile
43069	58	8		14	However, SRM is not a replacement for CDR—while it can lower temperatures, it cannot remove CO2. More R&D on SRM is urgently needed: “In the context of mitigation pathways, only a few studies have examined solar radiation management (SRM) finding that when accounting for risks and impacts, globally optimal SRM does not reduce the need for mitigation. Nonetheless, SRM has a significant option value and can help deal with tipping points but the full range of social risks should be considered.”	Accepted. We have revised this paragraph in response to this comment and comments from other reviewers	Graeme Taylor	BEST Futures	Australia

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
29723	58	9	58	15	With regards to SRM, the inclusion in Chapter 3 seems out of scope. The only reference to SRM in the outline to this report is to Chapter 14, and then only about "Ethics and governance". Elements of what i mentioned here seems to fit better in Chapter 14. Please consider deleting this para. We also find it surprising that you actually use the term Geoengineering.	Partially accepted. We have removed the word "geoengineering" and revised the text in response to other review comments. However, we have kept this mention of SRM in the Chapter since there is literature on its inclusion in long-term pathways.	Government of Norway	Norwegian Environment Agency	Norway
47173	58	9	58	15	Solar radioation modification (SRM): SRM coverage is problematic and does not adequately point to caveats and risks	Accepted. We have added a note on caveats and risks.	Stuart Minchin	The Pacific Community	Australia
63551	58	9	58	15	Some parts of this paragraph about the role of SRM in mitigation pathways are unclear. 1. What is meant by "too much geoneengineering is used"? Too much relative to what? 2. What is meant by "SRM has significant option value"? This is technical terminology perhaps; not readily understood. 3. For balance, (in addition to, or instead of referring to the potential use of SRM to avoid tipping points), it would be appropriate to refer to the potential use of SRM in reducing peak temperatures within a broad portfolio of measures to reduce the risks of climate change, that prioritize mitigation and adaptation. See for example the 2015 US NAS report on Climate Intervention: reflecting sunlight to cool earth.	Accepted. We have revised this paragraph in response to this comment and comments from other reviewers	Government of Canada	Environment and Climate Change Canada	Canada
65317	58	9	58	15	This summary of findings is clearer than what is in the introductory summary on SRM. Would encourage improvement at the beginning, to ensure the findings are understood/grasped.	Noted.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
71333	58	9	58	15	This SRM paragraph is ok. However, it should also be stated that SRM is outside of scope for the definition of mitigation taken in WG3, is subject to different political agreements than those covering regulation of GHGs, and is addressed mainly in WG1.	Partially accepted. We have added references to WGI, as well as the cross-working group box on SRM	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
80199	58	9	58	12	The "finding" represented in this sentence (that SRM does not reduce the need for mitigation) is perjorative and misleading as possible while being correct in the narrowest, most binary sense. It is therefore policy-perscriptive and a mischaracterization of both the cited and broader literature. Instead, the literature universally supports nearly the opposite formulation: that even when accounting for risks and impacts, globally optimum SRM reduces climate impacts, lowers the costs of mitigation, and extends the window for sociotechnical transition. It is therefore a complement to mitigation, but not a replacement. Furthermore, these effects are substantial and ethically meaningful; Emmerling and Tavioni 2018a reports 11 Trillion USD in avoided climate impacts, most of which accrue to Africa and Asia. Ariona 2016 quantify the value of the mere availability of SRM as a potential response as at least 2.3 Trillion USD. Huetel 2016 shows the welfare differences are very high in magnitude in the presence of multiple types of tipping points, including economic. A more warranted and policy-relevant reformulation of the statement follows: "...finding that globally optimum SRM may reduce climate impacts and extend the time available to achieve mitigation and just transition. These findings are robust to uncertainty in costs and risks of SRM; however, these uncertainties are large and can dramatically change the amount of SRM used in optimal climate policies." References: Tavoni, M., Bosetti, V., Shayegh, S., Drouet, L., Emmerling, J., Fuss, S., Goeschl, T., Guivarch, C., Lontzek, T.S., Manoussi, V. and Moreno-Cruz, J., 2017. Challenges and opportunities for integrated modeling of climate engineering. Heutel, G., Moreno-Cruz, J. and Shayegh, S., 2018. Solar geoengineering, uncertainty, and the price of carbon. Journal of Environmental Economics and Management, 87, pp.24-41. Helweggen, Koen G., Claudia E. Wieners, Jason E. Frank, and Henk A. Dijkstra. "Complementing CO 2 emission reduction by solar radiation management might strongly enhance future welfare." Earth System Dynamics 10, no. 3 (2019): 453-472.	Partially accepted. We have revised this paragraph in response to this comment and other comments. However, we did not use the exact phrasing proposed by the reviewer.	Kelly Wanser	SilverLining	United States of America
83201	58	9	58	9	Please use "solar radiation modification", as established in SR1.5	Accepted.	Geden Oliver	German Institute for International and Security Affairs	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
83207	58	9	58	15	This paragraph should be better linked to ch14, which now not only has a section on SRM governance but also a cross-WG box on SRM	Accepted.	Geden Oliver	German Institute for International and Security Affairs	Germany
50099	58	10	58	10	"Arinoa" should be "Arino." The reference (perhaps Mendeley too) should be corrected.	Accepted.	Masahiro Sugiyama	University of Tokyo	Japan
80201	58	12	58	13	This sentence uses the term "geoengineering" which has been deprecated in AR6, for the more specific term "solar radiation management".	Partially accepted. We have removed geoengineering, but are using "solar radiation modification", as established in SR1.5	Kelly Wanser	SilverLining	United States of America
80203	58	12	58	13	This is not the most relevant statement regarding SRM and international cooperation. Instead, analysis of SRM in strategic contexts has consistently found that lack of cooperation is dependent on the degree of uncertainty about SRM's costs and impacts. The greater the uncertainty, the greater the room for disagreement based on beliefs about SRM effectiveness. Critically, studies find that while lack of cooperation can lead to deviations from the global optimum amount of SRM, the realized uncoordinated SRM amount is still positive and welfare enhancing versus a scenario of no SRM. References: Meiera, F. and Traegerb, C., 2020. Solar Geoengineering in a Regional Analytic Climate Economy. Manoussi, V., Xepapadeas, A. and Emmerling, J., 2018. Climate engineering under deep uncertainty. Journal of Economic Dynamics and Control, 94, pp.207-224. Flegal, J.A., Hubert, A.M., Morrow, D.R. and Moreno-Cruz, J.B., 2019. Solar geoengineering: social science, legal, ethical, and economic frameworks. Annual Review of Environment and Resources, 44, pp.399-423.	Accepted. We have revised this sentence in response to this and other coments.	Kelly Wanser	SilverLining	United States of America
14951	58	13	58	15	The presentation of SRM as a helpful option to prevent tipping points from being reached must not be maintained in the way it is currently presented. The statement does not adequately reflect the vast uncertainties around SRM, both in the technical aspects as well as in the social, political and ethical dimensions.	Accepted. We have edited this paragraph and added information on uncertainties.	Government of Saint Kitts and Nevis	Department of Environment - Ministry of Agriculture, Marine Resources, Cooperatives, Environment and Human Settlements	Saint Kitts and Nevis
23451	58	13	58	15	Unless it is mentioned elsewhere, we recommend to point out that SRM has never be tested at the scale required, and the logistics of worldwide deployment are unclear. On the governance side, the need to maintain SRM deployment for perhaps centuries would require a multigenerational commitment never experienced before.	Noted. The cross-chapter box on SRM covers these issues. We have added a reference to that.	Government of France	Ministère de la Transition écologique et solidaire	France
80205	58	13	58	15	The statement that SRM "can help deal with tipping points" is vague and misleading, and does not faithfully represent the cited paper's most policy-relevant conclusion. A risk-management framing requires that the tradeoffs between strategies under deep uncertainty be compared. The most relevant characteristic of SRM in the context of tipping points is that it is the only potential strategy that can reduce both physical and economic damages AFTER a tipping point is reached. This is because SRM has the potential to rapidly influence the climate that cannot be replicated with mitigation or CDR, due to the lags between GHG concentration and temperature. A more informative statement would be: "...and may be the only effective response available to reduce damages after a tipping point has occurred."	Partially accepted. We have revised this paragraph in response to this comment and other comments. However, we did not use the exact phrasing proposed by the reviewer.	Kelly Wanser	SilverLining	United States of America
83205	58	13	58	13	Please don't use "geoengineering" as an analytical term (see COGS)	Accepted	Geden Oliver	German Institute for International and Security Affairs	Germany
39041	58				"In the context of mitigation pathways, only a few studies have examined solar radiation management (SRM) (Emmerling and Tavoni 2018a,b; Arinoa et al. 2016), finding that when accounting for risks and impacts, globally optimal SRM does not reduce the need for mitigation..." That's one way to put it. But it also completely elides the issue of whether any such attempts are (a) practical, (b) straightrtfoward, or (c) understood well enough to encompass all possible outcomes. This is a large planetary experiment that's being considered--having the only observation being one about "well, we have to mitrigate anyway" doesn't seem to advance the discourse here very much.	Noted. A more in depth discussion of these issues is included in the cross-working group box on SRM, which is now referenced here.	Robert Buhr	Green Planet Consulting Ltd.	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
60345	59	1	60	12	The section on timing of net zero emissions need to highlight modelling uncertainties upfront to not be misunderstood. The timing of the net zero year per sector is largely determined by the input assumptions of the models. The models used usually have less detailed mitigation options for buildings and transport and therefore project a later net zero year. As example, the statement "The energy supply sector typically decarbonises before the economy as a whole, while the demand sectors decarbonise later" could be reworded into "The models project that the energy supply sector typically decarbonises before the economy as a whole, while the demand sectors decarbonise later, because..." The fast development of electric vehicles in transport and heat pumps in buildings are often not covered by the models as such exponential growth is difficult to predict. The current section could be interpreted that the transport and budling sectors can lean back and that zero emissions is not expected from them.	Accepted.	Niklas Höhne	NewClimate Institute	Germany
74807	59	1	59	3	circular markers in Figure 4.4, panel b should be explained to make the figure more understandable	Rejected. There is no figure 4.4 on page 59	Government of Kenya	Kenya Meteorological Service	Kenya
83605	59	1	60	12	The discussion of the timing of net zero emissions should include a discussion of how the net-zero timing depends on near-term emissions levels. That information can then help to interpret how emissions reductions ranges in 2030 relate to range of net zero timings for a given scenario category. (Or maybe that's covered in the next section - please ignore if that would be the case)	Accepted	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
47235	59	2	59	19	It may be good to underscore more clearly here that all studied scenarios reflect a net-zero economy by 2050 and that the indicators in Fig 3.28 do not say anything about the 'technically assumed available mitigation potential' per sector (or that Fig 3.28 does not prescribe a mitigation level for policy makers, SBTs, etc). Its just an artefact of how the model and scenario exercise is parameterised (with negative emission potentials shifting the mitigation profile as mentioned). Fig 3.28 would have been more meaningful if MIPs would have run scenarios with subsectoral net-zero emission targets, for apple-apple comparisons.	Rejected. All scenarios do not reach net zero by 2050	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
76093	59	2	59	2	You may add "in the scenarios addressed here" at the end of the sentence	Accepted	Jan Fuglestedt	CICERO	Norway
17603	59	10	59	11	On the choice of discount rate and its implications on timing of net zero: can you please expand further and provide details as to how this has been dealt with in the scenarios submitted to the database. Thanks	Accepted	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
23453	59	16	59	17	We suggest to take into account that the problem with scenario modelling is not only that they often include CDR options and exclude demand-side mitigations options such as changes in life-style, it is also that they assume that CDR options are readily available and speculate on "early deployment". With the exception of afforestation/reforestation none of the CDR technologies are at deployment stage.	Noted. These issues are covered in Section 3.8	Government of France	Ministère de la Transition écologique et solidaire	France
52043	59	16	59	17	CDR Could be deployed early on to reduce temperature overshoot. This important to include in the SPM.	Noted	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
76095	59	22	59	22	"later than in sectoral model": This is important. You have a brief explanantion of why, but this could also need further attention when synthesized in SPM. And also some reflections on how to use the different model results together. It also needs to be reflected on the sectoral chapters.	Noted	Jan Fuglestedt	CICERO	Norway
17605	59	26	59	26	In figure 3.28: the transport sector never reaches net zero under C1, which implies it should never reach net zero under C2-7. However it seems from the figure that it does reach net zero under C2. Please elaborate. Even when looking at the argument in the previous paragraph: "decarbonisation of the transport sector does occur in IAMs when carbon prices are sufficiently high" that doesn't explain why transport decarbonises in C2 but not C1, given that C-prices in C1 are the highest. I hope I understood this correctly.	Noted. This figure has been updated and the specific comment here is no longer relevant	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
83209	59	26	59	31	Please highlight in the figure that this is about net zero CO2 only (since good figures tend to get used in isolation later), by adding CO2 to "Year of Net Zero" (right) and "reach net egative values" (caption)	Accepted.	Geden Oliver	German Institute for International and Security Affairs	Germany
63553	59	27	59	27	Figure 3.28. This is a very easy to understand figure illustrating differences in the timing of net zero carbon emissions across sectors. Consider using this Figure as an alternative to the box and whisker plots in Figure SPM.7 and the corresponding figure in the Technical Summary.	Noted	Government of Canada	Environment and Climate Change Canada	Canada
1869	60	1			Same as above. Very difficult to follow this figure	Noted. This figure has been removed.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
71335	60	1	60	2	Explain why LAM reaches net zero before the world.	Noted. We have removed this figure and discussion in response to other comments and due to space limits	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
17607	60	8	60	8	Figure 3.29: the x-axis values (years) could be presented vertically / diagonally for better readability	Noted. We have removed this figure and discussion in response to other comments and due to space limits	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
65567	60	8	60	8	The scenario names in Figure 3.29, are too distant from their respective figures, making it difficult to understand which scenarios corresponds to each figure.	Noted. We have removed this figure and discussion in response to other comments and due to space limits	Cristian Chadwick	University of Chile	Chile
83211	60	8	60	12	Assuming that "supply" is mainly/only energy (supply) you should get "energy" somewhere into the figure legend, otherwise readers will be confused. Also, "buildings" sector is not mentioned in legend	Noted. We have removed this figure and discussion in response to other comments and due to space limits	Geden Oliver	German Institute for International and Security Affairs	Germany
9683	60	13	61	37	please make forward reference to chapter 12 section 6 which deals in more detail with cross-sectoral mitigation linkages.	Accepted.	Mustafa Babiker	Saudi Aramco	Saudi Arabia
14887	60	15			The subheading sounds promising. However, the content is nearly exclusively about bioenergy. On sector coupling, arguably one of the most important developments post AR5, there is one sentence only (l.15 ff). That topic would deserve much more attention. Moreover, the word "sector coupling" is not mentioned once (p. 47 goes a bit into this --> electrification).	Accepted.	Felix Creutzig	MCC Berlin & TU Berlin	Germany
80323	60	18	60	20	The decarbonization process is already a consolidated commitment for some countries, what is seen as necessary, perhaps, is the standardization of a submission of the model to see the applicability of energy policies in other countries that are not yet signatories.	Rejected. Unfortunately, we are not sure what the reviewer is suggesting in this comment	JUAN DIAZ	Association	United States of America
37633	60	29	60	31	Include pathways that do not constraint available options, and come up with a least cost option.	Rejected. Many pathways do not constrain available options. This sentence is highlighting the few pathways that do	Ravi B Grover	Homi Bhabha National Institute	India
47237	61	4	61	4	Supplement 'biomass production' with an indicator for its purpose ('energy uses')	Accepted.	Mariess van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
23455	61	11	61	11	Replace "Not of these trade-offs are fully represented" with "Not all of these trade-offs are fully represented"	Accepted.	Government of France	Ministère de la Transition écologique et solidaire	France
47685	61	14	61	17	The biomass potentials mentioned here should be consistent with those in section 7.4.4. A larger range is presented there (46-245 EJ/yr by 2050 from energy crops, 4-57 EJ/yr by 2050 for residues)	Accepted.	Vassilis Daioglou	Utrecht University	Netherlands
23457	61	18	61	18	We recommend rephrasing the term "marginal lands". Indeed, marginal land is a concept dependent on cultural values and deep-rooted agricultural practices. What is marginal land for the expert agronomist is utilised land for local people. An aggregated figure on marginal lands at global level is not the most appropriated term. Degraded lands require soil restoration before being put to use the costs of which are usually not taken into account. BECCS companies are likely to opt for non-marginal lands for a higher return on investment ratio.	Accepted	Government of France	Ministère de la Transition écologique et solidaire	France
45835	61	22	61	37	The increased demand for biomass from forests can lead to disincentives resulting in e.g. increased logging. This section please needs to discuss the question of feedstock for BECCS in more detail.	Accepted. We've expanded the discussion.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
65319	61	22	61	24	This sentence clearly states the well known concerns and should be used in the opening chapter summary when addressing BECCS to support effective policy making - "Bioenergy and BECCS can affect the timing of emissions mitigation. The inclusion of technologies like BECCS often leads to delays in reducing emissions (in some or all sectors) compensated by negative emissions in the second half of the century."	Noted	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
47687	61	27	61	30	How this effect affects the technical potential of BECCS is quantified and elaborated upon in a recent paper by Hanssen et al. (2020). They disaggregate the different GHG PBPs across different land types, and relate them to the total available BECCS. https://www.nature.com/articles/s41558-020-0885-y	Accepted. We have added this reference	Vassilis Daioglou	Utrecht University	Netherlands
8093	61	30	61	30	Please check and correct: the paper cited here as "Marelli et al. 2013" is not available. A paper with this title has been published in 2014 (see: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC70663/eur25354en_online.pdf), but Marelli is the editor. Authors are Agostini et al., they should be cited.	Accepted. We have corrected this reference	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
43063	61	38		44	A major problem with CDR is that it cannot be deployed quickly, and it will take time to draw down CO2 levels: "Returning warming to lower levels requires large scale deployment of CDR measures to obtain net negative CO2 emissions in the second half of the century. However, CDR cannot be deployed at will to compensate any degree of overshoot. CDR ramp-up rates and absolute deployment levels are tightly limited by techno-economic, political and sustainability constraints."	Intention of the comment unclear. It directs to the first paragraph of Section 3.5 which does not mention CDR. It quotes text from Section 3.5.2.1. We have now included text on the CDR limitations in the key messages of the section.	Graeme Taylor	BEST Futures	Australia
71337	61	46	61	46	Suggest to also reference the UNEP Emissions Gap Reports here.	Accepted. Report is cited.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
63555	62	4	62	4	These key messages are helpful, especially as they are written in plain language. Can they/should they have confidence language associated with them? For example, we note that text similar to the first key message on page 66, lines 36-40 has high confidence associated with it.	Introduction to the section was revised, as key messaging is covered in the ES. Confidence language added.	Government of Canada	Environment and Climate Change Canada	Canada
37635	62	5	62	9	Given the urgency as expressed in these lines, why is an established technology like nuclear getting a cold shoulder by IPCC?	Noted. This section does not assess the energy transition.	Ravi B Grover	Homi Bhabha National Institute	India
65321	62	5	62	18	Very good, clear sentence on the realities before us if we are to be serious about 1.5C/2C. Do you feel these messages are as clear in the opening summary, if not, use this language!	Noted. The messaging is taken up in the executive summary.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
71339	62	5	62	8	Is it possible with slightly higher overshoot?	Yes, there are scenarios that go through the NDCs and return to below 1.5°C by 2100 with high overshoot. This has been added to the message and further elaborated in Section 3.5.2	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
47239	62	10	62	14	May be valuable to include a mention of the 'carbon budget' differences between early and late action	Noted. The connection to the carbon budget is described in Section 3.5.1.	Mariësse van Sluiseveld	PBL Netherlands Environmental Assessment Agency	Netherlands

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
47241	62	24	62	27	Fuzzy statement. Does it say: delayed action implies relatively higher premiums on carbon?	Accepted. Statement has been clarified.	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
75071	62	40	62	43	This single line does not really provide the substantive discussion required about the implications of path dependent mitigation pathways. Most IAMs are deterministic and do not allow for path dependency, particularly the possibility of tipping points in mitigation action beyond which belief in the inevitability of the transition to zero emissions leads to an acceleration. If this is the case, most IAMs fundamentally misrepresent the potential future path and costs of mitigation action. Among the literature that should be cited here are Zenghelis (2019) and Ekins (2019), which both show how once a critical tipping point of deployment is reached, the reduction in technology costs can generate a positive feedback that can then lead to further acceleration of deployment of the technology. Zenghelis, D. (2019) Securing decarbonisation and growth. National Institute Economic Review. Volume: 250 issue: 1, page(s): R54-R60 https://doi.org/10.1177/002795011925000118 . Ekins, P. Ekins P (2019) Report to the Committee on Climate Change of the Advisory Group on costs and benefits of net zero. London: Committee on Climate Change. https://www.theccc.org.uk/wp-content/uploads/2019/05/Advisory-Group-on-Costs-and-Benefits-of-Net-Zero.pdf	Noted. The discussion of path dependency has now been substantially expanded, including a mentioning of the possibility of accelerating dynamics. It is incorrect that IAMs do not capture path dependency. The focus of Chap. 3 are detailed process IAMs which account for path dependency as described in the revised text.	Robert Ward	London School of Economics and Political Science	United Kingdom (of Great Britain and Northern Ireland)
39043	62				Regarding "In general, weaker near-term action until 2030 strongly exacerbates mitigation challenges after 2030 to reach the Paris climate targets compared to more ambitious action. It requires higher transitions speeds after 2030 and increases the risk of overshooting the target. Overshooting the target entails higher climate impact risk and the need for larger deployment of carbon dioxide removal (CDR) measures in the second half of the century." Again, there appears to be a rather heavy reliance on the emergence of these carbon dioxide removal technologies. There should be at least some discussion of the impacts of such technologies not being developed--what are the alternative scenarios?	Noted. The message was augmented by a mentioning of the potential limitations of CDR, indicating the risk of relying on them for returning from an overshoot. Alternative scenarios with very limited CDR show deeper emissions reductions in 2030, widening the emissions gap to the NDCs. A sentence was added to the message to indicate this. The point is further discussed in Section 3.5.2.1.	Robert Buhr	Green Planet Consulting Ltd.	United Kingdom (of Great Britain and Northern Ireland)
27619	63	3	63	18	Analysis to considered NDCs submitted in the course of 2019/2020 as well.	Agreed. Assessment updated to NDC submissions up to xxx (Coordinate with Chap. 4)	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
76097	63	3	63	18	In addition to updating to numbers from WGI Ch5 as noted, please also check consistency with what is done in other chapters in WGIII.	Agreed. Consistency is checked.	Jan Fuglestedt	CICERO	Norway
83213	63	3	63	18	The enormous uncertainties in the WG1 carbon budget calculations and the many substantial changes in the WG1 methodology (between SR1.5 and AR6) might warrant to avoid the countdown language used here	Accepted. The particular sentence has been removed.	Geden Oliver	German Institute for International and Security Affairs	Germany
63557	63	4	63	5	recommend adding the phrase "to stay within the remaining carbon emission budget" to this sentence. That is: "...the less CO2 can be emitted thereafter, to stay within the remaining carbon emission budget and below a warming limit".	Recommendation was implemented.	Government of Canada	Environment and Climate Change Canada	Canada

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
80603	63	5	63	9	Consideration of non-CO2 climate forcings, in particular cooling aerosol co-emitted with fossil fuel combustion can lead to significant deviation from the assumptions of linearity in the carbon budget (Feijoo et al., 2019). Feijoo F., Mignone B.K., Kheshgi H.S., Hartin C., McJeon H., & Edmonds J. (2019) Climate and carbon budget implications of linked future changes in CO2 and non-CO2 forcing, Environmental Research Letters 14(4): 044007. Accessed at http://iopscience.iop.org/article/10.1088/1748-9326/ab08a9/meta . ("However, total forcing (panel c of figure 1), which includes the contribution from both CO2 and other forcing agents, does not immediately deviate from the Reference Case and, to the extent that it does deviate, actually increases relative to the Reference Case. The primary reason for this effect is that SO2 forcing is a mirror image of CO2 emissions (compare panel a to panel e of figure 1), a consequence of the fact that CO2 emissions are strongly correlated with SO2 emissions (both are produced from the combustion of coal), but that the radiative forcing contribution from SO2 emissions is negative. The temperature trajectories (panel d of figure 1) largely follow the total forcing trajectories. The significant increase in SO2 direct forcing (panel e of figure 1) and related indirect forcing constrains the feasibility of certain global temperature objectives."). It is also important when referring to the carbon budget to include the risk that feedbacks will further reduce the budget. Lenton T. M., Rockstrom J., Gaffney O., Rahmstorf S., Richardson K., Steffen W., & Schellnhuber H. J. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575(7784):592–595, 592 ("Models suggest that the Greenland ice sheet could be doomed at 1.5 °C of warming3, which could happen as soon as 2030. ...The world's remaining emissions budget for a 50:50 chance of staying within 1.5 °C of warming is only about 500 gigatonnes (Gt) of CO2. Permafrost emissions could take an estimated 20% (100 Gt CO2) off this budget, and that's without including methane from deep permafrost or undersea hydrates. If forests are close to tipping points, Amazon dieback could release another 90 Gt CO2 and boreal forests a further 110 Gt CO2. With global total CO2 emissions still at more than 40 Gt per year, the remaining budget could be all but erased already. ...We argue that the intervention time left to prevent tipping could already have shrunk towards zero, whereas the reaction time to achieve net zero emissions is 30 years at best. Hence we might already have lost control of whether tipping happens. A saving grace is that the rate at which damage accumulates from tipping — and hence the risk posed — could still be under our control to some extent.").	Noted. We are following the WG1 assessment in our discussion of remaining carbon budgets. It takes the role of Earth system feedbacks and non-CO2 emissions into account. The role of Non-CO2 climate forcings is further discussed in the text.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
80747	63	5	63	9	Consideration of non-CO2 climate forcings, in particular cooling aerosol co-emitted with fossil fuel combustion can lead to significant deviation from the assumptions of linearity in the carbon budget (Feijoo et al., 2019). Feijoo F., Mignone B.K., Kheshgi H.S., Hartin C., McJeon H., & Edmonds J. (2019) Climate and carbon budget implications of linked future changes in CO2 and non-CO2 forcing, Environmental Research Letters 14(4): 044007. Accessed at http://iopscience.iop.org/article/10.1088/1748-9326/ab08a9/meta . ("However, total forcing (panel c of figure 1), which includes the contribution from both CO2 and other forcing agents, does not immediately deviate from the Reference Case and, to the extent that it does deviate, actually increases relative to the Reference Case. The primary reason for this effect is that SO2 forcing is a mirror image of CO2 emissions (compare panel a to panel e of figure 1), a consequence of the fact that CO2 emissions are strongly correlated with SO2 emissions (both are produced from the combustion of coal), but that the radiative forcing contribution from SO2 emissions is negative. The temperature trajectories (panel d of figure 1) largely follow the total forcing trajectories. The significant increase in SO2 direct forcing (panel e of figure 1) and related indirect forcing constrains the feasibility of certain global temperature objectives."). It is also important when referring to the carbon budget to include the risk that feedbacks will further reduce the budget. Lenton T. M., Rockstrom J., Gaffney O., Rahmstorf S., Richardson K., Steffen W., & Schellnhuber H. J. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575(7784):592–595, 592 ("Models suggest that the Greenland ice sheet could be doomed at 1.5 °C of warming3, which could happen as soon as 2030. ...The world's remaining emissions budget for a 50:50 chance of staying within 1.5 °C of warming is only about 500 gigatonnes (Gt) of CO2. Permafrost emissions could take an estimated 20% (100 Gt CO2) off this budget, and that's without including methane from deep permafrost or undersea hydrates. If forests are close to tipping points, Amazon dieback could release another 90 Gt CO2 and boreal forests a further 110 Gt CO2. With global total CO2 emissions still at more than 40 Gt per year, the remaining budget could be all but erased already. ...We argue that the intervention time left to prevent tipping could already have shrunk towards zero, whereas the reaction time to achieve net zero emissions is 30 years at best. Hence we might already have lost control of whether tipping happens. A saving grace is that the rate at which damage accumulates from tipping — and hence the risk posed — could still be under our control to some extent.").	Noted. We are following the WG1 assessment in our discussion of remaining carbon budgets. It takes the role of Earth system feedbacks and non-CO2 emissions into account. The role of Non-CO2 climate forcings is further discussed in the text.	Gabrielle Dreyfus	Institute for Governance & Sustainable Development	United States of America
78377	63	6	63	6	Check up to date WG I numbers. Need a coherent approach.	Numbers updated to be consistent with WG1 assessment.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54923	63	13	63	18	These statements, along with their 2°C counterparts, should be elevated to the chapter summary.	The statement has flown into the summary that if conditional and unconditional NDCs are followed until 2030, it is no longer possible to stay below 1.5°C warming with no or low overshoot	Government of United States of America	U.S. Department of State	United States of America
65451	63	15	63	18	There should be updated numbers on the NDC; the publication of the UNFCCC INDC synthesis report (26 Feb) may be useful. There may also be academic literature that have updated these numbers?	Agreed. Numbers have been updated in coordination with Chap. 4	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
37637	63	17	63	18	When it is clear that announced NDCs are not sufficient, why advocate those technologies which have not been deployed on large-scale at the cost of technologies that are deployable at large scale right away namely nuclear.	Noted. This section does not assess the technology mix in the transition scenarios.	Ravi B Grover	Homi Bhabha National Institute	India
9685	63	27	64	14	Note that a critical parameter for cost-effectiveness across time is the discount rate.	Agreed. Now mentioned in the text.	Mustafa Babiker	Saudi Aramco	Saudi Arabia
54925	63	38	63	38	The concept of cost-effectiveness or cost-effective pathways comes up multiple times throughout the chapter. Suggest defining what is meant by "cost-effective" much earlier, perhaps in Section 3.2.1.	Accepted. Moved to Section 3.2	Government of United States of America	U.S. Department of State	United States of America
10549	63	39	63	42	Has any study introduced another temperature goal which might be the time derivative of temperature around 2100?	Rogelj et al., 2019, discussed this as ancillary target, the paper is cited. We have removed the "either...or" from the sentence to indicate there can be more options.	Philippe Waldteufel	CNRS	France
78379	64	6	64	14	These lines could be re-drafted to improve clarity.	Agreed. Text has been redrafted	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
66859	64	15	64	35	Somewhere in this paragraph it should be mentioned that rapid reductions in short-lived climate forcer emissions, including SO ₂ , in combination with CO ₂ mitigation does not cause a substantial increase in the near-term rate of warming (Shindell & Smith 2019, https://www.nature.com/articles/s41586-019-1554-z)	Noted. We have improved the discussion drawing also on the assessment of WG1 Chap. 6.7. There is a net warming due to unmasking of aerosol cooling in the near term, but it is attenuated by CH ₄ and black carbon reductions. Shindell & Smith is now cited.	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
76257	64	15	64	35	Please check what WGI Ch6 is saying about the effects of SLCF over time and the net effect of changing warming and cooling SLCFs. There is a section and figure on this in Ch6.	Agreed. The assessment of WG1 Chap. 6.7 is now referenced in the text.	Jan Fuglestedt	CICERO	Norway

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
80605	64	25	64	27	<p>This statement misunderstands the findings of Xu and Ramanathan (2017) by incorrectly attributing the reduction in cooling aerosol to policies targeting non-CO2. The reduction of cooling aerosols tends to be viewed as due to explicit air pollution measures, rather than partly or mostly due to reduction in fossil fuel usage driven by decarbonization policies. Previous studies have sought to disentangle the effects of CO2 and SCLP mitigation (Rogelj et al., 2014; Hienola et al., 2018; Allen et al., 2020) by asking the question: how would policies targeting SCLPs limit future warming in the absence of, or with the presence of, CO2 mitigation policies; however, they have stopped short of recognizing the direct linkage between fossil fuel combustion and SO2 emissions and implications for decarbonization measures. As described in Dreyfus et al. (in preparation), this confusion and misattribution to air pollution policies persists despite the short-term warming associated with transitioning away from coal and reduction in associated SO2 emissions having long been recognized (Hayhoe et al., 2002; Wigley, 2011). When this relationship was considered by Feijoo et al. (2019), they observed near-term warming and a significant deviation from the established transient carbon response relationship.</p> <p>CITATIONS: Dreyfus G.B., Y. Xu, S. O. Andersen, N. Borgford-Parnell, D. Shindell, V. Ramanathan, G. Velders, D. Zaelke (in preparation). Hayhoe K., Ksheshgi H.S., Jain A.K., & Wuebbles D.J. (2002) Substitution of Natural Gas for Coal: Climatic Effects of Utility Sector Emissions, <i>Climatic Change</i> 54(1): 107–139. Accessed at https://doi.org/10.1023/A:1015737505552. (“Using the electric utility sector as an example, changes in emissions of CO2, CH4, SO2, and BC resulting from the replacement of coal by natural gas are evaluated, and their modeled net effect on global mean-annual temperature calculated. Coal-to-gas substitution initially produces higher temperatures relative to continued coal use. This warming is due to reduced SO2 emissions and possible increases in CH4 emissions, and can last from 1 to 30 years, depending on the sulfur controls assumed. This is followed by a net decrease in temperature relative to continued coal use, resulting from lower emissions of CO2 and BC.”). See also Wigley T.M.L. (2011) Coal to gas: the influence of methane leakage, <i>Climatic Change</i> 108(3): 601. Accessed at https://doi.org/10.1007/s10584-011-0217-3. 607 (“In summary, our results show that the substitution of gas for coal as an energy source results in increased rather than decreased global warming for many decades — out to the mid 22nd century for the 10% leakage case. This is in accord with Hayhoe et al. (2002) and with the less well established claims of Howarth et al. (2011) who base their analysis on Global Warming Potentials rather than direct modeling of the climate. Our results are critically sensitive to the assumed leakage rate. In our analysis, the warming results from two effects: the reduction in SO2 emissions that occurs due to reduced coal combustion; and the potentially greater leakage of methane that accompanies new gas production relative to coal. The first effect is in accord with Hayhoe et al. In Hayhoe et al., however, the methane effect is in the opposite direction to our result (albeit very small). This is because our analyses use more recent information on gas leakage from coal mines and gas production, with greater leakage from</p>	<p>Noted. The referencing of Xu and Ramanathan has been revised and the discussion of the individual contributions to non-CO2 warming was clarified, also drawing on the assessment of WG1 Chap. 6.7. Integrated assessment models represent the coupling of CO2 and cooling aerosol emissions and can distinguish between the emissions implications of this coupling and the implications of additional air quality policies (e.g Rao et al, 2017, <i>Glob Env Chang</i>; Smith et al., 2020, <i>Clim Chang</i>)</p>	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
80749	64	25	64	27	<p>This statement misunderstands the findings of Xu and Ramanathan (2017) by incorrectly attributing the reduction in cooling aerosol to policies targeting non-CO2. The reduction of cooling aerosols tends to be viewed as due to explicit air pollution measures, rather than partly or mostly due to reduction in fossil fuel usage driven by decarbonization policies. Previous studies have sought to disentangle the effects of CO2 and SCLP mitigation (Rogelj et al., 2014; Hienola et al., 2018; Allen et al., 2020) by asking the question: how would policies targeting SCLPs limit future warming in the absence of, or with the presence of, CO2 mitigation policies; however, they have stopped short of recognizing the direct linkage between fossil fuel combustion and SO2 emissions and implications for decarbonization measures. As described in Dreyfus et al. (in preparation), this confusion and misattribution to air pollution policies persists despite the short-term warming associated with transitioning away from coal and reduction in associated SO2 emissions having long been recognized (Hayhoe et al., 2002; Wigley, 2011). When this relationship was considered by Feijoo et al. (2019), they observed near-term warming and a significant deviation from the established transient carbon response relationship.</p> <p>CITATIONS: Dreyfus G.B., Y. Xu, S. O. Andersen, N. Borgford-Parnell, D. Shindell, V. Ramanathan, G. Velders, D. Zaelke (in preparation). Hayhoe K., Ksheshgi H.S., Jain A.K., & Wuebbles D.J. (2002) Substitution of Natural Gas for Coal: Climatic Effects of Utility Sector Emissions, <i>Climatic Change</i> 54(1): 107–139. Accessed at https://doi.org/10.1023/A:1015737505552. (“Using the electric utility sector as an example, changes in emissions of CO2, CH4, SO2, and BC resulting from the replacement of coal by natural gas are evaluated, and their modeled net effect on global mean-annual temperature calculated. Coal-to-gas substitution initially produces higher temperatures relative to continued coal use. This warming is due to reduced SO2 emissions and possible increases in CH4 emissions, and can last from 1 to 30 years, depending on the sulfur controls assumed. This is followed by a net decrease in temperature relative to continued coal use, resulting from lower emissions of CO2 and BC.”). See also Wigley T.M.L. (2011) Coal to gas: the influence of methane leakage, <i>Climatic Change</i> 108(3): 601. Accessed at https://doi.org/10.1007/s10584-011-0217-3. 607 (“In summary, our results show that the substitution of gas for coal as an energy source results in increased rather than decreased global warming for many decades — out to the mid 22nd century for the 10% leakage case. This is in accord with Hayhoe et al. (2002) and with the less well established claims of Howarth et al. (2011) who base their analysis on Global Warming Potentials rather than direct modeling of the climate. Our results are critically sensitive to the assumed leakage rate. In our analysis, the warming results from two effects: the reduction in SO2 emissions that occurs due to reduced coal combustion; and the potentially greater leakage of methane that accompanies new gas production relative to coal. The first effect is in accord with Hayhoe et al. In Hayhoe et al., however, the methane effect is in the opposite direction to our result (albeit very small). This is because our analyses use more recent information on gas leakage from coal mines and gas production, with greater leakage from</p>	<p>Noted. The referencing of Xu and Ramanathan has been revised and the discussion of the individual contributions to non-CO2 warming was clarified, also drawing on the assessment of WG1 Chap. 6.7. Integrated assessment models represent the coupling of CO2 and cooling aerosol emissions and can distinguish between the emissions implications of this coupling and the implications of additional air quality policies (e.g Rao et al, 2017, <i>Glob Env Chang</i>; Smith et al., 2020, <i>Clim Chang</i>)</p>	Gabrielle Dreyfus	Institute for Governance & Sustainable Development	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
80607	64	27	64	35	Note that reducing SLCs also is the only plausible way to limit warming over the next 20 years because of unmasking of cooling aerosols that happens when reducing CO2. CITATION: Shindell D. & Smith C. J. (2019) Climate and air-quality benefits of a realistic phase-out of fossil fuels, Nature 573:408–411, Addendum “Methods” (“We note that, although this study focuses on the effects of fossil-fuel related emissions, accounting for the effects of reductions in greenhouse gases from non-fossil sources—including fluorinated gases and both methane and nitrous oxide from agriculture—along with biofuels that are a large source of warming black carbon, could eliminate any near-term penalty entirely. In fact, given that the net effect of the fossil-fuel phase-out on temperature is minimal during the first 20 years (Fig. 3), reducing those other emissions is the only plausible way in which to decrease warming during that period.”). It is also important when referring to the carbon budget to include the risk that feedbacks will further reduce the budget. Lenton T. M., Rockstrom J., Gaffney O., Rahmstorf S., Richardson K., Steffen W., & Schellnhuber H. J. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575(7784):592–595, 592 (“Models suggest that the Greenland ice sheet could be doomed at 1.5 °C of warming, which could happen as soon as 2030. ...The world’s remaining emissions budget for a 50:50 chance of staying within 1.5 °C of warming is only about 500 gigatonnes (Gt) of CO2. Permafrost emissions could take an estimated 20% (100 Gt CO2) off this budget, and that’s without including methane from deep permafrost or undersea hydrates. If forests are close to tipping points, Amazon dieback could release another 90Gt CO2 and boreal forests a further 110 Gt CO2. With global total CO2 emissions still at more than 40 Gt per year, the remaining budget could be all but erased already. ...We argue that the intervention time left to prevent tipping could already have shrunk towards zero, whereas the reaction time to achieve net zero emissions is 30 years at best. Hence we might already have lost control of whether tipping happens. A saving grace is that the rate at which damage accumulates from tipping — and hence the risk posed — could still be under our control to some extent.”).	Noted. The discussion of the individual contributions to non-CO2 warming was clarified, also drawing on the assessment of WG1 Chap. 6.7. The risk of tipping points from overshoot is now mentioned explicitly in Section 3.5.2.1 and Lenton et al., 2019, is cited.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
80751	64	27	64	35	Note that reducing SLCs also is the only plausible way to limit warming over the next 20 years because of unmasking of cooling aerosols that happens when reducing CO2. CITATION: Shindell D. & Smith C. J. (2019) Climate and air-quality benefits of a realistic phase-out of fossil fuels, Nature 573:408–411, Addendum “Methods” (“We note that, although this study focuses on the effects of fossil-fuel related emissions, accounting for the effects of reductions in greenhouse gases from non-fossil sources—including fluorinated gases and both methane and nitrous oxide from agriculture—along with biofuels that are a large source of warming black carbon, could eliminate any near-term penalty entirely. In fact, given that the net effect of the fossil-fuel phase-out on temperature is minimal during the first 20 years (Fig. 3), reducing those other emissions is the only plausible way in which to decrease warming during that period.”). It is also important when referring to the carbon budget to include the risk that feedbacks will further reduce the budget. Lenton T. M., Rockstrom J., Gaffney O., Rahmstorf S., Richardson K., Steffen W., & Schellnhuber H. J. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575(7784):592–595, 592 (“Models suggest that the Greenland ice sheet could be doomed at 1.5 °C of warming, which could happen as soon as 2030. ...The world’s remaining emissions budget for a 50:50 chance of staying within 1.5 °C of warming is only about 500 gigatonnes (Gt) of CO2. Permafrost emissions could take an estimated 20% (100 Gt CO2) off this budget, and that’s without including methane from deep permafrost or undersea hydrates. If forests are close to tipping points, Amazon dieback could release another 90Gt CO2 and boreal forests a further 110 Gt CO2. With global total CO2 emissions still at more than 40 Gt per year, the remaining budget could be all but erased already. ...We argue that the intervention time left to prevent tipping could already have shrunk towards zero, whereas the reaction time to achieve net zero emissions is 30 years at best. Hence we might already have lost control of whether tipping happens. A saving grace is that the rate at which damage accumulates from tipping — and hence the risk posed — could still be under our control to some extent.”).	Noted. The discussion of the individual contributions to non-CO2 warming was clarified, also drawing on the assessment of WG1 Chap. 6.7. The risk of tipping points from overshoot is now mentioned explicitly in Section 3.5.2.1 and Lenton et al., 2019, is cited.	Gabrielle Dreyfus	Institute for Governance & Sustainable Development	United States of America
80207	64	31	64	35	“Therefore a strong near - to-medium-term reduction of emissions from methane and other warming agents like black carbon can support staying below a peak warming limit (light blue lines in Figure 3.30) (Rogelj et al. 2015b; Tanaka and O’Neill 2018; Harmsen et al. 2020; Smith et al. 2020b). Such emissions reductions have also been advocated due to co-benefits for, e.g., reducing air pollution (Shindell et al. 2017).” COMMENT There is uncertainty as to these effects that is not adequately represented, including, but not limited to, that the reduction in aerosols from industrial emissions will have a counteracting warming effect, potentially very significant and accelerating the timeframe and degree of overshoot. See: Takemura, T. (2020). Return to different climate states by reducing sulphate aerosols under future CO2 concentrations. Scientific Reports, 10(1), 21748. https://doi.org/10.1038/s41598-020-78805-1	Noted. The discussion of the individual contributions to non-CO2 warming was clarified, also drawing on the assessment of WG1 Chap. 6.7.	Kelly Wanser	SilverLining	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
83215	64	36	63	43	Maybe it should be briefly mentioned (once again) that substantial amounts of CDR will be needed even under net-zero	Noted. The discussion here focuses on overshoot. The fact that CDR has multiple uses and is also deployed in mitigation pathways without net negative CO2 emissions is mentioned in Section 3.5.2.1 and other places of the report.	Geden Oliver	German Institute for International and Security Affairs	Germany
43075	64	38		40	The risks of overshoot need further investigation, e.g. in regards to tipping points: "A few studies confirmed the ability of net negative CO2 emissions to reduce warming, but pointed to the need for further research particularly for cases of high overshoot."	This risk is mentioned in Section 3.5.2.1 including citation of related literature like Lenton et al., 2019, Nature.	Graeme Taylor	BEST Futures	Australia
43359	64	39	64	43	I believe that there is very little discussion and notice on the effectiveness of the Carbon Dioxide Removal and overshoot. I think it would be better to introduce the public to the problems that overshoot might create to CDR and "general" Earth temperature, e.g. the ongoing work of David Keller, in a more detailed way.	Noted. CDR is assessed in Chapter 12 including a box on CDR. The text in this section has been expanded to convey the assessment of WG1 on the reversibility of overshoot by net negative CO2 emissions. The work of David Keller is cited, but final results of CDRMIP were not published by the time of the publication deadline for the assessment.	BEATRIZ BECCARI BARRETO	Politecnico di Milano	Brazil
85307	64	39	64	43	This is a key reality check on whether we can actually count on getting temperatures down after overshoot. Hence, this would merit to be acknowledged at least in the TS, if not SPM.	Noted.	Kaisa Kosonen	Greenpeace	Finland
76099	64	40	64	41	See also WGI Ch5	Noted. WG1 Chap. 5.6 is referenced and key findings of its assessment are now mentioned.	Jan Fuglestedt	CICERO	Norway
62061	65	12	65	12	INDCs: please use NDCs.	This is a reference to the underlying scenarios in the database which follow the names used by the underlying studies, in this case ENGAGE.	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
71341	65				The figure can be improved. For example, it would be relevant to give more prominence to the 2020-2030-2050 time period. Another question is why none of the pathways seem to be 1.5C pathways, when the first figure indicates that net-zero is reached around mid-century?	The discussion in 3.5.1 on the relationship between near term action and long-term warming limits requires to show the full century. The timing of net zero can vary as discussed in the text and a newly added box on net zero CO2. As we wanted to compare examples of scenarios with direct action on the target and near term action following the NDCs and still reaching the target, we had to choose a set of scenarios from class C3 (likely 2°C, C4 in FGD). 1.5°C pathways with no or low overshoot that follow the NDCs until 2030 do not exist in the literature.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
27621	66	1	66	13	Analysis should specify whether "current NDCs" also include the 2019/2020 NDC submissions. The same comment applies for the analysis of this entire section.	Agreed. This has now been specified.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
5097	66	5	66	13	Please add what you refer to when mentioning "current" NDCs as these were updated in December 2020.	This has now been added.	Lina Hollender	n/a	Germany
71343	66	16	66	16	I think the reference should be to UNEP 2020a here (the emissions gap report). Furthermore, the 2020b reference is not correct as the Production gap report should not be cited as a UNEP report	Thank you. References corrected.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
1871	66	32	66	33	There is something that is not quite working with this formulation	Noted. Formulation has been clarified.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
54927	66	32	66	36	The point about confirming a major finding of the SR1.5 should be elevated to the chapter summary.	Noted. The message is contained in the chapter summary.	Government of United States of America	U.S. Department of State	United States of America
39045	66				discussion of stranded assets is solid, but seems pretty limited to only fossil fuel sectors of the economy. However, there is reason to think that (and some references about) that there is considerable potential stranded assets in a range of industries. Any industry that generates massive amounts of heat for production, for example (steel, aluminum, copper, cement, utilities, petrochemicals.) In addition, most transportation infrastructure is also vulnerable. The stranded asset concern persists throughout this section and the report more broadly.) It needs a broader discussion of the range of potential industries at risk. Just as a random and recent case in point: https://www.ft.com/content/46d4727c-761d-43ee-8084-ee46edba491a	Noted. The section on stranded assets is based on available literature, focusing on mitigation pathways in this chapter. More precise elements on industries are in the dedicated chapter 11 of the report.	Robert Buhr	Green Planet Consulting Ltd.	United Kingdom (of Great Britain and Northern Ireland)
1873	67	4			Much of the information here is pending updates, which limits the ability to comment	Noted	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
1875	67	5			The section on economic benefits/avoided impacts refers to percentages of global GDP. It would be useful if the section on costs could also indicate global GDP effects in %	Comment unclear. There is no discussion of costs in Section 3.5. Section 3.6 provides global GDP effects in %.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
20183	68	30	69	26	A very detailed discussion on CDR and respective challenges is also available here: - Fuss, S., Canadell, J. G., Ciais, P., Jackson, R. B., Jones, C. D., Lyngfelt, A., ... & Van Vuuren, D. P. (2020). Moving toward Net-Zero Emissions Requires New Alliances for Carbon Dioxide Removal. <i>One Earth</i> , 3(2), 145-149.	Noted. Reference is now cited.	Nikas Alexandros	National Technical University of Athens	Greece
65455	68	30	69	26	Again, per my points in previous comments, this section would lend itself well to some discussion about what overshooting may look like. Can you refer to relevant WGI chapters or literature in this section? Expanding on the "increased climate risk" of overshooting. Could you also include some allusion/discussion about the governance/employment and financing of CDR technologies? Do scenarios suggest that technical or political barriers are the most relevant to immediate CDR deployment? What are the risks? If this is found elsewhere in the report, could you please signpost.	Noted. Key insights from the WG1 assessment are now reported in text, with references to the underlying WG1 sections. CDR is assessed in general in Section 12.3 of the report which is now explicitly referenced.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
76101	68	42	68	43	Strange wording	Noted. Wording has been changed.	Jan Fuglestedt	CICERO	Norway
66861	69	1	69	2	refer also to IPCC SRCL 2019, chapter 2 (Jia et al)	Reference has been included	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
65453	69	12	69	21	This section contains some really valuable and clear insight: notably that (i) CDR is needed in 1.5 scenarios with no/low overshoot as it will compensate for hard-to-abate sectors (instead of allowing budget overshoot), and (ii) CDR is a long-term mitigation tool, only having a limited effect on immediate climate goals. Would it be possible to elevate these two findings into the earlier sections of the text? For example when talking about the reliance of C1/C2 scenarios on CDR?	These findings are summarized in the ES.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
83217	69	12	69	21	Would it be possible to indicate quantitatively the volumes of CDR used to counterbalance residual emissions only (and/or as share of total CDR)	Noted. Section 3.5 is not the suitable place to assess this information.	Geden Oliver	German Institute for International and Security Affairs	Germany
43065	69	17		23	CDR will not be able to prevent overshoot: "Given the timescales that would likely be needed to ramp-up CDR to Gigaton scale, it can be expected to only make a limited contribution to reaching net zero CO2as fast as possible. In the vast majority (95%) of below 2°C mitigation pathways assessed for this report, cumulative CDR deployment did not exceed 100 GtCO2 until mid-century. This confirms the risk of excessively relying on CDR to compensate for weak mitigation action until 2030 by either facilitating massive net CO2 emissions reduction rates during 2030-2050 or allowing a high (> 0.1°C) temporary overshoot of 1.5°C until the end of the century."	Noted. The quoted sentence from the text captures the risk of overly relying on CDR.	Graeme Taylor	BEST Futures	Australia
20075	69	22	69	26	CDR aspects ahead of COP26 are discussed in Fuss et al. (2020): -Fuss, S., Canadell, J. G., Ciais, P., Jackson, R. B., Jones, C. D., Lyngfelt, A., ... & Van Vuuren, D. P. (2020). Moving toward Net-Zero Emissions Requires New Alliances for Carbon Dioxide Removal. <i>One Earth</i> , 3(2), 145-149.	Noted. Reference is now cited.	Haris Doukas	National Technical University of Athens, Greece	Greece

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
29357	69	27	71	37	The discussion of stranded assets could benefit from greater attention and discussion of the following issues: (1) fossil fuel reserves and electricity production infrastructure are likely to be impacted differently. It would be worth clarifying this. (2) With regard to electricity generation, some flexible capacity may be valuable in high VRE scenarios -- so the infrastructure may not be stranded if the value stream shifts from generation to capacity, even if the amount of fuel used declines. Similarly, retrofitting existing infrastructure with CCS or repowering with lower-carbon fuels may be possible in some cases. (3) With regard to fossil fuel reserves, it is worth noting that production/reserve ratios differ significantly by fuel and region. The potential for stranded assets is different if booked reserves are (for example) a decade worth of production versus 100 years worth of production. (4) Also, some attention should be given to how natural field decline affects statements about stranded assets. For example, in some cases, continued investment is consistent with level or declining production, given the rate of natural field decline.	Thank you for your comment. The subsection here is limited to assessing the literature on lock-in and stranded assets in the context of mitigation pathways. The elements you are detailing are treated in the chapter dedicated to energy systems (chapter 6, in particular sections 6.7.3, 6.7.4 and Box 6.11). Cross-reference to it has been added.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
65457	69	27	71	37	Could you link to the discussion in Chapter 17 (17.2.3.3) on stranded assets and just transitions in this context?	Accepted. The link is now made.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
27623	69	30	69	37	Delete "For example, pursuing mitigation ambition as stated in current NDCs does not lead to a significant reduction in carbon intensity of electricity generation (Figure 3.31f), coal use (Figure 3.31g) and oil and gas use (Figure 3.31h) (UNEP 2020b) in contrast to immediate action pathways. In general, the stronger the carbon lock-in in 2030, the higher the societal, economic and political strain of rapidly ramping up emissions reduction rates after 2030. The disruption does not only occur for fossil fuel assets, but also applies to ramp-up rates of renewable energy production (see Figure 3.31d+f) and investment flows in fossil fuel vs. non-fossil fuel installations (Kriegler et al. 2018b; Riahi et al. 2015).", as the analysis does not consider the 2019/2020 NDCs and does not take into account the impact of the pandemic on investment flows and energy demand.	The report cannot restrict the assessment to articles that were published in 2021 (to account for the impact of the Covid crisis and the updated NDCs), but assesses more broadly the literature since previous report. The sentence has been rephrased to clarify that the NDCs version in the analysis here are the ones before the last round of updates.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
1877	69	31			Could this subsection draw on a larger literature than the scenario base? There are other studies with different methodologies in this area	Noted. Due to space constraints the subsection is limited to the literature that considers stranded assets and lock-in in the context of mitigation pathways. Cross references are added to indicate other chapters in the report that draw on other literature.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
1879	69	32			The meaningfulness of the tables would be increased if numbers are reported in other terms in addition to absolute numbers, i.e. percentage of global GDO or percentage increase compared to a baseline. It is furthermore unclear whether these are total investment needs or additional investment needs for the mitigation scenarios.	There are no tables on page 69. The comment is probably referring to the subsection of section 3.6 on investments. In the revised version, tables have been replaced by Figure to ease readability.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
37639	69	34	69	37	This sentence is incoherent. First it refers to renewable energy production, and then fossil versus non-fossil. Why not stick to non-fossil at both the places.	Accepted. The sentence is now, consistently with the Figure, referring to low carbon electricity production.	Ravi B Grover	Homi Bhabha National Institute	India
61651	69	34	69	37	"The disruption does not only occur for fossil fuel assets, but also applies to ramp-up rates of renewable energy production (see Figure 3.31d+f) and investment flows in fossil fuel vs. non-fossil fuel installations." "Renewables" need not to be separately mentioned, "non-fossil installations" cover all low-carbon installations, including renewable energy sources.	Accepted. The sentence is now, consistently with the Figure, referring to low carbon electricity production.	Rauli Partanen	Think Atom	Finland
65691	69	34	69	37	"The disruption does not only occur for fossil fuel assets, but also applies to ramp-up rates of renewable energy production (see Figure 3.31d+f) and investment flows in fossil fuel vs. non-fossil fuel installations." Why are "renewables" separated from "non-fossil fuel installations"? Renewables are a subgroup of non-fossil energy. I would expect using "non-fossil installations" to be a less biased way of expressing the same intent, especially as Fig. 3.31d+f does not mention "renewables" but only the carbon intensity of electricity generation. Revise accordingly.	Accepted. The sentence is now, consistently with the Figure, referring to low carbon electricity production.	Eero Hirvijoki	Aalto University	Finland
5237	69	35	65	39	after renewable add "or nuclear in some countries"	The sentence is now, consistently with the Figure, referring to low carbon electricity production.	Michel SIMON	Retraité/ Pdt d'association	France
78381	70	7	70	9	I don't actually think the Caldecott definition (accounting lives) and modellers practice (physical lives) are the same.	Noted. Due to space constraints, we cannot add explanations on this topic.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
80385	70	14	70	14	I would suggest that add that more in general, the set of economic activities that are potentially affected by a low carbon transition is wide and includes also transportation and buildings. In this respect, the concept of Climate Policy Relevant Sectors introduced in Battiston, S., Mandel, A., Monasterolo, I., Schütze, F., Visentin, G., Mandel, Antoine Monasterolo, I., ... Visentin, G. (2017). A Climate stress-test of the financial system. Nature Climate Change, 7(4), 283–288. https://doi.org/doi:10.1038/nclimate3255 , have been used in transition risk assessments of several financial supervisors (e.g. EBA, ESMA, ECB).	Due to space constraints, we had to shorten the subsection, not allowing to add what you suggest.	Stefano Battiston	University of Zurich	Switzerland
61653	70	15	70	17	"[.]: new regulations (e.g. carbon pricing via taxes or trading schemes, subsidy regimes for fossil fuels or renewables, disclosure requirements), technological change (e.g. falling costs of renewables, disruptive technologies)". Use "low-carbon" instead of "renewables" to be more inclusive and scientifically accurate.	The sentence was deleted in the process of shortening the section to fit space constraints.	Rauli Partanen	Think Atom	Finland
65693	70	15	70	17	"[.]: new regulations (e.g. carbon pricing via taxes or trading schemes, subsidy regimes for fossil fuels or renewables, disclosure requirements), technological change (e.g. falling costs of renewables, disruptive technologies)". The word "renewables" should be substituted with either "non-fossil" or "low-carbon". Also the price of nuclear energy is projected to decrease and should to receive subsidies for displacing carbon-intensive production.	The sentence was deleted in the process of shortening the section to fit space constraints.	Eero Hirvijoki	Aalto University	Finland

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
37641	70	16	70	17	Should one talk only about private cost of generators of renewable energy? Increased penetration of renewables is accompanied by increased system cost. That also needs to be mentioned. Not saying so is conveying only a part of the information.	Noted. The subsection here is specifically about carbon lock-in and stranded assets along mitigation pathways. The question of systems costs with increased penetration of renewables is assessed in the chapter dedicated to energy systems (chapter 6), in section 6.4.3 Energy System Integration.	Ravi B Grover	Homi Bhabha National Institute	India
79123	70	20	71	37	This stranded-assets discussion overlooks two important recent insights. First, RMI/CarbonTracker/SC's influential June 2020 analysis of the world's coal-fired power-plant fleet (How To Retire Early, https://rmi.org/insight/how-to-retire-early/) shows that (hypothetically) immediately replacing all those plants with market-price unsubsidized renewables, using efficiently structured financial instruments like securitization, would be cost-neutral by year 2 and return >\$100b/y by year 5, valuing all mitigation and co-benefits at zero. Second, self-reinforcing capital flight from fossil fuels to renewables (doi:10.1088/1748-9326/abc3f2) is already monetizing stranded-asset risks, creating winners and losers in a way that dramatically speeds mitigation. A third set of arguments in my "harder-to-abate-sectors" 2021 analyses cited in my comments on Ch 3's 49:17–21, too detailed to summarize here, shows that self- and mutually-reinforcing capital shifts in heavy transport and industrial heat will further speed mitigation. All three points usefully augment the policy-centric (i.e. insufficiently market-conscious) discussion following in section 3.5.3.	Noted. The discussion is suited for Chapters on innovation, finance and policies. Chapter 3 and the discussion of stranded assets in Section 3.5 assesses the literature on quantitative global mitigation pathways.	Amory B. Lovins	Rocky Mountain Institute; also Adjunct Professor of Environmental & Civil Engineering, Stanford University	United States of America
71345	71	38	60	2	3.5.3 (bridging) is an important section. But it would be better to have these points incorporated into Section 3.5.1 (and Figure 3.3), so that the reader has the relevant evidence in one place.	Rejected. The section is structured into a general discussion of the relationship between near- and long-term action, the impact of delay (3.5.2) and means and benefits of accelerated action pathways (3.5.3). Key findings from all subsections are summarized in the beginning.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
65459	71	39	71	42	For cohesion, could you link to the concept of an "implementation gap" as introduced in Chapter 4.	The implementation gap is now mentioned in the text.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
1881	71	41	71	46	Can these findings be more directly compared with the findings in the previous section on the costs of mitigation?	Comment unclear. There is no discussion of mitigation costs in this or previous sections.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
73021	72	8	72	10	The sentence advocates a gradual transition using an accelerated pathway, onto a 1.5oC or 2oC pathway. Consideration should also be given in the paragraph that the reality of the already present climate emergency is increasingly being recognized by the public and governments (see my comments above) and a pathway – soon to disappear – for staying well below 1.5oC should be pursued by those nations that are able to contribute to such an effort.	Agreed. Language has been added to indicate that the need for disruptive action is increasingly recognized.	Larry Edwards	Larry Edwards Environmental Consulting	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
1883	72	12	72	13	Is it possible to do a map like in the preceding section?	It is not clear which map or section is meant and why a map should accompany the target sentence. The comment appears to be misplaced.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
1885	72	21			Perhaps some of this should come in the introduction to section 3.6	Rejected. This text introduces the scope of the assessment in Section 3.5.3	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
5099	72	33	72	33	what do you mean by "time-inconsistency"?	Sentence was removed.	Lina Hollender	n/a	Germany
73023	72	37			Add another citation to the existing one: Edwards & Cox 2020. (See details in one of the comments above.)	Rejected. Paragraph refers to international cooperation mechanisms to strengthen action.	Larry Edwards	Larry Edwards Environmental Consulting	United States of America
27625	72	39	72	44	Delete "Other examples base the design of enhanced international action on Article 6 of the Paris Agreement (Stua 2017; Edmonds et al. 2020). Paroussos et al. (2019) find economic benefits of joining a climate club despite the associated higher mitigation effort, in particular due to access to technology and climate finance. Edmonds et al. (2020) also find economic gains from sharing NDC emissions reduction commitments under Article 6. If reinvested in mitigation efforts, the study projects an additional reduction of 9 billion tons of CO2 in 2030.", as Article 6 is still an unresolved negotiation issue under the PAWP.	Noted. The mentioning of Article 6 was removed, but the studies in the peer reviewed literature stand.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
85951	73	14	73	15	Suggest text should read: "The Paris Agreement has spurred the formulation of NDCs for 2025 and 2030, and long term strategies around the world", removing the reference to 2050. Parties' NDCs used 2025 and 2030 as a target year variously. Neither Article 4, para 19 or para 35 of 1/CP.21 refer to 2050.	Noted. Para 36 of 1/CP.21 refers to mid-century, long-term low GHG emission development strategies. Mid-century indicates 2050. Wording was rephrased to "mid-century strategies" and the mentioning of 2050 removed.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
73025	73	20			Add another citation to the existing one: Edwards & Cox 2020. (See details in one of the comments above.)	Rejected. Paragraph refers to studies on global policy best practice policy packages.	Larry Edwards	Larry Edwards Environmental Consulting	United States of America
62063	73	25	73	30	Please also include here the study: Fekete, H., Kuramochi, T., Roelfsema, M., den Elzen, M., Forsell, N., Höhne, N., ... & Gusti, M. A review of successful climate change mitigation policies in major emitting economies and the potential of global replication. <i>Renewable and Sustainable Energy Reviews</i> , 137, 110602. This study has similar results as van Soest et al. (2020). It shows that the global replication of sector progress would reduce greenhouse gas emissions by 2030 by about 20% compared to a current policies scenario. All countries analysed would overachieve the emissions reduction targets in their post-2020 climate targets. However, the resulting reduction in global emissions by 2030 would still not be sufficient to keep the world on track for a global cost-effective pathway that keeps temperature increase below 2°C.	Agreed. The study is now included in the assessment.	Michel den Elzen	PBL Netherlands Environmental Assessment Agency	Netherlands
5239	73	37	73	37	after renewable add "or nuclear"	Added.	Michel SIMON	Retraité/ Pdt d'association	France
54929	74	3	75	8	Some readers will take the relative size of the arrows too literally, rather than viewing the graphic as a qualitative synthesis of many kinds of disparate estimates. If it remains in the chapter, consider the following changes: (1) using a more traditional legend than roughly matching the colors of the arrows with font colors below the y-axis; (2) explaining what "partially" and "quantified in the scenarios database" mean; (3) more carefully explaining the meaning of the dark and light orange arrows; (4) giving additional information about what "pre-existing distortions" means, given that the phrase seems to only get one brief mention in the entire chapter; (5) defining "short term" and "long term", at least broadly; (6) adding a caveat to the figure legend that this representation doesn't include benefits that can't be (or haven't been) monetized; and (7) specifying that this is for the globe vs. a particular region.	This Figure has been deleted.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
61655	74	3	74	14	In Figure 3.32, the reference (van Soest et al, 2020a, preprint at https://doi.org/10.21203/rs.3.rs-126777/v1), discusses pathways to bridge the emissions gap. The study claims to be "going beyond relatively abstract cost-optimal pathways as guidance for policy-making by focusing on concrete policy measures that can be implemented to close the emission gap." In the energy sector, these policies include an enforced 1.4%-point "Increase of the share of renewables in total electricity generation per year (starting in 2020, until 2050 and up to 50%, maximum)". Similar policies are not included for nuclear energy, making this reference a priori biased, and it should therefore not be used.	Rejected. The analysis of van Soest et al. is based on peer-reviewed literature that identified a set of best practice policies that have proven successful in selected geographies (https://doi.org/10.1080/14693062.2017.1397495 ; https://doi.org/10.1080/14693062.2018.1481356). Nuclear energy is still incentivized by cross-sectoral emissions pricing.	Rauli Partanen	Think Atom	Finland
65695	74	3	74	14	In Figure 3.32, the reference (van Soest et al, 2020a, preprint at https://doi.org/10.21203/rs.3.rs-126777/v1), discusses pathways to bridge the emissions gap. The study claims to be "going beyond relatively abstract cost-optimal pathways as guidance for policy-making by focusing on concrete policy measures that can be implemented to close the emission gap." In the energy sector, these policies include an enforced 1.4%-point "Increase of the share of renewables in total electricity generation per year (starting in 2020, until 2050 and up to 50%, maximum)". Without including any similar policies for nuclear energy, an important low-carbon energy source, the reference is a priori technologically biased. All low-carbon technologies should be treated without a priori dismissal.	Rejected. The analysis of van Soest et al. is based on peer-reviewed literature that identified a set of best practice policies that have proven successful in selected geographies (https://doi.org/10.1080/14693062.2017.1397495 ; https://doi.org/10.1080/14693062.2018.1481356). Nuclear energy is still incentivized by cross-sectoral emissions pricing.	Eero Hirvijoki	Aalto University	Finland
10551	74	10	74	10	This line of figure 3.32 legend is dealing with subplot (f) rather than (e)	Sentence was removed.	Philippe Waldteufel	CNRS	France
65571	75	4	75	14	Figure 3.33 would benefit from an explanation of what do the arrows meaning is. I have gone back and forth through the text, figure and caption, and I can not completely understand the Figure. Maybe it is me or maybe the figure needs further clarification in its caption.	Thank you. The Figure has been removed.	Cristian Chadwick	University of Chile	Chile
78963	75	9	75	10	This appears to be an optical misrepresentaiton: The blue arrows look rather long - as if the combined losses from lower economic activity over short-term and long-term periods hardly exceeded the gains from avoided impacts and co-benefits.	Thank you. The figure has been removed.	Young-jin Choi	Phineo gAG	Germany
54931	75	11	75	14	Could cut this figure. It doesn't provide additional information or clarify the text, but does open up questions of what is meant by short and long term.	Thank you. The Figure has been removed.	Government of United States of America	U.S. Department of State	United States of America
76103	75	16			I miss some more explananation of the basis for how the models calculate costs of mitigation. I.e. how this depends on the assumption about costs and availability of various measures and technologies that are included in the models. Sorry if I missed something you have written about this.	The box on macro-economic impacts of mitigation, as well as Annex C on Models and Scenarios, have been improved to provide further explanation of how costs of mitigation are calculated.	Jan Fuglestedt	CICERO	Norway

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
79125	75	16	83	16	This economics section, though admirable in its literature synthesis like Tables 3.5–3.7, leaves me puzzled because the storytelling is insufficiently clear. Seen from satellite level, not down in the woods and thickets, the economics seem arrestingly simple: efficient use is cheaper than supply, renewables are now cheaper than fossil fuels (virtually everywhere for newbuild and now or soon about everywhere even on the short-run margin), those options (plus profitable materials efficiency—please see my comments on Ch 3 49:17–21) together mitigate emissions, so since both are cheaper than baseline, any properly modeled low-carbon future should show declining not increasing costs. Any model showing the contrary must therefore have problematic structure or numerical assumptions. Indeed, nearly all IAMs omit most demand-side opportunities—doi:10.1088/1748-9326/ab55ab, strangely not cited—and use old, high, far-above-market-actuals renewable prices (or assume unnecessarily costly and asymmetrical grid-balancing investments, doi:10.1016/j.tej.2017.06.002 and 10.1016/j.tej.2017.11.006, or both). Some bottom-ups, starting with Grubler et al 2018, take efficient use far more seriously and overstate renewable costs by less. But one needn't get into their rich details to see that the big picture is really simple: one cheaper option (efficient use) plus another (modern renewables) cannot add up to a costlier total. That should not be a hard story to tell, simply and prominently, and flowing back upstream to all the higher-level summaries throughout the report. It could be a useful addition to the welcome and clear declaration in FAQ3.1 on Ch 3 p 116.	Thank you for your appreciation of the literature synthesis, and the references. The assessment and synthesis reflects the state of the results in the literature and the ensemble of scenarios that have been submitted to the AR6 database. Further efforts have been made to clarify the storytelling, and give some context about the strengths and limitations of the modelling tools that have produced these results.	Amory B. Lovins	Rocky Mountain Institute; also Adjunct Professor of Environmental & Civil Engineering, Stanford University	United States of America
78383	75	17	76	3	A figure illustrating price trajectories would be helpful, as would a short discussion about the role of discounting in defining trajectories.	A short discussion about the role of discounting is added in the revised version. The wide ranges of carbon price estimates did not make a figure of trajectories readable, box plot of values at different dates are given.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
1887	75	21	75	33	An equally relevant question is whether they can be achieved under stringent mitigation. Surprisingly, this also to be the first time confidence is indicated in chapter 3	noted.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
52045	75	21	75	22	"marginal abatement cost of carbon increases for lower temperature categories." These differences in costs must also be elaborated on in this section.	Noted. Section 3.6.1 elaborates on the different costs indicators (marginal abatement cost, total macroeconomic cost and investments), and how they depend on the temperature categories.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
78965	75	32	75	34	"...mitigation can be a welfare-enhancing strategy..." => why "can be"? If it was the case that mitigation "can be" welfare enhancing, but is not reasonably certain to do so, why bother with mitigation at all?	The sentence has been rephrased to clarify.	Young-jin Choi	Phineo gAG	Germany
27627	75		75		Figure 3.33 - it should be indicated that regional and national differentiation and special circumstances are not considered for developing this graph.	This figure was meant to be qualitative. It has been removed due to space constraints.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
23459	76	2	76	3	The point that mitigation pathways with low energy demand exhibit lower carbon values is very interesting and important. Could it possible give a range of reduction of the carbon values?	Thank you for your comment. The result is indeed interesting but a robust range cannot be extracted from the scenario database due to difficulty of comparison between studies of energy consumption patterns and lack of full meta-data for all scenarios to attribute carbon prices variations to socioeconomic assumptions and consumption patterns. The range from the article cited is too specific to the assumptions of the specific scenarios modelled to be given here.	Government of France	Ministère de la Transition écologique et solidaire	France
54933	76	5	77	11	The language here is extremely unclear; perhaps a graphic representation of Baseline and Reference Scenarios would help.	Thank you for the suggestion. however, due to space constraints we cannot add a Figure here.	Government of United States of America	U.S. Department of State	United States of America
12609	76	9	76	26	Also Drouet et al. 2021, under revision Nature climate change, explores impacts of climate change departing from cost effectiveness analysis MIP	Thank you for the reference. It has been included further in the section.	valentina bosetti	bocconi	Italy
8349	76				Box 3.4 – The point about minimising costs is again at odds with reality, which is mentioned in the paragraph on P14 line 26. Macro-econometric models like E3ME do not adopt this assumption so there is published literature on this (and scenarios in the database unless they were excluded). I have to say I am not comfortable with the way so many scenarios have been excluded (especially given the time researchers would have put in using the portal). Presumably the authors made sure their own results got through the checks (as the chart suggests!) so there is potential selection bias. At minimum, much more transparency is needed.	Thank you for your comments. Only scenarios submitted before SOD deadline could be included in the analysis. The process and criteria for scenario exclusion is made transparent in Annex C on models and scenarios.	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)
8351	76				The point on line 41 is nonsensical – the economy is never at full capacity, no one even knows how to define full capacity properly. It would be better to be honest and say that most economic models assume the economy is at full capacity even though it is not (see p16 here for a presentation of European data https://ec.europa.eu/energy/sites/default/files/documents/case_study_2_capacity_constraints_and_macro_performance.pdf) Furthermore, the reason that the economy is not at full capacity is not just because of policy causing frictions – this is little more than right-wing ideology and should definitely not be in an IPCC report. Gaps in knowledge (Keynes, 1921; Knight, 1921), non-rational behaviour (Herbert Simon, 1955), issues to do with finance, etc, etc are much more fundamental and important (and missing from the models).	Phrasing has been improved in the box to avoid misinterpretation and clarify the relationship between modelling assumptions and real-world economy.	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
74079	77	13	77	13	add "on" after "depends" so it reads ..."depends on the modelling framework"	corrected.	Beate Antonich	Center for Climate Change, Energy and Environmental Law (CCEEL) School of Law, University of Eastern Finland	United States of America
1889	77	14			Is it possible to bring out and summarize the synergies and tradeoffs between achieving the SDGs and the PA goals more directly?	Section 3.7 is focusing on sustainable development along mitigation pathways, and chapter 17 is precisely on this topic of mitigation in the context of sustainable development	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
1891	77	14			There is significant overlap with section 3.6.4. The latter could be enveloped in section 3.7. Furthermore, several subsections under section 3.7 still seem to be of a preliminary nature.	Noted.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
1893	78	2			Needs to be specified further. Which mitigation scenario is used?	Caption has been extended to provide additional information.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
66863	78	2	78	2	Again, on figures and colours: this is a great plot but a link back to the colour scheme used in SR1.5 would be great for visual continuity (blue for 1.5 low OS and 1.5 high OS, orange and red for lower 2C and higher 2C, and choose some new ones for 2.5 and 3C - purple and black?)	Color palette has been harmonized with the report guidelines.	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
18095	78	5	78	33	This section could usefully discuss the (lack of) treatment of learning by doing and induced technological change, and its potential to reduce mitigation costs as with wind, solar and EVs. Also at aggregate level as in e.g. https://www.ineteconomics.org/uploads/papers/WP_112-Grubb-and-Wieners-Climate-Change-2.pdf	noted. Elements on induced technological change have been added, and reference to chapter 16 were it is treated in detail. Reference noted.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
27629	78	5	78	33	It should be stressed that analysis is implemented at a global level, and therefore regional and national differentiation are not considered.	noted. regional analysis is provided further in the section, and national scenarios are treated in chapter 4.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
48193	78	18	78	20	Additional references are recommended: Wei, Y. M., Han, R., Wang, C., et al. (2020). Self-preservation strategy for approaching global warming targets in the post-Paris Agreement era. <i>Nature communications</i> , 11(1), 1-13.	Thank you for the reference.	Yang Wang	Beijing Climate Center	China
54935	78	19	78	25	This is a really missed opportunity and needs more explanation. "not optimal" presumably means "does not assume full employment". The way this is phrased comes off as somewhat dismissive of these models, but models that do not assume full employment are clearly a more accurate representation of the current state of the world (and one that will be of great interest in the context of the current policy discourse). Suggest a concerted effort to reconcile the differing perspectives presented by Chapters 3 and 15.	Right. Efforts to rephrase and clarify have been pursued along the lines indicated.	Government of United States of America	U.S. Department of State	United States of America
23461	78	30	78	32	We suggest a clarification on this sentence. Does it mean that few studies find that climate stabilisation below 2°C is only reached under a GDP non-growth/degrowth approach without climate policy?	The sentence has been rephrased to clarify.	Government of France	Ministère de la Transition écologique et solidaire	France
70135	78	30			Conversely, multiple studies...	noted.	Rayner Andersen	Department of Fisheries and Oceans	Canada
12611	78		78		Figure 3.35 should come before figure 3.34 as it is discussed before in text.	noted. but actually panel a of figure 3.34 is discussed first in the text...	valentina bosetti	bocconi	Italy

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
15785	79	2	79	24	"From the SSP database of scenarios, (...) uncertainty in the cost to reach a given warming level is (...) dominated by uncertainty in emissions reductions costs for the 2°C and 1.5°C target, and costs differences between different socio economic development paths can be larger than the difference in median estimates for the two low temperature targets." Mitigation costs for these targets, that is for scenarios C1, C2 and C3 are comparable in magnitude to avoided climate change damages for the same targets (chapter 3 pages 83-85). For higher global warming (C4, C5, C6, C7), climate damages, though uncertain, are definitely at an order of magnitude much higher than mitigation costs required to avoid these scenarios. [continued below]	see below	Jean-Michel Trochet	EDF group (French Utility)	France
15787	79	2	79	24	The proof is slightly more tenuous to justify C1, C2 and C3 (even though chapter 3 page 86 line 84 states "if empirical estimates of damages, risk, consistent intergenerational discounting and distributional considerations are taken into account, pathways associated with least cost delivery of the global temperature stabilization below 2°C are likely to be economically optimal at the global level; i.e., with global benefits exceeding costs over long-term time horizons"). In no way, my comment here intends to cast a doubt on the pertinence of scenarios C1, C2 and C3. On the contrary, what should be emphasized here is that the quality of mitigation policies matters and is even more critical in order to control mitigation cost and ease their social acceptability. This includes "no delay" and "no-lock-in" arguments developed elsewhere in the report. [continued below]	noted. It has been included in the final draft.	Jean-Michel Trochet	EDF group (French Utility)	France
15789	79	2	79	24	It includes as well the importance of using the whole portfolio of decarbonised or very low carbon technologies that are already mature today (see technologies mentioned in Chapter 6). Strategies that would rely too early and too exclusively on the development of a couple of technologies (namely solar PV and wind power) would be more costly. (NB: I further develop this argument below in remarks regarding other parts of the report (notably Box 6.6 in Chapter 6)	noted.	Jean-Michel Trochet	EDF group (French Utility)	France
50275	79	9			Wrong unit in panels (b) and (d)?	Thank you for flagging the error. It has been corrected.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
65323	79	21	79	22	Again, excellent, clear summary of findings. Could this be better, clearer language for the finding as stated in the opening summary?	Thank you. This phrasing is used in the revised executive summary.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
78967	79	21	79	24	These are very important messages that belong into the summary for policy makers: "Mitigation pathways with early emissions reductions represent higher mitigation costs in the short-run but lower mitigation costs in the long-run compared to delayed transition pathways " and "...pathways with earlier mitigation action bring higher long-term GDP than pathways reaching the same end-of-century temperature but with weaker early action"" It should be pointed out (repeatedly) that enormous risks (some of which - e.g. geopolitical risks of increased conflict and migration - are difficult to quantify) are being reduced.	noted.	Young-jin Choi	Phineo gAG	Germany
12613	79		79		Figure 3.36: Panel (d) is at odds with figure 3.33 where mitigation costs are represented as decreasing in time. Please comment	Figure 3.33 has been removed.	valentina bosetti	bocconi	Italy
78969	80	1	80	5	These are very important messages that belong into the summary for policy makers: "Comparing counterfactual history scenarios, Sanderson and O'Neill (2020) also find that delayed mitigation action leads to higher peak costs. Rogelj et al. (2019) and Riahi et al. (2021) also show that pathways with earlier timing of net zero CO2, and thus lower cumulative CDR, lead to higher transition costs but [comparatively] lower long term mitigation costs, due to dynamic effects arising from lock-in avoidance and learning effects." What is the net benefit in USD?	noted. Ranges of results have been added.	Young-jin Choi	Phineo gAG	Germany
50277	80	9	80	10	It is unclear relative to what base case emission trading (between countries/regions) can reduce aggregate mitigation cost - an NDC scenario? This literature is of course not new, studies emerged with the Kyoto protocol. Another broad multi-model comparison on this was also analyzed recently by Christoph Böhringer, Sonja Peterson, Jan Schneider and Malte Winkler: Carbon Pricing after Paris: Overview of Results from EMF 36 (submitted in line with IPCC AR6 submission deadlines).	Thank you for the additional reference. The sentence has been clarified to precise the reference case.	Matthias Weitzel	European Commission, Joint Research Centre	Spain

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
52049	80	12			Response Measures and addressing its impacts should be discussed in this section	thanks for your comment. As this section focuses on the regional distribution of mitigation costs, response adaptive measures are not discussed here. Chapters 13 and 14 assess the literature on policies and international coordination.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
78385	80	13	80	24	Non-academci scenarios tend to assume regionally divergent C prices, see Skes et al (2021) in TFSC.	thanks you for the reference.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
52047	80	16	80	18	Showcases Carbon Intensive Countries will have the highest economic costs for a given Carbon price because of a deeper "transformation" of their economies and trade losses in FF markets. This should be included in the SPM.	thanks, this is a well known and somewhat obvious result. It was already highlighted in AR5. we'll discuss how to make the regional section more prominent in the SPM.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
78971	80	22	80	38	These are very important messages that belong into the summary for policy makers: "Together with co-benefits, such as health benefits of improved air quality, the economic benefits of mitigating climate change outweigh costs in most regions" [...] "Equitable burden sharing compliant with the Paris Agreement leads to negative carbon allowances for developed countries as well as China (van den Berg et al. 2020), more stringent than cost-optimal pathways".	thank you for your appreciating comment, we'll discuss how to make the regional section more prominent in the SPM.	Young-jin Choi	Phineo gAG	Germany
71347	80	33	80	44	If mentioning this theoretical literature on transfers, it is important that the paragraph explains what these "transfers" consist of, especially since they do not necessarily resemble the traditional climate finance regimes that policymakers would be more familiar with. If I understand Bauer et al. correctly, the several hundred billion per year assumes i) all countries (including developing countries) instigate a carbon price or equivalent policies that are equally stringent; ii) countries make or receive transfer payments such that their relative income loss from instigating the carbon price regime is equalised. This implies strict requirements for both the 'donor' and 'recipient' countries in an the context of a global cap on absolute emissions, and therefore cannot be used as an argument for climate finance on looser terms (e.g. purely project based).	thank you for your comment. Indeed, the literature model financial transfers in a relatively abstract way (as essentially governmental transfers). We will clarify the eligibility requirements implicit in the literature and that they cannot be used for a broader interpretation of climate finance.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
23463	80	36	80	37	Could it be specified the dates of this burden sharing (up to 2030 ? 2050 ?)	yes, dates are specified.	Government of France	Ministère de la Transition écologique et solidaire	France
54937	81	1	81	1	Clarify if the right panel in Figure 3.37 is also in the year 2050.	ok, clarified.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
78973	81	1	81	1	Figure 3.37: what does "1.5 OS" and "1.5 noOS" mean? What would these figures look like with accounting for climate change damages or avoided damages? This is important.	OS noOS refers to the amount of temperature overshoot. We clarified using the harmonized temperature categories of pathways used in the report. Damages are not included in the scenario database. As discussed in the text, including emission reduction benefits would result in significant economic gains, especially for developing countries.	Young-jin Choi	Phineo gAG	Germany
5019	81	10	81	10	"tables" should be deleted	corrected.	Tiziana Susca	Italian National Agency for New Technologies, Energy and Sustainable Economic Development	Italy
37643	81	12	81	14	Another sentence emphasising shift from fossil to renewable and not using a neutral term like non-fossil or low-carbon.	Changed.	Ravi B Grover	Homi Bhabha National Institute	India
61657	81	12	81	14	"They show requirements for increased investments, and a major shift away from fossil generation and extraction towards renewable technologies and efficiency in lower temperature categories". The word "renewable" should be substituted with "low-carbon" to be more scientifically accurate and inclusive.	Changed.	Rauli Partanen	Think Atom	Finland
65697	81	12	81	14	"They show requirements for increased investments, and a major shift away from fossil generation and extraction towards renewable technologies and efficiency in lower temperature categories". The word "renewable" should be substituted with either "low-carbon" or "non-fossil".	Changed.	Eero Hirvijoki	Aalto University	Finland
71349	81	22	82	10	The meaningfulness of the tables would be increased if numbers are reported in other terms in addition to absolute numbers, i.e. percentage of global GDO or percentage increase compared to a baseline. It is furthermore unclear whether these are total investment needs or additional investment needs for the mitigation scenarios.	noted. It has been clarified.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
61659	82	7	82	9	Table 3.7 divides categories to "fossil" and "renewables", yet this excludes nuclear energy and CCS. It should be divided between "Fossil" and "non-fossil" or "Low-carbon" (to also include CCS for fossil fuel.)	Changed.	Rauli Partanen	Think Atom	Finland
65699	82	7	82	10	The table 3.7 is displaying a division to fossil and renewables and not accounting for the investments, e.g., in nuclear and CCS. The table should instead display the binary division between fossil and non-fossil investment categories and the accordingly updated numbers. Revise accordingly.	Changed.	Eero Hirvijoki	Aalto University	Finland
37645	82	9	82	10	Why nuclear is missing from table 3.7?	The Figures (replacing the Tables) include nuclear for the world aggregated values, but focus only on the four subcomponent with highest investments for the regional level, for readability reasons. It is specified in the caption.	Ravi B Grover	Homi Bhabha National Institute	India

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
74163	82	9	82	10	Table 3.7 only includes references to fossil and renewables. It should be updated to include investments in carbon free nuclear energy.	The Figures (replacing the Tables) include nuclear for the world aggregated values, but focus only on the four subcomponent with highest investments for the regional level, for readability reasons. It is specified in the caption.	Jeffrey Merrifield	Pillsbury Law Firm	United States of America
76105	83	18	85	27	I miss attention to the time dimension here in this box. Rate of change must in my view be an important aspect here, and I suggest to try to incorporate this here. Given the title "...along long-term mitigation pathways" one would expect the importance of the time dimension to be more visible. Involving a WGI author as CA could help addressing this aspect. (I see this is addressed very briefly on page 86, but I think this box also needs to include this.)	Thank you. Further attention, yet limited due to space constraints, to the time dimension is given in the revised box.	Jan Fuglestedt	CICERO	Norway
81445	83	18	85	25	Overall, this box could benefit from a more positive framing: what is it that we know and that can be captured as economic costs/benefits. Instead it elaborates on methodological limits. It might be worth elaborating more on which climate risks are captured by the studies on the benefits of mitigation.	Noted. Framing updated.	Hans Poertner	Alfred-Wegener-Institute	Germany
23465	83	19	83	20	Cross Working Group Box 1: Literature about "Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change" (Weitzman , 2011) should be taken more into account and presented here.	Noted.	Government of France	Ministère de la Transition écologique et solidaire	France
78975	84	4	84	5	I noticed that Stern & Stiglitz paper is not being cited, although it makes a really important contribution. https://www.nber.org/system/files/working_papers/w28472/w28472.pdf	Thank you. This paper was not available at the time SOD was written. The paper is now accepted for publication, and included in the literature assessed in section 3.6.2.	Young-jin Choi	Phineo gAG	Germany
78977	84	27	84	31	"However, this difference cannot be directly computed from damage estimates across the studies assessed...due to consistency issues with differing socioeconomic assumptions, scenarios design and counterfactual reference scenarios between studies." This sends a terrible message. What are policy makers to make out of this? Conceptually, I don't see why we should be unable to a) estimate mitigation costs on the one hand and b) estimates damage of unmitigated climate change on the other and come a conclusion about which figures are higher. Of course, we would need to make sure not to underestimate the economic damages of climate change, which represents a real risk with high stakes => See this report: https://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2019/09/The-missing-economic-risks-in-assessments-of-climate-change-impacts-1.pdf this article https://www.linkedin.com/pulse/towards-realistic-comprehensive-estimate-future-costs-choi-frsa/ and this critical analysis by Steve Keen: https://profstevekeen.medium.com/economic-failures-of-the-ipcc-process-e1fd6060092e	The sentence has been rephrased to clarify.	Young-jin Choi	Phineo gAG	Germany
54939	84	43	84	43	"Social cost of carbon model" needs to be defined.	Noted.	Government of United States of America	U.S. Department of State	United States of America
50445	85	9	85	17	The title of the chart is the benefits of mitigation from avoided damages. However, the Y-axis is not clearly described or labelled, which %GDP should be further described as the damages that expressed in terms of GDP, to avoid misinterpretation of the %GDP that could be avoided.	Figure has been improved.	Hoy Yen Chan	ASEAN Centre for Energy	Malaysia
54941	85	9	85	16	The SSPs would be easier to distinguish for people with color-blindness if they each had different symbols and/or fill patterns (instead of solid circles for all SSPs).	Figure has been improved.	Government of United States of America	U.S. Department of State	United States of America
81447	85	10	85	10	The illustration could be improved, first by not using colours (difficult for colour-blind people to capture), secondly by explaining why the four panels are distinct. What are the baselines?	Figure has been improved, and caption extended to provide further explanation.	Hans Poertner	Alfred-Wegener-Institute	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
23467	85	11	85	11	This graph appears problematic. Highlighting through a graph the economic benefit in terms of percentage of GDP induced by mitigation from avoided climate change impacts in 2100 is a source of misinterpretation. Indeed, even if the text warns about the validity of the estimates that are presented, such a graph will inevitably be widely taken up and reused without the safeguards set out in the text on the limits of validity of these results. However, this graph is based on a limited number of evaluations, these evaluations present many imperfections and are not complete in terms of coverage of damages, and finally, these benefits in relation to GDP will not fail to be compared to the cost of mitigation in relation to GDP. The magnitude of the expected benefits appears to be very low, particularly for scenarios with a warming of more than 3°C (5° for example is above 3°C, and could enter in this category) compared to scenarios with a warming of less than 2°C. 15 points of GDP in 2100 compared to 2020 with an average annual GDP growth of 2.5%, would only represent an annual increase in economic growth of 0.2%.	The Figure has been improved, and caption extended to provide context and avoid misinterpretations.	Government of France	Ministère de la Transition écologique et solidaire	France
18097	85	18	85	19	It would be valuable to mention these missing risks, and their potential order of magnitude relative to the costs presented	noted.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
54943	85	18	85	21	The critical point about including non-monetary evidence in decisionmaking should be more clearly and firmly emphasized in the Executive Summary.	noted.	Government of United States of America	U.S. Department of State	United States of America
75073	85	18	85	21	These statements need to explicitly indicate that many authors have concluded that the biggest potential risks associated with climate change, such as the breaching of climate and social thresholds, are omitted from these model estimates. See Stern, N. and Stiglitz, J. (in review) The economics of immense risk, urgent action and radical change: towards new approaches to the economics of climate change. Journal of Economic Methodology. Stern, Nicholas. 2013. The Structure of Economic Modeling of the Potential Impacts of Climate Change: Grafting Gross Underestimation of Risk onto Already Narrow Science Models. Journal of Economic Literature, 51 (3): 838-59. DOI: 10.1257/jel.51.3.838. Stoerk, T., G. Wagner, and R. E. T. Ward. 2018. Recommendations for improving the treatment of risk and uncertainty in economic estimates of climate impacts in the Sixth Intergovernmental Panel on Climate Change Assessment Report. Review of Environmental Economics and Policy 12 (2): 371–76. doi: 10.1093/reep/rey005.	Thank you for the additional references.	Robert Ward	London School of Economics and Political Science	United Kingdom (of Great Britain and Northern Ireland)
78979	85	18	85	21	"The quantification of aggregate benefits from avoided impacts expressed in GDP terms or monetary terms does not encompass all avoided climate risks [such as the risk of armed and nuclear conflicts]. Therefore, other lines of evidence on climate risks, beyond monetary climate costs estimates, should be considered in supplement for decision making." It is of critical importance to emphasize to policy makers the national security risks and geopolitical risk of (nuclear) war: => https://www.thenation.com/article/archive/nuclear-defense-climate-change/	noted.	Young-jin Choi	Phineo gAG	Germany
9875	85	29	86	31	• Economic perspectives strive to balance costs and benefits associated with mitigation. The total economic effects at different temperature levels would include mitigation costs, co-benefits of mitigation, adverse side-effects of mitigation, adaptation costs and climate damages, Therefore, merely comparing mitigation cost and climate damage estimates at any given temperature level would give only a partial view of the cost and benefits of mitigation. • In addition, comparing total economic costs and benefits of mitigation raises a number of methodological and fundamental difficulties, as monetising the full range of climate change impacts is extremely hard if not impossible and socioeconomic assumptions underlying mitigation costs estimates on one side and damage estimates on the other side may not be consistent. Other important complications include the ethical underpinnings about aggregating costs and benefits over time and across individuals when values are heterogeneous	Sorry, I do not see any comment or question here. These are sentences directly taken from the SOD text.	Government of Indonesia	Ministry of Environment and Forestry	Indonesia
18099	85	29	86	9	It's true there are inconsistencies in assumptions that make precise comparisons between mitigation costs and impacts difficult, but given the uncertainties are much more bounded on the mitigation side, and the order of magnitude of uncertainty on impacts is so high (at least for higher temperatures), isn't it still possible to draw conclusions?	The revised version of the Box is strengthened in terms of conclusions.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
76107	85	29	85	30	This sounds very general; i.e. "economic perspectives strive..."	Rephrased to be more specific.	Jan Fuglestedt	CICERO	Norway

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
28285	85		87		Chapter 3 discusses cost-benefit analysis, but doesn't address the weaknesses of this mode of analysis when it's impossible to accurately calculate technology costs and benefits decades hence. The alternative method of setting a warming limit and doing COST-EFFECTIVENESS analysis to achieve that warming limit (working forward toward a goal) pervades this chapter, but when the economic effects of scenarios are described on pp-85-87, the cost-effectiveness approach is not really discussed at all. It does show up later on pp 76-77. The distinction between these two modes of analysis is important enough that it should be mentioned early in this chapter as well as in the SPM. It's important for framing the discussion in both places. Key references: Koomey, Jonathan. 2013. "Moving Beyond Benefit-Cost Analysis of Climate Change." Environmental Research Letters. vol. 8, no. 4. December 2. [http://iopscience.iop.org/1748-9326/8/4/041005/]. Meinshausen, Malte, Nicolai Meinshausen, William Hare, Sarah C. B. Raper, Katja Frieler, Reto Knutti, David J. Frame, and Myles R. Allen. 2009. "Greenhouse-gas emission targets for limiting global warming to 2 degrees C." Nature. vol. 458, April 30. pp. 1158-1162. [http://www.nature.com/nature/journal/v458/n7242/full/nature08017.html]. Caldeira, Ken, Atul K. Jain, and Martin I. Hoffert. 2003. "Climate Sensitivity Uncertainty and the Need for Energy Without CO2 Emission " Science. vol. 299, no. 5615. pp. 2052-2054. [http://www.sciencemag.org/cgi/content/abstract/299/5615/2052]	Thank you for the comment and references. A discussion of the frameworks has been added, and a reference to chapter 1 where more space is devoted to it.	Jonathan Koomey	Koomey Analytics	Canada
54945	86	1	86	32	The caveats in the section are extensive and redundant, which may bury the lede. Suggest condensing and explaining what is meant by "long term" on line 35.	thank you for the suggestion. Revised accordingly.	Government of United States of America	U.S. Department of State	United States of America
64195	86	10	86	25	How about citing National Academies of Sciences, Engineering, and Medicine (2017) which illustrates current understandings and challenges on the CBA or SCC comprehensively? *National Academies of Sciences, Engineering, and Medicine. (2017). Valuing climate damages: updating estimation of the social cost of carbon dioxide. National Academies Press.	Thank you for the suggestion. Reference added.	Soichi Morimoto	The Institute of Energy Economics, Japan	Japan
75075	86	10	86	30	Other important references: See Stern, N. and Stiglitz, J. (in review) The economics of immense risk, urgent action and radical change: towards new approaches to the economics of climate change. Journal of Economic Methodology. Stern, Nicholas. 2013. The Structure of Economic Modeling of the Potential Impacts of Climate Change: Grafting Gross Underestimation of Risk onto Already Narrow Science Models. Journal of Economic Literature, 51 (3): 838-59. DOI: 10.1257/jel.51.3.838. Stoerk, T., G. Wagner, and R. E. T. Ward. 2018. Recommendations for improving the treatment of risk and uncertainty in economic estimates of climate impacts in the Sixth Intergovernmental Panel on Climate Change Assessment Report. Review of Environmental Economics and Policy 12 (2): 371–76. doi: 10.1093/reep/rey005.	Thank you for the additional references.	Robert Ward	London School of Economics and Political Science	United Kingdom (of Great Britain and Northern Ireland)
43077	86	14		16	Urgent research is required on both overshoot and mitigation risks. Their costs and risks may be seriously underestimated, e.g.: "CBA raised numerous critics, in particular for underestimating damages from climate change, missing non-monetary damages, the uncertain and heterogeneous nature of damages and the risk of catastrophic damages."	Noted.	Graeme Taylor	BEST Futures	Australia
64197	86	18	86	25	As for the relationship between damage and growth, National Academies of Sciences, Engineering, and Medicine (2017) (p.149) does not recommend an approach based on top-down estimation of a total global damage function like Dell et al. (2012) or Burke et al. (2015), and Tol (2019) points out a problem on the statistical processing in Burke et al. (2015). How about writing on the possible problems included in an approach based on top-down methods? *National Academies of Sciences, Engineering, and Medicine. (2017). Valuing climate damages: updating estimation of the social cost of carbon dioxide. National Academies Press. *Dell, M., Jones, B.F., Olken, B.A., 2012, July. Temperature shocks and economic growth: evidence from the last half century. Am. Econ. J. Macroecon. 4 (3), 66–95 *Burke, M., S. M. Hsiang, and E. Miguel, 2015: Global non-linear effect of temperature on economic production. Nature, 527, 235–239. *Tol, R. S. (2019). A social cost of carbon for (almost) every country. Energy Economics, 83, 555-566.	this topic is by nature a WGII topic, and it is treated in WGII chapter 16. Here, we refer to it.	Soichi Morimoto	The Institute of Energy Economics, Japan	Japan
64199	86	18	86	25	As for the tipping elements, how about citing literatures based on physical process model also? For example, Norhaus (2019) and Yumashev et al. (2019) model the tipping elements based on the physical process models, and they show relatively moderate impacts on the CBA by the tipping elements. *Nordhaus, W. (2019). Economics of the disintegration of the Greenland ice sheet. Proceedings of the National Academy of Sciences, 116(25), 12261-12269. *Yumashev, D., Hope, C., Schaefer, K., Riemann-Campe, K., Iglesias-Suarez, F., Jafarov, E., ... & Whiteman, G. (2019). Climate policy implications of nonlinear decline of Arctic land permafrost and other cryosphere elements. Nature communications, 10(1), 1-11.	Thank you for the additional references.	Soichi Morimoto	The Institute of Energy Economics, Japan	Japan

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
45837	86	26	86	37	Despite all caveats and omissions of CBA this is a highly important finding that should be captured in the Executive Summary and the SPM, section C11 please: The <2-degree goal is likely economically optimal at the global level.	Noted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
48195	86	27	86	37	It is recommended to quote the Comprehensive Assessment Model of Climate Change in China (C3IAM) developed by Chinese scholars (Wei et al. 2020) and add some comments after 37: "Actually, even without accurately empirical estimates for damage, we can also make assumptions about potential future damage and set different damage magnitudes to reflect extreme disasters, tipping points, etc., which are not considered in current modeling. We can carry out simulation for different hypothetical scenarios in IAM and conduct relevant cost-benefit analysis. In this way, even if the future is uncertain, we can also prepare optimal strategies in advance to face any possible situations (Wei et al. 2020)." Supporting documents: Wei, Y. M. et al.: Self-preservation strategy for approaching global warming targets in the post-Paris Agreement era. Nat. Commun., 11, 1624 (2020)	Thank you for the additional reference.	Yang Wang	Beijing Climate Center	China
29359	86	30	86	35	It is difficult to understand the various conditions on which the conclusion about likelihood rests. Does "empirical estimates" refer to the top-down studies only? How do these compare to other estimates? What are the specific assumptions about discounting and distributional considerations? Another test of this statement would be to compare the earlier estimates of marginal abatement cost to the global social cost of carbon (global marginal benefit). Would it be possible to show the ranges in costs and benefits side-by-side? Any changes made here should also be reflected on p. 3-8. "However, emerging evidence suggests that, even without accounting for co-benefits of mitigation on other sustainable development dimensions (see section 3.2.3 for elements on co-benefits), if empirical estimates of damages, risk, consistent intergenerational discounting and distributional considerations are taken into account, pathways associated with least-cost delivery of the global temperature stabilisation below 2°C are likely to be economically optimal at the global level; i.e., with global benefits exceeding costs over long-term time horizons."	The paragraph has been revised to clarify.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
75077	86	30	86	37	Dietz et al 2018 found that limiting warming to 1.5C could also satisfy a CBA. Dietz, S., Bowen, A., Doda, B., Gambhir, A., and Warren, R. (2018) The Economics of 1.5°C Climate Change. Annual Review of Environment and Resources. Vol. 43:455-480 https://doi.org/10.1146/annurev-environ-102017-025817	Thank you for the additional reference.	Robert Ward	London School of Economics and Political Science	United Kingdom (of Great Britain and Northern Ireland)
76109	86	30	86	37	This is a very long sentence. Consider splitting.	Yes. Rephrased with shorter sentences.	Jan Fuglestedt	CICERO	Norway
78981	86	32	86	35	" if empirical estimates of damages, risk, consistent intergenerational discounting and distributional considerations are taken into account, pathways associated with least cost delivery of the global temperature stabilisation below 2°C are likely to be economically optimal at the global level; i.e., with global benefits exceeding costs over long-term time horizons " What about more "costly" delivery pathways ? I'm rather certain that the global benefits of a stabilized climate over long term horizons will almost always exceed the costs of a ruined planet. This is not something to "optimize", but something that must be gotten right the first time because there is only one try...	Noted.	Young-jin Choi	Phineo gAG	Germany
54947	86	34	86	36	As written, this implies "optimal" means benefit > cost, not maximization of (benefit-cost), which is what optimal actual means.	Noted, and rephrased to clarify.	Government of United States of America	U.S. Department of State	United States of America
9687	86	37	86	39	Need to be more explicit about robustness to wide range of normative parameters. In particular what is the range of discount rate used and how differences in uncertainties related to mitigation costs and benefits are treated.	Additional details are provided along the lines suggested.	Mustafa Babiker	Saudi Aramco	Saudi Arabia
76111	86	44	86	44	What is "too rapidly"? Compared to what?	The sentence has been deleted.	Jan Fuglestedt	CICERO	Norway
10553	87	7	87	27	These comments concerning the employment issue are rather sketchy. For example one should be careful not to consider new jobs related to thermal renovation of buildings (which are temporary, likely to be created for a couple of decades) as compensating the loss of former everlasting jobs such as related to fossil fuel extraction. In case the published research work is lacking, the employment issue might be mentioned as a knowledge gap.	Thank you for the comment and suggestion. The elements on employment are revised accordingly.	Philippe Waldeufel	CNRS	France
84541	87	10	87	10	Please change the reference "Karlsson et al. 2020b" into "Karlsson et al. 2020b". This is provi	Sorry, I do not understand the request here.	Mikael Karlsson	KTH Royal Institute of Technology	Sweden

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
23469	87	14	87	15	Concerning the biodiversity component, it is worth developing more on the benefits of mitigation for preserving the many, often-undervalued ecosystem services biodiversity provides to humanity. To do so, the following can be added to the end of this paragraph: "Regarding biodiversity, many species and ecosystems are highly sensitive to temperature, and a changing climate directly threatens valuable ecosystem services that are critical to human wellbeing. This includes the provision of fresh-water and food, livable space, and various sources of income from terrestrial and aquatic ecosystems. For example, coral reefs host a large portion of marine biodiversity, and provide food, income, and coastal protection to millions of people, but are threatened by current changes in ocean temperature and pH (Hughes et al. 2017)". REF: Hughes TP, Barnes ML, Bellwood DR, Cinner JE, Cumming GS, Jackson JB, Kleypas J, Van De Leemput IA, Lough JM, Morrison TH, Palumbi SR, van Nes EH, Scheffer M. 2017. Coral reefs in the Anthropocene. Nature 546(7656):82-90.	Thank you for the reference and comment. Due to space constraints, ecosystems services and biodiversity cannot be addressed here. They are extensively treated in WGII assessment report.	Government of France	Ministère de la Transition écologique et solidaire	France
43937	87	14	87	25	One of the key issues missing here is the consideration of alternative welfare frameworks. All of what is mentioned can be accommodated in a standard Discounted Utilitarian framework, yet this is not the only ethically plausible one. For an overview, see Botzen, W. W., & van den Bergh, J. C. (2014). Specifications of social welfare in economic studies of climate policy: overview of criteria and related policy insights. Environmental and Resource Economics, 58(1), 1-33.. Some alternative approaches include, e.g., Sustainable Discounted Utilitarianism (Dietz, S., & Asheim, G. B. (2012). Climate policy under sustainable discounted utilitarianism. Journal of Environmental Economics and Management, 63(3), 321-335.) or Prioritarianism (Adler, M., Anthoff, D., Bosetti, V., Garner, G., Keller, K., & Treich, N. (2017). Priority for the worse-off and the social cost of carbon. Nature Climate Change, 7(6), 443-449.).	I believe the comment refer to page 86 and not 87; and take it on board there. Thank you for the suggestion and references.	Moritz Drupp	University of Hamburg	Germany
47689	87	15	87	15	There is a paper under review currently which quantifies the tradeoffs between BECCS and biodiversity. Hanssen, S.V., Steinmann, Z.J.N., et al. (under review). Global biodiversity loss from lignocellulosic crop-based bioenergy with carbon capture and storage. Environmental Research Letters	Thank you for the reference. However this topic belongs more to section 3.7 on sustainable dimensions, as well as to chapter 7 on agriculture, forestry and other land uses. The reference is passed on to the corresponding authors.	Vassilis Daiglou	Utrecht University	Netherlands
86217	87	19	87	21	WG1 chapter6 (section 6.7.3) also shows (in the SSP3 context) the delay in the air pollution benefits when they comes from climate mitigation compared with air pollution mitigation. Please consider to add a reference.	Thank you for the suggestion.	Sophie Szopa	LSCE	France
86219	87	22	87	22	"negative effect of reduced aerosols", I recommend to mention specifically "cooling aerosols" as the mix can change (is changing) and sign of aerosol effect can thus also change.	accepted. thank you.	Sophie Szopa	LSCE	France
43939	87	24	87	25	"and damages to non-market goods (Bastien-Olvera and Moore 2020)" revise to "and damages to natural capital and non-market goods" and add references to: Drupp, M. A., & Hänsel, M. C. (2021). Relative Prices and Climate Policy: How the Scarcity of Nonmarket Goods Drives Policy Evaluation. American Economic Journal: Economic Policy, 13(1), 168-201.; Sterner, T., & Persson, U. M. (2008). An even sterner review: Introducing relative prices into the discounting debate. Review of Environmental Economics and Policy, 2(1), 61-76.; Tol, R. S. (1994). The damage costs of climate change: a note on tangibles and intangibles, applied to DICE. Energy Policy, 22(5), 436-438.	Thank you for the additional references. The most recent are included.	Moritz Drupp	University of Hamburg	Germany
54949	87	35	87	36	This is an important point yet the text is confusing due to vague words like "limited" and "increased". Clarify which of these -- costs or benefits -- is larger than the other.	The sentence has been rephrased to clarify.	Government of United States of America	U.S. Department of State	United States of America
78983	88	8	88	20	"Aggregate employment impacts of a low-carbon policy framework are likely to be low" and "Mitigation action through thermal renovation of buildings, installation and maintenance of low-carbon generation, the build-out of public transit all lead to job creation, while jobs are lost in fossil fuel extraction, energy supply and energy intensive sectors in mitigation pathways " This messaging appears incomplete and implausible. It could be a recipe for climate inaction. In general there are substantial NET positive employment impacts to be expected from the work that is needed to drive the transformation of global industrial and energy infrastructure - the renewable energy sector is more labor intensive than the fossil fuel energy. And creating those millions of additional jobs would help avert a looming economic crisis and its job losses. Please refer to this important data-based report about the green job creation potential in the US: https://www.rewiringamerica.org/jobs-report	Noted.	Young-jin Choi	Phineo gAG	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
78985	88	8	88	10	<p>I'm really taking issue with the way this sentence is formulated: "Aggregate employment impacts of a low-carbon policy framework are likely to be low (Chateau and Saint-Martin 2013; Vandyck et al. 2016; Barker et al. 2016; Garcia-Casals et al. 2019; Pollitt and Mercure 2018; Fujimori 11 et al. 2020)"</p> <p>It creates the impression that low carbon policies (which ones? by when?) either somewhat slightly reduce or increase employment. But it completely ignores the job creation potential of ambitious investment towards netzero by 2050, especially accelerated renewable energy deployment and electrification. (https://www.rewiringamerica.org/jobs-report) This is a missed opportunity, especially for a summary that is to dedicated to policymakers.</p> <p>Let's take a closer look at the quoted references: Chateau and Saint-Martin 2013: "In Europe, employment declines by 0.2% from baseline levels in 2030 in the best-case scenario, and by 1.6% in presence of strong wage rigidities. Similar outcomes are projected for the OECD area as a whole. In both regions, the worst-case scenario represents a strong deficit in job creation. Indeed, the mitigation policy reduces substantially the [RELATIVE] pace of employment growth over the period 2012-2030, from 7.8% to 5.5% in the OECD, and from 5.9% to 4.2% in Europe. However, this scenario is most likely to be overly pessimistic as it assumes very strong wage rigidities than are unlikely to persist over a 18-year period. Moreover, as most available CGE models developed for the economic analysis of mitigation costs, the ENV-linkages model has two characteristics which tend to overstate the long-run cost of mitigation policies: i) technological progress is assumed to be exogenous, so that the model does not fully capture the potential effects of environmental policies in stimulating the innovation of new green technologies; and ii) the ENV-linkages model does not account for the potential economic damages from climate change and, hence, omits the economic benefits from mitigation policies that operate through reduced environmental disruption. Both characteristics imply that in the long run, certain employment gains (or avoided job losses) induced by the mitigation policy that are not captured in the modelling framework" [...] The employment impact of mitigation policies crucially depends on how ETS revenues are redistributed. When permit revenues are used to reduce taxation on labour, the pace of employment growth would accelerate, and this, without any loss of purchasing power for workers. OECD employment would increase by 7.3% over the period 2012-2030, against 5.9% in absence of mitigation actions. In Europe, the migration policy boost job creation even more substantially: employment increase by 7.3% over the period 2012-2030, against 5.9% in the baseline scenario. In turn, this positive impact on employment could temporarily raise GDP levels above the baseline projection." This model doesn't even include the impact on innovation and doesn't account for economic damages?! Moreover, it describes relative job losses to a baseline, which assumes increasing employment in a business as usual scenario. how much employment</p>	noted. The sentence has been rephrased.	Young-jin Choi	Phineo gAG	Germany
85757	88	17	88	20	<p>Suggest this sentence is not consistent with the International Energy Agency information on jobs from energy efficiency 'Energy efficiency supports the creation of decent jobs by new service companies providing services for energy efficiency, but the net employment effect of efficiency improvement remains uncertain due to macro-economic feedbacks (McCollum et al. 2018b).' See https://www.iea.org/articles/energy-efficiency-and-economic-stimulus</p>	Thank you for the reference. In the effort to shorten the section, due to space constraint for the final draft, this sentence has been deleted.	Government of Australia	Department of Industry, Science, Energy and Resources	Australia
54951	88	30	88	33	<p>People engaged in indoor occupations are also vulnerable to climate-related health harms, particularly if they are in spaces without air conditioning or proper ventilation. Furthermore, the wording of the phrase "dangerousness of outdoor occupations induced by climate change" makes it sound like climate change is inducing outdoor occupations. Finally, does "decent work" have a scientific definition, or is it a rhetorical statement/value judgement? Suggest striking the second sentence and rephrasing the first one as follows: "Mitigation reduces the future impact of heat stress on labour productivity and helps protect workers from the occupational health and safety hazards imposed by climate change (Kjellstrom et al., 2016, 2018, 2019; Levi et al., 2018; Day et al., 2019)."</p>	Thank you for the suggestion. Accepted.	Government of United States of America	U.S. Department of State	United States of America
54953	88	32	88	33	<p>Suggest elevating this sentence to the Executive Summary.</p>	This suggestion is not consistent with your previous suggestion to strike this sentence. Rejected.	Government of United States of America	U.S. Department of State	United States of America
8311	88	34	90	43	<p>I appreciate the discussion of inequality related to climate impacts and mitigation. However, this section is quite hard to read, as it piles up findings without a clear structure. As a guiding framework, the dimensions used in the meta-analysis by Ohlendorf et al. (2020) could be helpful. https://doi.org/10.1007/s10640-020-00521-1</p>	Thank you for the reference. the structure of the section has been improved to ease readability.	Michael Jakob	MCC Berlin	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
50281	88	34			This section is silent on horizontal equity, i.e. the different implications for different groups within income groups (carbon pricing on transport fuels would potentially be more concentrated in rural households rather than in a specific income group). There is an emerging literature on this topic, e.g.: Douenne, T. (2020). The vertical and horizontal distributive effects of energy taxes: A case study of a French policy. The Energy Journal, 41(3). Cronin, J. A., Fullerton, D., & Sexton, S. (2019). Vertical and horizontal redistributions from a carbon tax and rebate. Journal of the Association of Environmental and Resource Economists, 6(S1), S169-S208. Fullerton, D., & Muehlegger, E. (2019). Who bears the economic burdens of environmental regulations?. Review of Environmental Economics and Policy, 13(1), 62-82. Pizer, W. A., & Sexton, S. (2019). The distributional impacts of energy taxes. Review of Environmental Economics and Policy, 13(1), 104-123.	Thank you for the references.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
54955	88	35	89	9	This paragraph is extremely unclear. The "high confidence (medium evidence, high agreement)" assessment in the first sentence does not seem to be supported by the back and forth in the rest of the text. To what is the phrase "Yet, the absolute effect remains moderate" referring? Also, an 8% increase in emissions sounds rather large without a time scale associated with it. Finally, it would be helpful to see citations of research showing that eliminating extreme poverty could be associated with reduced emissions, given the allusion to that concept in lines 38 and 39.	The paragraph has been revised to clarify.	Government of United States of America	U.S. Department of State	United States of America
23471	88	43	88	46	Concerning Rao and Min (2018) and Sager (2019), what is the time horizon and the mitigation objective of these studies?	These details have been added.	Government of France	Ministère de la Transition écologique et solidaire	France
78237	89	7	82	9	Omission - Table 3.7 doesn't mention nuclear making it inconsistent to be read with table 3.6	The Figures (replacing the Tables) include nuclear for the world aggregated values, but focus only on the four subcomponent with highest investments for the regional level, for readability reasons. It is specified in the caption.	Reetesh Chaurasia	Department of Atomic Energy, Government of India	India
52007	89	10	89	16	The graph is not clear. The indication of the colored arrows not clear too. Fix.	This Figure has been deleted.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
54957	89	10	89	16	Some readers will take the relative size of the arrows too literally, rather than viewing the graphic as a qualitative synthesis of many kinds of disparate estimates. If it remains in the chapter, consider the following changes: (1) using a more traditional legend than roughly matching the colors of the arrows with font colors below the y-axis; (2) more carefully explaining the meaning of the dark and light orange arrows; and (3) defining "inequality" in the context of this figure.	This Figure has been deleted.	Government of United States of America	U.S. Department of State	United States of America
54959	89	10	89	20	Suggest cutting Figure 3.38 and either deleting text on lines 18 through 20 or revising to better clarify that these four arrows are not separate from one another. Mitigation policies, shown in blue, include the other three categories. These concepts may outweigh each other, but they are a part of a whole policy, not separate. This figure may confuse rather than clarify the text.	This Figure has been deleted.	Government of United States of America	U.S. Department of State	United States of America
8313	89	30	89	33	In my view, the question of recycling of carbon pricing revenues is central and deserves much more attention than in this chapter. For instance, you could shed some light on the potential of different schemes for SDG financing (e.g. Franks et al., 2018, NCC, https://doi.org/10.1038/s41893-018-0083-3), discuss options to implement such schemes in the real world (see e.g. Schaffitzel et al. 2020, EP, https://doi.org/10.1016/j.enpol.2019.111120) or examine how targetting errors for transfer schemes can be minimized,	The topic is important indeed. However, due to space constraint, it cannot be treated in great detail here. It is in chapter 13 on National and subnational policies and institutions, which we refer to.	Michael Jakob	MCC Berlin	Germany
50279	89	30	89	33	This is also assessed in EMF 36 in a number of models, the overview paper summarizes the findings: Christoph Böhringer, Sonja Peterson, Jan Schneider and Malte Winkler: Carbon Pricing after Paris: Overview of Results from EMF 36 (submitted in line with IPCC AR6 submission deadlines).	Thank you for the reference.	Matthias Weitzel	European Commission, Joint Research Centre	Spain

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
27631	89		89		Figure 3.38 is a repetition of Figure 3.33.	This Figure has been deleted.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
78987	90	1	90		"The impacts of renewable energy subsidies have also been explored. If not implemented carefully, these have proven to increase inequalities via two mechanisms" ... but what if implemented carefully?	In the effort to shorten the section, due to space constraints for the final draft of the chapter, this sentence has been deleted.	Young-jin Choi	Phineo gAG	Germany
5241	90	16	90	16	I suggest to had one sentence : "It is clear that development of renewable, specially solar eat or electricity production in developing countries, if the investment is properly subsidised by rich countries improve the quality of life of these populations, with very limited emissions of GHG.	Thank you for the suggestion. Without proper references, it is not possible to add this sentence. This is an assessment of the literature.	Michel SIMON	Retraité/ Pdt d'association	France
54961	90	17	90	21	This paragraph would benefit from a little more hedging about the policy-dependent nature of the benefits to vulnerable communities. That's especially true for co-benefits that are scale- or geography-dependent. For example, average decreases in air pollution over a wide area may do little to help the most vulnerable in frontline communities next to polluting facilities or highways.	Thank you for the suggestion. More careful phrasing is now used.	Government of United States of America	U.S. Department of State	United States of America
1895	90	25			Interesting figure. Can it also be developed for 2 degrees? And what does 'compared to national policy' mean?	It seems that this comment refers to Figure 3.41 on page 107.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
5101	90	27	90	28	Please add level of agreement and confidence for the statement that higher levels of warming are projected to generate higher inequality	Accepted.	Lina Hollender	n/a	Germany
23473	91	1	91	1	All across this section, we suggest if possible, to include benefits from avoided climate impacts or otherwise to clarify it up front in a very explicit manner.	Accept. We are implementing this by highlighting benefits from avoided impacts across each sustainable development area we cover.	Government of France	Ministère de la Transition écologique et solidaire	France
71351	91	1			Is it possible to bring out and summarize the synergies and tradeoffs between achieving the SDGs and the PA goals more directly in this section?	Accept. Thanks to new research, we are able to highlight particular areas of trade-offs, synergies and strategies to decrease trade-offs.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
78387	91	1	91	1	This section could helpfully refer to Chapter 4 "shifting sustainable development pathways" - there is alignment between their qualitative assessment and the numbers here.	Accept. This is now done.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
23475	91	13	91	15	Several of these issues are summarized in Kayal et al. 2019. In the context of this sentence, the suggested reference article discusses interdependencies between the social and the ecological spheres, and highlights several shortcomings that hinder achieving sustainable goals, notably ethical issues related to societal inequalities and their links to the levels of vulnerability and responsibility towards global change. Overall, given the highly compartmentalized nature of the IPCC report, where solutions and risks are discussed in separate paragraphs, such transdisciplinary considerations are key to convey an integrated message about the socio-ecological challenges associated with climate change. REF: Kayal M., Lewis H., Ballard J., Kayal E. 2019. Humanity and the 21st century's resource gauntlet: a commentary on Ripple et al.'s article "World scientists' warning to humanity: a second notice". Rethinking Ecology 4: 21–30. https://doi.org/10.3897/rethinkingecology.4.32116	Noted. This reference will be taken into consideration. Due to length limitations, and the need to cut this section by half, we will not be able to include all relevant material.	Government of France	Ministère de la Transition écologique et solidaire	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54963	91	25	92	11	The colorful symbols to the upper left of each panel are illegible, and there's no description of them in the figure caption. The lines would be easier to distinguish for people with color-blindness if they each had different symbols and/or fill patterns (instead of open circles for all lines). The y-axis labels are missing from two panels and need additional detail in others. For example, is "million" in panel A just millions of any people? Or a specific demographic? What is the grid size in "species (per grid)"? Likewise, additional detail about the panel titles would be extremely helpful. What does "Secondary industry share" mean? Is "Agricultural price" just for staple crops, or a broader array or agricultural products?	This figure has been removed and replaced with a multi-model figure with clearly legible and described aspects.	Government of United States of America	U.S. Department of State	United States of America
61661	92	1	92	11	Figure 3.39 panel e). It be more meaningful to show the share of low-carbon or non-fossil energy instead of choosing renewables and leaving out nuclear and CCS. The current choice seems to be technologically biased against nuclear and CCS and as such, scientifically inaccurate from climate mitigation point of view.	This figure has been removed and replaced with a multi-model figure with clearly legible and described aspects.	Rauli Partanen	Think Atom	Finland
65701	92	1	92	11	Figure 3.39 panel e) should show the share of low-carbon or non-fossil energy instead of choosing renewables and leaving out nuclear and CCS.	This figure has been removed and replaced with a multi-model figure with clearly legible and described aspects.	Eero Hirvijoki	Aalto University	Finland
82281	92	1	92	11	Is this study and figure only for Asia or is it global?	This figure has been removed and replaced with a multi-model figure with clearly legible and described aspects.	Jarmo Kikstra	IIASA	Austria
10555	92	2	92	2	Since the main purpose of small icons in the top left corner of each subplot is to indicate the relevant SDG, the numbers in these icons ought to be printed larger. Right now one can hardly read them.	This figure has been removed and replaced with a multi-model figure with clearly legible and described aspects.	Philippe Waldteufel	CNRS	France
71353	92	4			well-below 2 degree C should be specified further as it is not aligned with the previous classification/scenarios. Are the other scenarios aligned with C1-C7? would be good to indicate.	This figure has been removed and replaced with a multi-model figure with clearly legible and described aspects.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
1897	92	11			The style of this section is quite different from the rest of the chapter. It would be useful to link it more directly to the IAMs/scenarios and underlying assumptions used in preceding sections. Furthermore, there seems to be very limited linking to the literature on transformational change and tipping points for accelerating deployment of mitigation technologies	Noted. As discussed in the introduction to the chapter, IAMs in general are not designed or suited to covering sustainable development aspects, which is why the style of this section is a departure. The literature on technical transformations and tipping points is not directly relevant to sustainable development, and may be more relevant to sections on sectoral transformation or feasibility.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
5103	92	12	92	16	Please explain why the section focusses on six of the 17 SDGs only	Accept. The motivation for covering these specific areas will be explained in the introduction to the section. Briefly these are the areas best represented in the literature, and the specific SDG dimensions are relevant to a particular UN effort, whereas our chapter looks beyond the SDG deadline in terms of timeframe, so does not take the exact SDGs as our sustainable development framework, although we do refer to them.	Lina Hollender	n/a	Germany
71355	92	17	92	17	Consider including in the Food chapter also the aquatic sources food (fisheries, aquaculture, alternative proteine).	Thank you. Some aquatic impacts are included in section 3.7.5 . We will consider how to allocate it across sections, but must be aware of section length limitations.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
18101	92	21	93	11	Could impacts on trade and supply chains also be referenced? e.g. 'risks to food production and trade', which would likely overlap and help inform national climate change risk assessments such as the UK CCRA	Thank you. Considered. Climate change would affect production of food, resulting in changing trade and supply chains. These are considered in the most of studies.	Government of United Kingdom (of Great Britain and Northern Ireland)	Department for Business, Energy & Industrial Strategy	United Kingdom (of Great Britain and Northern Ireland)
75719	92	21	93	14	Nothing is said in this section on the effects (potential effects) of extrem events such as storms, inondations, wild fires, extrem droughts etc. all of which are likely to increase in frequence and/or duration.	Thanks, we will include discussion on the effects of extreme event.	Sylvain Pichat	University of Lyon, Ecole normale supérieure de Lyon, Laboratoire de Géologie (LGL-TPE)	Germany
28883	92	22	92	23	What about the effects of demography on food system	Thanks, future demographic changes are considered in the most of studies.	Nathalie Hilmi	Centre Scientifique de Monaco	France
23477	92		92		Figure 3.39 : We suggest the removal of the graph as the baseline does not include climate impacts and could be a source of confusion and misinterpretation. It could be interpreted as : climate mitigation will increase population at risk hunger, and decrease main species richness. Furthermore we found that it contradicts what is said in the following sections (3.7.1 ... 3.7.6) starting from the impact of climate change (within the context of a "baseline"). If the removal isn't possible, we recommend to make the design of the baseline more distinct of the scenarios in order to facilitate comparing scenarios with the baseline and to add a baseline on graph C	This figure has been removed and replaced with a multi-model figure with clearly legible and described aspects.	Government of France	Ministère de la Transition écologique et solidaire	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
52051	92		105		Cost Benefit Analysis must be included with the implications of mitigation pathways. (Costs must be compared to benefits).	Reject. The sustainable development framework should not be reduced to monetary terms. Sustainable development goals are not measured as such, for example. These are goals in their own right, not just based on cost effectiveness.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
1899	93	4			Are there ways of improving this figure?	This figure has been removed and replaced with a multi-model figure with clearly legible and described aspects.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
23479	93	5	93	7	We suggest for this sentence to add something on pest such as the alteration of ecosystem functioning such as recycling and to mention harvested wild species by reformulating "...affecting crops, livestock, and harvested species in the wild".	Noted. Due to length limitations, we were not able to include this aspect.	Government of France	Ministère de la Transition écologique et solidaire	France
61301	93	5	93	14	ADD.."Climate change also leads to land degradation and desertification exacerbating adverse impacts of climate change on food production"	Noted. Due to length limitations, we were not able to include this aspect.	Graham von Maltitz	UNIVERSITY OF STELLENBOSCH; UNCCD SCIENCE POLICY INTERFACE	South Africa
45839	93	7	93	8	The sentence "Increases in temperatures can affect fisheries and livestock in other ways..." says little (which other ways?) and has no literature reference. Please expand or delete.	Noted. Due to length limitations, we were not able to include this aspect.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
45841	93	7	93	8	Aquaculture can be mentioned here, as it also can be affected by climate change.	Partially accepted. Thank you. Some aquatic impacts are included in section 3.7.5 . We will consider how to allocate it across sections.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
29361	93	12	93	13	This statement seems too general and overlooks the key uncertainties affecting agriculture yields due to climate change (including CO2 fertilization as well as changes in N application), regional patterns, and the possibility of adaptation, including changes in regional production and trade patterns. It would be a good idea to cross-check this finding with the WG2 discussion of agriculture. "In summary, climate change will reduce crop yields, increase food insecurity and influence nutrition and mortality (high confidence)."	Noted. Thank you. We have deleted this sentence and revised the paragraph.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
60743	93	15	94	30	Confidence levels for each important finding are missing .	Noted. The paragraph has been deleted.	Lourdes Tibig	Climate Change Commission, Philippines	Philippines
72155	93	15			This section is problematic as it implies that it is the imprint of stringent mitigation that creates food risks. That is not quite the full truth. Much more, it is the impact of a hypothetical uniform carbon price across all sectors that leads to this. But will never be real world policy. The effects documented in IAMs are thus more the outcomes of the input assumptions than anything else. Not critically reflecting on this can be quite misleading for policy makers. This is criticized in Hayek et al. 2020 and the authors should take this criticism very seriously.	Noted. We have added a note of the assumption on these studies imposing uniform carbon price.	Carl Schleusner	Climate Analytics	Germany
54965	93	16	94	30	There is some repetition in this section, so text may be streamlined and reduced.	Noted. We have removed the repeated parts.	Government of United States of America	U.S. Department of State	United States of America
8095	93	21	93	26	Please clarify this sentence: the "main channels" are not well separated. E.g., "2" can easily be subsumed into "3".	Noted. This part has been removed.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
9863	93	21		28	Reduction in food availability due to the dominance of bioenergy crops'. This statement will be depend on the market price (profit) between bioenergy and food crops, and on the species of bioenergy crops in developing countries. If the market price of bioenergy crop is lower than food crops, then there will be land use change from bioenergy crops to food crops. Suggestion : 'if not properly managed' is added to the statement	Noted. This part has been removed.	Government of Indonesia	Ministry of Environment and Forestry	Indonesia
28887	93	21	93	21	What about macro algae as bio energy?	Noted. Thank you. Since there is no literature on this, we have not mentioned this.	Nathalie Hilmi	Centre Scientifique de Monaco	France
86767	93	24	93	25	In line with previous comments, we suggest the following wording: "(2) Reduction in food availability due to the dominance of CERTAIN TYPES OF bioenergy (crops) PRODUCTION";	Noted. This part has been removed.	Government of Argentina	Ministry of Environment and Sustainable development of Argentina	Argentina
3947	93	29		33	Is the cause the increase of forests at the expense of agricultural land? It would be convenient to briefly indicate the main reasons for it.	Accepted. We have clarified the language.	Rosa M Poch	ITPS and UdL	Spain
28885	93	29	93	33	Reference here	Accepted. We have clarified the language.	Nathalie Hilmi	Centre Scientifique de Monaco	France
80325	93	39	93	41	Extending the study on the reduction of emissions about biofuels, such as corn, compared to fossil fuels, as a step in modernizing the energy system and as an incentive to do so.	Accepted. We have added 'Introducing more biofuels and bioenergy and' to consider this point.	JUAN DIAZ	Association	United States of America
86769	93	41	93	42	As stated, not all meat production systems play a detrimental role in terms of GHG emissions. We suggest deleting this sentence.	Noted. We agree but we include this because the literature show reduced meat consumption brings the benefit in general.	Government of Argentina	Ministry of Environment and Sustainable development of Argentina	Argentina
61303	93	45	93	46	ADD "Restoration of degraded crop and pasture lands could provide synergistic benefit of Carbon sequestration in land and increasing crop and livestock production".	Noted. We will include this if literature shows this.	Graham von Maltitz	UNIVERSITY OF STELLENBOSCH; UNCCD SCIENCE POLICY INTERFACE	South Africa
55119	94	9	94	10	Regarding GHG Emissions and the impact on climate change, the emphasis should be on productions systems, rather than on the final product, as it has more influence in the final GHG balance. There are ways to produce both plants and animals that can be either high in emissions or can control and neutralize the emissions. There for, plant-based diets do not for themselves, guarantee the reduction or control of related emissions. And, on the other hand, livestock systems, when considering conservationist and integrated agricultural strategies, can neutralize emissions, and promote a balanced and diversified, hence resilient, production system. Focusing on productions systems, integrated, diversified, and sustainable, adapted to local landscapes, the outcomes are not only related to GHG emissions and resilience, but also, diversification of food sources, nutrient value, and, of course, income and accessibility.	Rejected. We really would like to incorporate such knowledge and if scientific literature actually implementing such measures exists and shows its effectiveness, we are happy to add these things.	Government of Brazil	Ministry of Foreign Affairs of Brazil	Brazil
31527	94	10	94	12	It would be appropriate to reference a systematic review of the emissions and health effects of different diets here https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0165797 and another systematic review 'Climate change mitigation through dietary change: a systematic review of empirical and modelling studies on the environmental footprints and health effects of 'sustainable diets' https://iopscience.iop.org/article/10.1088/1748-9326/abc2f7/meta	Noted, but unable to include these references due to length limitations.	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
31525	94	12	94	13	The text implies that reduction of all animal products would have the same health benefits but consumption of poultry does not seem to increase health risks - the focus should be on red and processed meat consumption (although this has been disputed most nutritional scientists accept the evidence - see for example https://www.health.harvard.edu/staying-healthy/whats-the-beef-with-red-meat). The GBD study gives estimates of the disease burden associated with red and processed meat consumption https://www.thelancet.com/article/S0140-6736(19)30041-8/fulltext	Noted, but unable to go into such detail to length limitations.	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
86771	94	12	94	15	Such statement does not consider the important nutritional contribution that red meat provides, significantly contributing to food security and nutrition (SDG 2, Agenda 2030). We suggest balancing the phrase.	Rejected since the literature supports it.	Government of Argentina	Ministry of Environment and Sustainable development of Argentina	Argentina
31529	94	15	94	16	The implication here is that all the health benefits of more sustainable diets come from reduced animal product consumption in high consuming populations. This is misleading because there are even larger potential health benefits from increasing inadequate intakes of whole grains, fruits, nuts and seeds and vegetables, see for example the Global Burden of Disease estimates for dietary risk factors https://www.thelancet.com/article/S0140-6736(19)30041-8/fulltext . It would therefore be helpful to clarify that reductions in red and processed meat should be combined with increases in these categories of plant-based foods to achieve optimal improvements in health. The EAT Lancet Commission is a prominent example of an ambitious proposal for dietary optimisation - 'the Planetary Health diet'. A review of 21 peer-reviewed studies allowed the comparison of 66 dietary scenarios. It identified that the so-called Mediterranean and Atlantic diets present high nutritional scores and low carbon footprints. https://www.sciencedirect.com/science/article/abs/pii/S004896971832415X . A dietary optimisation study of the UK diet showed that optimisation to a WHO recommended diet would reduce GHG emissions and improve health https://bmjopen.bmj.com/content/bmjopen/5/4/e007364.full.pdf . Its seems possible to reduce GHG emissions by 30-40% without completely removing animal products from the diet. There may be trade-offs with increased freshwater demands in some cases.	Noted, but unable to go into such detail to length limitations.	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
86773	94	15	94	16	We suggest deleting the recommendation on shifting to mediterranean diets. Although the beneficial effects on health of that type of diet can be relevant, it should be taken into account that these recommendations are associated with dietary patterns, availability and access to typical foods of the Mediterranean countries. Healthy diets in many other parts of the world may also play a central role in achieving food security and nutrition, and they should also be acknowledge. The Mediterranean diet should be one option among many other possible healthy diets, taking into account that the specific needs and requirements of each population are many times associated with local consumption patterns.	Noted, but unable to go into such detail to length limitations.	Government of Argentina	Ministry of Environment and Sustainable development of Argentina	Argentina
17609	94	20	94	30	There are many overlaps in this paragraph and previous ones. For instance check Page 93 I36 onwards.	Accepted. We will remove the overlapped parts.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
54967	94	20	94	30	This paragraph is extremely unclear. Does the sentence starting on line 27 mean that net global welfare could decline 3.6% with climate action? If so, how does that agree with the next line about food security? How is welfare being defined?	Partially accepted. We apology that we led this misunderstanding. We have refered to the mitigation cost which is shown in the other section and remove welfare numbers to avoid this misunderstanding.	Government of United States of America	U.S. Department of State	United States of America
86775	94	21	94	24	In line with previous comments, we suggest the following wording (added language in capital letters and deleted wording between brackets/parenthesis): "Reconciling bioenergy demands with food and biodiversity, and the (inherent) competition for land and water THAT IN SOME CASES OCCUR, will require (major) changes in food systems – agricultural intensification, open trade, (less consumption of animal-products) and reduced food losses – or advanced biotechnologies -Henry et al. 2018b; Xu et al. 2019a-".	Noted, but unable to go into such detail to length limitations.	Government of Argentina	Ministry of Environment and Sustainable development of Argentina	Argentina
31731	94	24	94	24	"or advanced biotechnologies" - will this be and advanced biotechnologies instead of 'or'	Rejected due to consensus in the literature.	Shreya Some	Ahmedabad University	India
23481	94	31	94	34	We recomand to add the following to mention critical environmental considerations in relation to agriculture : "Additional solutions to negative impacts associated with food production and consumption include waste reduction, and transition to a sustainable, local and organic agriculture that is less resource intensive, more resilient to a changing climate, and in line with biodiversity and social targets (Kayal et al. 2019)."	Accepted.	Government of France	Ministère de la Transition écologique et solidaire	France
76929	94	32	94	34	Although this concludes an interesting and important discussion, I have the impression that it could be made clearer: here the focus is on how measures are "implemented". Is this solely an implementation issue? Fujimori et al. 2019 (cited in your text) summarizes the problem as "carelessly designed climate mitigation policies" (which could be improved to take food security into account, but at a cost). My impression is that policy design can be more than just implementation (e.g. choice of measures, integration in a broader context...), so the "policy design" wording might be more accurate / appropriate here.	Noted but limited space means this discussion had to be removed.	Philippe Marbaix	Université catholique de Louvain	Belgium

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
52009	95	1	95	2	The font of the table is unreadable.	Noted. We will remove the figure.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
60745	95	1	95	6	Figure 3.40 is not easy to appreciate. More labeling is required. For instance, for c) what is represented by the numbers in the x-axis.	Noted. We will remove the figure.	Lourdes Tibig	Climate Change Commission, Philippines	Philippines
4405	95	8	97	41	Add Reference: Sharma S , Bharat A, DasV.M (2013), Statistical change detection in water cycle over two decades and assessment of impact of urbanization on surface and sub-surface water flows, Open journal of modern hydrology , scientific research publishing, 7th Oct. 2013, ISSN (print) 2163 – 0461 , ISSN (online) 2163 – 0496	Rejected. Given space constraints, we cannot include all publications and have relied mostly on publications since AR5 (2014) and WGII for this section.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4407	95	8	97	41	Add Reference: Nair Rekha .S ,Bharat A, Manu G. Nair (2013), Impact of climate change on water availability : Case study of a small coastal town in India, Journal of water and climate change (by IWA Publishing), Vol. 4 , No. 2 , 2013 , pp 146 – 159, ISSN: 2040-2244	Rejected. Given space constraints, we cannot include all publications and have relied mostly on publications since AR5 (2014) and WGII for this section.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4409	95	8	97	41	Add reference: Sharma D, Bharat A (2009), Conceptualising Risk assessment framework for impacts of Climate change on water resources, current science Vol. 96, no. 8, 25 April 2009, pg. 1044 – 1052, ISSN 0011-3891	Rejected. Given space constraints, we cannot include all publications and have relied mostly on publications since AR5 (2014) and WGII for this section.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
3949	95	9		12	It would be necessary to comment here the increase of irrigation water needs as well. It is not clear if they are taken into account in these models.	Noted. In this paragraph, irrigation is included as part of "demand". More information on irrigation is included later in the subsection	Rosa M Poch	ITPS and UdL	Spain
45843	95	9	95	9	Please add "SDG Targets 12.4 and 3.9, water pollution and health, and SDG 15 ecosystem protection and water systems " after "...sanitation". Rationale: These SDG targets address further important aspects of water quality and water quantity.	Accepted	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
60747	95	13	96	33	It is noted that for the whole discussion, only the general statement on impacts have a confidence level, whereas most look more of a literature review.	Partially accepted. We have shortened this section given space constraints, limiting the amount of literature review and focusing on synthesis statements with confidence levels.	Lourdes Tibig	Climate Change Commission, Philippines	Philippines
7697	95	14	95	28	Because of change of precipitation pattern which led to increasing runoff and sudden floods and sever damages to economy and environment, suggestion is: to presenting needed approaches for correction of quality of drinking water which is cause of many digestive disease. It was because of entrance of waste water to consumption cycle.	Noted. Water-related health issues are covered in the health subsection.	Leila Rashidian	Meteorological	Iran

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
39047	95	15		17	"Many studies show increases in total global precipitation, runoff and water availability with increases in warming (Hanasaki et al. 2013; Greve et al. 2018). However, the effects vary by region, with some regions showing increases in water availability and other regions showing decreases (Hanasaki et al. 17 2013; Koutroulis 2019; Schewe et al. 2014; Schlosser et al. 2014a)." This REALLY needs further amplification. Why are some regions looking at increased water availability, while some are not—in fact, the reverse.	Partially accepted. We have added some clarification of this statement. However, more detailed information related to climate and water availability is in the WGI and WGII reports	Robert Buhr	Green Planet Consulting Ltd.	United Kingdom (of Great Britain and Northern Ireland)
39049	95	29		32	"Studies quantifying the effect of climate change on water show that global exposure to water stress will increase with increased warming, but increases will not be felt in all regions, and limited areas might experience decreases..." This statement seems very much at odds with the statement on lines 15-17. More discussion here please.	Partially accepted. This statement was consistent with the one on lines 15-17 (some regions experience increases and some experience decreases). We have slightly rephrased it to be clearer.	Robert Buhr	Green Planet Consulting Ltd.	United Kingdom (of Great Britain and Northern Ireland)
79831	95	29	96	2	Even in areas where precipitation increases, due to intense rainfall within short period of time, the actual availability of the water in terms of its quantity and quality may be reduced. These aspects of water supply reduction due to increased intensity and frequency of extreme rainfall events should also be highlighted in this section.	Accepted.	Madoka Yoshino	United Nations University Institute for the Advanced Study on Sustainability	Japan
79835	95	32	95	33	Suggest indicating/specifying for what the risk is referring to in "the decreases in water resources occur starting at 2.3C, contributing to high risk."	Partially accepted. We have revised this statement for consistency with WGII. The new statement does provide more context on risk, although summarised for space limitations	Madoka Yoshino	United Nations University Institute for the Advanced Study on Sustainability	Japan
79837	95	32	95	35	"water resources" and "water supply" have broad meanings and will help specifying, i.e. neither sentences do not specify whether they are referring to "water resources" and "water supply" for human population or covering broader species.(mentioning that water issues related to non-human species are covered later in biodiversity section may be helpful as well)	Noted. We are limited by what is quantified in the underlying literature and have opted to use the terms they use.	Madoka Yoshino	United Nations University Institute for the Advanced Study on Sustainability	Japan
61305	96	3	96		ADD: "Land degradation and loss of soil quality due to climate change, both warming and increased precipitation intensity, could exacerbate the adverse impact of climate change on water availability for crop and livestock production	Noted, but unable to include this aspect due to length limitations.	Graham von Maltitz	UNIVERSITY OF STELLENBOSCH; UNCCD SCIENCE POLICY INTERFACE	South Africa
66867	96	3	96	33	It's worth skimming WG1 chapters 8 and 11 for assessments of the hydrological cycle in climate models, including extremes.	Accepted. We are now referring to WGI and WGII.	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)
1901	96	6			The figure is very difficult to understand	Comment should have been for page 95. Noted. This figure has now been removed.	Anne Olhoff	UNEP DTU Partnership, Technical University of Denmark	Denmark
10557	96	6	96	7	Here and below, you refer to Schlosser et al. (2014), Schlosser et al.(2014a), and Schlosser et la.(2014b). Actually, while the reference list includes two Schlosser (2014) items, they are completely identical. Apparently, what Schlosser et al. mainly demonstrate is that the incidence on water demand of climate change is much weaker than the influence of population growth and economic activity.	Accepted. We have corrected the citation error	Philippe Waldeufel	CNRS	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31531	96	23	96	23	There could be discussion of the potential for climate change to exacerbate freshwater depletion in areas that have over exploited their aquifers for example in North West India https://www.sciencedirect.com/science/article/pii/S0048969717303261 https://www.sciencedirect.com/science/article/pii/S0048969718323350 Foods of animal origin are major contributors to the green Water Footprints of diets, whereas cereals, fruits, nuts, and oils are major contributors to the blue WF of diets https://academic.oup.com/advances/article/11/2/375/5564833	Partially accepted due to length limitations (diet mentioned but depletion not).	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
23483	96	26	96	26	Concerning "nitrogen loading" we recommend to also take into account other pollutants such as pesticides. With impacts on surface water but also on groundwaters. Lower precipitation or concentrated during extreme events may lead to a lower recharge that can result in an increase of groundwater salinization especially in coastal areas with seawater intrusion. This will be amplified by the sea level rising (e.g. Werner et al., 2013; Petelet-Giraud et al., 2018) REF: Petelet-Giraud, E., Cary, L., Cary, P., Bertrand, G., Giglio-Jacquemot A., Hirata, R., Aquilina, L., Alves, L.M., Martins, V., Melo, A.M., Montenegro, S., Chatton E., Franzen, M., Aurouet, A. and the COQUEIRAL team. 2018. Multi-layered water resources, management, and uses under the impacts of Global Changes in a Southern Coastal Metropolis: when will it be already too late? Crossed analysis in Recife, NE Brazil. Science of the Total Environment, 618: 645–657. https://doi.org/10.1016/j.scitotenv.2017.07.228 . Werner, A., Bakker, M., Post, V.E.A., Vandenbohede, A., Lu, C., Ataie-Ashtiani, B., Simmons, C.T., Barry, D.A., 2013. Seawater intrusion processes, investigation and management: recent advances and future challenges. Adv. Water Resour. 51, 3–26.	Noted, but unable to include this aspect due to length limitations.	Government of France	Ministère de la Transition écologique et solidaire	France
28889	96	34	96	37	And demography?	Rejected	Nathalie Hilmi	Centre Scientifique de Monaco	France
60749	96	34	97	39	Please do an improved synthesis with confidence levels.	Accepted	Lourdes Tibig	Climate Change Commission, Philippines	Philippines
23485	96	36	96	37	Concerning "mitigation efforts can substantially increase water demand" we suggest to add that some of the mitigation solutions (such as hydrogen electrolysis seen as alternative to fossil fuels) have large water related impacts as for 1 kg of Hydrogen almost 9 liters of water are needed REF : ("The electrolytic processes, mainly by proton exchange membrane fuel (cell-PEM) with grid electricity has the worst performance in most of the impact categories" - Metmehdi A. and al, 2018 - Life cycle assessment and water footprint of hydrogen production in production methods: from conventional to emerging technologies, Environments 2018, 5, 24; doi:10.3390/environments020024).	Partially accepted. We've added more nuance to the discussion of mitigation effects on water; however, due to space limits, we cannot add all references suggested	Government of France	Ministère de la Transition écologique et solidaire	France
17611	97	1	97	5	Exact sentence is duplicated but with difference references	Accepted. We have corrected this duplication.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
29025	97	1	97	21	Some further supporting evidence to show that the water use of CO2 capture can be managed to not increase, see references: Giannaris, S. et al (2020). "Implementing a second generation CCS facility on a coal fired power station", Greenhouse Gases: Science and Technology, 10(3), ; IEAGHG (2020) "Understanding the cost of reducing water usage in coal and gas fired power plants with CCS", IEAGHG 2020-09; IEAGHG (2011) "Evaluation and Analysis of Water Usage of Power Plants with CO2 Capture" IEAGHG 2010/05; IEAGHG (2020) "CCS and the Sustainable Development Goals", IEAGHG 2020-14; Mikunda et al (2020) "CCS and the Sustainable Development Goals", International Journal of Greenhouse Gas Control (submitted 17 Nov 2020).	Partially accepted. We have added some, but not all, of these references	Jasmin Kemper	IEAGHG	United Kingdom (of Great Britain and Northern Ireland)
37647	97	1	97	1	Please also refer to the paper regarding water stress mentioned at s. no. 1.	Rejected. Unfortunately, we are not sure what "s. no. 1." means.	Ravi B Grover	Homi Bhabha National Institute	India
47691	97	1	97	5	Sentence is repeated with different references.	Accepted. We have corrected this duplication.	Vassilis Daioglou	Utrecht University	Netherlands
60163	97	1	97	5	sentence repetition with different references	Accepted. We have corrected this duplication.	Government of Hungary	Ministry of Innovation and Technology - Climate Policy Department	Hungary
66865	97	1	97	4	Repeated sentence	Accepted. We have corrected this duplication.	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
3951	97	3		4	Sentence repeated from above, but references change. Please check.	Accepted. We have corrected this duplication.	Rosa M Poch	ITPS and UdL	Spain
27633	97	3	97	4	Delete "Bioenergy and BECCS can result in substantial increases in water withdrawals and water consumption" as the sentence is repeated.	Accepted. We have corrected this duplication.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
28605	97	3	97	4	Sentence is repeated	Accepted. We have corrected this duplication.	Tim Dixon	IEAGHG	United Kingdom (of Great Britain and Northern Ireland)
31533	97	10	97	10	More detail could be provided about the need for promoting dietary choices that both reduce freshwater demands and mitigate climate change, particularly where freshwater availability is limited e.g. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0165797 https://www.sciencedirect.com/science/article/pii/S2542519618302067 https://www.sciencedirect.com/science/article/pii/S0048969718323350	Accepted	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
3953	97	22		29	But the main implications regarding irrigated agriculture are the increase of irrigation water needs, due to an increase of evapotranspiration due to increasing temperatures !! Is this not taken into account in the models ? And this is indeed with high confidence.	Noted, but unable to go into this detail level due to section length limitations.	Rosa M Poch	ITPS and UdL	Spain
75741	97	23	97	23	The link between conventional oil and gas operations or coal mining and salinity should be explained further.	Noted, but unable to go into this detail level due to section length limitations.	Alfred Ahenkorah	Regulatory	Ghana
5243	97	24	97	24	after renewable add "or nuclear"	Noted, but unable to go into this detail level due to section length limitations.	Michel SIMON	Retraité/ Pdt d'association	France
61663	97	24	97	25	"Renewable electricity could reduce freshwater toxicity compared to fossil fuel based electricity (Karlsson et al. 2020b)." There should be a similar mention of nuclear, and especially of the enormous potential for nuclear-based desalination (see the review by Al-Othman et al., 2019, https://doi.org/10.1016/j.desal.2019.01.002). Mentioning only renewables in this context seems biased.	Rejected. This sentence is not about desalination technologies, but rather the effect of mitigation options on water quality.	Rauli Partanen	Think Atom	Finland
65703	97	24	97	25	"Renewable electricity could reduce freshwater toxicity compared to fossil fuel based electricity (Karlsson et al. 2020b)." To be fair, there should be a similar mention of nuclear, and especially of the huge potential of nuclear-based desalination (see the review by Al-Othman et al., 2019, https://doi.org/10.1016/j.desal.2019.01.002). Mentioning only renewables in this context is rather biased, especially since every year the largest US nuclear power plant "Palo Verde recycles more than 20 billion gallons of wastewater from surrounding municipalities to cool the plant." Revise accordingly.	Rejected. This sentence is not about desalination technologies, but rather the effect of mitigation options on water quality.	Eero Hirvijoki	Aalto University	Finland
45845	97	43	97	44	Please write "This section is relevant to SDG 7 on sustainable and affordable energy access. Access to reliable, affordable and renewable energy in abundance is a key pillar of sustainable development." instead of "This section is relevant to SDG 7 on clean and affordable energy access. Access to reliable, affordable and clean energy in abundance is a key pillar of sustainable development." Rationale: The term "clean energy" is not used in the SDGs. Therefore the terms "sustainable energy" or renewable energy (SDG Target 7.2) should be used, when directly referring to the SDGs (see also p.98, line 43).	Accepted. The text will be revised accordingly.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
29363	98	1	99	20	This discussion of energy seems to omit some potential impacts of climate change and mitigation. On the benefits side, a potentially significant energy-related benefit of avoided climate change is reduced demand for cooling in developing regions. On the cost side, the discussion of mitigation does not really discuss directly the potential for higher energy costs that could result from mitigation.	Noted. This point is relevant, but due to space constraints we are not able to include all the relevant points in this section. Economic considerations of mitigation are in section 3.6.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
60751	98	1	98	28	The writing team is encouraged to synthesize the subsection (not a literature review), indicating confidence levels for the key messages on benefits of avoided impacts along mitigation pathways for the energy sector	Noted. The suggestion is well taken.	Lourdes Tibig	Climate Change Commission, Philippines	Philippines
82611	98	1	98	12	Increases in temperature also decrease the generation of solar panels, as noted below. This should be mentioned in lines 3 and 5-6 as well as just line 10. Changes in cloud cover could either increase or decrease solar, rather than just increase as currently stated. Previous IPCC reports have stated some uncertainty with respect to effects of climate change on cloud cover and precipitation so it must go both ways. Finally suggest changing “Coastal energy facilities are also threatened by sea-level rise (Brown et al. 2014)” to “Coastal energy facilities could potentially be impacted by sea-level rise (Brown et al. 2014)”. The abstract of Brown et al. 2014 reads “Sea-level rise and extreme events have the potential to significantly impact coastal energy infrastructure through flooding and erosion.”	Partially accepted. A core reference is now Yalew et al 2020 which is a review and counters some of these points.	Jonathan Cobb	World Nuclear Association	United Kingdom (of Great Britain and Northern Ireland)
61665	98	2	98	7	"Increases in temperature reduce efficiencies of thermal power plants (e.g., fossil fuel and nuclear plants) by 0.4-0.7% per degree Celsius of increase in ambient temperature (Cronin et al. 2018; Yalew et al. 2020b)." This statement is flawed. The cited source (Cronin) represents no original research and cites (Chuang and Sue, 2005, https://doi.org/10.1016/j.energy.2004.10.003) where the focus is on air-cooled condensers assuming a fixed coolant flow rate. Existing wet-cooled thermal plants operate in conditions where the ambient temperature varies tens of degrees of Celsius over the course of a year. In wintertime, thermal plant efficiency regularly rise to above 100% of nameplate capacity due to the plant being designed for warmer temperature coolant. The condensing rate in a thermal plant is controlled via changing the flow rate of the coolant, and not by the ambient temperature.	Rejected. Recent review Yalew et al 2020 shows a decrease in thermal energy due to warming, across multiple studies.	Rauli Partanen	Think Atom	Finland
65705	98	2	98	7	"Increases in temperature reduce efficiencies of thermal power plants (e.g., fossil fuel and nuclear plants) by 0.4-0.7% per degree Celsius of increase in ambient temperature (Cronin et al. 2018; Yalew et al. 2020b)." This statement is critically flawed. The source (Cronin) cites (Chuang and Sue, 2005, https://doi.org/10.1016/j.energy.2004.10.003) where the focus is on air-cooled condensers assuming a fixed coolant flow rate. Existing wet-cooled thermal plants operate in conditions where the ambient temperature varies tens of degrees of Celsius over the course of a year, yet, the thermal efficiency of a wet-cooled nuclear power plant remains constant over this period. The condensing rate in a thermal plant is controlled via changing the flow rate of the coolant, and not by the ambient temperature. Revise accordingly.	Rejected. Recent review Yalew et al 2020 shows a decrease in thermal energy due to warming, across multiple studies.	Eero Hirvijoki	Aalto University	Finland
23487	98	11	98	12	We recommend that this part be enhanced adding to what regard sea-level rise threatens coastal energy facilities.	Noted. This point is relevant, but due to space constraints we are not able to include all the relevant points in this section.	Government of France	Ministère de la Transition écologique et solidaire	France
24669	98	15	98	19	Here the report speaks of the impact of Climate Change (droughts, water scarcity) on thermo-electric power plants. Regarding nuclear power plants, it should be noted that it is technically feasible to adapt them in the event of more recurrent drought/water scarcity issues (see for example the Palo Verde NPP located in the Arizona [US] desert which uses wastewater)	Noted. This point is relevant, but due to space constraints we are not able to include all the relevant points in this section.	Ann Jessica Johnson	FORATOM (European Atomic Forum)	Belgium
82521	98	33	98	34	The report was talking about IEA's World Energy Outlook 2020 in the previous pages, but the figure 3.7 is referring the 2019 version. It will be better to update the data to 2020 version and use the latest data in the entire chapter.	Noted. The text will be revised.	Jinsun Lim	International Energy Agency	France
10559	98	36	98	36	The (Millward-Hopkins et al. 2020) reference can only be found in the reference list for chapter 4	Noted. The references will be rectified.	Philippe Waldteufel	CNRS	France
54969	98	40	98	47	The phrase "there are also risks" makes it seem that extending energy access to all in line with SDG7 is risky, but that's not clear until the following paragraph. The sentences in lines 41 to 48 only seem to support the first part of the sentence, about positive outcomes not being guaranteed.	Accepted. The phrase has been removed.	Government of United States of America	U.S. Department of State	United States of America
66869	98	42	98	44	See also van Ruijven et al 2019 https://www.nature.com/articles/s41467-019-10399-3 , which I believe is cited elsewhere in the chapter already	Accepted.	Chris Smith	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
48197	99	15	99	20	China's current industrial structure adjustment path led by energy conservation policy is a representative successful case. It is suggested to give examples or cite in this paper. Supporting documents: [1] Wang J et al. How to balance China's sustainable development goals through industrial restructuring: A multi-regional input–output optimization of the employment–energy–water–emissions nexus. Environmental Research Letters 2020, 15, 034018. https://iopscience.iop.org/article/10.1088/1748-9326/ab666a [2] Yu et al. Can China realise its energy-savings goal by adjusting its industrial structure? Economic Systems Research Volume 28, 2016 Issue 2 https://doi.org/10.1080/09535314.2015.1102714	Noted. This point is relevant, but due to space constraints we are not able to include all the relevant information in this section.	Yang Wang	Beijing Climate Center	China
84427	99	16	99	18	"Viable transition pathways must be identified to ensure that energy security and equity are not compromised, minimising potential resistance against renewables and efficiency improvements." As there are many examples of resistance to nuclear power, it would make sense to mention it here.	Noted. The length restrictions on this section may not enable this level of detail.	Mattias Lantz	Uppsala university	Sweden
54971	99	21	102	18	The section is not a comprehensive review; it is not even a balanced review. A few references are cherry-picked with no clear criteria for why they were selected. Protecting and promoting health is the point of SDG3.	Noted. This section is undergoing thorough revisions informed by health & climate experts, and will be referring much more strongly to WG2 assessment results.	Government of United States of America	U.S. Department of State	United States of America
54973	99	22	99	23	This sentence isn't clear. Perhaps there are words missing?	Noted. This sentence will be revised.	Government of United States of America	U.S. Department of State	United States of America
54975	99	24	99	36	Not clear how the list of risks and citations are being pulled together here. Wouldn't it be more logical to cite the IPCC's own reports on the matter, including the extensive health section in the WGII volume?	Noted. This section is undergoing thorough revisions informed by health & climate experts, and will be referring much more strongly to WG2 assessment results.	Government of United States of America	U.S. Department of State	United States of America
54977	99	24	99	36	While true attribution studies for climate change-related health risks are still unfolding, the inclusion of health impacts like mental health in this section suggests that this topic is meant to give a scope of the far-reaching exposure pathways and health impacts.	Noted. This section is undergoing thorough revisions informed by health & climate experts, and will be referring much more strongly to WG2 assessment results.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54979	99	24	99	38	<p>This utility section would benefit from considering the existing literature on the adverse health-related economic damages related to climate-sensitive events. It is a topic that unifies the existing discussions of "health" and "economic" benefits in the chapter. Reduced spending on healthcare triggered by climate-sensitive harms is a widely neglected area of work, but existing studies demonstrate a substantial health-related economic toll of climate-linked exposures. Two key papers to consider citing in this section are:</p> <p>Limaye, Vijay S., Wendy Max, Juanita Constible, and Kim Knowlton. "Estimating the Health-Related Costs of 10 Climate-Sensitive U.S. Events During 2012." <i>GeoHealth</i> 3, no. 9 (September 2019): 245-65. https://doi.org/10.1029/2019GH000202.</p> <p>Knowlton, K. M. Rotkin-Ellman, L. Geballe, W. Max, and G.M. Solomon. "Six Climate Change-Related Events in the United States Accounted for About \$14 Billion in Lost Lives and Health Costs." <i>Health Affairs</i> 30, no. 11 (2011): 2167-76. https://doi.org/10.1377/hlthaff.2011.0229.</p> <p>These papers shed light on the major economic burden of climate-sensitive illnesses and injuries across many exposure categories linked to climate sensitivity. Many of these exposures are described in the chapter with regards to health implications but not related in economic terms through healthcare spending. While the overall evidence base articulating the fuller scope of health-related economic toll of climate-sensitive events remains limited, the available evidence supports the assertion that climate change mitigation policies will reap substantial benefits in terms of reduced healthcare costs linked to climate-sensitive exposures. These health-related economic benefits also merit discussion in this chapter. See this relevant citation:</p> <p>Limaye, Vijay S., Wendy Max, Juanita Constible, and Kim Knowlton. "Estimating the Costs of Inaction and the Economic Benefits of Addressing the Health Harms of Climate Change." <i>Health Affairs</i> 39, no. 12 (2020): 2098-2104. https://doi.org/10.1377/hlthaff.2020.01109.</p> <p>The lack of available quantitative estimates at the national and global scales of the health-related cost savings of climate change mitigation and adaptation is worth mentioning in this section because such information, if available to a fuller extent in the future, can help to guide policymakers towards mitigation and adaptation strategies that could achieve efficient economic cost reductions from reduced human health damages and healthcare spending. Because these existing studies demonstrate the magnitude of current health-related costs of climate-sensitive exposures, they also point the way to major opportunities for benefits from avoided future climate impacts. As such, this section should include a paragraph on "Implied health benefits of avoided climate impacts" similar in approach to those discussed in Section 3.7.5.1 (under "Biodiversity impacts").</p>	Noted. This suggestion is interesting and we will review the references. However, due to space constraints, we will not be able to include all possible relevant literature.	Government of United States of America	U.S. Department of State	United States of America
54981	99	24	101	3	The benefits of avoided health risks could be summarized in a figure from WGII AR6 Chapter 7, Watts et al., Haines and Ebi, or other summary of these issues.	Noted. This suggestion will be considered.	Government of United States of America	U.S. Department of State	United States of America
54983	99	26	99	26	For "heatwaves", consider using the description "extreme heat" or "heat stress" as the health harms of heat can often be seen before the true temperature threshold for heatwaves. Studies have found that heat-related health harms vary significantly by region in the U.S. Example citation: Vaidyanathan et al (2019) PNAS available at https://www.pnas.org/content/116/12/5420 .	Noted. Due to length restrictions we had to shorten this section.	Government of United States of America	U.S. Department of State	United States of America
54985	99	26	99	26	Consider expanding Watts et al. (2017a) citation to possibly include all reports and/or at least include the most recent report (2020) available at https://www.thelancet.com/article/S0140-6736(20)32290-X/fulltext . Also of note, there are currently duplicate 2017 and 2019 entries (currently a/b), and unclear if there is meant to be a differentiation (perhaps citing different sections).	Accepted. This is now clarified.	Government of United States of America	U.S. Department of State	United States of America
54987	99	26	99	28	The initial description of pathways could just include extreme heat, air quality, food supply and safety, water quality and quantity, extreme weather, vector-borne diseases, and social factors (e.g., Haines and Ebi, 2019, NEJM; Salas and Solomon, 2019), NEJM; available at https://www.nejm.org/doi/full/10.1056/nejmp1906035 , which reflects the categories). Given that a few of these pathways cause mental health harms, mental health would not necessarily be a true pathway, per se, but a health harm (direct/indirect). Authors could then follow with a sentence that outlines the broad health harms that can result from these exposures, such as cardiovascular, pulmonary, renal, and obstetric disease, and mental health could be included here. Authors could also then mention in these initial sentences that public health infrastructure and healthcare systems are disrupted as a result of these exposures, which then sets up the example of the indirect health harm mentioned next (see Watts et al. 2018; Salas and Jha, 2019, BMJ), available at https://www.bmj.com/content/366/bmj.l5302 ; Haines and Ebi, 2019, NEJM; Salas and Solomon, 2019, NEJM; Salas, 2020, NEJM, available at https://www.nejm.org/doi/full/10.1056/NEJMp2000331 .	Accepted. The language around pathways and health has been clarified as recommended.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
54989	99	26	99	31	The distinction between direct and indirect health impacts is a confusing distraction here. The examples provided as indirect would be considered direct health impacts; they just happen to occur after the climate event. This space would be better used by providing a distinction between acute and chronic health impacts and impacts that cumulate or compound over someone's lifetime. This paragraph would also benefit from additional and more recent citations than just Watts (2017).	Noted. This section is undergoing thorough revisions informed by health & climate experts, and will be referring much more strongly to WG2 assessment results.	Government of United States of America	U.S. Department of State	United States of America
54991	99	27	99	27	For ""air pollution"", this could be expanded to ""air quality impacts"", thus could also include decreased air quality from wildfire smoke and pollen. This is in addition to heat-related ozone air pollution and particulate matter. Given that authors describe particulate matter below in the implications of mitigation efforts, there may be a benefit of mentioning the relationship here. One possible framing is that the combustion of fossil fuels produces both air pollution and GHG emissions. Thus, noting this framing here could lay the groundwork to note that mitigation has near-term benefits to health through reduction of air pollution in addition to the longer-term health benefits of reducing the climate change-related health harms. In addition, noting that in addition to mortality impacts, there are also other health harms such as increases in admissions from short-term exposures and associations with stroke, autism, ADHD, cognitive decline, respiratory diseases, heart disease, Type II diabetes, and birth outcomes such as pre-term birth and low birth weight. Example air quality citations follow: - Wildfire: Indicator 1.2.1 in Watts et al. (2020) Lancet Countdown (new indicator this year); multiple other studies available with examples of some recent studies include Jones et al (2020) J Am Heart Assoc available at https://pubmed.ncbi.nlm.nih.gov/32290746/ and Burke et al (2021) PNAS available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7812759/ . - Pollen: Neumann et al. (2019) GeoHealth available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6516486/ ; Anenberg et al (2017) GeoHealth available at https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017GH000055 - PM Air Pollution Mortality: Liu et al. (2019) ""Ambient Particulate Air Pollution and Daily Mortality in 652 Cities, NEJM available at: https://www.nejm.org/doi/full/10.1056/NEJMoa1817364 ; Watts et al (2020) Lancet Countdown (Indicator 3.3) - PM Air Pollution Hospital Admissions: Gu et al. (2020) PLOS Medicine available at https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003188 ; Wei et al (2019) BMJ available at https://www.bmj.com/content/367/bmj.l6258 - PM Air Pollution Other Health Harms: Sun et al. (2019) PLOS ONE available at https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0216550 ; Landrigan et al (2018) Lancet available at https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(17)32345-0/fulltext .	Noted. This section is undergoing thorough revisions informed by health & climate experts, and will be referring much more strongly to WG2 assessment results.	Government of United States of America	U.S. Department of State	United States of America
54993	99	28	99	31	The direct and indirect effects could be framed as examples, to clearly convey that these are just a few of many that could be outlined across the different pathways.	Noted. This section is undergoing thorough revisions informed by health & climate experts, and will be referring much more strongly to WG2 assessment results.	Government of United States of America	U.S. Department of State	United States of America
54995	99	31	99	36	Limaye et al. (2019) identified populations expected to shoulder a disproportionate share of illness-related costs linked to climate-sensitive events in the USA: Limaye, Vijay S., Wendy Max, Juanita Constible, and Kim Knowlton. ""Estimating the Health-Related Costs of 10 Climate-Sensitive U.S. Events During 2012."" GeoHealth 3, no. 9 (September 2019): 245-65. https://doi.org/10.1029/2019GH000202 .	Noted. This section is undergoing thorough revisions informed by health & climate experts, and will be referring much more strongly to WG2 assessment results.	Government of United States of America	U.S. Department of State	United States of America
54997	99	34	99	34	Consider deleting first "women" as authors mention pregnant women and women caring for small children later and perhaps could be combined (e.g., women -- especially those that are pregnant or care for small children). It is mentioned in the 2019 Lancet Countdown that the main evidence is related to pregnancy, though a broader statement could be further supported with the reference of Sorensen et al. (2018, PLOS MEDICINE, available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6038986/).	Noted. Due to length restrictions we had to shorten this section.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
5105	99	39	102	18	In 3.7.4.1 you elaborate on deadly heatwaves, air pollution, nutrition, water, and extreme weather and exposure to diseases. However, in 3.7.4.2 you only elaborate on deadly heatwaves, air pollution, and nutrition. Hence for the purpose of consistency, you may want to include sections on water and extreme weather too.	Noted, although for reasons of length limitations, we are not able to cover all elements in the desired detail.	Lina Hollender	n/a	Germany
54999	99	39	99	40	The citation should be Dosa et al. (2018). It would also be good to specify the population as "world" or "global". Furthermore, given the many different definitions of "heatwaves" and estimates of population exposure to heat, it would be good to discuss a range of estimates beyond Dosio et al. (e.g., Ma and Yuan, 2021, https://www.sciencedirect.com/science/article/abs/pii/S004896972100070X?via%3Dihub) and Lange et al., 2020, https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020EF001616).	Noted. However, due to space constraints, we are not able to cite all the relevant literature.	Government of United States of America	U.S. Department of State	United States of America
55001	99	39	100	4	Consider also briefly discussing the effects of heat stress on cognition and learning, as has been done in the nutrition section later in the chapter. For example: Yuta J. Masuda et al., Heat Exposure from Tropical Deforestation Decreases Cognitive Performance of Rural Workers: An Experimental Study, "" Environmental Research Letters 15, no. 12 (December 2020): 124015, https://doi.org/10.1088/1748-9326/abb96c Donnan et al., 2021: The effects of exercise at different temperatures on cognitive function: A systematic review, Psychology of Sport and Exercise 54. https://doi.org/10.1016/j.psychsport.2021.101908 .	Noted. However, due to space constraints, we are not able to cite all the relevant literature.	Government of United States of America	U.S. Department of State	United States of America
55003	99	39	100	4	Consider reframing the heading of this section as extreme heat or heat stress, given that the true burden of heat injury may lie more in the morbidity outcomes than mortality. In addition, the mortality impacts are likely underestimated given that the death may be attributed to another cause without the impact of the heat exposure being recognized or categorized. On line 45, consider adding an example of what a direct impact of heat stress is, such as heat stroke. On page 100, line 2, consider adding in Watts et al. (2020) which includes heat-related productivity as an indicator (Indicator 1.1.4). If authors wish to include mortality, Watts et al. (2020) includes heat-related mortality in older persons in Indicator 1.1.3.	Noted. Due to length restrictions we had to shorten this section.	Government of United States of America	U.S. Department of State	United States of America
31535	99	41	99	42	The reduction in exposure to deadly heat from climate change is not a co-benefit but a direct benefit of climate change mitigation. The term 'co-benefit' is defined as an ancillary benefit, for example due to reduced air pollution exposure. The wording in this section also suggests that much of the planet will become uninhabitable as a result of extreme heat exposure, potentially during this century. I think this is a misreading of the Mora et al 2017 findings. They based their analyses on 783 cases of excess human mortality associated with heat from 164 cities in 36 countries. Based on the climatic conditions of those lethal heat events, they identified a global threshold beyond which daily mean surface air temperature and relative humidity become 'deadly'. However this does not imply that the region is uninhabitable - indeed they are currently inhabited! This misunderstanding may arise from their use of the word 'deadly' which implies incorrectly that these regions exceed survivability thresholds. Another approach that attempts to assess survivability using a conservative approach (where the maximum daily wet-bulb globe temperature exceeds 40°C for 3 consecutive days), suggests that the number of people who are likely to be exposed to heat stress exceeding the survivability threshold increases with global temperature change, to reach around 20 million people globally after an increase of about 2-5°C global mean temperature, estimated from the median of several models, but with a large model uncertainty. https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(18)30240-7/fulltext This threshold may be too high and therefore more people may be exposed but it will depend on factors such infrastructure, poverty and adaptation. Another paper using wet bulb temperature suggests substantial areas affected by the end of the century under high emissions scenarios https://advances.sciencemag.org/content/6/19/eaaw1838	Noted. Due to length restrictions we had to shorten this section.	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
55005	99	45	99	45	These indirect health effects of heat aren't just manifested during heatwaves. Consider changing "heatwaves" to "extreme heat conditions are also linked" or "extreme heat exposure is also linked".	Noted. Due to length restrictions we had to shorten this section.	Government of United States of America	U.S. Department of State	United States of America
9865	99				Another indirect benefit of avoided climate impacts along pathways related to health is being physically active i.e. active travel, as it may reduce obesity, increase mental health and physical wellbeing. Such correlation is necessary to be discussed in the health section to showcase its importance.	Noted. This point is relevant, but due to space constraints we are not able to include all the relevant information in this section.	Government of Indonesia	Ministry of Environment and Forestry	Indonesia
55007	100	3	100	4	Consider including this citation in addition to Kuehn and McCormick (2017): Chersich Matthew Francis et al. Associations between high temperatures in pregnancy and risk of pre-term birth, low birth weight, and stillbirths: systematic review and meta-analysis BMJ 2020; 371 :m3811 https://doi.org/10.1136/bmj.m3811	Noted. However, due to space constraints, we are not able to cite all the relevant literature.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
55009	100	5	100	8	This section mischaracterizes the vast body of research on climate-related air quality impacts on health. This is one of the MOST studied climate health impacts, which is noted on page 102, line 3. While more research may be needed, as with any topic, the problem with climate air quality literature is that it is almost completely focused in North America and Europe. So the real need for more literature is in the global south. This very brief section hides a lot of nuance and fails to mention specific health impacts of increased dust from drought, increased aeroallergens, and, most importantly, increased wildfire smoke. Suggest expanding with at least a few sentences that demonstrate the wide body of literature and the huge importance of this well-studied health impact.	Noted. This point is relevant, but due to space constraints we are not able to include all the relevant information in this section.	Government of United States of America	U.S. Department of State	United States of America
55011	100	5	100	8	This paragraph would benefit from one or two sentences about the health impacts (mortality AND morbidity) of ozone and PM2.5, as has been done for other hazards in Section 3.7.4. With regards to the impacts of specific climate-sensitive pollutants, there is more evidence for increasing harm from ozone-related exposures than fine particle-related ones. See: Jacob, Daniel J., and Darrell A. Winner. ""Effect of Climate Change on Air Quality."" Atmospheric Environment 43, no. 1 (January 2009): 51-63. https://doi.org/10.1016/j.atmosenv.2008.09.051 . Additionally, the growing problem of wildfire smoke is notably absent from this chapter other than a couple of passing mentions. Consider including a discussion of that topic, including the following citations: Cascio, Wayne E. ""Wildland Fire Smoke and Human Health."" Science of The Total Environment 624 (May 15, 2018): 586-95. https://doi.org/10.1016/j.scitotenv.2017.12.086 . Black, Carolyn, Yohannes Tesfaigzi, Jed A. Bassein, and Lisa A. Miller. ""Wildfire Smoke Exposure and Human Health: Significant Gaps in Research for a Growing Public Health Issue."" Environmental Toxicology and Pharmacology 55 (October 1, 2017): 186-95. https://doi.org/10.1016/j.etap.2017.08.022 . Liu, Jia Coco, Loretta J Mickleby, Melissa P Sulprizio, Xu Yue, Roger D Peng, Francesca Dominici, and Michelle L Bell. ""Future Respiratory Hospital Admissions from Wildfire Smoke under Climate Change in the Western US."" Environmental Research Letters 11, no. 12 (December 1, 2016): 124018. https://doi.org/10.1088/1748-9326/11/12/124018 . Fann, Neal, Breanna Alman, Richard A. Broome, Geoffrey G. Morgan, Fay H. Johnston, George Pouliot, and Ana G. Rappold. ""The Health Impacts and Economic Value of Wildland Fire Episodes in the U.S.: 2008-2012."" Science of The Total Environment 610-611 (January 2018): 802-9. https://doi.org/10.1016/j.scitotenv.2017.08.024 . More broadly, consider including these citations in reference to the effects of climate change on air pollution and human health: Kinney, Patrick L. ""Interactions of Climate Change, Air Pollution, and Human Health."" Current Environmental Health Reports 5, no. 1 (March 2018): 179-86. https://doi.org/10.1007/s40572-018-0188-x . Fann, Neal L., Christopher G. Nolte, Marcus C. Sarofim, Jeremy Martinich, and Nicholas J. Nassikas. ""Associations Between Simulated Future Changes in Climate, Air Quality, and Human Health."" JAMA Network Open 4, no. 1 (January 4, 2021): e2032064. https://doi.org/10.1001/jamanetworkopen.2020.32064 .	Noted. However, due to space constraints, we are not able to cite all the relevant literature.	Government of United States of America	U.S. Department of State	United States of America
55013	100	5	100	8	Consider adding additional perspectives noted in previous U.S. comment on page 99, lines 24-36, about expansion to other air quality concerns that are climate-related such as wildfire smoke and pollen (see example citations there) and that combustion of fossil fuels is the same root cause for both air pollution and GHG emissions. In addition, even if this remains only air pollution, the description of the health impacts can also include current health harms (as is reported under heat) and not just models of future impacts (example citations included in comment on Page 99, lines 24-36). As noted, this can include both current mortality and morbidity (hospitalizations and health harms) impacts. In addition, of note, the USGCRP Climate and Health Assessment (2016) reports likely, high confidence for ground-level ozone pollution (available at: https://health2016.globalchange.gov), recognizing geographic variability globally.	Noted. However, due to space constraints, we are not able to cite all the relevant literature.	Government of United States of America	U.S. Department of State	United States of America
55015	100	5	100	8	Landrigan et al. summarized the health risks of air pollution in a Lancet paper, estimating that about 7 million people die prematurely from air pollution (indoor and outdoor). This would be a much better source. Or refer to WGII AR6 Chapter 7.	Accepted. The section now refers more to WGII summaries and is thus more robust.	Government of United States of America	U.S. Department of State	United States of America
86221	100	5	100	8	Please here be consistent with statement in WG1 chapter 6 executive summary about effect of climate change on air pollution (not as straightforward as said here, see also WG1 chapter 6 section 6.5). As air pollution in the future will essentially depend on the choices made in term of policies fro climate and/or air pollution (and thus on emission/mitigation), a discussion of benefit on air pollution from decarbonisation would be more suited here than the effect of climate change in isolation. (see for example discussion in WG1 chapter 6 6.6.3 and 6.7.3).	Accepted. The relevant parts of WG1 will be cited and the discussion will reflect these points.	Sophie Szopa	LSCE	France
55017	100	9	100	12	Consider revising the sentence to read: ""Elevated atmospheric CO2 concentrations can negatively impact the zinc, iron, and/or protein content of certain major crops (wheat, rice, barley, field peas, soybeans, maize), which has the potential to deepen deficiencies for the two billion people already inadequate in one or more (Myers et al., 2014)."" These changes would clarify that only those two micro-nutrients were studied in detail (others like Ca, Mg, K, P, were also studied and found to be inconsistent), and some crops showed little or no response to eCO2 (sorghum), or only for some nutrients (Fe/Zn for field peas, soybeans, and maize).	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
55019	100	9	100	25	Watts et al. (2020) also includes food security and undernutrition as indicators (1.4.1, 1.4.2). Extreme heat and extreme weather also contribute to additional food-related impacts such as impaired food safety (climate-sensitive foodborne pathogens such as Salmonella) and distribution challenges (Haines and Ebi, NEJM, 2019; USGCRP Climate and Health Assessment 2016). This is touched upon in the "Extreme weather and exposure to disease" section, but this can occur as a result of extreme heat as well.	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America
55021	100	9	100	25	Refer to WGII AR6 Chapter 7 to provide a more complete summary of undernutrition.	Accepted. The section now refers more to WGII summaries and is thus more robust.	Government of United States of America	U.S. Department of State	United States of America
31537	100	17	100	17	Recent systematic reviews also show that climate change will reduce yields of vegetables, legumes, fruit, nuts and seeds, all of which are essential for a healthy diet, particularly to reduce the risks of non communicable diseases -- see https://www.pnas.org/content/115/26/6804 https://iopscience.iop.org/article/10.1088/1748-9326/ab5ccc	Noted. The length restrictions placed on this section may not enable this level of detail..	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
31539	100	18	100	26	The terms undernutrition and malnutrition seem to be used interchangeably here but there are important differences between them. According to WHO 'Malnutrition, in all its forms, includes undernutrition (wasting, stunting, underweight), inadequate vitamins or minerals, overweight, obesity, and resulting diet-related noncommunicable diseases.' https://www.who.int/news-room/fact-sheets/detail/malnutrition	Accepted. The terminology has been revised.	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
45847	100	22	100	23	Please add "Other important health issues are addressed in SDG 2 (nutrition)." after "efforts." Rationale: As the chapter focuses on the effects on the SDGs including nutrition.	Rejected since nutrition & SDG 2 are the specific topic of section 3.7.1, they are not mentioned here to avoid confusion.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
29365	100	26	100	32	This section on water assumes water availability is likely to decrease, but this seems inconsistent with the earlier discussion of water in this section.	Noted. This section is undergoing thorough revisions informed by health & climate experts, and will be referring much more strongly to WG2 assessment results.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
55023	100	26	100	32	Additional water-related health implications for consideration include: - Drought: Additional health harms include associations with mortality and admissions (Berman et al., 2017, Lancet Planetary Health available at: https://www.thelancet.com/pdfs/journals/lanph/PIIS2542-5196(17)30002-5.pdf) - Harmful Algae / Vibrio / Water-Borne Diseases (e.g., campylobacter, harmful algae blooms): Watts et al. (2020) includes Vibrio as a climate-sensitive disease in Indicator 1.3.1; Haines and Ebi NEJM, 2019; USGCRP Climate and Health Assessment, 2016.	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America
55025	100	26	100	32	This text to be replaced with a cross-reference to WGII AR6 Chapter 7. The current text is insufficient.	Accepted. Reference to WGII is now made.	Government of United States of America	U.S. Department of State	United States of America
55027	100	34	100	34	It is inappropriate to include infectious diseases in a section on extreme weather and climate events. Please separate, and refer to WGII AR6 Chapter 7.	Accepted. Reference to WGII is now made.	Government of United States of America	U.S. Department of State	United States of America
55029	100	34	100	47	Combination of infectious disease threats and extreme weather events is inappropriate. Extreme events are linked to some infectious risks, but other infectious risks are due to more gradual shifts.	Accepted. Reference to WGII is now made.	Government of United States of America	U.S. Department of State	United States of America
55031	100	38	100	41	This section on the impact of droughts and floods on food security could be placed under nutrition given that the discussion of health impacts of undernutrition could align nicely with current health implications of malnutrition.	Noted. Sections have been reshaped.	Government of United States of America	U.S. Department of State	United States of America
55033	100	38	101	2	The sentence citing Mbow et al. (2019) would benefit from more explanation, particularly since vector-borne diseases are also touched on in the next paragraph. Further, the final sentence needs a citation and should be caveated (e.g., "Climate change can also increase"), given that the range of some vectors and/or the disease-causing organisms they carry may contract, e.g., if the southern part of their range gets too hot.	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
55035	100	41	101	1	Flood impacts on food-borne and water-borne diseases could go under the water section and food section (if expanded beyond just nutrition) though the following sentences include broader disease implications. Thus, another possibility is to move this sentence after the first sentence of the next paragraph, thus onto line 45 following "...Christensen 2018)".	Noted. Sections have been reshaped.	Government of United States of America	U.S. Department of State	United States of America
55037	101	1	101	2	The discussion of vector-borne diseases (currently described as ""mosquito-, rodent- and tick-borne diseases"") could be expanded into its own section given the significant implications here including, for example, Dengue, Malaria, Lyme disease, etc. (Watts et al., 2020; Haines and Ebi, NEJM, 2019). In addition, another category on social factors, such as the health implications of violent conflict and forced migration, could be included here (e.g., as noted in Haines and Ebi, NEJM, 2019). This would round out a broad description of the different exposure pathways. If desired, the implications for disruptions to public health infrastructure and healthcare delivery could be outlined in more detail, though this is an emerging area of evidence.	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America
23489	101	3	101	3	In section 3.7.4.2 it would be necessary to had a paragraph related to the impact of active travel (walk, bicycle) that can be induced by climate policies in transportation, on physical activity and on health. This issue is really important and the economic value of this co-benefit can really be big!! Quam, V.; Rocklöv, J.; Quam, M.; Lucas, R. Assessing Greenhouse Gas Emissions and Health Co-Benefits:A Structured Review of Lifestyle-Related Climate Change Mitigation Strategies.Int. J. Environ. Res.Public Health2017,14, 468. Shaw, C.; Hales, S.; Howden-Chapman, P.; Edwards, R. Health co-benefits of climate change mitigationpolicies in the transport sector.Nat. Clim. Chang.2014,4, 427–433. Xia, T.; Zhang, Y.; Crabb, S.; Shah, P. Cobenefits of Replacing Car Trips with Alternative Transportation:A Review of Evidence and Methodological Issues.J. Environ. Public Health2013,2013. Grabow, M.L.; Spak, S.N.; Holloway, T.; Stone, B.; Mednick, A.C.; Patz, J.A. Air Quality and Exercise-RelatedHealth Benefits from Reduced Car Travel in the Midwestern United States.Environ. Health Perspect.2011,120, 68–76. Lindsay, G.; Macmillan, A.; Woodward, A. Moving urban trips from cars to bicycles: Impact on health andemissions.Aust. N. Z. J. Public Health2011,35, 54–60. Wolkingner, B., Haas, W., Bachner, G., Weisz, U., Steininger, K. W., Hutter, H. P., ... & Reifeltshammer, R. (2018). Evaluating health co-benefits of climate change mitigation in urban mobility. International journal of environmental research and public health, 15(5), 880.	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of France	Ministère de la Transition écologique et solidaire	France
55039	101	3	102	18	This section should also make reference to the substantial economic co-benefits from reduced healthcare costs linked to reduced climate-sensitive exposures. A number of studies have identified substantial health-related costs from climate-sensitive events and health-related cost savings from the expected decrease in harmful exposures linked to climate change mitigation actions: Limaye, Vijay S., Wendy Max, Juanita Constible, and Kim Knowlton. ""Estimating the Health-Related Costs of 10 Climate-Sensitive U.S. Events During 2012."" GeoHealth 3, no. 9 (September 2019): 245-65. https://doi.org/10.1029/2019GH000202 . Liu, Yang, Shubhayu Saha, Brendalynn O. Hoppe, and Matteo Convertino. ""Degrees and Dollars - Health Costs Associated with Suboptimal Ambient Temperature Exposure."" The Science of the Total Environment 678 (August 15, 2019): 702-11. https://doi.org/10.1016/j.scitotenv.2019.04.398 . Bosello, Francesco, Roberto Roson, and Richard S.J. Tol. ""Economy-Wide Estimates of the Implications of Climate Change: Human Health."" Ecological Economics 58, no. 3 (June 2006): 579-91. https://doi.org/10.1016/j.ecolecon.2005.07.032 . Barber, Loren M, Jerome J Schleier III, and Robert KD Peterson. ""Economic Cost Analysis of West Nile Virus Outbreak, Sacramento County, California, USA, 2005."" Emerging Infectious Diseases 16, no. 3 (2010): 480. Estrada, Francisco, WJ Wouter Botzen, and Richard SJ Tol. ""Economic Losses from US Hurricanes Consistent with an Influence from Climate Change."" Nature Geoscience 8, no. 11 (2015): 880. https://doi.org/10.1038/ngeo2560 . Frame, David J., Suzanne M. Rosier, Ilan Noy, Luke J. Harrington, Trevor Carey-Smith, Sarah N. Sparrow, Daithi A. Stone, and Samuel M. Dean. ""Climate Change Attribution and the Economic Costs of Extreme Weather Events: A Study on Damages from Extreme Rainfall and Drought."" Climatic Change 162, no. 2 (September 2020): 781-97. https://doi.org/10.1007/s10584-020-02729-y . Kochi, Ikuho, Geoffrey H. Donovan, Patricia A. Champ, and John B. Loomis. ""The Economic Cost of Adverse Health Effects from Wildfire-Smoke Exposure: A Review."" International Journal of Wildland Fire 19, no. 7 (2010): 803. https://doi.org/10.1071/WF09077 . Shea, E., F. Perera, and D. Mills. ""Towards a Fuller Assessment of the Economic Benefits of Reducing Air Pollution from Fossil Fuel Combustion: Per-Case Monetary Estimates for Children's Health Outcomes."" Environmental Research 182 (March 2020): 109019. https://doi.org/10.1016/j.envres.2019.109019 . Fann, Neal, Breanna Alman, Richard A. Broome, Geoffrey G. Morgan, Fay H. Johnston, George Pouliot, and Ana G. Rappold. ""The Health Impacts and Economic Value of Wildland Fire Episodes in the U.S.: 2008-2012."" Science of The Total Environment 610-611 (January 2018): 802-9. https://doi.org/10.1016/j.scitotenv.2017.08.024 .	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
55041	101	3	102	18	<p>Given that the global research community is still understanding the full breadth of direct and indirect health harms from climate change, the true understanding of the ""co-benefits"" of mitigation is still being realized. As this understanding emerges, this will also translate to a more accurate understanding of the clear economic benefits of mitigation. While authors only have three of the exposures covered previously included this section, is there a way to perhaps more clearly transmit the understanding that this does not imply that there are not mitigation health co-benefits, and thus economic benefits, for the other exposure pathways. Authors note in the nutrition section that there are not robust enough studies to make conclusions, and similar statements could be said for other exposure pathways (especially if the discussion expanded). Thus, an edit of the current framing outlined in page 101, line 45 to page 102, line 12 could be placed either at the start of Section 3.7.4.2 or at the end in order to more clearly translate the fact that the true health implications of mitigation are still being quantified.</p> <p>Example additional mitigation / health benefits studies for consideration: Sampedro et al (2020) Environment International available at https://www.sciencedirect.com/science/article/pii/S016041201933911X Scovronick et al (2019) Nature Communications available at https://www.nature.com/articles/s41467-019-09499-x Thompson et al (2014) Nature Climate Change available at https://www.nature.com/articles/nclimate2342 Dimanchev et al (2019) Environ Res Lett available at https://iopscience.iop.org/article/10.1088/1748-9326/ab31d9 Additional economic costs Limaye et al (2019) GeoHealth available at: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019GH000202 Economic cost of heat-related worker productivity losses and air pollution in Watts et al 2020 (Indicators 4.1.3; 4.1.4)</p>	Noted. This suggestion has been taken into account.	Government of United States of America	U.S. Department of State	United States of America
55043	101	3	102	18	<p>Where is the significant literature on the health co-benefits of mitigation policies and technologies? A very large number of studies are missing. It is unclear the criteria for cherry-picking the few studies highlighted. Large, comprehensive reviews were conducted by Chang et al. (ERL) and Gao et al. (Science Total Environment), and Hess et al. (Environ Health Perspect) recently published guidance on conducting health co-benefits analyses. These publications would provide better entry points for this section. The health co-benefits of dietary change are not covered, although they are considerable.</p>	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America
55045	101	4	101	4	<p>Suggest dropping the 'co' from co-benefits and just saying benefits in this section header sentence. The paragraph that immediately follows this sentence is not about co-benefits, but benefits of mitigation for human health.</p>	Accepted, this language has now been revised.	Government of United States of America	U.S. Department of State	United States of America
55047	101	5	101	6	<p>Consider changing "Mitigation which prevents severe and deadly heatwaves" to "Mitigation which limits future increases in the number, frequency, and severity of deadly heatwaves".</p>	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America
55049	101	5	101	8	<p>Authors include adaptation interventions here for heat. There are others as well, in addition to adaptation interventions for all other exposure pathways. Consider either expanding to include adaptation interventions in all exposure categories or removing here.</p>	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America
55051	101	8	101	8	<p>A highly relevant citation to include about energy demand associated with cooling and downstream impacts on air quality and health is: Abel, David W., Tracey Holloway, Monica Harkey, Paul Meier, Doug Ahl, Vijay S. Limaye, and Jonathan A. Patz. ""Air-Quality-Related Health Impacts from Climate Change and from Adaptation of Cooling Demand for Buildings in the Eastern United States: An Interdisciplinary Modeling Study."" Edited by Madeleine Thomson. PLOS Medicine 15, no. 7 (July 3, 2018): e1002599. https://doi.org/10.1371/journal.pmed.1002599.</p>	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America
20077	101	9	101	9	<p>see also: -Yang, X., Pang, J., Teng, F., Gong, R., & Springer, C. (2021). The environmental co-benefit and economic impact of China's low-carbon pathways: Evidence from linking bottom-up and top-down models. Renewable and Sustainable Energy Reviews, 136, 110438. -Van de Ven, D. J., Sampedro, J., Johnson, F. X., Bailis, R., Forouli, A., Nikas, A., ... & Doukas, H. (2019). Integrated policy assessment and optimisation over multiple sustainable development goals in Eastern Africa. Environmental Research Letters, 14(9), 094001. -Forouli, A., Nikas, A., Van de Ven, D. J., Sampedro, J., & Doukas, H. (2020). A multiple-uncertainty analysis framework for integrated assessment modelling of several sustainable development goals. Environmental Modelling & Software, 131, 104795.</p>	Noted. The length restrictions placed on this section may not enable this level of detail..	Haris Doukas	National Technical University of Athens, Greece	Greece

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
20185	101	9	102	12	A the regional level (Sub-Saharan Africa), for mitigation-air/mortality co-benefits across different SSPs, to also consider: - Van de Ven, D. J., Sampedro, J., Johnson, F. X., Bailis, R., Forouli, A., Nikas, A., ... & Doukas, H. (2019). Integrated policy assessment and optimisation over multiple sustainable development goals in Eastern Africa. Environmental Research Letters, 14(9), 094001. - Forouli, A., Nikas, A., Van de Ven, D. J., Sampedro, J., & Doukas, H. (2020). A multiple-uncertainty analysis framework for integrated assessment modelling of several sustainable development goals. Environmental Modelling & Software, 131, 104795.	Noted. The length restrictions placed on this section may not enable this level of detail..	Nikas Alexandros	National Technical University of Athens	Greece
31543	101	9	101	36	I would have expected to see some discussion of the health co-benefits of mitigating short-lived climate pollutants - black carbon and methane (through its effect on tropospheric ozone) as well as the effect of carbon dioxide mitigation. Black carbon and tropospheric ozone both have important effects on health. Here is a paper on black carbon mitigation https://link.springer.com/article/10.1007/s10584-020-02800-8 . Here is the WHO review of Reducing global health risks through mitigation of short-lived climate pollutants https://www.who.int/phe/publications/climate-reducing-health-risks/en/	Noted. The length restrictions placed on this section may not enable this level of detail..	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
55053	101	9	102	12	The air pollution section could more clearly outline that mitigation has near-term benefits to health through reduction of air pollution as health benefits will be realized on a much shorter time scale. This is in addition to the other health benefits of reducing GHG emissions and these climate change-related health harms, in addition to adaptation.	Noted. The length restrictions placed on this section may not enable this level of detail. The shorter timescale issues may be covered in chapter 4.	Government of United States of America	U.S. Department of State	United States of America
76113	101	9	102	12	Please check ch6 in WGI on SLCF and add references as relevant	Noted. The length restrictions placed on this section may not enable this level of detail..	Jan Fuglestvedt	CICERO	Norway
86223	101	9	102	18	Very interesting discussion (consistent with and complementary to WG1 chapter 6 section 6.6.3 and section 6.7.3), make sure it remains even if the chapter is shorten!	Noted. The length restrictions placed on this section may not enable this level of detail..	Sophie Szopa	LSCE	France
55055	101	11	101	13	Another relevant study linked specifically to the Paris targets: Patz, Jonathan A. and J Jason West. ""The Paris Agreement Saves Lives in China."" The Lancet Planetary Health 2, no. 4 (April 2018): e147-48. https://doi.org/10.1016/S2542-5196(18)30052-4 .	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America
55057	101	13	101	16	The sentence starting "Rao et al. (2017) developed ..." is hard to follow.	This section has been shortened and this sentence removed.	Government of United States of America	U.S. Department of State	United States of America
55059	101	17	101	17	Consider striking the phrase "to be wide ranging across scenarios" for the sake of clarity and conciseness.	Accepted. This sentence has been removed	Government of United States of America	U.S. Department of State	United States of America
55061	101	22	101	25	This sentence needs correcting because the 35g m-3 cutoff point for fine particle air pollution actually applies to a daily (24-hour) exposure averaging time, rather than the annual average as indicated here. The corresponding annual exposure limit (standard) in the USA, for example, is 12g m-3 while the annual exposure limit (standard) is 35g m-3: https://www.epa.gov/criteria-air-pollutants/naaqs-table The WHO air quality guidelines for PM2.5 are 10 (annual mean) and 25 (24-hour mean): https://apps.who.int/iris/bitstream/handle/10665/69477/WHO_SDE_PHE_OEH_06.02_eng.pdf The correct WHO air quality guideline is noted on page 101, line 29.	Noted. The length restrictions placed on this section may not enable this level of detail..	Government of United States of America	U.S. Department of State	United States of America
55063	101	24	101	24	While "standard" is the correct technical term, it is best interpreted as a "limit". Consider rewording.	This section has been shortened and this sentence removed.	Government of United States of America	U.S. Department of State	United States of America
55065	101	25	101	27	Consider breaking up the sentence starting "Vandyck et al. (2018) ..." or otherwise rewording for clarity.	This section has been shortened and this sentence removed.	Government of United States of America	U.S. Department of State	United States of America
55067	101	32	101	35	Most of the sentence starting "Transport sector mitigation ..." is a direct quote from Schmale et al. (2014). Furthermore, the meaning of the sentence in the context of the mention of Amann et al. (2020) isn't clear. The behavioral changes referenced by Amman et al. are focused on emission "sources which make only marginal contributions today", such as tobacco smoking (i.e., not transport emissions).	This section has been shortened and this sentence removed.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
84429	101	32	101	34	"Transport sector mitigation options like electric-car sharing, or energy-sector shifts from fossil fuels to renewable power generation, ..." Also here nuclear power could be mentioned as part of the shift from fossil fuels.	Noted. The length restrictions placed on this section may not enable this level of detail.	Mattias Lantz	Uppsala university	Sweden
5245	101	33	101	33	after "renewable", add "and/or nuclear"	Noted. The length restrictions placed on this section may not enable this level of detail.	Michel SIMON	Retraité/ Pdt d'association	France
37649	101	33	101	33	Please replace renewable by renewable and nuclear.	Noted. The length restrictions placed on this section may not enable this level of detail.	Ravi B Grover	Homi Bhabha National Institute	India
61667	101	33	101	36	"[...] energy-sector shifts from fossil fuels to renewable power generation, would reduce consumption and overall emissions and lead to behavioural shifts that are beneficial in both the near-and long-term (Schmale 2014)." It would be equally important to mention the proven track record of nuclear energy in the context of reducing air pollution (see, e.g., Kharecha and Hansen, 2013, https://doi.org/10.1021/es3051197 ; Gibon et al., 2017, https://doi.org/10.1088/1748-9326/aa6047).	Noted. The length restrictions placed on this section may not enable this level of detail.	Rauli Partanen	Think Atom	Finland
65707	101	33	101	36	"[...] energy-sector shifts from fossil fuels to renewable power generation, would reduce consumption and overall emissions and lead to behavioural shifts that are beneficial in both the near-and long-term (Schmale 2014)." With respect to reducing emission and, e.g., air pollution, the sentence should mention the proven track record of nuclear energy in this context (see, e.g., Kharecha and Hansen, 2013, https://doi.org/10.1021/es3051197 ; Gibon et al., 2017, https://doi.org/10.1088/1748-9326/aa6047).	Noted. The length restrictions placed on this section may not enable this level of detail.	Eero Hirvijoki	Aalto University	Finland
20187	101	37	101	44	To also consider, for China: Yang, X., Pang, J., Teng, F., Gong, R., & Springer, C. (2021). The environmental co-benefit and economic impact of China's low-carbon pathways: Evidence from linking bottom-up and top-down models. <i>Renewable and Sustainable Energy Reviews</i> , 136, 110438.	Noted. The length restrictions placed on this section may not enable this level of detail.	Nikas Alexandros	National Technical University of Athens	Greece
31541	101	37	101	46	The approach to estimating the economic value of co-benefits should be clarified - most studies use the Value of a Statistical life which results in large economic benefits but the policy relevance of such estimates is unclear because they depend on estimates of willingness to pay for air pollution reductions conferring reduced risks of premature death.	Noted. The length restrictions placed on this section may not enable this level of detail.	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
37527	101	37	101	44	"The most favourable cost-benefit ratios were in India and China, but benefits outweigh costs in all geographic regions." This sentence should give more details on how benefits outweigh costs in other countries. Please do not single out any country.	Noted. In this case, the report is not "singling out" specific countries, but assessing the relevant literature.	Government of India	Ministry of Environment, Forests and Climate Change	India
37529	101	37	101	44	"Another important finding is that the additional expense required to achieve a 1.5°C climate mitigation target will generate a net benefit substantially greater than that associated with the achievement of a 2.0°C target, especially in China and India." The time period should be mentioned here- when will payback be achieved? Otherwise this is hard to convince. Again this is singling out India and China; this is true for all countries. Why not shut down everything in global north from today, since they have overconsumed their fair share of emissions and derive the benefits in real time.	This section has been shortened and this sentence removed.	Government of India	Ministry of Environment, Forests and Climate Change	India
55069	101	37	101	38	Because this statement only applies to air quality-related co-benefits, the percentage of mitigation costs is artificially inflated. The sentence should acknowledge that inclusion of the other types of health-related co-benefits of climate change mitigation policies would substantially raise this figure so that the co-benefits represent a far higher fraction of (indeed, they substantially outweigh) climate change mitigation costs.	Noted. The length restrictions placed on this section may not enable this level of detailed discussion. Moreover without peer-reviewed studies to support this point, it cannot be made in this report.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31545	101	39	101	42	There is inconsistency between the statements in line 39 and 42 with the latter stating that benefits outweigh costs in all regions. Markandya et al 2018 conclude ' At the regional level, the costs of reducing greenhouse gas emissions could be compensated with the health co-benefits alone for China and India, whereas the proportion the co-benefits covered varied but could be substantial in the European Union (7–84%) and USA (10–41%), respectively.' Other analyses show somewhat more favourable benefit to cost ratios in high income settings for example Thompson et al find that monetized human health benefits associated with air quality improvements can offset 26–1,050% of the cost of US carbon policies http://ipclimatechange.trg-learning.com/wp-content/uploads/2013/11/Thompson-et-al-2014-Health-Benefits-of-Carbon-Policies-nclimate23421.pdf . A recent paper assesses the impact of including cooling aerosols in health economic evaluation of the health co-benefits of air pollution reduction policies https://www.nature.com/articles/s41467-019-09499-x . This shows that 'roughly 45–60% more decarbonization is optimal over the next five decades (and 10–40% thereafter) compared to the reference case that only considers climate consequences. The additional emission reductions that result from the inclusion of the health co-benefits cumulatively amounts to ~270 GtC (Fig. 1a). Importantly, all of these results account for the damages from lost cooling attributable to the aerosol co-reductions.' A further study shows that larger health co-benefits and emissions reduction arise from carbon pricing than from Renewable Portfolio Standards (RPSs) https://iopscience.iop.org/article/10.1088/1748-9326/ab31d9	Noted. The length restrictions placed on this section may not enable this level of detail.	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
15225	101	42	101	44	This is a universal conclusion, and similar situations exist for other countries as well, so there is no need to deliberately highlight China and India here. It is suggested to delete the last sentence of this paragraph, "especially in China and India".	Noted. In this case, the report is not "singling out" specific countries, but assessing the relevant literature.	Government of China	China Meteorological Administration	China
55071	101	45	102	4	This paragraph should explicitly note that climate change mitigation is expected to reduce the health-related cost burden of a wide array of climate impacts, not just those from air quality. These expected health improvements also include reductions in disease and death from coastal storms, extreme precipitation and drought, allergenic pollen, certain climate-sensitive infectious diseases (including vector-borne diseases), extreme heat, and wildfire smoke. See this citation for more justification of this claim: Limaye, Vijay S., Wendy Max, Juanita Constible, and Kim Knowlton. ""Estimating the Health-Related Costs of 10 Climate-Sensitive U.S. Events During 2012."" <i>GeoHealth</i> 3, no. 9 (September 2019): 245-65. https://doi.org/10.1029/2019GH000202 .	Noted. The length restrictions placed on this section may not enable this level of detail.	Government of United States of America	U.S. Department of State	United States of America
55073	101	45	102	8	Consider making these points more strongly in the Executive Summary, perhaps as a standalone key message. They don't come across as clearly in the summary as they do here.	Accepted. The summary statement will be revised.	Government of United States of America	U.S. Department of State	United States of America
55075	101	45	102	12	This is a well-written section but seems to be awkwardly tucked into the air quality header. Though most of the co-benefits discussed are related to air quality, this text would be better suited as its own section on co-benefits. This is important information.	Noted. Due to length restrictions, a new section may not be possible. The location of this text will be reconsidered.	Government of United States of America	U.S. Department of State	United States of America
29367	101	46	102	3	This statement appears to make a quantitative comparison between health co-benefits and climate benefits. What finding in this report is being referenced? Please provide the reference or adjust the sentence to clarify. "The key contribution of this report is that it makes visible the very large, previously hidden health and economic benefits of climate mitigation and shows that these benefits are greater than the costs of climate change prevention."	This section has been shortened and this sentence removed.	Bryan Mignone	ExxonMobil Research and Engineering Company	United States of America
31547	102	13	102	18	The conclusion suggest that 'it is not currently possible to robustly conclude on the mitigation 18 pathway implications for future nutritional availability and security.' This is strictly correct but there is much compelling evidence discussed in preceding pages (see earlier comments) that shows that dietary change could support both mitigation and improved nutrition and feed security because in high consuming countries reduced consumption of red and processed meat and increased fruit,vegetable, nuts and seeds are likely to be beneficial for health and the environment. At the same time animal products provide important nutritional benefits for some groups such as children and provide livelihoods for 500 million farmers - they also consume feed that is not digestible by humans https://www.sciencedirect.com/science/article/abs/pii/S2211912416300013 . A balanced approach is needed that considers nutrition, livelihoods and the environment in an integrated way.	This section has been shortened and this sentence removed.	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
23491	102	19	102	19	We recommand that this section "Biodiversity (land and water) " also cover biodiversity of micro organisms	Noted. We recognize microorganisms are key on mitigation but are limited by length of this section.	Government of France	Ministère de la Transition écologique et solidaire	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
45849	102	24	102	24	After "... Production (SDG 12)." please insert a reference to the IPBES Global Assessment (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondizio E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. 56 pages. https://ipbes.net/sites/default/files/2020-02/ipbes_global_assessment_report_summary_for_policymakers_en.pdf	Accepted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
23493	102	27	102	27	We highly recommend the inclusion of an overview of the literature that point to the highly deleterious impacts that the large-scale deployment of some climate mitigation and CDR land-use measures such as BECCS/bioenergy is set to have on biodiversity. This literature exists and should be reflected here, such as Santangeli, A., et al. (2016) Global change synergies and trade-offs between renewable energy and biodiversity. GCB Bioenergy, 8(5), 941–951. and Hof, C., et al. (2018). Bioenergy cropland expansion may offset positive effects of climate change mitigation for global vertebrate diversity. Proceedings of the National Academy of Sciences, 115(52), 13294–13299. This inclusion can be as followed, after "their services" on line 27 suggestion to add a paragraph :“Some literature does exist however that assesses the negative impacts of climate mitigation land-use measures on biodiversity when deployed at very large-scale (i.e. defined as over 11.3 GtCO ₂ /yr by the IPCC SRCL SPM), and the impact of different types of emission reduction pathways. For example, Hof et al. 2018 assess that a 1.5°C world with vast BECCS deployment would have a worse impact on biodiversity than a 4°C world without bioenergy use (Hof et al. 2018), while Santangeli et al. 2016 project that half of the potential bioenergy production areas are situated in biodiversity hotspots (Santangeli et al. 2016). This suggests that choosing emission reduction pathways with more modest amounts of bioenergy and BECCS would be most beneficial for biodiversity conservation, which in turn underscores the importance of ambitious mitigation in the 2020-2030 decade, in order to avoid needing to recur to very large-scale deployment of land-based CDR (i.e. BECCS) closer to mid mid-century (c.f. illustrative 1.5°C emission reduction pathways in IPCC SR 1.5, Figure SPM.3b).” Further detail to back this up: The IPCC SR1.5 SPM indeed suggests that the only way to reach the 1.5°C goal in spite of unambitious mitigation in the 2020-2030 decade, would be precisely for countries to compensate for such current inaction by recurring to very large amounts of carbon dioxide removal in latter decades (especially starting in 2040-2050), namely through BECCS. Specifically, one can point to the type of emission reduction pathway of the P4 illustrative pathway presented in the SR1.5 SPM, in which, to compensate for unambitious mitigation in 2020-2030, by 2050 countries recur to very large-scale amounts of carbon dioxide removal under the form of BECCS – i.e. 16.1 GtCO ₂ /yr) which the SR1.5 database (Huppman et al., 2018) projects would amount to 7.3 million km ² in 2050 of land needed for planting bioenergy crops, an area roughly equivalent to the size of Australia, (also projected to 33% of global agricultural land (Huppman et al. 2018). The SRCL SPM already projected that such a large scale of bioenergy (it defined 'large scale' as being 11.3 GtCO ₂ /yr, well above	Partially accepted. Unfortunately, we dont have space to include an exhaustive overview nor the suggested text, but we will include a sentence "Large-scale deployment of some climate mitigation and CDR land-use measures could have deleterious impacts on biodiversity" with the indicated references in the section on implications of mitigation pathways on biodiversity.	Government of France	Ministère de la Transition écologique et solidaire	France
23495	102	33	102	33	We suggest a clarification on the term "functional habitats"	Noted. Due to length restrictions, the original sentence was removed.	Government of France	Ministère de la Transition écologique et solidaire	France
45851	102	43	102	43	After the sentence "... harmful for biodiversity" it is suggested to consider more specific information that can be found in the following section of the IPBES Global Assessment (2019): "For example, a synthesis of many studies estimates that the fraction of species at risk of climate-related extinction is 5 per cent at 2°C warming and rises to 16 per cent at 4.3°C warming. Coral reefs are particularly vulnerable to climate change and are projected to decline to 10 to 30 per cent of former cover at 1.5°C warming and to less than 1 per cent of former cover at 2°C warming. Therefore, scenarios show that limiting global warming to well below 2°C plays a critical role in reducing adverse impacts on nature and its contributions to people.." (Source: p. 16 in: Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondizio E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. 56 pages. https://ipbes.net/sites/default/files/2020-02/ipbes_global_assessment_report_summary_for_policymakers_en.pdf	Rejected due to length restrictions. This information is covered in WG2 chapters 2 & 3 which we refer to.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
55077	102	45	102	46	May be worth discussing the impact of climate change on insect populations a little more, as this as a major, if understated, ecological, health, and economic impact. Some good recent research was published in the Proceedings of the National Academy of Sciences. See: Special Feature January 12, 2021; vol. 118 no. 2. The Global Decline of Insects in the Anthropocene Insect decline in the Anthropocene: Death by a thousand cuts David L. Wagner, Eliza M. Grames, Matthew L. Forister, May R. Berenbaum, David Stopak, Proceedings of the National Academy of Sciences Jan 2021, 118 (2) e2023989118; DOI: 10.1073/pnas.2023989118 Agricultural intensification and climate change are rapidly decreasing insect biodiversity Peter H. Raven and VDavid L. Wagner PNAS January 12, 2021 118 (2) e2002548117; https://doi.org/10.1073/pnas.2002548117	Rejected . While we agree with your suggestion, unfortunately we don't have space to expand on this subject and believe the current text reflects the importance of cc on insect populations.	Government of United States of America	U.S. Department of State	United States of America
23497	103	2	103	3	We suggest a reformulation of "in species vulnerable to reduced geographic range" for it to be clearer	Noted. Due to length restrictions, the original sentence was removed.	Government of France	Ministère de la Transition écologique et solidaire	France
23499	103	3	103	5	The sentence stating with "including pests and diseases" need clarification. Also, we recommend to add something on the other aspect of ecosystem functioning and services such recycling of nutrient, prevention of erosion, etc...	Partially Accepted . New sentence reads: "...including pests and diseases, could negatively affect existing ecosystems". Nutrient cycling and erosion will be covered by the AFOLU chapter	Government of France	Ministère de la Transition écologique et solidaire	France
23501	103	8	103	9	We suggest to rephrase this sentence.	Noted. Due to length restrictions, the original sentence was removed.	Government of France	Ministère de la Transition écologique et solidaire	France
61307	103	9	103	13	ADD: "Land restoration and halting land degradation under all mitigation scenarios has the potential for synergy between mitigation and adaptation". This dimension has to be added along with implications for biodiversity and water.	Accepted . New sentence added: "Land restoration and halting land degradation under all mitigation scenarios has the potential for synergy between mitigation and adaptation"	Graham von Maltitz	UNIVERSITY OF STELLENBOSCH; UNCCD SCIENCE POLICY INTERFACE	South Africa
23503	103	13	103	13	A very thin part compared to the implications relative to Marine and coastal ecosystems. Furthermore, could be added to this part: - Mangroves, which represent a substantial part of these ecosystems - Wetlands (salt marshes...)	Rejected - Unfortunately we don't have space to include these suggested topics. We refer to WG2 chapter 2 and 3 for relevant coverage.	Government of France	Ministère de la Transition écologique et solidaire	France
71357	103	13	103	18	The formulation would allow one to think that CC is not affecting the marine ecosystems (growing non-climate pressures are mentioned coupled with lack of long-term ecological data sets). The influence (impact) of climate change on the ocean and the marine ecosystems is known, with ample evidence, incl. IPCC AR6 WGI and II. IPBES, EEA, etc. Maybe it is just a case of redrafting slightly the text to accommodate/acknowledge the research and knowledge of CC on the marine ecosystems.	Noted. Due to length restrictions, the original sentence was removed.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
71359	103	14	103	14	Consider land-sourced (instead of land-based)	Accepted	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
23505	103	19	103	21	<p>We recommend to add the following to the coral reef point to express the urgency related : "...disappearing), coral reefs in some regions being already situated at their upper thresholds of temperature tolerance (Vajed Samiei et al. 2015), and rising to >99% of coral reefs...". The case of coral reefs is particularly illustrative of the environmental challenge climate change represents, as despite the critical role they play for biodiversity and society, many coral reefs are already on the brink of collapse.</p> <p>REF: Vajed Samiei J, Saleh A, Mehdinia A, Shirvani A, Kayal M. 2015. Photosynthetic response of Persian Gulf acroporid corals to summer versus winter temperature deviations. PeerJ. 3:e1062.</p> <p>We also recommend to for this point that developing these risks would be of great interest for the understanding of the reader.</p> <p>e.g.: coral bleaching would lead to biodiversity loss</p> <p>- Adding stakes would be interesting too</p> <p>e.g.: The fish that grow and live on coral reefs are a significant food source for more than one billion people worldwide (NOAA, 2020)</p>	<p>Rejected -Unfortunately we dont have space to include these suggested additions and consider that the current text effects the level of urgency realted with coral reefs. We refer to WG2 chapter 3 for coverage of this topic.</p>	Government of France	Ministère de la Transition écologique et solidaire	France
23507	103	24	103	25	<p>We suggest a clarification on the term "physical structure and ecosystem function" What are the physical strutures affected? which ecosystem functions?</p>	<p>Rejected due to length restrictions. This information is covered in WG2 chapter 3 which we refer to.</p>	Government of France	Ministère de la Transition écologique et solidaire	France
23509	103	24	103	26	<p>We found that developing the threats and the implications for human society would be important concerning this point</p>	<p>Rejected -Unfortunately we dont have space to expand on these suggestions</p>	Government of France	Ministère de la Transition écologique et solidaire	France
23511	103	31	103	40	<p>We recommend to diversify the sources or to signal the lack of studies on this topic for this paragraph as it is heavily based on Bindoff et al. (2019).</p>	<p>Rejected - Bindoff et al. is a review of studies on the topic made for IPCC. This citation is appropriate for this short section.</p>	Government of France	Ministère de la Transition écologique et solidaire	France
23513	103	31	103	34	<p>Ocean acidification is another rising concern worth mentioning here: "Another major concern relates to ocean acidification as a result of atmospheric carbon absorption by the ocean, which has particularly detrimental effects on calcifying marine species, such as shellfish, algae, and corals, and on the ecosystems they build (Gattuso et al. 2015)." REF: Gattuso JP, Magnan A, Billé R, Cheung WW, Howes EL, Joos F, Allemand D, Bopp L, Cooley SR, Eakin CM, Hoegh-Guldberg O., et al. 2015. Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios. Science 349(6243).</p>	<p>Rejected due to length restrictions. This information is covered in WG2 chapter 3 which we refer to.</p>	Government of France	Ministère de la Transition écologique et solidaire	France
71361	103	42	103	46	<p>Benefits of cc mitigation are significant is an understatement. With ocean acidification and other negative impacts caused by GHG absorbtion by the ocean, some marine ecosystems are rapidly declining and are threatened with extinction (see coral and some plankton that are having difficulties to form their shells and skeletons, and existing shells may begin to dissolve, also see reductions in size of fish, see impacts on spawning and recruiting, see lack of possibility to migrate for locked in sea basins, etc., etc.). So, I would suggest using a stronger adjective like paramout, vital for the integrity of the ocean and its ecosystems, etc.</p>	<p>Noted but limited space means this discussion had to be removed.</p>	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
23515	104	1	104	2	<p>We suggest a clarification on the sentence starting at "ecosystem services...."</p>	<p>Rejected - the sentence is self explanatory</p>	Government of France	Ministère de la Transition écologique et solidaire	France
10447	104	4	104	4	<p>After "... areas.", could you please add the following text?: " the use of white roofs increases solar reflectance by about 0.40, yielding to a reduced atmospheric temperature equivalent to reducing CO2 emissions by 10 t/100 m2. Cool-colored roofs that increase solar reflectance by about 0.20, yield a one-time CO2 offset of 5 t/100 m2. The solar reflectance of pavements can be raised on average by about 0.15 resulting in an equivalent offset of 4 t CO2/100 m2." Reference: Hashem Akbari, H. Damon Matthews, Global cooling updates: Reflective roofs and pavements, Energy and Buildings, Volume 55, 2012, Pages 2-6. https://doi.org/10.1016/j.enbuild.2012.02.055.</p>	<p>Noted. The length restrictions on this section may not enable this level of detail.</p>	Aniceto Zaragoza	Oficemen	Spain

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11603	104	4	104	4	After "... areas.", could you please add the following text?: " the use of white roofs increases solar reflectance by about 0.40, yielding to a reduced atmospheric temperature equivalent to reducing CO2 emissions by 10 t/100 m2. Cool-colored roofs that increase solar reflectance by about 0.20, yield a one-time CO2 offset of 5 t/100 m2. The solar reflectance of pavements can be raised on average by about 0.15 resulting in an equivalent offset of 4 t CO2/100 m2." Reference: Hashem Akbari, H. Damon Matthews, Global cooling updates: Reflective roofs and pavements, Energy and Buildings, Volume 55, 2012, Pages 2-6. https://doi.org/10.1016/j.enbuild.2012.02.055 .	Noted. The length restrictions on this section may not enable this level of detail.	PEDRO MORA PERIS	UNIVERSITY	Spain
23517	104	6	104	7	Please expand a bit on Ohashi et al (2019) results.	Rejected - Unfortunately we are already over the word limit and the current text is a fair reflexion of Ohashi et al (2019) results	Government of France	Ministère de la Transition écologique et solidaire	France
45853	104	8	104	20	This paragraph does not yet clearly indicate the importance of the time dimension for CDR and its impacts on biodiversity. E.g. based on the SR1.5 Figure SPM 3 with P1 & P2: ambitious climate mitigation today makes us less dependent on 'negative emissions'/carbon dioxide removal (CDR) in future decades and allows for biodiversity conservation in natural ecosystems, while P3 & P4, in contrast, reaching the 1.5°C goal in spite of unambitious climate action today would require widespread CDR/BECCS in future decades with negative impact on global biodiversity due to land use change. This fundamental message of the interlinkages between short- and long-term measures and the scale of CDR and the associated risks for biodiversity is not conveyed here.	Accepted. new sentence added: "Some studies show that stringent GHG and constant mitigation practices ..."	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
79843	104	10	104	20	Although this section is on "implications of mitigation efforts", the sentences seem to focus on the impacts of the mitigation measures on biodiversity and is not clear if the outcomes of stringent mitigation efforts on biodiversity are considered at the same level. Suggest adding explanation on how "a net benefit to global biodiversity can be achieved".	Rejected - Unfortunately we are already over the word limit count so we cant afford to add this explanation	Madoka Yoshino	United Nations University Institute for the Advanced Study on Sustainability	Japan
3955	104	12			It is irregular to cite a submitted paper. Please remove or correct if the paper is published before the final version of the report	Accepted. As the paper has not been accepted before cutoff date, the reference has been deleted.	Rosa M Poch	ITPS and UdL	Spain
79841	104	14	104	16	Suggest adding what "many such consequences" refer to as the earlier sentences do not mention them or is referring to something written too far apart.	Rejected - The consequences refer to desprovision of clean water and sanitation and health and well-being among other sustainable development goals, listed at the beginning of the paragraph	Madoka Yoshino	United Nations University Institute for the Advanced Study on Sustainability	Japan
23519	104	21	104	24	As the environmental conservation: this sentence should be rephrase.	Accepted. new sentence added: word "the" removed on line 21	Government of France	Ministère de la Transition écologique et solidaire	France
23521	104	24	104	31	We recommend that this paragraph be reframe with more precision and more direct references to publications.	Noted. This section had to be shortened due to length limitations.	Government of France	Ministère de la Transition écologique et solidaire	France
3957	104	27		31	This sentence is not clear at all. In AFOLU chapter the problems of agriculture intensification have been addressed, which are difficult to make them compatible with a sustainable land use. The whole sentence could be removed without losing the message of the paragraph.	Noted. This section had to be shortened due to length limitations.	Rosa M Poch	ITPS and UdL	Spain
8097	104	27	104	31	Please explain how nitrogen should be protected.	Noted. This section had to be shortened due to length limitations.	Joachim Rock	Thuener-Institute of Forest Ecosystems	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
79839	104	27	104	31	Suggest revising the sentence for clarity ("mitigating..." repeats within a long sentence; "forest, water and nitrogen" themselves are not "environmental protection"; "reserving sustainably use of land" needs correction; "other multiple sustainability goals" is missing a verb).	Noted. This section had to be shortened due to length limitations.	Madoka Yoshino	United Nations University Institute for the Advanced Study on Sustainability	Japan
3959	104	28			Remove the parenthesis (such as forest, water and nitrogen); since naming nitrogen seems to be out of environment at the same level as forest and water; otherwise name, for instance three resources: (such as forest, soil and water).	Noted. This section had to be shortened due to length limitations.	Rosa M Poch	ITPS and UdL	Spain
49699	104	32	105	47	The content on cities and infrastructure misses to describe how sustainable cities can be realised through an integrated, comprehensive planning approach. Synergies between climate action and sustainable development for transport (with many examples and discussions on urban mobility) can be found here: http://slocat.net/wp-content/uploads/2020/04/SLOCAT-ISDB_2020_Transport-Climate-Action-Sustainable-Development.pdf	Noted. The length restrictions on this section may not enable this level of detail.	Nikola Medimorec	SLOCAT Partnership on Sustainable, Low Carbon Transport	Republic of Korea
79439	104	32	105	47	The content on cities and infrastructure needs to describe how sustainable cities can be realised through an integrated, comprehensive planning approach. Synergies between climate action and sustainable development for transport (with many examples and discussions on urban mobility) can be found here: http://slocat.net/wp-content/uploads/2020/04/SLOCAT-ISDB_2020_Transport-Climate-Action-Sustainable-Development.pdf	Noted. The length restrictions on this section may not enable this level of detail.	Mark MAJOR	Partnership on Sustainable Low Carbon Transport	Spain
5021	104	38	104	40	The sentence might result not true due to pandemic. I suggest to review the sentence	Accepted. Studies on the impact of covid on urbanisation have been explored and new study Kii 2021 has been included.	Tiziana Susca	Italian National Agency for New Technologies, Energy and Sustainable Economic Development	Italy
86225	104	42	104	44	Such aspects are discussed in a box in WG1 chapter 10, it could be interesting to mention it.	Accepted. Reference to WG1 Box 10.3 is now made.	Sophie Szopa	LSCE	France
84503	105	1	105	23	The content on cities and infrastructure provides a valuable overview with connections to Chapter 8. The emphasis on carbon, energy and material footprints may be supported by additional references as appropriate, including Moran et al. (2018) and Lee et al. (2021) for carbon footprints (https://doi.org/10.1016/j.gloenvcha.2020.102205).	Noted. Connections to chapter 8 are made in the section. The length restrictions on this section do not enable this level of detail, especially of references that do not have long term trends as their focus.	Siir KILKIS	The Scientific and Technological Research Council of Turkey	Turkey
16925	105	2	105	23	Which are the evidences/articles/fundamentals to conclude that high density urbanisation can play a valuable role in mitigation by reducing transport. There are lots of examples (macro cities) showing how high density population put pressure in resources and implies more transport intensity. In contrast, distribution of activities along different areas or smaller towns contribute to local production and consumption, therefore diminishing transport intensity.	Rejected. The reference here is to chapter 8 in the same report, where compact cities are associated with supporting lower emissions.	Government of Spain	Area de Estrategias de Adaptacion - Oficina de Cambio Climatico - Ministerio de la Transicion Ecologica	Spain
85179	105	2	105	23	The section on cities and infrastructure should address or at least mention carbon lock-in that cities produce through their infrastructure and urban design. Energy use for buildings will vary substantively depending on urban form (Gunalp et al 2017, https://www.pnas.org/content/114/34/8945). Also, under BAU urban expansion scenarios, urban areas will modify their regional climates to such on average summer daytime and nighttime warming will increase by 0.5 °C–0.7 °C, and up to ~3 °C in some locations and will likely drive a substantive increase in air conditioning use and cold storage for food.	Partially Accepted. The lock-in effects are mentioned, but there is insufficient space to go into details of urbanization warming and energy demand in this section. Chapter 8 is referred throughout.	Karen Seto	Yale University	United States of America
31549	105	7	105	13	The sentence is repeated	Accepted. Duplicates have been deleted.	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
23523	105	9	105	9	The issue related to physical activity and significant positive health impacts induced active travel is disregarded in this section 3.7.6 and also 3.7.4. Some reference on the issue : - Quam, V.; Rocklöv, J.; Quam, M.; Lucas, R. Assessing Greenhouse Gas Emissions and Health Co-Benefits:A Structured Review of Lifestyle-Related Climate Change Mitigation Strategies.Int. J. Environ. Res.Public Health2017,14, 468. -Shaw, C.; Hales, S.; Howden-Chapman, P.; Edwards, R. Health co-benefits of climate change mitigationpolicies in the transport sector.Nat. Clim. Chang.2014,4, 427–433. -Xia, T.; Zhang, Y.; Crabb, S.; Shah, P. Cobenefits of Replacing Car Trips with Alternative Transportation:A Review of Evidence and Methodological Issues.J. Environ. Public Health2013,2013. - Grabow, M.L.; Spak, S.N.; Holloway, T.; Stone, B.; Mednick, A.C.; Patz, J.A. Air Quality and Exercise-RelatedHealth Benefits from Reduced Car Travel in the Midwestern United States.Environ. Health Perspect.2011,120, 68–76. - Lindsay, G.; Macmillan, A.; Woodward, A. Moving urban trips from cars to bicycles: Impact on health andemissions.Aust. N. Z. J. Public Health2011,35, 54–60. - Wolkinge, B., Haas, W., Bachner, G., Weisz, U., Steininger, K. W., Hutter, H. P., ... & Reifeltshammer, R. (2018). Evaluating health co-benefits of climate change mitigation in urban mobility. International journal of environmental research and public health, 15(5), 880.	Noted. The length restrictions on this section may not enable this level of detail.	Government of France	Ministère de la Transition écologique et solidaire	France
79845	105	9	105	13	Suggest adding brief explanation of green-blue infrastructures.	Noted. The length restrictions on this section may not enable this level of detail.	Madoka Yoshino	United Nations University Institute for the Advanced Study on Sustainability	Japan
23525	105	10	105	13	This sentence is repeated twice	Accepted. Duplicates have been deleted.	Government of France	Ministère de la Transition écologique et solidaire	France
31551	105	10	105	13	There is a substantial literature on the health co-benefits of active travel in cities. Most of the benefit is from increased physical activity rather than reduced air pollution. There can also be substantial reductions in costs to health systems as a result of decreased non-communicable diseases related to sedentary lifestyle e.g. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(12)60766-1/fulltext	Noted. The length restrictions on this section may not enable this level of detail.	Andrew Haines	London School of Hygiene and Trop Med	United Kingdom (of Great Britain and Northern Ireland)
9867	105	11		12	This statement supports the above comment. (page 99 chapter 3)	Noted. This point is relevant, but due to space constraints we are not able to include all the relevant information in this section.	Government of Indonesia	Ministry of Environment and Forestry	Indonesia
79847	105	22	105	23	"Thus," does not flow from the previous sentences. It seems to jump to a conclusion that is not well explained.	Accepted. This section has been rephrased.	Madoka Yoshino	United Nations University Institute for the Advanced Study on Sustainability	Japan
65325	105	23	105	33	This paragraph recognises the current situation of unsustainable economies as drivers of climate change. Do the authors think that this recognition could be better woven in the chapter areas engaged with economic transformation? It is an elephant in the room, so to speak, and does have a place in mitigation (WG3 as well as WG2).	Noted. The length restrictions on the chapter may not enable this level of detail.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation	Germany
61669	105	24	105	43	In describing sustainable consumption, especially the resource intensity of wind and solar energy, it would be more accurate to mention that nuclear uses the least amount of raw-materials of all the clean energy sources, produces the least amount of waste per MWh produced (Table 1 in Brook and Bradshaw, 2014, https://doi.org/10.1111/cobi.12433), and has overall very beneficial health effects (Markandaya and Wilkinson, 2007, https://doi.org/10.1016/S0140-6736(07)61253-7 ; Kharecha and Hansen, 2013, https://doi.org/10.1021/es3051197).	Noted. The length restrictions on the chapter may not enable this level of detail.	Rauli Partanen	Think Atom	Finland
65709	105	24	105	43	In describing sustainable consumption, especially the resource intensity of wind and solar energy, it should be mentioned that nuclear uses the least amount of raw-material resources of the clean energy sources, produces the least amount of waste per MWh produced (Table 1 in Brook and Bradshaw, 2014, https://doi.org/10.1111/cobi.12433), and has overall very beneficial health effects (Markandaya and Wilkinson, 2007, https://doi.org/10.1016/S0140-6736(07)61253-7 ; Kharecha and Hansen, 2013, https://doi.org/10.1021/es3051197). Revise accordingly.	Noted. The length restrictions on the chapter may not enable this level of detail.	Eero Hirvijoki	Aalto University	Finland

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
52011	105	31	105	31	Brief mention of food waste but should elaborated analysis in the Agriculture section above is required.	Accepted. Food waste is now mentioned in the summary section.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia
10449	105	36	105	36	After "... (Kalembkiewicz and Chmielarz 2012)", could you please add the following text?: " and ground Coal Bottom Ash (Argiz et al. 2017; Menéndez et al. 2019)." Reference: Cristina Argiz; Miguel Ángel Sanjuán; Esperanza Menéndez. Coal Bottom Ash for Portland Cement Production. Advances in Materials Science and Engineering. Volume 2017 (2017), Article ID 6068286, 7 pages https://doi.org/10.1155/2017/6068286 Menéndez, E.; Argiz, C.; Sanjuán, M.Á. Chloride Induced Reinforcement Corrosion in Mortars Containing Coal Bottom Ash and Coal Fly Ash. Materials 2019, 12, 1933. https://doi.org/10.3390/ma12121933	Noted. The length restrictions on the chapter may not enable this level of detail.	Aniceto Zaragoza	Oficemen	Spain
11605	105	36	105	36	After "... (Kalembkiewicz and Chmielarz 2012)", could you please add the following text?: " and ground Coal Bottom Ash (Argiz et al. 2017; Menéndez et al. 2019)." Reference: Cristina Argiz; Miguel Ángel Sanjuán; Esperanza Menéndez. Coal Bottom Ash for Portland Cement Production. Advances in Materials Science and Engineering. Volume 2017 (2017), Article ID 6068286, 7 pages https://doi.org/10.1155/2017/6068286 Menéndez, E.; Argiz, C.; Sanjuán, M.Á. Chloride Induced Reinforcement Corrosion in Mortars Containing Coal Bottom Ash and Coal Fly Ash. Materials 2019, 12, 1933. https://doi.org/10.3390/ma12121933	Noted. The length restrictions on the chapter may not enable this level of detail.	PEDRO MORA PERIS	UNIVERSITY	Spain
10451	105	40	105	40	After "... amounts of coal-ash ...", could you please add the following text?: " ground granulated blast-furnace slag and silica fume among other residues or by-products... (Sanjuán et al. 2020; Sanjuán et al. 2016)." Reference: Sanjuán, M.A.; Argiz, C.; Mora, P.; Zaragoza, A. Carbon Dioxide Uptake in the Roadmap 2050 of the Spanish Cement Industry. Energies 2020, 13, 3452. https://doi.org/10.3390/en13133452 Miguel A. Sanjuán; Esperanza Menéndez; Cristina Argiz; Amparo Moragues. COAL BOTTOM ASH RESEARCH PROGRAM FOCUSED TO EVALUATE A POTENTIAL PORTLAND CEMENT CONSTITUENT. II International Conference on Concrete Sustainability, ICCS16. Madrid, 13-15 junio, 2016. CIMNE Ed. 532-543. 13/06/2016 - 15/06/2016. ISBN: 978-84-945077-7-9 Argiz, C.; Menéndez, E.; Sanjuán, M.A.; Moragues, A. Alkali-silica resistance of coal bottom ash mortars. In ICCS16 Concrete Sustainability, Proceedings of The second International Conference on Concrete Sustainability, ICCS16, Madrid, Spain, 13-15 June, 2016; J.C. Gálvez et al., Eds.; International Center for Numerical Methods in Engineering (CIMNE): Barcelona, Spain, 2016, 350-360. https://www.researchgate.net/publication/340660040_Coal_bottom_ash_research_program_focused_to_evaluate_a_potential_P ortland_cement_constituent_Second_International_Conference_on_Concrete_Sustainability_M_A_Sanjuan_C_Argiz_E_Menendez_and_A_Moragues_13/references#fullTextFileContent	Noted. The length restrictions on the chapter may not enable this level of detail.	Aniceto Zaragoza	Oficemen	Spain
11607	105	40	105	40	After "... amounts of coal-ash ...", could you please add the following text?: " ground granulated blast-furnace slag and silica fume among other residues or by-products... (Sanjuán et al. 2020; Sanjuán et al. 2016)." Reference: Sanjuán, M.A.; Argiz, C.; Mora, P.; Zaragoza, A. Carbon Dioxide Uptake in the Roadmap 2050 of the Spanish Cement Industry. Energies 2020, 13, 3452. https://doi.org/10.3390/en13133452 Miguel A. Sanjuán; Esperanza Menéndez; Cristina Argiz; Amparo Moragues. COAL BOTTOM ASH RESEARCH PROGRAM FOCUSED TO EVALUATE A POTENTIAL PORTLAND CEMENT CONSTITUENT. II International Conference on Concrete Sustainability, ICCS16. Madrid, 13-15 junio, 2016. CIMNE Ed. 532-543. 13/06/2016 - 15/06/2016. ISBN: 978-84-945077-7-9 Argiz, C.; Menéndez, E.; Sanjuán, M.A.; Moragues, A. Alkali-silica resistance of coal bottom ash mortars. In ICCS16 Concrete Sustainability, Proceedings of The second International Conference on Concrete Sustainability, ICCS16, Madrid, Spain, 13-15 June, 2016; J.C. Gálvez et al., Eds.; International Center for Numerical Methods in Engineering (CIMNE): Barcelona, Spain, 2016, 350-360. https://www.researchgate.net/publication/340660040_Coal_bottom_ash_research_program_focused_to_evaluate_a_potential_P ortland_cement_constituent_Second_International_Conference_on_Concrete_Sustainability_M_A_Sanjuan_C_Argiz_E_Menendez_and_A_Moragues_13/references#fullTextFileContent	Noted. The length restrictions on the chapter may not enable this level of detail.	PEDRO MORA PERIS	UNIVERSITY	Spain

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
45855	105	44	105	45	In order to highlight your point of addressing multiple SDG arenas requiring (should be replaced by a less policy-prescriptive formulation) new systemic thinking using synergies, please also quote the GSDR-approach of "entry points" and "levers" (see e.g., p. 2 https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf). The Global Sustainable Development Report (GSDR) defines the "entry points", where the interconnections across the SDGs and targets are essential for accelerating transformation	Noted. The length restrictions on the chapter may not enable this level of detail.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
4411	106	1	108	5	Add reference: Bharat A, Chandan C (1997/ 2001), Urban governance for sustainable Development CAP Newsletter Vol. 9, June 03 page 13, www.commonwealth-planners.org_Governance_For_Sustainable_Development.pdf (ResearchGate)	Rejected. The focus of AR6 is more recent literature published since AR5 and SR1.5.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4413	106	1	108	5	Add refernce: Bharat A, Sharma D 92007) "Climate Change and Cities: what it means to us and how India addresses the issue ", - Spacio Economic Development Record (SDR), Vol. 14, No. 4 July - Aug.07, Page no. 5 – 13, ISSN 0971 - 4944	Noted. The length restrictions on the chapter may not enable this level of detail.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4415	106	1	108	5	Add reference: Nair Rekha .S ,Bharat A, Manu G. Nair (2013), Impact of climate change on water availability : Case study of a small coastal town in India, Journal of water and climate change (by IWA Publishing), Vol. 4 , No. 2 , 2013 , pp 146 – 159, ISSN: 2040-2244	Noted. The length restrictions on the chapter may not enable this level of detail.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4417	106	1	108	5	Add reference: Nair Rekha .S ,Bharat A, Manu G. Nair (2012), DPIRS Framework for sustainable development of coastal areas, Bonfring International Journal of Industrial Engineering & Management science, Vol. 2 , no.4 , 2012 , pp 117 – 124, ISSN (Online):2277-5056 ISSN (Print):2250-1096	Noted. The length restrictions on the chapter may not enable this level of detail.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4419	106	1	108	5	Add refernce: Nair Rekha .S ,Bharat A, Manu G. Nair (2012), Framework for Integrating adaptation policies for climate change in development plan, International Journal of Environmental Engineering and Management, Vol. 3 , No. 3 ,2012 , pp 235-249, ISSN 2231-1319	Rejected. The focus of WG3 is mitigation, not adaptation, so this falls out of scope.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4421	106	1	108	5	Add reference: Nair Rekha S, Bharat A (2012), Framework for integrated coastal zone planning & management in view of climate change. Spacio Economic Development Record (SDR) Vol. 19 No. 3, May – June 12, Page no. 67 – 76 RNI No. 57320/94, ISSN 0971 – 4944	Rejected. The focus of WG3 is mitigation, not adaptation, so this falls out of scope.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4423	106	1	108	5	Add refernce: Nair Rekha S, Bharat A (2011) , Methodological frameworks for Assessing vulnerability to climate change; Journal of the Institute of Town planners India, Vol. 8 no. 1, Jan. – Mar., Page no. 1 – 15, ISSN 0537 – 9679	Rejected. The focus of WG3 is mitigation, not adaptation, so this falls out of scope.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
4425	106	1	108	5	Add reference:Bharat A, Arti C (2009) An overview for promoting sustainable development in India CAP Newsletter Vol.21, Nov. 09 page 22 & On Website www.commonwealth-planners.org	Rejected. The focus of AR6 is more recent literature published since AR5 and SR1.5.	Alka Bharat	Maulana Azad National Institute of Technology (An Institute of National importance), Bhopal	India
76931	106	15	106	18	The wording "depending on the type used, are likely to negatively impact" is unclear : is the negative impact likely in general (i.e. in at least 66% of some cases) or only likely for some "types" of CDR ? This sentence might possibly be misunderstood, especially if taken out of context, so please by very careful.	Accepted. The wording has now been changed for clarity.	Philippe Marbaix	Université catholique de Louvain	Belgium
86777	106	21	106	22	The goal of the international community is achieving "food security" as enshrined in the 2030 Agenda and its SDGs, being "food security" the multilaterally agreed term at the UN and FAO. Thus we suggest replacing the reference to "food sufficiency/sovereignty" in this sentence for the aforementioned term.	Noted. However, the report reflects the published literature, and thus uses terms from that literature.	Government of Argentina	Ministry of Environment and Sustainable development of Argentina	Argentina

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
19881	106	27	106	27	Please add after "... Figure 3.40.": "Conflicts may in particular be minimized through policies that do not prioritise one sustainable development objective above all other, but seek to mobilize synergies based on local socio-economic and environmental conditions (Honegger et al. 2020).". New reference: Honegger, M., Michaelowa, A., & Roy, J. (2020). Potential implications of carbon dioxide removal for the sustainable development goals. <i>Climate policy</i> , 1-21.	Noted. The length restrictions on the chapter may not enable this level of detail.	Axel Michaelowa	University of Zurich	Switzerland
10561	106	28	106	36	While all this is very true, you miss the point that achieving SDG#5 would beyond doubt contribute to decrease GHG emissions. It should therefore be considered, among other things, as a mitigation method.	Accepted. We have searched for literature to this effect, and now cite O'Sullivan 2018 "Synergy between Population Policy, Climate Adaptation and Mitigation".	Philippe Waldteufel	CNRS	France
5023	107	1	107	1	Figure 3.41, I suggest to substitute Sp&C with the whole words as the meaning is not clear	Accepted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results.	Tiziana Susca	Italian National Agency for New Technologies, Energy and Sustainable Economic Development	Italy
8099	107	1	107	5	Figure 3.41: please revise or delete figure. The figure is not comprehensible. The message here is that holistic policies have but negative impacts and that narrow-focussed policies have much larger positive impacts? And these impacts are the same over all groups / sectors?	Accepted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
31319	107	1			It would be clearer if all labels "Hunger" Health" "Water" etc were along the top of the figure and not scattered. "Sp&c" needs to put in full or a footnote added to explain it. The figure also needs greater explanation in the Caption. Why for example does "(electricity)" appear four times in the narrow policies middle figure - one having adverse and three having beneficial consequences? Food prices should be "Increased food prices" I assume if they are to have adverse consequences. Overall the stand-alone figure and caption is hard to understand.	Accepted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results.	Ralph Sims	Massey University	New Zealand
47325	107	1	107	5	Figure 3.41 needs to create a clear legend for the types of climate impacts instead of writing names of impacts in the same color in the figure.	Accepted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results.	Khaled Mohamed Madkour	Ain Shams University, Cairo, Egypt	Egypt
50101	107	1	107	5	I somehow feel Figure 3.41 was mis-pasted.	Accepted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results.	Masahiro Sugiyama	University of Tokyo	Japan
52013	107	1	107	1	Not clear if red energy-related through all three charts. Use consistent labeling colors.	Accepted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results.	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
55079	107	1	107	5	This figure is impossible to interpret. What do the colors of the bars mean? Why do two bars within each panel share a color (brown), but all the other bars have different colors? Do the widths of the bars mean anything, or is that just an artifact of needing space for labeling? Why are the bars within a given panel all the same heights? What does the position of the text labels within the bars on the top panel mean? (Also, red on red is hard to read.) Does "compared to national policy" mean "compared to all national policies worldwide" or something else? What is the baseline year, and is that baseline the same in each panel? How are "narrow policies" and "holistic policies" defined?	Accepted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results.	Government of United States of America	U.S. Department of State	United States of America
71363	107	1	107	2	Some parts of the tables are not readerfriendly (review colour schemes).	Accepted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
76933	107	1			Figure 3.41: what is the meaning of "comparing to national policy?". Please clarify. Byers et al. 2018 mostly compares 1.5, 2, and 3°C. Is the baseline considered here equal to 3°C? Is the figure linked to a particular point in time, such as 2050 (given that Byers et al. uses SSP data for 2050)?	This has been clarified to state that 'Current Policy' is equivalent to the 3°C scenario in Byers et al 2018.	Philippe Marbaix	Université catholique de Louvain	Belgium
76937	107	1			Figure 3.41: The concept of comparing all these changes is interesting, but it does not appear comprehensive w.r.t. climate impacts: it might be useful to indicate that it is not meant to be comprehensive, if that is the case. In particular, Byers et al 2018 does not assess risks to biodiversity. Presenting impacts only "relative to baseline" also limits the interpretation potential : sometimes what is avoided can be a large risk, but it appears as a 50% reduction, while avoiding a moderate risk will appear as 100% reduction. It should be made clear that the impacts of climate change shown in this figure are only those for which mitigation may also have effects. A full assessment would need an in-depth cooperation with WGII.	The indicator from Byers et al 2018 used was "habitat degradation", calculated as the extent of land use change in natural habitats, thus considered a proxy to biodiversity pressure. Thus to clarify the figure, the "Biodiversity" label is moved to the top (in line with reviewer comment 31319), whilst the indicator "habitat degradation" remains in the column related to biodiversity.	Philippe Marbaix	Université catholique de Louvain	Belgium
61309	107	2	107	5	Figure 3.41; Can you add Land restoration and soil fertility improvement which provide synergistic co-benefits between mitigation and adaptation.	Rejected. The figure can only display the indicators for which the cited studies provide data.	Graham von Maltitz	UNIVERSITY OF STELLENBOSCH; UNCCD SCIENCE POLICY INTERFACE	South Africa
71365	107	2			Interesting figure but very difficult to read. Can it also be developed for 2 degrees? And what does 'compared to national policy' mean?	Noted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results. The cited studies compare 1.5 degrees with 3, not 2 degrees with 3, so this request cannot be fulfilled.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
3961	107	4			It is irregular to cite a submitted paper. Please remove or correct if the paper is published before the final version of the report	Noted. The paper citation will be removed if it is not published by the IPCC cutoff deadline.	Rosa M Poch	ITPS and UdL	Spain
3963	107				Figure 3.41. not clear, it seems incomplete. Only the upper part has some words inside, the others lack lines or markers.	Accepted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results.	Rosa M Poch	ITPS and UdL	Spain
23527	107		107		The objective of Figure 3.41 needs clarification	Accepted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results.	Government of France	Ministère de la Transition écologique et solidaire	France
39051	107		108		Very interesting figures--there are some good stories embedded here. Just a random thought--was any consideration given to preparing this information in terms of the Stockholm Resilience Institute's Planetary Boundary categories?	Noted. The figure has been reworked. The version shown in the SOD became corrupted and did not in fact display the results. The dimensions relate to the variables considered in the studies cited, and do not align with the planetary boundaries framework.	Robert Buhr	Green Planet Consulting Ltd.	United Kingdom (of Great Britain and Northern Ireland)
10563	108	6	108	10	This statement about demand, on top of the whole 3.7 section, strengthens the conviction that the WG3 report might consider actions inducing a decrease of world population as a direct mitigation method against climate change.	Noted. However demand and population do not align automatically, due to extremely unequal distribution. Literature on demography and mitigation has been considered.	Philippe Waldteufel	CNRS	France
5107	108	7	108	17	I think you should at least mention the possibility of rebound effects here	Rejected. Policies that target demand address the rebound effect directly, unlike policies that target efficiency alone.	Lina Hollender	n/a	Germany
83219	108	10	108	10	Not sure if this is true for CDR and BECCS (or better "CDR, particularly BECCS") or only for BECCS (definitely in van Vuuren et al., but even Grubler et al. have large-scale afforestation)	Accepted. The wording has now been changed for clarity.	Geden Oliver	German Institute for International and Security Affairs	Germany
20457	108	17	108	17	Other reference can be added regarding nexus food-water-energy together with the existing one (Bertram et al. 2018) : Van Vuuren, D.P., Bijl, D.L., Bogaart, P. et al. Integrated scenarios to support analysis of the food–energy–water nexus. Nat Sustain 2, 1132–1141 (2019). https://doi.org/10.1038/s41893-019-0418-8	Accepted.	Jordi Solé	Universitat Rovira i Virgili	Spain

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
76115	108	41			This is a section that can add some very relevant perspectives to the communication and use of scenarios. Most attention is - for good reasons - given to the low scenarios. But I think the reader would also find it useful if plausibility of the high end scenarios are also addressed.	thanks. This is indeed an important remark. Most of the quantitative literature has assessed the feasibility of low carbon pathways. The discussion of an appropriate counterfactual is a crucial one for plausibility rather than feasibility- We will discuss whether to include a remark to the likelihood of high end scenario either in this section or in preceding ones (as is currently the case).	Jan Fuglestedt	CICERO	Norway
71367	108				The style of this section is quite different from the rest of the chapter. It would be useful to link it more directly to the IAMs/scenarios and underlying assumptions used in preceding sections. Furthermore, there seems to be very limited linking to the literature on transformational change and tipping points for accelerating deployment of mitigation technologies	thank you. We will connect the section more to the models and scenarios, although given the topic we feel it is important to refer to the parallel literature on feasibility from socio-technical transition studies, political economy, etc.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
78389	109	2	109	14	I did not understand the second half of this paragraph. What's it saying?	this paragraph is meant to distinguish between feasibility and desirability, drawing from the political science framework who classify the two concepts on the basis of the softness vs hardness of the constraints, respectively. We will rewrite it to make it clearer-	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
83221	109	2	109	2	"Effectively responding to climate change" might be more appropriate than "solving..."	thanks for your suggestion, we will use the suggested rewording	Geden Oliver	German Institute for International and Security Affairs	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
27635	109	3	109	4	Delete "Given the fossil-based status quo, transitioning to a low carbon world probe the limits of practical political possibility".	we believe it is important to highlight the transformation challenges as a function of the status quo, which happens to be fossil led. We will adjust the sentence to make it clearer, but it does represent the evidence that higher carbon intensity leads to higher feasibility concerns.	Eleni Kaditi	Organization of the Petroleum Exporting Countries, OPEC	Austria
66195	109	17	109	17	It is suggested to add the following reference to support the point of political constraints of phasing out fossil fuels: "Peszek, Grzegorz; van der Mensbrugghe, Dominique; Golub, Alexander; Ward, John; Zenghelis, Dimitri; Marijs, Cor; Schopp, Anne; Rogers, John A.; Midgley, Amelia. 2020. Diversification and Cooperation in a Decarbonizing World : Climate Strategies for Fossil Fuel-Dependent Countries. Climate Change and Development. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/34011 License: CC BY 3.0 IGO."	thanks for the excellent reference, we will add it. however, please note that the link provided refers to a report not a peer-reviewed publication. Will look into whether the work has been published in a journal.	Maksym Chepeliev	Purdue University	United States of America
73027	109	26	109	28	Add at the end: ", and as climate-caused or -augmented catastrophes increase in severity and frequency."	not sure I understand the proposed suggestion in the context of the paragraph. seems to be on a different topic	Larry Edwards	Larry Edwards Environmental Consulting	United States of America
43071	109	28		31	The report needs to examine how critical risks are assessed and managed. For example: "The question is whether the feasibility frontier can move faster than the pace at which the carbon budget is exhausted. Jewell et al. show that the emission savings from the pledges of premature retirement of coal plants is 150 times less than globally committed emissions from existing coal power plants."	thanks for your suggestion, we will consider it in the revisions	Graeme Taylor	BEST Futures	Australia
23529	109	33	109	37	This statement can be completed by mentioning the need for an institutionalized enforcement instrument to guarantee that promised climate policies are actually kept.	excellent suggestion, we'll add it in the text	Government of France	Ministère de la Transition écologique et solidaire	France
83223	109	37	109	37	Rickards et al. 2014 might be the wrong reference here, I guess the right (or a suitable additional one) is Geden 2016 (https://onlinelibrary.wiley.com/doi/abs/10.1002/wcc.427). Cultural-institutional factors of climate governance/policy are now also discussed in chapter 13.4	thanks for the reference, we'll correct	Geden Oliver	German Institute for International and Security Affairs	Germany
84543	109	37	109	38	Please add: "All in all, a number of different delay mechanisms in both science and policy have been identified to potentially impede climate goal achievement (Karlsson and Gilek 2019)."	thanks for your suggestion, we will consider it in the revisions	Mikael Karlsson	KTH Royal Institute of Technology	Sweden
10565	110	1	114	13	This 3.8 section suffers a significant number of editorial mistakes. Sorry, I cannot point to all of them.	thanks for pointing out to general editing problems, we'll try to resolve them in the revision	Philippe Waldteufel	CNRS	France
50447	110	1	110	5	Hard to follow	we will remove the figure	Hoy Yen Chan	ASEAN Centre for Energy	Malaysia
52015	110	1	110	1	Figure 3.42 is not especially compelling-not much that this visual is adding to what the text already explained	we will remove the figure	Government of Saudi Arabia	Sustainability Advisor to the Minister Ministry of Petroleum and Mineral Resources	Saudi Arabia

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
55081	110	1	110	5	Suggest cutting this figure. It is incredibly confusing, and the legend and caption do not help clarify the meaning or give the reader a sense of what it is trying to convey.	we will remove the figure	Government of United States of America	U.S. Department of State	United States of America
71369	110	1			Are there ways of improving this figure?	we will remove the figure, also as suggested by the other reviewers.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
5025	110	12	110	12	"is" is missing in "However, it still unclear...."	thanks, will correct that	Tiziana Susca	Italian National Agency for New Technologies, Energy and Sustainable Economic Development	Italy
76117	110	23	110	23	Re "models cannot solve": I dont think all readers will understand this. I suggest you reword and explain.	thank you we will explain it more clearly	Jan Fuglestedt	CICERO	Norway
78391	110	23	110	23	What's a "hard-coded constraint"?	these are constraints implicitly or explicitly embedded in the models, such as max technical potential, geological storage. etc. Will clarify better	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
3965	110				Figure 3.42. The arrows and lines are meaningless without the context of the research paper.	we will remove the figure, also as suggested by the other reviewers.	Rosa M Poch	ITPS and UdL	Spain
3967	111	11			Fix the edit, perhaps: Gambhir et al. (2017) constrained the models...	will do	Rosa M Poch	ITPS and UdL	Spain
10567	111	11	111	13	illustration of the former comment	got it, will fix this	Philippe Waldteufel	CNRS	France
74803	111	11	111	11	the line is not easily understandable and should therefore be rephrased	got it, will fix this	Government of Kenya	Kenya Meteorological Service	Kenya
76119	111	11	111	11	Something wrong with language here	got it, will fix this	Jan Fuglestedt	CICERO	Norway
78393	111	14	111	14	The methods are almost opaque to the reader. What are they to conclude? The coincidence of the feasibility indicator in Section 3.44 with plausible warming levels is a recipe for confusion.	we will improve the explanation of the methods underlying the feasibility work in this section. We also plan to add a section in the Annex, to improve clarity and transparency.	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
83905	111	22	111	36	Evidence that scenarios go outside of historical bounds for the economic growth-energy demand relationship is furnished by Semieniuk et al. (2021), which could be cited here. Semieniuk, G. et al. (2021) 'Plausible energy demand patterns in a growing global economy with climate policy', Nature Climate Change, Accepted M. https://doi.org/10.1038/s41558-020-00975-7	thanks for the new reference, we will include it	Gregor Semieniuk	University of Massachusetts Amherst	United States of America
10569	111	34	111	36	more of the same	got it, will fix this	Philippe Waldteufel	CNRS	France
76595	111	34	111	36	A verb seems to be missing in this sentence.	thanks, we will correct this	Charlotte MIJEON	Réseau "Sortir du nucléaire" (organization affiliated to the French Climate Action Network)	France
84431	111	34	111	36	Some words are missing in this sentence in order for it to make sense: "Van Sluiseveld et al. (2018b) that scenarios and experts align for BAU scenarios, but diverge for low carbon ones, with scenarios relying on more conventional technologies (nuclear and CCS) than experts."	thanks, we will correct this	Mattias Lantz	Uppsala university	Sweden

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
47243	111	35	111	36	Conventional means here that existing infrastructures are mostly preferred (e.g. by keeping thermal power plants such as fossil fuelled power plants (with CCS) and nuclear) over new modular ones (which also partly is created due to pessimistic assumption on technology developments)	thanks, noted	Mariësse van Sluisveld	PBL Netherlands Environmental Assessment Agency	Netherlands
43073	111	43		44	Policy makers should not be presented with unrealistic scenarios: “The reality check identified that many 1.5°C compatible scenarios violate the feasibility corridors. The ones which didn’t are associated with significant energy demand reductions, or carbon removal via AFOLU and CDR.”	the purpose of this section is exactly to discuss what makes scenarios more or less realistic	Graeme Taylor	BEST Futures	Australia
65467	111	44	111	45	Why has carbon removal via CDR and AFOLU been separated here? Surely CDR is a umbrella term for any carbon removal, including AFOLU (like deforestation)	well taken point, will just use CDR	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
76121	111	45	111	45	What type of CDR?	various types of CDR, that is those include in the scenarios (which vary from model and scenario). will clarify it	Jan Fuglestedt	CICERO	Norway
37651	112	14	112	19	This figure acknowledges nuclear as an established technology. Reflect it everywhere in the report	noted	Ravi B Grover	Homi Bhabha National Institute	India
55083	112	16	112	19	While the definitions in this figure appear to be helpful, it is unclear why they are in this dinner plate formation, why some boxes are blue and others white, and what the words in the middle of the plate mean or have to do with the other definitions. This figure may be better displayed as a simple table with one column of icons, one column of the five dimensions, and one column of the examples.	thanks, we will change the figure format and turn it into a table or a more illustrative display	Government of United States of America	U.S. Department of State	United States of America
61671	112	16	112	19	In Figure 3.43 there are effectively only three technologies (solar, wind, and nuclear) rated as established technologies. Still, the unproven CCS and BECCS contribute with a major role in the illustrated pathways while nuclear is limited to a very marginal role. This is a striking conflict and seems biased against nuclear / not technology neutral. Considering sustainability, in addition to no air pollution, nuclear waste requires a comparatively tiny space for storage with next to no risk for future generations (see Posiva’s report on the Onkalo final repository: https://inis.iaea.org/collection/NCLCollectionStore/_Public/44/091/44091445.pdf), whereas CCS requires four orders of magnitude larger storage spaces and which therefore faces much higher unknown risks for harmful leakage.	thanks, we will change the figure format and turn it into a table or a more illustrative display	Rauli Partanen	Think Atom	Finland
65711	112	16	112	19	In Figure 3.43 there are effectively only three technologies (solar, wind, and nuclear) rated as established technologies. Why is it then that nuclear is not contributing a major role to the illustrated pathway scenarios but the hypothetical CCS and BECCS are? Isn’t there a conflict here? In regards of sustainability, this is even more confusing. In addition to the air pollution issue, CCS requires typically a final deposit volume four orders of magnitude larger than that of nuclear (Stamford and Azapagic, 2011, https://doi.org/10.1016/j.energy.2011.08.011) and, while the risks from nuclear waste reduce exponentially over time, the risks from CCS waste remain constant indefinitely.	thanks, we will change the figure format and turn it into a table or a more illustrative display	Eero Hirvijoki	Aalto University	Finland
3969	112	20		21	It is irregular to cite a submitted paper. Please remove or correct if the paper is published before the final version of the report	the paper has been published, it is now correctly cited	Rosa M Poch	ITPS and UdL	Spain
76123	112	20	112	20	I think this should be figure. 3.43	yes it is	Jan Fuglestedt	CICERO	Norway
83225	112	20	112	29	Please refer to chapter 13.4 here and consider taking up some of the colleagues’ findings which are broadly in line with what you say	will do	Geden Oliver	German Institute for International and Security Affairs	Germany
10571	113	1	113	1	No reference to this (difficult to understand) figure 3.44 can be found in the text.	it is in line 20 page 112	Philippe Waldteufel	CNRS	France
15565	113	1	113	7	Figure 3.44 impossible to read	thanks, we will change the figure format and turn it into a table or a more illustrative display	Lucas Desport	MINES ParisTech, Total	France
47327	113	1	113	6	figure 3.44 needs to be more illustrated because all contents are not readable	thanks, we will change the figure format and turn it into a table or a more illustrative display	Khaled Mohamed Madkour	Ain Shams University, Cairo, Egypt	Egypt
50103	113	1	113	6	Figure 3.44: the vertical axis (feasibility concern) should be described.	thanks, we will change the figure format and turn it into a table or a more illustrative display	Masahiro Sugiyama	University of Tokyo	Japan

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
65469	113	1	113	1	Figure 3.44: writing is way too small. Very challenging to read.	thanks, we will change the figure format and turn it into a table or a more illustrative display	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
76125	113	1	113	6	This figure is interesting but I think it needs more explanation;i.e., how is the quantifications done etc. (It is also hard to read in the pdf)	thanks, we will work on a revised figure version, making it more clear and informative	Jan Fuglestedt	CICERO	Norway
83227	113	1	113	6	It is close to impossible to review this figure, simply because of the quality of the figure, particularly the upper right panel	thanks, we will work on a revised figure version, making it more clear and informative	Geden Oliver	German Institute for International and Security Affairs	Germany
50105	113	8	113	8	Geels et al. (2020, https://doi.org/10.1016/j.techfore.2018.04.001) and related papers are relevant here.	thanks for the reference, we will add it	Masahiro Sugiyama	University of Tokyo	Japan
75079	113	8	114	20	Two other important references should be included in this section. Grubb et al (2021) show how “most models project an assumed cost of technologies, often declining over time, without any reference to how much effort it is made in the interim. Such models therefore underestimate the value of action today, in favour of waiting for low carbon technologies to get cheaper ‘like manna from heaven’ tomorrow”. Way et al. (2020) on the cost of energy transition using probabilistic forecasting methods. They show that “Energy prices become lower than historical averages after 2030 and considerably lower after 2050. This yields an expected net present saving at any sensible discount rate; at 4% for example, we predict savings of \$5.6 trillion. In contrast, a slower transition is more expensive, while a nuclear scenario is substantially more expensive”. This work uses very different methods from standard climate-economic modelling and IAMs; instead they come from complexity theories and agent-based modelling, which are considered by some a useful tool to overcome the limits of climate-economic models. Grubb et al (2021) Induced innovation in energy technologies and systems: a review of evidence and potential implications for CO2 mitigation. Environ. Res. Lett. https://doi.org/10.1088/1748-9326/abde07 . Way, R., Mealy, P. & Farmer, J.D. (2020). 'Estimating the costs of energy transition scenarios using probabilistic forecasting methods'. INET Oxford Working Paper No. 2021-01.	thanks for the reference. Regarding Grubb et al, 2021, the paper refers to the benefit-cost IAMs such as DICE. Detailed process models do model these inertias. It seem there is an endless confusion about the very different categories of models.	Robert Ward	London School of Economics and Political Science	United Kingdom (of Great Britain and Northern Ireland)
65471	113	11	113	12	Carbon neutral technology? Do you mean carbon negative? Or is this a group term for technology like CCS (neutral). Please define.	it is intended broadly as climate mitigation techs. will correct it	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
82827	113	21	113	21	After "Wangel et al. 2013" Add other references: 1. "Waisman et al. 2019 : https://doi.org/10.1038/s41558-019-0442-8 " 2. "Julien Lefèvre , Yann Briand , Steve Pye , Jordi Tovilla , Francis Li , Ken Oshiro , Henri Waisman , Jean-Michel Cayla & Runsen Zhang (2020): A pathway design framework for sectoral deep decarbonization: the case of passenger transportation, Climate Policy, DOI: 10.1080/14693062.2020.1804817 "	thanks for the references	Yann BRIAND	Iddri, Sciences Po	France
8355	114	13			P114, line 13 – the last sentence in this paragraph is really strange. It seems to be promoting the misapplication of models? Do things badly because you can do more things badly is not a good line to go with. It should also be pointed out that the scope of IAMs is already narrow.	not sure which sentence you refer to exactly. we are mostly citing the existing literature here. the purpose of this section is to indeed point out the narrow scope of model based assessments (all of them), and place them in the larger literature.	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)
46989	114	22	115	13	I think many enabling factors have been omitted here or are not discussed in detail, such as normative change, legislation (Ecocide Law), education, etc. A seminal paper by Otto et a. (2020) on "Social tipping dynamics for stabilizing Earth's climate by 2050" published in PNAS (https://www.pnas.org/content/117/5/2354) discusses important social dynamics that are crucial for progress on climate change mitigation.In particular normative change could be quite crucial (see also Green (2018), Anti-fossil fuel norms in Climatic Change, 150, 103-116, https://link.springer.com/article/10.1007/s10584-017-2134-6).	thanks for the reference	Viktoria Spaiser	University of Leeds	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
8357	114	23			Line 23 – Strong agreement that institutional factors and technological progress have a ‘profound impact’ on attainability. Indeed, this is obvious to most people but definitely worth reiterating. But, again, why is this not included in the descriptions of the limitations of IAMs in the previous sections?	the previous sections are not meant to discuss the limitation of models, but rather to illustrate what scenarios can (and cannot) tell us about their implementability. The feasibility analysis of scenarios illustrates that institutional factors (based on governance indicators of scenarios) are the most important dimension of feasibility	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)
10573	114	23	114	28	In this context, it is a pity that no reference could be found covering the period of the Trump presidency	not sure what is meant by this message	Philippe Waldteufel	CNRS	France
8353	114				P114 – first paragraph. Here the text talks more about the legitimate use of using optimisation models to see what is technically feasible, before moving to real-world analysis. This is a really good section and very clear, but these comments must be reflected in the earlier sections, e.g. the idea of least-cost optimisation as an approximation of real-world behaviour is not tenable when viewed in the context of p114.	thanks, noted	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)
2457	115	1	115	2	The claim that "revenue recycling can be used to increase support" should be backed up with a reference. There is a large literature on this. One recent paper to explore how support for taxes can be increased (across five countries) is Carattini, Stefano, Steffen Kallbekken and Anton Orlov, 2019. How to win public support for a global carbon tax. Nature 565, 289-291.	thanks will add the reference	Steffen Kallbekken	CICERO	Norway
66197	115	6	115	6	It is suggested to add the following reference (Chen, J., et al. 2020. EU Climate Mitigation Policy. International Monetary Fund. Departmental paper series No. 20/13. https://www.imf.org/~media/Files/Publications/DP/2020/English/EUCMPEA.ashx) to support the point of the necessity to implement the mix of policy instruments to achieve climate mitigation efforts.	thanks for the reference. Please note that it is a working paper and not a peer reviewed publication, and as such we will not include it.	Maksym Chepeliev	Purdue University	United States of America
85057	115	15	116	25	This whole section would be better placed much higher in the chapter, immediately preceding the current section 3.3 (mitigation pathways), as it is essential context for the limitations of IAMs and the benefits of combining multiple approaches.	thanks, we will consider moving it earlier in the chapter	Tennant Reed	Australian Industry Group	Australia
55085	115	17	115	45	Suggest reviewing section to see if text that is redundant to Section 3.2 could be cut.	thanks, will double check with section 3.2	Government of United States of America	U.S. Department of State	United States of America
65473	115	24	115	32	Can you be more specific? How many % of scenarios assessed in the report are overshoot scenarios? And how many are not-to-exceed? I see you note later that statistical results from the database need to be handled with care - but maybe this point can be elevated?	thanks, we will add details on scenario categories. please also refer to previous sections for similar information	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)
73029	115	24	115	32	The paragraph provides conclusions about overshoot scenarios and not-to-exceed scenarios. Its three sentences all concern scenarios that rely on pricing carbon. Discussion should be added regarding scenarios that don't rely on price, including ones that instead rely on mandates or command and control methods.	thanks, will do that. However, please note that the scenario database allows to only partly quantify how many scenarios include policies beyond pricing.	Larry Edwards	Larry Edwards Environmental Consulting	United States of America
78395	115	26	115	26	The 5% point should have come 100 pages earlier!	we'll discuss with earlier sections on whether to move it at the onset of the chapter	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
73031	115	35	115	36	The text notes that the IPs "are an ensemble of opportunity". Text should be added to note the this is not a full suite of opportunities, since (see 3-17 at 22) the list of scenarios that were reviewed is not comprehensive and particularly that qualitative scenarios weren't considered.	thanks, noted	Larry Edwards	Larry Edwards Environmental Consulting	United States of America
78397	115	35	115	36	I know this comes from climate science world but this expression is quite devious. I.e. it was opportunistic - and nobody outside the modellers club will have the faintest idea what it means!	notes, will change the word	Jim Skea	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
17697	115	37	115	38	Could you provide a reasonable explanation of why scenarios that include degrowth are not represented? This would be of particular relevance because in the summary for policy makers (Section B.2, page 6 and 7) it is explicitly stated that 1) "Technological change driving energy efficiency improvements and a switch to lower carbon energy sources have led to a decoupling of economic growth and emissions in many countries, but fewer countries have experienced absolute emissions reductions. (high confidence). {2.3}." (B2.1), as well as "Energy demand has only decoupled from economic growth in relative terms, not in absolute amounts" (B2.3). Therefore, it becomes a contradiction if one hand the report argues with high confidence that there is no absolute decoupling, but on the other hand doesn't consider degrowth scenarios. In fact, degrowth scenarios are the ones where, in the case of not achieving absolute decoupling, a decrease of the energy demand is needed, that is likely to affect economic growth measured in GDP. For an explorations of these scenarios with macroeconomic tools, see the article in Nature Sustainability titled "Feasible Alternatives to Green Growth" by Simone D'Alessandro et al. These type of studied are already mentioned in Chapter 3 (Page 78, lines 30-32) "Conversely, few studies find that climate stabilisation below 2°C is only reached under a GDP non-growth/degrowth approach (Hardt and O'Neill 2017; D'Alessandro et al. 2020; Nieto et al. 2020)."	thanks for your comment. the scenario database include all scenario which were submitted, through an open call for scenarios. It is indeed a pity that no degrowth scenarios have been submitted. It is clear from the literature that the assumptions about economic growth are the most important drivers of future emissions. Meanwhile, papers such as the one cited and new ones have developed degrowth scenario, and yet none of them can be found in the database at this moment (submission is still open). We will refer to the literature and hope to see a broader set of scenarios included.	Federico Demaria	University of Barcelona	Spain
76131	115	37	115	38	It would be useful with a couple of sentences saying why.	Accepted. We have added a sentence on this.	Jan Fuglestedt	CICERO	Norway
76127	116	5	116	5	The title of this section "AR6 models" is a bit too broad since you focus on WGIII in AR6	noted	Jan Fuglestedt	CICERO	Norway
47693	116	8	116	9	The EMF-33 project provides sufficient references for how land use and bioenergy potential are represented in IAMs Bauer, N., Rose, S. K., Fujimori, S., Van Vuuren, D. P., Weyant, J., Wise, M., ... & Muratori, M. (2018). Global energy sector emission reductions and bioenergy use: overview of the bioenergy demand phase of the EMF-33 model comparison. Climatic Change, 1-16. Rose S., et al. (under review), Global biomass supply modeling for long-run management of the climate system, Climatic Change	thanks for the reference	Vassilis Daiglou	Utrecht University	Netherlands
23531	116	11	116	11	Issues around the representation of demand-side mitigation options in IAMs are really important. We recommend that it should be emphasized here	noted	Government of France	Ministère de la Transition écologique et solidaire	France
76129	116	19	116	23	I think this last point about IAMs vs SDG dimensions could be given more attention in the chapter.	noted	Jan Fuglestedt	CICERO	Norway
9047	116	27	116	42	About BECCS, it is very important to mention that technologies for CCS bring hazardous phenoma and it is relevant to manage these risks in order to prevent any GHG release in the atmosphere or ground water. Risk management of CCS contribute to the efficiency of the BECCS strategy. Samadi, J., Garbolino, E., 2018- Future of CO2 Capture, Transport and Storage Projects. Analysis using a Systemic Risk Management Approach. Springer Editor.- 87p.	Noted. The text has been substantially revised in response to reviewers comments.	Emmanuel Garbolino	Climpact Data Science	France

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
24913	116	27	116	27	I suggest considering a new question for the FAQ: "Are the anthropogenic GHG flux pathways by IAMs consistent with national GHG inventories and future climate plans?" The answer can be largely taken from cross-chapter box 5 (chapter 7) - this would provide an opportunity to make more visible the link between chapter 7 and chapter 3. A possible text could be "A large ~5 GtCO ₂ /yr gap exists on land fluxes between global models and national GHG inventories, mostly caused by differences in how the anthropogenic forest sink is estimated: countries consider a much larger area of managed forest than global models, and on this area consider the fluxes due to human-induced environmental change to be anthropogenic while global models consider them to be natural (7.2). Adjusting global models' results to make them more comparable with national GHG inventories is possible (Cross-Chapter Box 5 in Chapter 7) and would enable a more accurate assessment of collective progress towards the Paris Agreement's climate goals."	Noted. The text has been substantially revised in response to reviewers comments.	Giacomo Grassi	Joint Research Centre, European Commission	Italy
29843	116	27	116	29	The FAQs to this chapters are good. Please consider if they could benefit from including some supportive graphics and schematic figures that could further help the readers to understand the messages from especially FAQ3.1 and 3.2.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Norway	Norwegian Environment Agency	Norway
9287	116	28	116	42	I think it would be helpful if "net negative emissions" could be explained briefly, e.g. by saying "...where removals exceed emissions..."	Noted. The text has been substantially revised in response to reviewers comments.	Maike Nicolai	Helmholtz Centre Geesthacht	Germany
46509	116	28	116	42	FAQ 3.1 does not really answer the question it poses. Please elaborate on the feasibility of scenarios without NNCE. Please mention also that IAM do not represent reality, see also our comment on the Entire Report on IAMs.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
63559	116	28	116	29	FAQ 3.1: Shouldn't the answer to this FAQ - Is it possible to stabilize warming without net negative emissions? - be YES, if carbon emissions are kept within the allocated remaining carbon emission budget? This FAQ does not provide a direct answer to this question, and instead shifts immediately to talking about meeting stringent global warming levels. Recommend either revising the wording of the FAQ to be "Is it possible to stabilize warming at levels consistent with the Paris Agreement global temperature goal without net negative emissions" or providing a general answer first to the question of whether net negative emissions are required to stabilize global warming at any level.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Canada	Environment and Climate Change Canada	Canada
63565	116	28	116	28	FAQ 3.1: It would be very helpful if a schematic illustration of pathways with and without net negative CO ₂ emissions along with the resulting temperature response could be added to this FAQ.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Canada	Environment and Climate Change Canada	Canada
83607	116	28	116	42	Adding one line that gross negative emissions are used in all pathways, even if they don't reach net negative CO ₂ emissions would be really valuable to clarify in this FAQ.	Noted. The text has been substantially revised in response to reviewers comments.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
9283	116	29	116	31	Please rephrase to eliminate the unclear reference of the "that" in this first sentence, for example: "Many scenarios that were generated by integrated assessment models (IAMs) and used in earlier IPCC reports (AR5 and SR1.5) rely heavily on net negative CO ₂ emissions (NNCE) in the second half of this century to meet the stringent long-term climate goals." The current version might read as if the goals were generated by the models.	Noted. The text has been substantially revised in response to reviewers comments.	Maike Nicolai	Helmholtz Centre Geesthacht	Germany
17613	116	29	116	42	Perhaps the answer should include a sentence from the disruptiveness discussion earlier in the chapter	Noted. The text has been substantially revised in response to reviewers comments.	Alaa Al Khourdajie	IPCC	United Kingdom (of Great Britain and Northern Ireland)
80209	116	29	116	42	The statement addressing the possibility of staying below temperature limits should mention the potential use of SRM. Not mentioning it in the context of risk of insufficient mitigation ambition is misleading by omission and therefore policy-prescriptive. As per SR1.5, "SAI is the most-researched SRM method, with high agreement that it could limit warming to below 1.5°C" (SR1.5, Ch4, Cross-chapter box 10)	Noted. The text has been substantially revised in response to reviewers comments.	Kelly Wanser	SilverLining	United States of America
9285	116	31	116	32	The reference of "that" at the beginning of this second sentence is also slightly hard to understand. "Relying on such negative emissions" might be clearer.	Noted. The text has been substantially revised in response to reviewers comments.	Maike Nicolai	Helmholtz Centre Geesthacht	Germany
29027	116	32	116	36	What exactly is difficult about geological CO ₂ storage? Can you be more clear? Because technically it is not really difficult but you are probably aiming at its public acceptance, long-term liability etc.	Noted. The text has been substantially revised in response to reviewers comments.	Jasmin Kemper	IEAGHG	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
29845	116	34	116	34	If relevant, please consider including "stabilizing"/"destabilizing" or similar in front of "underground carbon storage", to specify what the issue with underground carbon storage is mainly about.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Norway	Norwegian Environment Agency	Norway
63563	116	36	116	42	FAQ 3.1: The response to the FAQ should state that these new IAM-generated scenarios show that meeting stringent global warming targets is possible (using the wording in the FAQ title) with currently available response options; however, feasibility has multiple dimensions (as emphasized in Chapter 3). A more balanced response to this question, addressing feasibility issues, would strengthen this FAQ.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Canada	Environment and Climate Change Canada	Canada
73033	116	36	116	37	Qualitative scenarios should be added into consideration, to develop the trend for scenarios providing a more rapid transformation.	Noted. The text has been substantially revised in response to reviewers comments.	Larry Edwards	Larry Edwards Environmental Consulting	United States of America
9289	116	39	116	40	The sentence "The scenarios without NNCE reach net zero 5 to 10 years earlier than those with no NNCE." seems to need checking. What is the difference between "without" and "with no"?	Noted. The text has been substantially revised in response to reviewers comments.	Maike Nicolai	Helmholtz Centre Geesthacht	Germany
15371	116	39	116	40	Either the 'without' or the 'no' in this sentence needs to be changed, otherwise it doesn't make sense: "The scenarios without NNCE reach net zero 5 to 10 years earlier than those with no NNCE". It's a very good FAQ.	Noted. The text has been substantially revised in response to reviewers comments.	Thomas Wiedmann	UNSW Sydney	Australia
23533	116	39	116	40	We suggest to rephrase that sentence	Noted. The text has been substantially revised in response to reviewers comments.	Government of France	Ministère de la Transition écologique et solidaire	France
29847	116	39	116	40	Please check wording with regards to NNCE in this sentence, it is hard to understand if there are any difference between scenarios "without NNCE" and "those with no NNCE". Intuitively it feels that either the "without" should be replaced by "with", or the "no" at the end of the sentence should be deleted. You might also consider if mentioning the second half of this century in this sentence, similarly as in line 31, would be appropriate.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Norway	Norwegian Environment Agency	Norway
46511	116	39	116	40	FAQ 3.1: this sentence contrasts "scenarios without NNCE" with "scenarios with no NNCE". Please correct (one has to be "with NNCE").	Noted. The text has been substantially revised in response to reviewers comments.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
55087	116	39	116	40	Check the sense of this sentence as written. It seems like deleting "no" before the final "NNCE" would be more consistent, making the sentence read, "The scenarios without NNCE reach net zero 5 to 10 years earlier than those with NNCE."	Noted. The text has been substantially revised in response to reviewers comments.	Government of United States of America	U.S. Department of State	United States of America
63561	116	39	116	40	FAQ 3.1: Presume this sentence should read " Scenarios without NNCE reach net zero 5 to 10 years earlier than those with no NNCE". Also, for an FAQ, recommend not using the NNCE acronym, which hinders readability. Write out net negative carbon emissions.	Noted. The text has been substantially revised in response to reviewers comments.	Government of Canada	Environment and Climate Change Canada	Canada
86057	116	39	116	39	Recommend deletion of word "no" in the following sentence (as it contains two negative statements but intended to contain only one negative statement: "The scenarios without NNCE reach net zero 5 to 10 years earlier than those with no NNCE."	Noted. The text has been substantially revised in response to reviewers comments.	Stuart Bruce	KPMG; International Chamber of Commerce Energy and Environment Committee Co-Chair; IUCN Energy Transition Project Co-Chair	United Kingdom (of Great Britain and Northern Ireland)
65475	116	40	116	42	Would it also be fair to say that NNCE, rapid transformation scenarios lead to less climate risks? E.g. avoided damage from potential overshoots?	Noted . The text has been substantially revised in response to reviewers comments.	Albertine Pegrum-Haram	European Climate Foundation	United Kingdom (of Great Britain and Northern Ireland)

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
9291	117	2	117	13	After reading this FAQ, I still wonder what a net-zero world "looks like". It might make sense to rephrase the question, for example as "How do different economic sectors interact [act together, depend on each other, work together, complement each other] in a net-zero world?"	Partially accepted. We have revised this question in response to this comment and other comments	Maike Nicolai	Helmholtz Centre Geesthacht	Germany
46513	117	2	117	13	FAQ 3.2: the title raises expectations of an illustrative description of a net zero world. The text in its current form does not deliver that. Please consider either rephrasing the title into e.g. "how would emission reductions in a net zero scenario be distributed across sectors" or re-focussing the text on a more illustrative description of how the typical FAQ-reader would have to imagine a net zero world.	Partially accepted. We have revised this question in response to this comment and other comments	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
63567	117	2	117	13	FAQ 3.2: recommend at a minimum that the title of this FAQ be reworded to say "What does a net zero emissions world look like?" (i.e. add 'emissions'). That said, this question, as posed, could be answered quite differently than in the current response, for example in terms of a world where energy is provided without generating carbon emissions, where the air is consequently much cleaner etc. Instead, the response to this FAQ suggests the question might be better worded as "How can net zero emissions be achieved?". Again, as per our comment on FAQ 3.1, an illustration would enrich this FAQ and make it more informative - Fig SPM.7 panel (b) shows that net zero carbon emissions can be achieved with different balances of positive emissions and negative emissions.	Partially accepted. We have revised this question in response to this comment and other comments	Government of Canada	Environment and Climate Change Canada	Canada
76135	117	2	117	13	I dont think this FAQ works well as it is now. It is not clear if net zero is CO2 or GHG. And what is meant by "responsibility of land-based mitigation.."? Some big issues are touched on this FAQ and the title is very ambitious. So I recommend some considerations of scope and ambition here.	Accepted. We have revised this FAQ to address these points	Jan Fuglestedt	CICERO	Norway
23535	117	3	117	3	We suggest to be more specific on "deep emission cuts across all sectors and regions". Given CDR constraints and limits to trade in carbon emissions reductions between countries, is it possible to achieve a net zero emissions target globally without achieving this target in all regions/countries?	Accepted. We have revised this FAQ to address these points	Government of France	Ministère de la Transition écologique et solidaire	France
46515	117	6	117	8	FAQ 3.2: please avoid "matter-of-fact" language when describing scenarios and rephrase e.g. as follows: "In general, AFOLU and energy supply sectors act as sinks and can be fully decarbonised...industry sectors would be responsible..."	Accepted. We have rephrased this.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
55089	117	6			"and energy supply" sector also acts as sink along with AFOLU? It would make more sense if it's specified that renewable energy supplies are being referenced. Since fossil fuels will still be part of the energy mix, specify which scenario or baseline is being referenced.	Accepted. This text has been clarified	Government of United States of America	U.S. Department of State	United States of America
23537	117	8	117	11	This seems to contradict the previous paragraph on FAQ3-1	Accepted. This text has been clarified	Government of France	Ministère de la Transition écologique et solidaire	France
83229	117	10	117	10	Better to use "gross carbon dioxide removal", to support making the difference between net negative and CDR as such more intuitive	Accepted.	Geden Oliver	German Institute for International and Security Affairs	Germany
17785	117	15	117	29	FAQ 3.3) This is phrased in technical language and could explain more clearly that by RCP8.5 we mean carrying on as we have with no mitigation, and with current economic trends (pre-covid) extrapolated. Good to say that it is not "business as usual" but could point out that the impacts and disruption of a 5º will mean business is very far from usual.	Noted. The text has been substantially revised in response to reviewers comments.	Jonathan Lynn	IPCC	Switzerland
63569	117	15	117	15	FAQ 3.3: Again, this title could be improved upon. "and what are their roles" is vague phrasing. One alternative could be "How plausible are high emission scenarios and how can they inform climate action"?	Accepted.	Government of Canada	Environment and Climate Change Canada	Canada
76137	117	15	117	29	FAQ 3.3: This will be a useful FAQ. I think you could expand a little by including some info from WGII and WGI. And within the WGIII field, you could consider reflecting some of the views expressed on likelihood - if you think this is not going into assessment.	Accepted.	Jan Fuglestedt	CICERO	Norway
46517	117	16	117	16	FAQ 3.3.: Please explain how IAMs develop SSPs since we would expect that SSPs are also actively fed into the IAMs as boundary condition?	Accepted.	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
63571	117	16	117	18	FAQ 3.3: the first sentence is filled with a lot of technical jargon which will prevent this FAQ being readily understood by many potential readers. It would be better if this FAQ started by describing in general terms the assumptions under which high emission scenarios are generated (e.g. high population growth, high energy demand that is met with carbon-based fuels etc.). Nowhere in this FAQ response is the SSP5 scenario described as a fossil-fuel intensive scenario, which would seem to be a key descriptor of this scenario.	Styj13%Ymj%yj}y%mf% gjjs%zgzxyfsynfqq-% wj{nxji%ns%wjxutsxj%yt% wj{nj jwx%htrrjsyx3	Government of Canada	Environment and Climate Change Canada	Canada
46519	117	18	117	27	FAQ 3.3.: the typical reader of FAQs may not be familiar with SSPs and RCPs. Please either explain in more detail or avoid specific references and rather describe more generally, e.g.: "Models are run with plausible scenarios describing potential developments of socioeconomic circumstances, greenhouse-gas emissions and climate warming in this century. Among those, the highest emissions scenario (called SSP5) is based on high demographic growth and low economic and technological developments...."	Styj13%Ymj%yj}y%mf% gjjs%zgzxyfsynfqq-% wj{nxji%ns%wjxutsxj%yt% wj{nj jwx%htrrjsyx3	Government of Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy	Germany
63573	117	18	117	20	FAQ 3.3: Here SSP5 is described as world with low economic growth which is not consistent with how this scenario is described elsewhere (as having rapid growth in the global economy).	Styj13%Ymj%yj}y%mf% gjjs%zgzxyfsynfqq-% wj{nxji%ns%wjxutsxj%yt% wj{nj jwx%htrrjsyx3	Government of Canada	Environment and Climate Change Canada	Canada
9299	117	21	117	21	Can you please clarify if "this scenario" refers to SSP5 or RCP8.5 (or a newer "SSP-RCP senario") and make sure these are not confused by readers in the second half of the FAQ?	Styj13%Ymj%yj}y%mf% gjjs%zgzxyfsynfqq-% wj{nxji%ns%wjxutsxj%yt% wj{nj jwx%htrrjsyx3	Maïke Nicolai	Helmholtz Centre Geesthacht	Germany
63575	117	22	117	25	FAQ 3.3: Unclear what "these strong trends" is referring to - the strong projected warming from this scenario or the underlying drivers of high population growth, fossil fuel use etc. Recommend rewriting this sentence to state explicitly that it is incorrect to refer to this scenario as a business-as-usual scenario; rather it is associated with a set of assumptions that characterize a plausible development pathway, but one that diverges from current policy commitments.	Styj13%Ymj%yj}y%mf% gjjs%zgzxyfsynfqq-% wj{nxji%ns%wjxutsxj%yt% wj{nj jwx%htrrjsyx3	Government of Canada	Environment and Climate Change Canada	Canada
9297	117	23	117	23	It does not become clear why the SSP5 scenario might be interpreted as a "business as usual" scenario. If this aspect is deemed important for an FAQ, I would suggest to explain where the assumption comes from and also clarify what "business as usual" means exactly.	Styj13%Ymj%yj}y%mf% gjjs%zgzxyfsynfqq-% wj{nxji%ns%wjxutsxj%yt% wj{nj jwx%htrrjsyx3	Maïke Nicolai	Helmholtz Centre Geesthacht	Germany
86059	117	26	117	26	The statement "COVID-19 may further push down emissions" is not entirely accurate and prone to be misleading. Data released by the IEA shows that while certain GHG emissions initially dropped significantly during the earlier stages of covid in 2020, by early 2021 emissions were almost back to or exceeding pre-covid emissions levels. Suggest this sentence, and all other covid-related comments in AR6, are fact-checked for data and textual accuracy before publication.	Styj13%Ymj%yj}y%mf% gjjs%zgzxyfsynfqq-% wj{nxji%ns%wjxutsxj%yt% wj{nj jwx%htrrjsyx3	Stuart Bruce	KPMG; International Chamber of Commerce Energy and Environment Committee Co-Chair; IUCN Energy Transition Project Co-Chair	United Kingdom (of Great Britain and Northern Ireland)
85623	118	11	167	28	First author name is missing. There are many other references missing the first author.	Noted.	San Win	Environmental Conservation Department, Ministry of Natural Resources and Environmental Conservation	Myanmar
76597	120	29	120	30	This chapter is ill-served by the reference to this article, which does not meet the criteria one could expect from literature quoted in IPCC reports. The authors are writing on a subject that does not belong to their academic field of competence : most of them are climate scientists or nuclear physicist, but none of them is qualified in energy planning. Since some of them have been or are currently working for the French nuclear industry, it lacks the conditions required for an objective and impartial assessment. Moreover, although the article was issued in 2017, the figures mentioned concerning levelised costs of different energies date back to 2010, thus not reflecting the dramatic drop of solar and wind energy cost and introducing a bias regarding compared energy costs.	Noted.	Charlotte MIJEON	Réseau "Sortir du nucléaire" (organization affiliated to the French Climate Action Network)	France
55091	127	40	127	41	Dosio et al. appears to be cited incorrectly. The year should be 2018, and the title should read "heat waves" not "heat waver". The journal and page numbers should be Environ. Res. Lett. 13 054006. https://doi.org/10.1088/1748-9326/aab827	Noted.	Government of United States of America	U.S. Department of State	United States of America
65573	128	12	128	13	The reference is missing the year.	Noted.	Cristian Chadwick	University of Chile	Chile
82519	137	10	137	11	Duplicated lines for the same source.	Noted.	Jinsun Lim	International Energy Agency	France
84433	139	25	139	26	Regarding the reference "Karlsson, M., and Coauthors, 2020a." The doi-link leads to a different article. The title does not correlate to the author either.	Noted.	Mattias Lantz	Uppsala university	Sweden

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
84545	139	25	139	26	The reference is wrong; the article referred has Hänsel MC as first author, not Karlsson. See also the references in the text, as noted above.	Noted.	Mikael Karlsson	KTH Royal Institute of Technology	Sweden
84547	139	29	139	30	Please insert the following reference: "Karlsson, M., Gilek, M. (2019) Mind the gap: Coping with delay in environmental governance. <i>Ambio</i> 49, 1067–1075 (2020). https://doi.org/10.1007/s13280-019-01265-z ."	Noted.	Mikael Karlsson	KTH Royal Institute of Technology	Sweden
55093	143	18	143	19	Is this the citation referenced? If so, consider including the URL: https://www.climatelinks.org/sites/default/files/asset/document/2019_USAID-ATLAS_Heat-Waves-and-Human-Health.pdf	Noted.	Government of United States of America	U.S. Department of State	United States of America
55095	158	2	158	2	This citation is missing et al. (there are 5 authors), the volume number, and the words "Air pollution:" from the start of the article title. https://www.nature.com/news/air-pollution-clean-up-our-skies-1.16352#/b3	Noted.	Government of United States of America	U.S. Department of State	United States of America
55097	158	14			Provide the link to this report. It's not clear which annual report this citation is referring to, and thus where the 20% figure comes from.	Noted.	Government of United States of America	U.S. Department of State	United States of America
71371	163	20	164	20	Wrong citation. should be: SEI, IISD, ODI, E3G, and UNEP. (2020). The Production Gap Report: 2020 Special Report. http://productiongap.org/2020report	Noted.	Philippe Tulkens	European Union (EU) - DG Research & Innovation	Belgium
8127					Please include a statement about the limitations of IAMs to assess biomass production within agriculture, forestry, and combined systems (agro-forestry) as your colleagues did in Chapter 12 (page 69, lines 20 - 26). This would explain many difficulties to estimate land area requirements and explain why there still is limited insight in biomass-based CCU.	Noted.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
8333					Many thanks for all the hard work that the authors have put into producing this draft. There is a lot of excellent material included. I apologise in advance if my comments appear overly negative – unfortunately the nature of this exercise is to focus on areas of disagreement. To me the chapter could be divided into two parts, with various sub-sections in each part. There is the part that relates long-term development in a real-world context, and the part that seems near fixated on Integrated Assessment Models (IAMs) and their results. To summarise my more detailed comments below (and talking as a modeller myself), I urge the authors to expand the excellent analysis in the former, and cut back substantially on the IAM parts. I do not have an issue with optimisation modelling or IAMs per se, but most of their use in this chapter is out of context and has potentially misleading results. It adds very little (and it could be argued nothing new) and clinging to simplistic neoclassical economics at a time when the rest of the world is moving to alternative approaches risks undermining other parts of the chapter and report. While I appreciate that this exercise is a literature review and there are many peer-reviewed articles based on IAMs (both large and small-scale), there are also many critiques out there. Some of these are elaborated in the chapter, but usually not in the sections where IAM results are reported. I therefore ask for more consistency – e.g. where GDP costs are reported in Section 3.1, also note in this section that a) these costs result from model assumptions rather than analysis, and b) these assumptions are not realistic. The reader should not have to go a further 80 pages to find out that there is little real-world basis for these results. A few detailed comments are below – I made these while reading and I hope they are useful. Best wishes to all involved.	Noted.	Hector Pollitt	Cambridge Econometrics	United Kingdom (of Great Britain and Northern Ireland)
12607					Is the page limit not imposed on Chapter 3 (maybe it is just very long boxes...)	Noted. Chapter 3 has 45 IPCC pages allocated to it and it is exactly within its page limit in its revised version.	valentina bosetti	bocconi	Italy

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
12789					<p>Studies show that previous systems such as CDM afforestation/reforestation did not have enough checks and balances in place to ensure that carbon forestry projects did not negatively affect local livelihoods. Prejudice about local people degrading their environments have been found to significantly influence many carbon forestry projects and such prejudices have enabled descriptions of local environmental and livelihood benefits when there were in fact no such benefits. Lack of knowledge of the history of environmental governance and development interventions in the Global South and mistakes made in the past, as well as absence of social science competence on researching issues of poverty and development in the design and implementation of carbon forestry processes, have led to repeating old mistakes and negatively affecting local situations. Despite lessons from development and conservation mistakes in the global South during the past 70 years, (See Hajdu & Fischer 2017), many of those mistakes have been repeated in carbon forestry projects resulting. Currently the report understates these problems and reduces them to "poorly implemented" projects when the issue is in fact systematic.</p> <p>Refs: Fischer, K. & Hajdu, F. (2018). The importance of the will to improve: how 'sustainability' sidelined local livelihoods in a carbon-forestry investment in Uganda. <i>Journal of Environmental Policy & Planning</i>, 20(3), 328-341. doi: 10.1080/1523908X.2017.1410429.; Gupta, A., Lövbrand, E., Turnhout, E. & Vijge, M. (2012). In pursuit of carbon accountability: the politics of REDD+ measuring, reporting and verification systems. <i>Current Opinion on Environmental Sustainability</i>, 4(6), 726-731. doi: 10.1016/j.cosust.2012.10.004; Hajdu, F. & Fischer, K. (2017). Problems, causes and solutions in the forest carbon discourse: a framework for analysing degradation narratives. <i>Climate and Development</i>, 9(6), 537-547. doi: 10.1080/17565529.2016.1174663. Engström L and Hajdu F 2019 Conjuring 'Win-World' – Resilient Development Narratives in a Large-Scale Agro-Investment in Tanzania. <i>Journal of Development Studies</i>. 55 (6) 1201-1220. DOI:10.1080/00220388.2018.1438599</p>	Noted.	Flora Hajdu	Swedish University of Agricultural Sciences	Sweden
55099					<p>Published in February 2021, IWG (2021) ""Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 Interagency Working Group on Social Cost of Greenhouse Gases, United States Government"" contains important information that should be considered by the authors. Of particular use, IWG (2021) includes a section describing the scientific and economic advances related to damage functions. That section of IWG (2021) is submitted here as comment to the WGIII authors, and may be of particular use for Sections 1.6.2 and 3.6.1. IWG (2021) Section 5 (Scientific and Economic Advances) Damage Functions highlights:</p> <ul style="list-style-type: none"> - At the core of IAMs are ""damage functions"" that map global mean temperature changes and other physical impacts of climate change into economic (both market and nonmarket) damages. Relative to how much progress has been made in modeling and improving our understanding of climate system dynamics and the physical impacts resulting from temperature change, efforts involved in, and the public resources targeted at, understanding how these physical changes translate into economic impacts have been significantly smaller (Auffhammer, 2018). Even so, in the time since the versions of the IAMs used in this TSD were published, there has been an explosion of research on climate impacts and damages. - Several efforts are underway to draw on recent literature for improving damage functions and to generate new damage estimates. In particular, the Climate Impact Lab is undertaking an effort to quantify and monetize damages at a fine spatial scale, relying on rigorous empirical methods to develop plausibly causal estimates for several sectors, including health (Carleton et al., 2020), energy (Rode et al., 2021), labor productivity (Rode et al., 2020), agriculture, conflict, and sea level rise. Other research efforts have sought to update the damage function for one sector in an existing IAM based on an updated review of the empirical literature on climate impacts pertaining to that sector (e.g., Moore et al., 2017, for agriculture damages in the FUND model). Damage functions specific to impacts within the U.S. have also been developed and improved for a number of sectors, such as impacts on coastal property, mortality due to extreme temperatures, transportation infrastructure, electricity supply and demand, water quality, recreation, and allergies (Neumann et al., 2020) and impacts of climate change on air quality and human health (Fann et al., 2021). Biodiversity loss is also a major potential source of potential damage. - Related to the development of damage functions, damages from climate change are uncertain and hence pose additional risks. Reductions in GHG emissions reduce not only expected damages, but also reduce the uncertainty and risks of catastrophic events. Evaluating the damages using the mean outcome does not account for the benefits of reducing uncertainty. Some researchers have raised the need to include this consideration in the SC-GHG (e.g., Carleton and Greenstone, 2021) consistent with the observation that individuals are regularly willing to pay for insurance against bad outcomes. - Furthermore, E.O. 13990 instructs the IWG to consider how best to reflect environmental justice and intergenerational equity 	Noted.	Government of United States of America	U.S. Department of State	United States of America
55101					<p>For improved flow, suggest Section 3.5 (Interaction between near-, medium- and long-term action in mitigation pathways) be moved after Section 3.3 (Emission pathways, including socio-economic, carbon budget and climate responses uncertainties). These two sections focus on the macro picture. Section 3.4 in between focuses on sectors.</p>	Noted.	Government of United States of America	U.S. Department of State	United States of America

Comment Id	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
55103					This chapter in many places reads more as a review than as an assessment. There are numerous sections that do not make assessment statements, and it is often difficult to trace the assessment statements made in the Executive Summary back to the underlying text. In general, the sections should have clear assessments using IPCC likelihood/confidence language. Finally, it is often unclear what is new since AR5 and SR1.5. This should be made more explicit.	Noted.	Government of United States of America	U.S. Department of State	United States of America
55105					A link to the Glossary would be useful. There are many acronyms and economic terms in this chapter.	Noted.	Government of United States of America	U.S. Department of State	United States of America
60761					There should be statements on necessary „CO2 only“-reductions (not only of CO2-equ reductions) from Chapter 3 in the SPM – we have seen this in SR 1.5: CO2 is less abstract for policy makers, it is possible to measure with recent numbers and easy to communicate in the media (P 28 Fig 3.8 is with only CO2)	Noted.	Manfred Treber	Germanwatch	Germany
60763					We should not use 2020 as reference year because the emissions of this year are not at all normal due to COVID-19. 2020 is no stable base year at all.	Noted. Year 2020 is never used as a reference, but as a "modeled" year.	Manfred Treber	Germanwatch	Germany
61141					Although the use of large-scale BECCS is assumed, the corresponding costs are not fully described. It is recommended that the related economic cost and ecological cost need to be discussed in detail?	Noted.	Shiyan Chang	Tsinghua University	China
82339					This chapter seems to have missed the opportunity to clarify what carbon neutrality means or what can be considered carbon neutrality (for the globe as well as for nations and sub-national actors), especially as to what extent the absolute level of emissions should be reduced to - is 70% reduction sufficient with the remaining 30% be offset, or should be 80% or even higher reduction in absolute emissions, or should we look at carbon budget instead? The current research seems sufficient to provide at least some crude guidance on this. For example, the report already says that the remaining carbon budget is 525 Gt to limit global warming to 1.5 in case of lower overshoot, and also provided estimates for offsetting potential by AFOLU and CDR options, so the maximum absolute carbon budget or absolute emissions reductions required can be worked as a % and used as a reference point for those who wonder.	Noted. Carbono neutrality is defined in the Glossary.	Yinlong Xu	Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences	China