

## IPCC AR6 WGIII - First Order Draft Review Comments and Responses - Chapter 3

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
12919	0	0	0	0	Considering that the Report is aimed at a diverse readership, terms like "long-term", "Medium-term" and "short-term" need to be (approximately) quantified.	Taken into account. Time horizons will be clearer in the next draft.	Prashant Goswami	Institute of Frontier Science and Application	India
16549	0	0	0	0	Please stay away as much as possible from a term such as "target" when actually talking about limits of global mean temperature. Use the term "limit" whenever possible. In the policy making context Long-term global goal (LTGG) and/or long-term target have a much broader meaning than merely temperature limit, while a specific temperature limit might be characteristic of such a LTGG. However, in contrast to the policy, the scientific community tends to talk all the time about targets, often called long-term targets, while actually meaning only a temperature limit. This is wrong and should be avoided throughout AR6 (not only WGIII!). This is in particular wrong and misleading, since policy makers have not agreed what long-term temperatures should follow once warming has been limited. The long-term temperature goal might well be very different from the limit, in particular well below the limit. Talking about a temperature long-term target implies as if the goal is to keep the temperature at a limit, say 1.5 or 2°C, "forever", while impacts differ a lot depending whether that would actually be the case or not.	Accepted. Text will be revised.	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
35931	0	0	0	0	in this chapter is alternatively used socioeconomic or socio-economic (and associated terms), it might be better to use only one form	Editorial. Accepted, thank you.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
35933	0	0	0	0	in this chapter is alternatively used GTCO2eq or GTCO2-eq, it might be better to use only one form	Editorial. Accepted, thank you.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
35975	0	0	0	0	be careful to explain acronyms as soon as they are first cited (except for the executive summary)	Editorial. Accepted, thank you.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
35991	0	0	0	0	in this chapter is alternatively used bio-energy or bioenergy (and associated terms), it might be better to use only one form	Editorial. Accepted, thank you.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
35995	0	0	0	0	this chapter does not consider the CCU(S) in the scenarios and works listed	Rejected. Several scenarios analyzed in the chapter include carbon capture and storage.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
36003	0	0	0	0	The report contains a number of items of information for the year 2020, output of model. Considering on the one hand that it will be published after 2020 and on the other hand that 2020 will be marked by a drop in emissions already observed, how will AR6 "take this into account"? It may not be necessary or relevant, but just in case?	Taken into account. Several chapters will address this issue. This chapter will also mention it.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
36017	0	0	0	0	For some results and graphs, the sources are not explained, in particular the model from which the results are derived. For example, Figure 3.16, etc. A large number of models and scenarios are identified in this chapter and condensed in some graphs, except in some cases and this lacks transparency.	Taken into account. Sources will be more clear in the next draft. Also, a scenario database will be available.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
36023	0	0	0	0	What about the influence of materials and rare-earths based materials as determinants of future technological choices? This is not dealt with in this chapter despite the influence it can have on long-term choices and scenarios. Modeling references exist as: Antoine Boubault, Nadia Maizi. Devising Mineral Resource Supply Pathways to a Low-Carbon Electricity Generation by 2100. Resources, MDPI, 2019, 8 (1), pp.33. (10.3390/resources8010033). (hal-02074216) // Salla Ahonen, Nikolaos Arvanitidis, Anton Auer, Emilie Baillet, Nazario Bellato, et al.. STRENGTHENING THE EUROPEAN RARE EARTHS SUPPLY-CHAIN Challenges and policy options A RE-PORT BY THE EUROPEAN RARE EARTHS COMPETENCY NETWORK (ERECON). [TechnicalReport] European Commission. 2015. <cea-01550114>	Taken into account. This indeed an important issue and we plan to mention it in the next draft of the chapter.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
36035	0	0	0	0	do not alternatively use non-CO2 and Non-CO2	Editorial. Accepted, thank you.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
36059	0	0	0	0	harmonize title with or without punctuation marks (outside question marks etc.)	Editorial. Accepted, thank you.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
33161	0			8	It should develop an international support framework how energy efficiency can be achieved in developing countries which are currently making rapid development changes resulting in greater emission in the near future	Noted.	Edris Alam	Rabdan Acadmey	United Arab Emirates
2257	0				Tipping points in the Earth system are not included in this chapter. A statement on how these might undermine long term goals such as stabilizing climate warming to 2 (or more) degrees might be appropriate. See <a href="https://www.pnas.org/content/115/33/8252">https://www.pnas.org/content/115/33/8252</a> . To what extent are Earth system tipping points included in the simulations presented in this chapter?	Taken into account. We will include the discussion on tipping points in the next draft.	Sara Vicca	University of Antwerp	Belgium
2267	0				Which techniques are considered under CDR? It would be useful to provide an overview table or figure to clarify this. This could also include important pro's and con's	Noted. Text will be revised and will contemplate this.	Sara Vicca	University of Antwerp	Belgium
5083	0				For the timing of GHG and CO2/carbon neutrality, no clear distinction is made throughout the chapter. It would be helpful to clearly define both and then use them consistently throughout the chapter. Currently, sometimes carbon neutrality is used and GHG neutrality in other cases.	Taken into account. Thank you. The distinction between these two concepts will be clearer in the next draft.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
9513	0				Obviously this -crucially important- Ch.3 would build on the extensive discussion in SR1.5C, and focus on new and additional literature and insights since its publication. The Ch.3 tends to read however as if all material is new.	Taken into account.	Tom Kram	PBL (Fellow)	Netherlands

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
9653	0				<p>Section 3.6.2 in Chapter 3 of IPCC WG3 AR5 (i.e., the last IPCC AR) summarized the state of knowledge on discounting and the applicability of the simple Ramsey rule and extensions. Table 3.2 also consider long-term social discount rates between from the literature between 1.4 and 16 percent. Two new contributions to the literature I) find larger consensus on the value of the long-term social discount, and II) questions the applicability of the simple Ramsey rule. I think it is important to highlight these more recent contributions.</p> <p>The key normative/ prescriptive (relating directly to Table 3.2. in the previous IPCC AR) is: Drupp, Moritz A., Freeman, Mark C., Groom, Ben, and Frikk Nesje (2018), Discounting Disentangled. American Economic Journal: Economic Policy 10(4), 109-34. Webpage: <a href="http://www.aeaaweb.org/articles?id=10.1257/pol.20160240">http://www.aeaaweb.org/articles?id=10.1257/pol.20160240</a></p> <p>Abstract: The economic values of investing in long-term public projects are highly sensitive to the social discount rate (SDR). We surveyed over 200 experts to disentangle disagreement on the risk-free SDR into its component parts, including pure time preference, the wealth effect and return to capital. We show that the majority of experts do not follow the simple Ramsey Rule, a widely-used theoretical discounting framework, when recommending SDRs. Despite disagreement on discounting procedures and point values, we obtain a surprising degree of consensus among experts, with more than three-quarters finding the median risk-free SDR of 2 percent acceptable.</p> <p>The key positive/ descriptive contribution is: Giglio, Stefano, Maggiori, Matteo, and Johannes Stroebel (2015), Very Long-Run Discount Rates. Quarterly Journal of Economics 130(1), 1–53. Webpage: <a href="https://doi.org/10.1093/qje/qjw036">https://doi.org/10.1093/qje/qjw036</a></p> <p>Abstract: We estimate how households trade off immediate costs and uncertain future benefits that occur in the very long run, 100 or more years away. We exploit a unique feature of housing markets in the United Kingdom and Singapore, where residential property ownership takes the form of either leaseholds or freeholds. Leaseholds are temporary, prepaid, and tradable ownership contracts with maturities between 99 and 999 years, while freeholds are perpetual ownership contracts. The price difference between leaseholds and freeholds reflects the present value of perpetual rental income starting at leasehold expiration, and is thus informative about very long-run discount rates. We estimate the price discounts for varying leasehold maturities compared to freeholds and extremely long-run leaseholds via hedonic regressions using proprietary data sets of the universe of transactions in each country. Households discount very long-run cash flows at low rates, assigning high present value to cash flows hundreds of years in the future. For example, 100-year leaseholds are valued at more than 10% less than otherwise identical freeholds, implying discount rates below 2.6% for 100-year claims.</p>	Taken into account. Text will be revised.	Frikk Nesje	Heidelberg University	Germany
10519	0				<p>It would be helpful if the chapter could assess the consequences of real-world trade-offs within scenarios - i.e. if decision-makers chose to do less mitigation on one gas or sector, how much more would they have to do to achieve the same overall climate change outcome, and how do the overall mitigation costs and feasibility change? As it stands, the chapter mostly describes what happens within each of the (mostly IAM-based) scenarios - which is great, but in reality, most governments will not do everything in all sectors that they should be doing and that the scenarios envisage. So it would be helpful to have a clearer picture how critical partial action is. E.g. currently, no government anywhere is putting a price on agricultural GHG emissions. Can you actually achieve the temperature goals of the PA if we continue to exempt agricultural non-CO2 emissions from climate policy - even if we did everything right on fossil CO2? How much more would we have to do on fossil CO2 reductions to compensate for the lack of action on agricultural emissions - can we make up for this lack of action? Does it change the feasibility of achieving the overall goals? This is just one example obviously. Section 3.4.7 would be well placed to address this but doesn't actually seem to deal with these sorts of trade-offs and consequences of partial action.</p>	Taken into account. Text will be revised.	Andy Reisinger	NZAGRC	New Zealand
10521	0				<p>It would be helpful if this chapter directly addressed the lively discussion amongst scientists about the on-going relevance and proper use, or misuse, of RCP85. A short box on this would help (or as part of an FAQ - what are baseline scenarios?)</p>	Taken into account. Text will include this.	Andy Reisinger	NZAGRC	New Zealand
10533	0				<p>There is a lot of overlap with chapter 2 on drivers of emissions - please consult with that chapter and harmonise, both to reduce inconsistencies and reduce length of the respective sections.</p>	Taken into account. Text will be revised.	Andy Reisinger	NZAGRC	New Zealand
16221	0				<p>For Chapter 3, consider adding a description of whether military emissions have been included in any of the scenarios analyzed, and add a brief treatment of uncertainty arising from their absence. Including the military sector will give a clearer picture of the importance of including national-level policy in mitigation pathway scenarios for reaching longterm climate goals.</p>	Taken into account.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
16741	0				<p>The current draft report is highly prescriptive in the classification of the emission pathway that would be in line with the Paris Agreement long term temperature target, particularly with regards to the probabilities that are assigned to 'below' or 'well below' 2°C. The 'well below' 2°C language represents a substantial strengthening of the "below 2°C" language of the Cancun agreement. The report at 3-11 line 19 states that there is ambiguity with regards to the Paris temperature target. There are however multiple lines of evidence that indicate that the "below 2°C" language is linked to a likely (66%) chance of staying below 2°C, and that thus "well below 2°C" must be classified as a higher than likely (66%) probability.</p>	Taken into account. Text will be revised.	Dennis van Berkel	Urgenda	Netherlands
16743	0				<p>[continued] •First, all COP decision after Cancun, until the Paris Agreement, in the preamble referred to the 'likely' classification of the IPCC when referring to the "below 2°C" target form the Cancun decision: "Noting with grave concern the significant gap between the aggregate effect of Parties' mitigation pledges in terms of global annual emissions of greenhouse gases by 2020 and aggregate emission pathways consistent with having a likely chance of holding the increase in global average temperature below 2 °C or 1.5 °C above pre-industrial levels"</p> <p>•Second, several decision of the meeting of the Parties to the Kyoto Protocol (1/CMP.6, preamble, 1/CMP.7, 1/CMP.8) refer to the finding of the IPCC AR4 report in order to stay below 2C, Annex 1 countries should reduce their emissions by 25-40% before 2020 compared to 1990. This reduction level is connected to a concentration of 450ppm (WGIII, table 13.7), which according to AR5 gives a 'likely' 66% chance of staying below 2°C.</p>	Taken into account. Text will be revised.	Dennis van Berkel	Urgenda	Netherlands
16745	0				<p>[continued] •Third, the AR5 report, including in the WG3 SPM and Synthesis report, linked the 'below 2°C' language of the Cancun Agreement to likely (66%) emission pathways. From the AR5 Synthesis report "There are multiple mitigation pathways that are likely to limit warming to below 2°C relative to pre-industrial levels."</p> <p>•Forth, the Paris COP decision at para 17, notes that in order to stay "below 2°C" emissions by 2030 need to be reduced to 40Gt. This relates to a 'likely' change of staying below 2°C, as is evident from the UNEP 2014 Gap report, table 2.2 (p.16) and the UNCCC secretariat NDC Synthesis report (FCCC/CP/2015/7), figure 2 (p. 11).</p>	Taken into account. Text will be revised.	Dennis van Berkel	Urgenda	Netherlands
16747	0				<p>[continued] The above lines of evidence all point at the fact that both the parties to the UNFCCC and following form this the IPCC in AR5, interpreted "below 2°C" as a likely (66%) chance of staying below 2C. It is also evident that the Paris Agreement 'well-below 2°C' language represents a substantial strengthening of the 'below 2°C' language from the Cancun agreement. 'Well below 2°C' therefore has to represent a higher than likely (66%) change of staying below 2°C. A simple 'relabeling' of the previous 66% below pathway from below 2°C to 'well below 2°C' would go counter to the previous decision of the COP and would moreover be policy prescriptive.</p>	Taken into account. Text will be revised.	Dennis van Berkel	Urgenda	Netherlands
16749	0				<p>[continued] At the very least IPCC cannot rule out the possibility that 'well below 2°C' should represent a higher than likely (66%) change of staying below 2°C. The current report however rules out that possibility. The IPCC has established language to provide likelihood assessments. Throughout the report, the IPCC should thereby provide assessments for pathways that are likely to hold warming below 2°C and for pathways that are very likely to do so, where the former should be connected to the "below 2°C" target and the latter to the "well below 2°C" target.</p>	Taken into account. Text will be revised.	Dennis van Berkel	Urgenda	Netherlands
16751	0				<p>[continued] The foregoing leads to the conclusion that the pathway classification needs to adjust its framing. For instance, the classification as provided in Table 3.3. goes counter to the language in the COP decisions (see above) and is policy prescriptive. It is also illogical. How can the term "below 2°C" be associated with pathways that have a 50% likelihood of exceeding 2°C? At the least the 50% category needs to be deleted. The table 3.3 should provide likely below 2°C and very likely below 2°C pathways, where the former should be connected to the "below 2°C" target and the latter to the "well below 2°C" target.</p>	Taken into account. Text will be revised.	Dennis van Berkel	Urgenda	Netherlands

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18549	0				This is a necessarily big and ambitious chapter, reflecting a huge amount of work. I have one main over-arching comment, relevant to the many statements on both timing / urgency, and sentiments that are reflected in the opening line of "... require unprecedented efforts from all sectors and all countries". The essential question is the extent to which combinations of innovation and supply chain pressures might enable leading regions and leading companies to exert sufficient pressure to drive global transformation. The renewables revolution did not require all countries to make 'unprecedented efforts' – just a few – to foster innovation such that solar is now cheaper than fossil fuels for power generation in many (and growing) regions of the world. It is not obvious that for these other countries and regions to adopt PV will require 'unprecedented effort', though they may need to reform power markets to make the best use of the new opportunities. The same is emerging in land transport, given the revolutions in battery technology and the multiple attractions (eg. resource dependence, air quality etc) of moving away from internal combustion engines. These real-world examples reflect the economics of induced innovation and the dynamics of sectoral transformations, including the roles of finance. I understand that this is very hard to model. A great paper by Mercure et al (2019) clearly illustrates the importance of how models represent innovation and finance as the key determinants of how they behave with respect to these issues. I think the chapter should be up-front and transparent about how many models in its database have explicit modeling of induced innovation and the financial sector. Insofar as such models are represented, it would be helpful to see whether and how this tends to influence the results, compared to more standard GE models. This Reference is cited in the chapter (Mercure et al 2019b) but the (single) reference point actually misses entirely the main point of the paper, which was an a collaboration between General Equilibrium and Econometric Systems modellers to clarify the underlying processes driving sometimes divergent results.	Taken into account.	Michael Grubb	UCL - Institute of Sustainable Resources	United Kingdom (of Great Britain and Northern Ireland)
18561	0				I think this chapter faces two potential strategic risks from its dominant reliance on the model database. One concerns issues, like induced innovation, path dependence, and positive technology spillovers which are necessarily very hard to model in such extensive and detailed models. I have commented on a couple of aspects of this. The other risk, however, is that the mainstream economics community is only very weakly represented. For example, there is not a single reference to papers led by the Nobel Laureate William Nordhaus, even though his DICE model is very widely used in the economics community and indeed economics faculties run classes with it. The authors may disagree with many aspects of such modelling (as I do) but I think ignoring this is potentially very problematic, including in terms of how the IPCC report may be received in the mainstream economics community	Taken into account.	Michael Grubb	UCL - Institute of Sustainable Resources	United Kingdom (of Great Britain and Northern Ireland)
37165	0				The IPCC is meant to be policy relevant, but not policy prescriptive. However, I find the current draft to be highly prescriptive in its pathway classification towards the Paris Agreement temperature goal by classifying what 'below' or 'well below' 2°C is in terms of probabilities. Obviously, policy makers did not make explicit reference to a probability level of concept. However, this does not mean it is unknown. Here are some indications that could guide an assessment on this crucial policy relevant question. Some background on this: <ul style="list-style-type: none"> <li>Pre-Paris, the 2010 Cancun language was 'below 2°C'. In response to that, the IPCC AR5 presented the likely (66%) below 2°C category. This has in turn been taken up by the UNFCCC. Both the preambles of the Doha and Lima decisions (COP 19 and COP20) refer to pathways with 'a likely chance' and Paragraph 17 1/CP.21 explicitly mentions a 40 Gt limit in 2030 that is linked to 66% 2°C pathways.</li> <li>The introduction of 'well below 2°C' in the Paris Agreement represents a clear strengthening of previous language (e.g. Schlessner et al. 2016) and is a reaction to the outcome of the 2013-2015 Review that established in its Structured Expert Dialogue that 2°C 'cannot be considered safe' (compare also decision 10/CP.21).</li> </ul>	Taken into account. Text will be revised.	Michiel Schaeffer	Climate Analytics	Netherlands
37167	0				(continued) This WG3 draft is now shifting the goalpost on 2°C. A 50% 2°C pathway becomes 'below 2°C' (which is at odds with what is commonly understood by the word 'below') and a 66% chance suddenly becomes 'well below' 2°C (compare table 3.3) but without changing anything in the IAM modeling protocols that determine the pathways that previously were used to inform the 'below' 2°C goal of the Cancun Agreements. This is highly policy prescriptive and arguably in contradiction with the evidence available on how to interpret the PA goal. Rather than interpret the PA, the IPCC should provide different 2°C pathways and label this factually, not normative (in terms of wrong- interpretations of PA language). The IPCC has calibrated likelihood language that can be deployed here. I would suggest to also add an additional 'very likely 2°C' pathway (compare e.g. SR1.5 Ch 3 Table SM2.12). Concretely, I propose changing C3 & C4 labels to a factual labeling, by using 'likely below 2°C' for C3, change C4 to "as likely as not below 2°C." and add a 'very likely below 2°C' category as C5. On a similar note, the C2 'high OS 1.5°C' category needs to be revised. The focus on 2100 probabilities is artificial and not rooted in any policy context. Following SR1.5 Ch 3 Table SM2.12, this category has a 'likely' change to exceed 1.5°C. It should therefore be called 'likely above 1.5°C overshoot pathways'. Also note that the 'high overshoot' 1.5°C category was omitted from the SR1.5 SPM for reasons of requiring unrealistically high CDR deployments. See also Schlessner, C.-F., Lissner, T. K., Rogelj, J., Fischer, E. M., Knutti, R., Licker, R., Levermann, A., Frieler, K., Schaeffer, M. and Hare, W. (2016) "Science and policy characteristics of the Paris Agreement temperature goal", Nature Climate Change 6, 827–835, doi:10.1038/nclimate3096.	Taken into account. Text will be revised.	Michiel Schaeffer	Climate Analytics	Netherlands
37169	0				(continued) and the following fragment from Wachsmuth et al (2019) "The EU long-term strategy to reduce GHG emissions in light of the Paris Agreement and the IPCC Special Report on 1.5°C", Fraunhofer ISI Working Paper Sustainability and Innovation No. S 22/2018: "The core scientific basis for mitigation pathways that underpinned the Cancun Agreements and subsequent literature, and the work of the SED on the 2013-2015 Review of the adequacy of the long-term goal (all preceding the Paris Agreement) systematically characterized the Cancun "hold below 2°C" global goal using pathways that limited warming to below 2°C with a chance of at least 66%, or "likely" in IPCC terms [15]. The decision to strengthen the long-term goal therefore has to be seen with reference to this context, which frames the negotiations over the ambition elements of the Paris Agreement. The Paris Agreement LTG strengthens the former Cancun temperature goal by referring to holding warming "well below 2°C" and, in this context, pursuing efforts to limit warming to 1.5°C. It therefore signals that warming needs to be held to a lower level than in the former (Cancun) goal, and hence increase both margin and likelihood by which warming is to be kept below 2°C compared to merely "hold below 2°C" [4]."	Taken into account. Text will be revised.	Michiel Schaeffer	Climate Analytics	Netherlands
37171	0				Also this chapter has a fundamental problem with lumping together C3 and C4 categories. C4 cannot in any way be seen as compatible with PA. One could make a case to lump C1-C3, but the use of "2°C scenarios" in many parts of this chapter is confusing and as part of pieces of text that refer to PA this is misleading in that context. C3 and C4 need to be split always in the text, as they are already in the figures.	Taken into account. Text will be revised.	Michiel Schaeffer	Climate Analytics	Netherlands

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37173	0				What happened to the wonderful analysis framework and findings of Special Report on 1.5°C and it's SPM.4 figure? That mapping of CC policies against SDGs was a major achievement and leap forward. AR6 cannot be complete without such a mapping, further developed, and including adaptation interventions. Missing this in AR6 is a major concern. Is Table 17.2 supposed to become a further developed version of SR1.5 SPM.4? If so, I have three major concerns: 1. this work is fundamental and should therefore be properly reviewed by the expert reviewers. Since it is missing in FOD, it should be in SOD and no later. 2. the current layout of table 17.2 is risky in terms of its 2°C and 1.5°C reference. See my comments for chapter 3 and other chapters that these labels are often unclear and inconsistently used throughout the whole WG3 FOD and will be misleading and policy-prescriptive if not referred to in strict factual manner (so "66% probability to hold warming below 2°C", instead of something wrong like "well below 2°C")	Taken into account. Text will be revised.	Michiel Schaeffer	Climate Analytics	Netherlands
40935	0				In general, I think the chapter is in good shape for a FOD. But for the SOD the chapter needs more assessment of the knowledge of the literature. As it is now, I think there is too much review and description of what papers find. In general, more critical assessment of what the literature tells us, how it relates to real world conditions and constraints, robustness of results, and where the knowledge gaps are. Regarding the results from the IAMs; very much relevant synthesis and overview is provided in a useful and structured manner, but also here I think there sometime is too much emphasis on describing the model results as such. So more assessment of what the model results are telling us and not telling us would be useful; i.e., limitations related to scope, resolution, mechanisms etc.	Taken into account. In the SOD, wider review of the literature will be provided. Also, the interpretation of results will be improved.	Jan Fuglestedt	CICERO	Norway
40937	0				The relation between Ch3 and Ch4 is important to communicate to the reader (wrt timescales, approaches, long term/near term, national, regional, global scale). In addition to the explanation given in section 3.1.2 and in ES, you may also consider a visual explanation. Such an illustration could be placed in Ch3 or alternative in Ch1. If possible, without making it too busy, such a visual explanation could also include relation to sectoral chapters - but since that bigger picture is addressed in Ch1, I think such an illustration should focus on Ch3-Ch4.	Taken into account. Text will be revised.	Jan Fuglestedt	CICERO	Norway
40939	0				This chapter contains results that will be useful for the calculation of remaining carbon budgets. This will be treated in WGI and may be updated again in SyR based on more scenario results available for non-CO2 in WGIII. Thus, to secure flexibility and availability of data needed for presentation of remaining carbon budgets in SyR, I hope Ch3 will provide a clear and transparent documentation of relevant carbon budget data; e.g. in Annex or Supplementary Material. You may use the Supplementary Material to Ch2 in SR1.5 as an example of information needed and how to present that. Close contact with WGI authors on this issue is essential in order for securing flexibility and consistency.	Taken into account. Text will be revised.	Jan Fuglestedt	CICERO	Norway
40941	0				The chapter has references to Art.4 of the Paris Agreement and the statement on GHG balance. But the chapter also uses the concepts "net zero CO2 emissions", "net zero GHG", just "net zero" and "carbon neutrality". It should be quite easy to clarify the relation between these concepts and their use in the chapter. I suggest a small box defining these concepts and making it clear what you use throughout the chapter. That can avoid confusion among reader, but also save space later in the chapter. Please also check consistency with Ch1 on this issue.	Accepted. The distinction between these concepts will be clarified for SOD.	Jan Fuglestedt	CICERO	Norway
40943	0				Looking at the choice of IPs, I wonder why you have not chosen a scenario with mid level forcing, e.g. 4.5 or so. The xWG team on scenarios, suggested a set of scenarios that could be used across WGs, and it would be very useful if you could include these. I would also believe that a "middle scenario" will be useful and relevant for policy makers. Furthermore, it would give us a good basis for use of scenarios in SyR.	Accepted. IPs in FOD are preliminary. For the SOD, there will be more IPs, a mid-level forcing IP will be included.	Jan Fuglestedt	CICERO	Norway
40945	0				In Annex C there is a quite clear statement on plausibility of a forcing level of 8.5. ("The highest forcing level, RCP8.5, is only obtained in a no policy baseline in SSP5 (SSP5-8.5). Since there are already moderate climate policies implemented in many countries around the world, this scenario may be already seen as a counterfactual. It is highly unlikely that a forcing level as high as RCP8.5 will actually be obtained in any world given current policy trends and the increasing threat from climate changes."). Having this assessment in the Annex C – and not in the chapter – seems a little surprising, but I guess more of this will appear in the chapter text in SOD. It is a statement that will receive much attention, and in my view, this could need more elaboration, nuances and explanation in the chapter. Similar attention to the plausibility of the low scenarios would be very useful. I think the chapter has the potential to provide extremely useful and relevant assessment on these questions. Contact with the later chapters, e.g. 13 and 14, may strengthen this assessment of feasibility.	Taken into account. Text will be revised.	Jan Fuglestedt	CICERO	Norway
40947	0				SLCF is a group of components that has received much attention. WGI has a separate chapter on this, and there are strong links to AQ and SDGs. Inclusion of some focus on this would be useful. We have discussed WGI-WGIII links on author levels, and these should be activated and used now. TSUs and bureau members can help with contact between authors on this.	Will contact Jan.	Jan Fuglestedt	CICERO	Norway
41259	0				It would be useful if you could check the use of units in tables and figures throughout the chapter	Accepted. Thank you.	Jan Fuglestedt	CICERO	Norway
41261	0				Coordinate definition of remaining carbon budgets with WGI and make it very clear how you use it in the chapter. Any deviations (e.g., due to what is available in underlying literature) should be clearly explained. Transparency and clarity on this concept is essential for a good treatment of this in SyR.	Taken into account. Text will be revised.	Jan Fuglestedt	CICERO	Norway
41573	0				"Mitigation potential" (used throughout the chapter) should be defined or its meaning explained.	Taken into account. Text will be revised.	Ida Andrea Braathen Sognaes	CICERO centre for international climate research	Norway
41583	0				It should be made clear everytime scenario results (e.g. range of renewables at a certain point in time) are discussed, whether they capture cost-optimal/cost-effective pathways or absolute requirements. This is important because cost is only one among many important criteria for policy makers. Policy makers might want to deviate from the most cost effective pathway due to other criteria such as energy security or distributional issues. Scenario results that depict cost effective pathways do not represent absolute boundaries and should not be presented as such. Scenario results that indicate cost-effective pathways should be separated from absolute requirements (e.g. physical boundaries) in a way that is consistent throughout the chapter.	Attention to cost-optimal scenarios vs. other constraints (connection to 3.2 / feasibility). Still needs to be done.	Ida Andrea Braathen Sognaes	CICERO centre for international climate research	Norway
41585	0				The chapter would benefit from a table similar to Table 3.3 that categorises emissions scenarios according to model types/structural assumptions.	Agree. Table needs to be added.	Ida Andrea Braathen Sognaes	CICERO centre for international climate research	Norway
45033	0				The proliferation of terms that include the words "carbon budget" but mean different things is deeply unhelpful and confusing. I realise the authors largely reflect the diverse use of the term in the literature, but just because the literature uses the term in 10 different ways doesn't mean we have to do the same in this assessment. E.g. transient budget, peak budget, end of century budget, exceedance budget - the multitude of meanings, associated with a multitude of numbers, essentially removes its utility for policymaking other than as communications tool. I would urge the authors to be more targeted and selective where they apply the concept of a carbon budget, and where they more explicitly (and ultimately, simply) say things like "cumulative CO2 emissions up to the point of net zero", or "cumulative emissions and removals until the end of the century". Reserve the use of "carbon budget" for peak warming, or temperature exceedance budgets.	Taken into account. Text will be revised.	Andy Reisinger	NZAGRC	New Zealand
45035	0				Given the persistent confusion and different interpretations of Article 4 of the PA, and whether and how this is consistent with Article 2, I feel this chapter should have a dedicated section that explains (merging WGI science with WGIII) how net-zero CO2 is different from net-zero all-GHG, and the temperature implications of the two different types of net-zero targets. This should not become an interpretation of the PA (IPCC is not the relevant body to do that), but a clarification of the extent to which those different goals are at least compatible with each other from a scientific perspective. It could perhaps even be done as a FAQ, but probably needs a bit more substance than that. Also please take care to ensure that whenever "net zero" is used, it is clear whether you mean CO2 only or all GHGs (right now I think there are quite a few instances where the text implies net-zero all GHGs but the numbers suggest that what is meant is net-zero CO2 only).	Taken into account. Text will be revised.	Andy Reisinger	NZAGRC	New Zealand

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
46713	0				Co-benefits need to be addressed in a more comprehensive manner, e.g. in 3.6.4. Please see below and in Mikael Karlsson, Eva Alfrédsson & Nils Westling (2020) Climate policy co-benefits: a review, Climate Policy, DOI: 10.1080/14693062.2020.1724070.	Taken into account. Text will be revised.	Mikael Karlsson	KTH Royal Institute of Technology	Sweden
18447	1	1	1	1	There is a lot of duplications on BECCS with chapters 3 and 6, please enhance coordination among the chapters	Noted.	Chang Shiyun	Tsinghua University	China
24199	1	1	92	6	The chapter reviews literature. It does not draw conclusions. It is not clear if all conclusions of all the chapters will be organised in one chapter but it will be good to have a section for conclusions at the end of each chapter.	Taken into account.	Alfred Oforu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
44523	1	1	96	6	Throughout the WGIII report, the use of "net zero" is quite inconsistent or ambiguous. This should be streamlined, and ch3 plays an important role in that respect. I think that early on in ch3 there should be a discussion of differences between the geophysical requirement (= net-zero CO2) and the PA Art 4 mitigation target (= net zero GHG), it would be helpful to have two figures, showing the differences in net-zero years and CDR requirements (since they are substantially higher for net zero GHG) for the same cluster of low-stabilization pathways. Of course, "net zero CO2" and "net zero GHG" should be used instead of "net zero" wherever possible. But readers will only get the relevance of this difference when it is discussed and visually represented early on (in 3.3 at the latest)	Taken into account. Thank you. The distinction between these two concepts will be clearer in the next draft	Oliver Geden	German Institute for International and Security Affairs	Germany
44525	1	1	96	6	Throughout the report, the use of CDR and (net) negative emissions is quite inconsistent. This should be streamlined, and ch3 plays an important role in that respect. It would be preferable to make very clear that these are not the same, by distinguishing gross and net removals, showing early on that significant amounts of CDR are needed to reach/maintain net zero CO2/GHG. This should probably be supported by one or two figures early on, not only in form of a global pathway but also by a more conceptual figure similar to figure 2.10 in SR1.5. Furthermore, it would be good to highlight the volumes for both gross CDR and net negative emissions, making clear that considerable amounts of CDR are needed just to reach and maintain net zero	Noted. The use of the term CDR will be harmonised.	Oliver Geden	German Institute for International and Security Affairs	Germany
30495	1	1	98	6	At the 52nd Meeting of the IPCC, Parties asked for the synthesis outline to include behavioral aspects - mitigation and adaptation related. Could this chapter have more research collated on the long term mitigation potential? There now exist climate modelling on dietary changes, for example, and policy makers really need to see this kind of concrete changes to reducing emissions, to help them imagine the wide range of what would help. In dietary changes, the sustainable agriculture implications are also very positive - charts, figures on this would help.	Taken into account. Lifestyle will be assessed for SOD.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
14707	1		98		This is an excellent FOD, with a good and logical structure and highlighting extremely valuable perspectives. However, much of the chapter is currently falling short from providing an assessment in which the evidence (its quality, strengths and limitations) are put in context of the agreement that is found in the literature. Although I didn't read every line of the chapter I could not locate a single statement of confidence. The current chapter text stops at the review and descriptive level. Unless there has been an explicit decision by the IPCC leadership to break with the IPCC's practice of providing a traceable confidence assessment for all its statement, this is probably a key improvement to be implemented during the writing of the SOD.	Thank you, confidence language will be included for SOD.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
27645	1	1	127	70	Congratulations for this exhaustive and for the most part well formulated chapter.	Thank you.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
27647	1	1	127	70	Parts of the report appear to overlap with Chapters 4 and 17 . Some consolidating might be worth considering.	Taken into account. Coordination between chapter is being improved fort the SOD	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
14153	1		127		Same comment through the text: as said in the report elsewhere ("The volumes of CDR deployment assumed in IAM-based global emissions mitigation scenarios are significant if compared to current volumes of deployment, given that the feasibility of rapid and sustained upscaling is uncertain" (1p15 Chapter 12), there are many uncertainties with relation to the feasibility of large-scale CDR deployment in the future, hence when referring to them it is crucial to keep always this in mind. It has to be said, and the tense of the verb should be switched to conditional instead of present to avoid giving a sensation of certainty.	Taken into account. We will consider rephrasing it for the next draft	Iñigo Capellán-Pérez	University of Valladolid	Spain
14179	1		127		It would be much better for the reader to have a full chapter 3 before this chapter about "modelling approaches" because now there is an abrupt jump from "emission drivers" in Chapter 2 to "long-term mitigation pathways". It is not transparent at all where the results come from. For example the section "knowledge gaps", which is said to be in sections 3.9 and/or3.10 is not present, in any case IAMs limitations which are now in Appendix C belongs to this part.  The limitations of IAMs should be stated more clearly so the reader can understand the results reported through the paper. In fact, most IAMs share some common assumptions which have been seriously challenged in the literature, which in case of being wrong would have the potential to qualitatively change the results presented in this chapter and the following. Check for example Sreicic et al 2013; Hardt & O'Neil 2017 and Capellán-Pérez et al 2020:  "Despite great advances achieved in the field over the years,8,10 most IAMs (and especially those more policy-influential), share a core set of common assumptions whose validity is being disputed in the scientific discussion. First, IAMs are generally characterized by a rather sequential structure with limited feedbacks among the represented subsystems. The interconnectivity of modules has likely been constrained by the historical development of most IAMs through linkage of existing modules which were not originally designed for being interlinked.15 For example, natural science models must respect the laws of thermodynamics, while economic models often do not. Also, the discrepancy between the natural scientists' understanding of ecological feedbacks and the representations of environmental damage found in IAMs (if any) is especially relevant for the case of climate change impacts. Most IAMs fail to capture the "potentially irreversible threat to human societies and the planet" stated, for example, in the Paris Agreement.4,9,16–21 Second, a lack of plurality in the methods to represent the economic dimension has been detected in the literature, dominated by assumptions of conventional general or partial equilibrium through optimization methods, perfect factor substitutability, as well as the widespread use of prices as indicators of scarcity. These simplifications fail to capture the relevance of sector complementarities within the economic structure, the socioeconomic system dynamics and the role of macroeconomic policies for sustainability governance.22–28 Third, the abundance of both fossil fuels and renewable energy sources is a default assumption in most of the prominent IAMs used for climate policy analysis; hence, future energy transitions are thus largely modeled as demand-driven transformations only constrained by available monetary investments.8,29,30 However, this assumption is disputed by studies in the literature showing that fossil fuels' extraction might face significant constraints in the next few decades related with increasing geological restrictions as the quality of the resource decreases.30–32 Furthermore, a branch of literature is also showing that the replacement of fossil fuels in the current socioeconomic system by the large scale deployment of RES faces serious challenges in relation to biophysical factors such as intermittency or mineral and land requirements.33–41 Fourth, most IAMs disregard the implications that the future energy investments required to achieve the transition to renewables may have for the system.42–46 In fact, a favorable energy return on energy invested (EROI) (energy surplus) is a critical aspect of the viability of societies and has been associated with such fields as biology or anthropology as a key driver of increasing complexity and evolution for plants, animals and humans.47–49 Finally, Fifth, (the lack of) transparency has been highlighted as being an issue in the field of IAMs critically affecting credibility and robustness of the results disseminated.11,50,5"	Taken into account. Text will be revised.	Iñigo Capellán-Pérez	University of Valladolid	Spain
					In particular, Capellán-Pérez et al (2019) showed that the transition to decarbonized energy systems will imply a strong increase in the energy required to extract/recycle and process all minerals and materials to build the new capacities, a phenomenon which is not considered by most IAMs.  Sreicic, S., Rezaei, A., Mechler, R., 2013. On the economic foundations of green growth discourses: the case of climate change mitigation and macroeconomic dynamics in economic modeling. WENE 2, 251–268. <a href="https://doi.org/10.1002/wene.57">https://doi.org/10.1002/wene.57</a> Hardt, L., O'Neill, D.W., 2017. Ecological Macroeconomic Models: Assessing Current Developments. Ecological Economics 134, 198–211. <a href="https://doi.org/10.1016/j.ecolecon.2016.12.027">https://doi.org/10.1016/j.ecolecon.2016.12.027</a>				

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20275	1		160		One brief mention of food waste in the Chapter 3.. I suggest the following addition – if acceptable please choose where it goes in the chapter. An increase by 2050 in the range of 1.7% to 2.8% is projected for modelled disposed municipal solid waste methane (MSW) emissions due to solely to desertification in Middle East and North African countries (Dumble 2017), though overall desertification MSW methane emissions may be much lower due to longer term drought conditions. In California extended drought periods since 1990 may have contributed to significant changes in landfill moisture and annual methane oxidation levels varying from 0% to 100% extended to the lowest levels by prolonged periods of low or no precipitation (Spokas et al 2015, Sadasivam and Reddy 2014; Yang et al., 2014, Spokas & Bogner, 2011, Hartz and Ham 1983). Dumble, P. (2017). Regional development and climate change mitigation modelling of municipal solid waste emissions in the Middle East. Water and Environment Journal, Vol.31, No.2, p226-234, May. DOI: 10.1111/ wej.12236. Spokas K, Bogner J, Corcoran M and Walker S (2015) From California dreaming to California data: Challenging historic models for landfill CH4 emissions.2015. Elementa Science of the Anthropocene. 2015; 3:000051. DOI: <a href="http://doi.org/10.12952/journal.elementa.000051">http://doi.org/10.12952/journal.elementa.000051</a> . Sadasivam B, Reddy K. (2014). Landfill methane oxidation in soil and bio-based cover systems: A review. Reviews in Environment Science and Bio/Technology, 13(1): 79–107, <a href="https://doi.org/10.1007/s11157-013-9325-z">https://doi.org/10.1007/s11157-013-9325-z</a> . Spokas KA and Bogner JE. (2011) Limits and dynamics of methane oxidation in landfill cover soils. Waste Management and Research, 31(5): 823–832, <a href="https://doi.org/10.1016/j.wasman.2009.12.018">https://doi.org/10.1016/j.wasman.2009.12.018</a> . Yang T, Yue DB, Han B and Sun Y. (2014). Field methane oxidation efficiency at municipal solid waste landfills located in the north of China. Advanced Materials Research, 878: 812–820, <a href="https://doi.org/10.4028/www.scientific.net/AMR.878.812">https://doi.org/10.4028/www.scientific.net/AMR.878.812</a>	Taken into account. Thank you for the suggestion and references. Food waste will be better addressed in the next draft (section 3.7).	Paul Dumble	Paul's Environmt Lentd	United Kingdom (of Great Britain and Northern Ireland)
43699	1	1			Chapter 3 is doing long-term scenarios and does not reflect current technological development in detail. Chapter 4 is focussing on NDCs and development pathways. Which chapter is responsible for reflecting current technological developments, and juxtaposing insights to Chapter 3?	Taken into account. There will be an Annex criating this bridge.	Felix Creutzig	MCC Berlin	Germany
43701	1	1			This chapter is grounded in IAMs. Most scenarios have outdated assumptions on at least some technologies, and are gauged in a small tech-specific literature. One example is the old data for solar PV as cited in Krey et al 2019. How is this problem handled? The key issue is that a bias in one technology cascades down to overall pathways.	Taken into account. Scenarios and text will be revised.	Felix Creutzig	MCC Berlin	Germany
35619	1				It would be good if you somewhere could comment the expected temperature increase after the year 2100. Perhaps by indicating for which scenarios the temperature is expected to increase further after the year 2100. It would be good not to give the impression that the temperature increase at 2100 is the total temperature increase.	Noted. But the time horizon of this Chapter is 2100.	Göran Finnveden	KTH Royal Institute of Technology	Sweden
47671	1				costs for all figures given in 2010 USD - Pls update to 2015 USD	Taken into account. Text will be revised.	raphael Slade	Imperial College	United Kingdom (of Great Britain and Northern Ireland)
1799	2	7	2	7	Specify sub-heads	Editorial. This will be addressed in the next draft.	Alka Bharat	Department of Architecture & Planning, M.A.National Institute of Technology (An Institute of National Importance),Bhopal (M.P.)	India
1801	2	8	2	8	shift "limited set of illustrative Pathways (Ips)" to sub-head 3.1.4	Editorial. This will be addressed in the next draft.	Alka Bharat	Department of Architecture & Planning, M.A.National Institute of Technology (An Institute of National Importance),Bhopal (M.P.)	India
1803	2	10	2	10	Reframe "Mitigation Pathways-Compatibility with Long-Term Goals"	Editorial. This will be addressed in the next draft	Alka Bharat	Department of Architecture & Planning, M.A.National Institute of Technology (An Institute of National Importance),Bhopal (M.P.)	India
1805	2	23	2	23	delete "supply"	Editorial. This will be addressed in the next draft	Alka Bharat	Department of Architecture & Planning, M.A.National Institute of Technology (An Institute of National Importance),Bhopal (M.P.)	India
1807	2	27	2	27	Sub-head 3.4.6 shift to 3.4.7- "Carbon Dioxide Removal Techniques"	Editorial. This will be addressed in the next draft	Alka Bharat	Department of Architecture & Planning, M.A.National Institute of Technology (An Institute of National Importance),Bhopal (M.P.)	India
1809	2	28	2	28	Swap with sub-head 3.4.6	Editorial. This will be addressed in the next draft	Alka Bharat	Department of Architecture & Planning, M.A.National Institute of Technology (An Institute of National Importance),Bhopal (M.P.)	India
1811	2	33	2	34	substitute 'reach' with 'limits'	Editorial. This will be addressed in the next draft	Alka Bharat	Department of Architecture & Planning, M.A.National Institute of Technology (An Institute of National Importance),Bhopal (M.P.)	India
1813	2	35	2	35	make sub-head 3.5.3 as 'long-term climate change and Emission goals'	Editorial. This will be addressed in the next draft	Alka Bharat	Department of Architecture & Planning, M.A.National Institute of Technology (An Institute of National Importance),Bhopal (M.P.)	India
31281	2	3			The high level scenarios IP1..IP5 should be used as a seamless quantification theme throught the whole report. A link should be provided between the High-level assessments (Chapters 2-4) and the Sectoral Chapters (5–12). This link should be established by discussing IP1..IP5 in the sectoral chapters! If no detailed enough data is available from IP1..IP5 then the sectoral chapters should set up detailed scenarios that can be linked to IP1..IP5. Otherwise, seeing IP1..IP5 in chapter 3 is nice, but the scenarios remain abstract if no quantification is made available that shows what they really mean in the sectoral chapters (and that shows how the differences between IP1..IP5 play out in the sectors!	Taken into account. IPs in FOD are preliminary. For SOD, a new set of IPs will be used.	Urs Ruth	Robert Bosch GmbH	Germany
1815	3	2	3	2	Replace 'avoiding' by 'Preventive, Curative and Adaptive'	Editorial. This will be addressed in the next draft	Alka Bharat	Department of Architecture & Planning, M.A.National Institute of Technology (An Institute of National Importance),Bhopal (M.P.)	India
1817	3	4	3	4	Replace 'Economies of reaching' by 'Opportunity Cost of achieving'	Editorial. This will be addressed in the next draft	Alka Bharat	Department of Architecture & Planning, M.A.National Institute of Technology (An Institute of National Importance),Bhopal (M.P.)	India

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26307	3	4	3	5	This may be just an error, but net-zero GHG emissions, rather than net-zero CO2 emissions, should be a more direct formulation of Article 4. The distinction between these two are sometimes not explicit or ignored, but it is important globally and for many countries whose CH4 emissions are significant relative to CO2 emissions.	Taken into account. Thank you. The distinction between these two concepts will be clearer in the next draft	Tanaka Katsumasa	Laboratoire des Sciences du Climat et de l'Environnement (LSCE), CEA, FRANCE; National Institute for Environmental Studies (NIES), JAPAN	France
1819	3	5	3	5	Reframe' Sustainable Development and Mitigating Impacts	Editorial. This will be addressed in the next draft	Alka Bharat	Department of Architecture & Planning, M.A.National Institute of Technology (An Institute of National Importance),Bhopal (M.P.)	India
44527	3	9	3	11	An example that referring to net zero can possibly lead to confusion. Here you highlight "carbon neutrality" while referring to PA Art 4.1 language (which is about GHGs, not CO2, which also means that while the quote is correct it is yet slightly misleading)	Taken into account. Thank you. The distinction between these two concepts will be clearer in the next draft	Oliver Geden	German Institute for International and Security Affairs	Germany
20265	3	12	3	13	"Stabilization of GHG concentrations." The notion of setting a limit on GHG concentration should be avoided in the report. Overshooting of concentrations is a desirable property of an optimal emissions path. This was shown by Lemoine, D., & Rudik, I. (2017). Steering the climate system: Using inertia to lower the cost of policy. American Economic Review, 107(10), 2947–2957.) and Mattauch, B. L., Matthews, H. D., Millar, R., Rezai, A., Solomon, S., & Venmans, F. (2020). Steering the Climate System : Using Inertia to Lower the Cost of Policy : Comment. American Economic Review, 110(4), 1–7. Although the climate model in Lemoine & Rudik is invalid, their argument that constraining CO2 concentrations rather than temperature is unnecessarily costly is valid (i.e. confirmed in the critique by Mattauch et al.). For this reason, limiting CO2 concentrations is almost never applied in the modelling community since more than a decade. Therefore, the IPCC should avoid future confusion by avoiding the notion of setting a limit on CO2 concentrations and using the term 'overshooting' only to trajectories that overshoot in temperature. (p12 line 32 is vague on overshoot)	Taken into account. Text will be revised.	Frank Venmans	UMons	Belgium
27899	3	13	3	13	Upon the first occurrence of 2 degrees and 1.5 degrees C, please specify which year this is relative to (e.g., is it 1750, 1850, 1900, 1920?). This makes a difference, particularly when discussing efforts to limit temperature rise to one of these two numbers.	Taken into account. The reference period 1850–1900 is used to approximate pre-industrial global mean surface temperature (GMST).	Mark Jacobson	Stanford University	United States of America
47699	3	17	3	20	The alternative approach proposed here seeks to replace taxes on carbon and other GHG emissions with an inherently dynamic, incentive-based strategy. This alternative proposal includes two interlocking components: 1) the first component consists of an excise duty applied on the extraction of fossil fuels and primary production of products with global warming potential (GWP) both synthetic and non-synthetic, including fluorocarbons and methane; 2) The second component involves a scalable refund that would make it possible to reclaim the excise duty levied upstream, in whole or in part. Refunds would be granted in exchange for a reduction in, or complete elimination of, emissions linked to the use of substances with a global-warming potential. Compared to the immediate sources of GHG emissions that are innumerable, there are indeed much fewer sources of extraction/production of GHG-emitting materials. Once adopted, the excise duty principle would be intrinsic in all participating countries and therefore more readily implemented.	Noted. Revised text will try to address these issues with literature to support.	Jacques de Gerlache	GreenFacts	Belgium
47701	3	17	3	20	As some 30 gigabarrels of oil are extracted each year, the excise duty on oil alone would generate at least \$300 billion.	Noted. Revised text will try to address these issues with literature to support.	Jacques de Gerlache	GreenFacts	Belgium
47703	3	17	3	20	<a href="https://www.euractiv.com/section/climate-environment/opinion/mondycop21-goals-an-alternative-path-to-success/">https://www.euractiv.com/section/climate-environment/opinion/mondycop21-goals-an-alternative-path-to-success/</a>	Noted. Revised text will try to address these issues with literature to support.	Jacques de Gerlache	GreenFacts	Belgium
17053	3	33	3	43	"in the absence of any new climate policies" is very theoretical. It may be useful for analytical purposes, but I wouldn't give it such a prominent position in the executive summary. Suggest to leave out entirely.	Taken into account. We will reconsider rephrasing for the next version of the ES	Kornelis Blok	Delft University of Technology	Netherlands
28431	3	49	3	49	Figure 3.31 quality is very low and unreliable, please be aware	Editorial. This will be addressed in the next draft	Matt Lewis	Bangor University	United Kingdom (of Great Britain and Northern Ireland)
14653	3		3		Somewhere should be mentioned that none of these pathways include climate impacts, and that any economic or demand shifts are purely assessed in absence of the compound effects of climate change, maybe with cross ref to appropriate WG2 chapters.	Taken into account. We will address this in the next draft	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
14659	3		8		The executive summary (ES) is lacking any reference to "evidence, agreement and confidence", the standard IPCC assessment indicators. This should be brought out in future iterations. Also, many ES statements describe characteristics found in the available pathways, but do not provide an assessment of the validity or usefulness of this information. For instance, the range across scenario is informative, but also our understanding of what makes a scenario end up at one end of the range is extremely useful. This could be further developed, particularly in light of the novel bias correction approach followed in the AR6. Furthermore, the ES starts out with highlighting several innovations in the scenario literature and its assessment (including the SSPs and the five IPs) but the rest of the ES does not make any reference to them. Either their introduction is hence unnecessary or more emphasis should be put on the insights derived with these assessment tools.	Taken into account. Confidence language will be included for SOD	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
33141	3		8		It should develop an international support framework how energy efficiency can be achieved in developing countries which are currently making rapid development changes resulting in greater emission in the near future	Taken into account.	Edris Alam	Rabdan Academy	United Arab Emirates
18829	3		83		From droughts to flooding rains and damaging frosts to heat waves, it is obvious that climate extremes are very important and must be considered in every society (Alex-ander 2016);	Taken into account.	Michael Ugom	University of Nigeria, Nsukka	Nigeria
18551	4	2	4	6	Surprisingly I think the opening statement may not actually be precise or even correct; see my general comments to the chapter. Some forms of modeling may indicate a difference between a global need to avoid carbon lock-in, combined with more focused efforts to drive innovation and transformation in specific countries, regions, or clubs of countries and companies of sufficient economic and technological weight to then diffuse globally. This may not sound like a major difference, but I think the message is important - one implies a framing in which the non-participation of any major country would essentially render the Paris goals impossible; the other, that what is needed is a critical mass, and that countries attempting to defer action may ultimately lose out for example in terms of greater stranded assets. See for example Paroussos, L., Mandel, A., Fragkiadakis, K. et al. Climate clubs and the macro-economic benefits of international cooperation on climate policy. Nat. Clim. Chang. 9, 542–546 (2019). <a href="https://doi.org/10.1038/s41558-019-0501-1">https://doi.org/10.1038/s41558-019-0501-1</a>	Taken into account. Rephrasing will be considered.	Michael Grubb	UCL - Institute of Sustainable Resources	United Kingdom (of Great Britain and Northern Ireland)
14629	4	2	4	11	The Paris Agreement includes many goals, not all of which are assessed in this Chapter. I suggest making specific for which goals this chapter assesses pathways (i.e. long-term temperature goal - note this is a singular goal, not a plural, the long-term mitigation goal, ...). Maybe the finance goal, but not the adaptation goal.	Taken into account. This will be considered for SOD	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)

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46463	4	2	4	11	The paragraph improperly claims action on climate change would be "unprecedented," which is misleading, since carbon emissions have been declining in developed nations for decades, not due to climate change. In Europe, emissions in 2018 were 23% below 1990 levels. In the U.S., emissions fell 15 percent from 2005 to 2016. The U.S. and Britain have seen their carbon emissions from electricity, specifically, decline by an astonishing 27 percent in the U.S. and 63 percent in the U.K., between 2007 and 2018. Most energy experts believe emissions in developing nations will peak and decline, just as they did in developed nations, once they achieve a similar level of prosperity. As a result, global temperatures today appear much more likely to peak at between two to three degrees centigrade over preindustrial levels, not four, where the risks, including from tipping points, are significantly lower. The International Energy Agency (IEA) now forecasts carbon emissions in 2040 to be lower than in almost all of the IPCC scenarios.	Taken into account. Rephrasing will be considered.	Michael Shellenberger	Environmental Progress	United States of America
30471	4	3	4	3	This BOLD section will be read as the 1.5C target is no longer possible. Is this what you imply? If not, can you quote the full sentence of the Paris Agreement, since you do refer to 1.5C later in the summary. Otherwise, the reader may assume emphasis is off 1.5C, at a time when urgency is critical.	Taken into account. Rephrasing will be considered.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
22371	4	4	4	4	Remove "takes a long-term perspective and" and add "from a long-term perspective" at the end of the sentence.	Editorial. This will be addressed in the next draft	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
14165	4	4	4	5	Please provide in brackets what do you mean by "long-term perspective", short and medium-term, e.g., "takes a long-term perspective (~2100)." or similar	Taken into account. Time horizons will be clearer in the next draft	Iñigo Capellán-Pérez	University of Valladolid	Spain
35935	4	6	4	6	replace "a more global view and on issues" with "a more global view as well as issues"?	Editorial. This will be addressed in the next draft	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
40949	4	8	4	11	suggest deleting "of carbon neutrality" since you introduce a similar but undefined concept to what you refer to later when you cite Art 4; i.e., "balance".	Taken into account. To be clarified in SOD	Jan Fuglestedt	CICERO	Norway
30067	4	9	4	9	"carbon neutrality" should be "climate neutrality" or net-zero GHG emissions; carbon neutrality means net zero CO2 emissions	Taken into account. Thank you. The distinction between these two concepts will be clearer in the next draft	Bert Metz	European Climate Foundation	Netherlands
4635	4	9	4	10	The double use of the term 'achieve' ('achieving' in line 9 and 'to be achieved' in line 10) sounds redundant.	Editorial. This will be addressed in the next draft	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
14631	4	9	4	10	To make this difference clear, it would be good to add a couple of more words of the Paris Agreement text and write: "a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases"	Accepted	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
35929	4	9	4	10	delete "achieving" or "would need to be achieved"	Editorial. This will be addressed in the next draft	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
39815	4	11	4	11	Readers would like to know what "long-term" refers to at the beginning of the chapter.	Taken into account. Time horizons will be clearer in the next draft	Hasegawa Toshihiro	National Agricultural and Food Research Organization	Japan
26091	4	12	4	12	It appears that this chapter does not deal with GHG concentrations. Stabilizing forcing does not necessarily limit warming anyway due to thermal inertia.	Accepted. We will rephrase it in the new version of the executive summary	Junichi Tsutsui	Central Research Institute of Electric Power Industry	Japan
40951	4	12	4	12	As far as I can see, you don't focus on stabilization of GHGs CONCENTRATIONS in the chapter. Please check and reformulate.	Accepted. We will rephrase it in the new version of the executive summary	Jan Fuglestedt	CICERO	Norway
24873	4	12	4	14	Mitigation pathways compatible with the long-term goals of the Paris Agreement should consider analysis in the context of sustainable development	Taken into account. This is addressed in section 3.7	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
30069	4	12	4	14	It is crucial to also mention that there are mitigation pathways that limit temp change to 1.5 C, as is clear from section 3.2; leaving it out could be interpreted as that this is no longer feasible.	Taken into account. We will try to make this clear in the SOD	Bert Metz	European Climate Foundation	Netherlands
16537	4	12	4	20	Introducing a category of mitigation pathways that would limit global mean warming to "well below 2°C" is starkly policy prescriptive. Any use of this category has to be avoided throughout the entire AR6. Therefore this is also a comment on the entire chapter and the entire WGIII report!  Rationale: For a majority of countries (106 Parties to the UNFCCC subscribed to the "Coalition of the ambitious" in the run-up to the Paris Agreement) "well below 2°C" means a limit of 1.5°C above pre-industrial levels. For all other countries it is unknown and not defined what "well below 2°C" means. That value may be understood by those Parties as falling in the range 1.5 .. 1.9, perhaps its upper end being even 1.99 (regardless whether this may sound cynical). Claiming in this report that we as scientists do know what that range is (e.g. Hof et al., 2017) becomes therefore normative ahead of what policy makers have discussed and therefore starkly policy prescriptive.  A category "below 2°C" understood as covering limits above 1.5°C and below 2°C (>1.5 .. <2) includes logically "well below 2°C" and is fine to introduce by AR6. Either you treat this entire interval as "below 2°C" or perhaps you could split this interval somewhere arbitrarily – there is some value for policy making in distinguishing the lower limit part of that interval from the upper limit part. Say you split it in the middle, you could speculate somewhere that the first half of this interval could perhaps be used by policy makers as a rough proxy for "well below 2°C", but you would need to stress the arbitrary nature of such a choice and disclaiming any consistency with Paris Agreement goals and use a policy neutral terminology to describe such a category of scenarios. In general any claim by IPCC to know what "well below 2°C" means must not be made. It preempts and prejudices the outcome of a heavy and contentious policy making process. That process may well not start before the first Global Stock Take, i.e. 2023, when the entire AR6 is already published. And the outcome of that may even come later if at all. Given this situation, AR6 must remain fully policy neutral.  Cited References: ----- Hof, A. F., M. G. J. den Elzen, A. Admiraal, M. Roelfsema, D. E. H. J. Gernaat, and D. P. van Vuuren, 2017: Global and regional abatement costs of Nationally Determined Contributions (NDCs) and of enhanced action to levels well below 2 °C and 1.5 °C. Environ. Sci. Policy, 2 https://doi.org/10.1016/j.envsci.2017.02.008	Taken into account. Text will be revised and references to "well below 2C" will be removed.	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
31159	4	12	4	20	Make reference to the 1.5°C goal.	Taken into account. We will try to make this clear in the SOD	Urs Ruth	Robert Bosch GmbH	Germany
39813	4	12	4	20	This statement sounds like it is easy to limit the temperature change to well below 2 degrees. Is this true?	Taken into account. We will consider rephrasing for SOD	Hasegawa Toshihiro	National Agricultural and Food Research Organization	Japan



Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
26981	4	12	4	32	This introduction seems very defensive. I don't think a defense of IAMs should be the first thing discussed. There are other powerful statements made in the Executive Summary. And these are important statements that can only be made via an analysis of IAMs. (Page 5 lines 25 to 42 would be a better way to start this discussion) Defend/critique IAMs in the text later on in the chapter. I wouldnt put it in the Executive Summary.	Taken into account. In the next version of the executive summary, we will try to shift the focus	Thomas Longden	Australian National University	Australia
37175	4	13	4	13	change "limit temperature change to 'well below 2°C' compatible with the long-term goals of the Paris Agreement" to "limit temperature change to 'well below 2°C' and represent efforts to limit warming to 1.5°C compatible with the long-term goals of the Paris Agreement" This addition adds information that reflects more completely the library of pathways and more fully the compatibility with the Paris Agreement	Taken into account. Rephrasing will be considered.	Michiel Schaeffer	Climate Analytics	Netherlands
10091	4	16	4	20	It is fine to explain the general description of pathways that are not predictions or forecasts, but to support policy relevance, it is important to relate these non-predictive pathways back to scenarios that are used in the energy policy community such as the IEA Current Policies scenario, so there needs to be an explicit comparison in some way here to actual 'baseline' forecasts that are extensions of today's energy system, as well as a relevant treatment of uncertainties. Otherwise this becomes a very abstract academic scenario exercise where the policy community will look for a forecast when there isn't one.	Taken into account. Text will be revised.	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
14167	4	17	4	17	"Pathways are generally 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 (such as demographic and socio-economic development, technological change, energy and land use) and their key relationships"  However, most IAMs do not consider climate change impacts, especially those used for exploring detailed energy transitions at sectoral level (cf. Diaz & Moore 2017; Dietz & Stern 2015). Also, It is extremely surprising that the variable which is identified as the most important driver of GHG emissions in Chapter 2 is considered as exogenous in climate scenarios (economic growth; another important socioeconomic driver, population, is also exogenous). This requires a nuancing.  Diaz, D., Moore, F., 2017. Quantifying the economic risks of climate change. Nature Climate Change 7, 774–782. Dietz, S., Stern, N., 2015. Endogenous Growth, Convexity of Damage and Climate Risk: How Nordhaus' Framework Supports Deep Cuts in Carbon Emissions. The Economic Journal 125, 574–620.	Taken into account. Nuancing and the description of the limitation of IAMs will be improved	Iñigo Capellán-Pérez	University of Valladolid	Spain
24109	4	19	4	19	insert "inter" before "relationships"	Editorial. This will be addressed in the next draft	Alfred Ofoosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
10093	4	21	4	32	It is unclear as to why this illustrative pathways approach is chosen as a core part of this chapter's structure when (i) there was such an extensive multi-year effort to develop the SSP scenarios as a basis for CMIP6 and the research to support other working groups, and (ii) a descriptive analysis of the AR6 WGIII scenario database could provide more useful insights. Otherwise, the IPs seem arbitrary rather than an extension of the considerable research that informs the full scenario database.	Illustrative pathways will be expanded, improved and further detailed. They will provide a good representation of the AR6 database	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
10095	4	21	4	32	There are further issues with the IP approach as currently employed because there is only a single baseline case representative of a fossil intensive baseline from the CD-Links MESSAGE scenario (where total fossil fuel use more than doubles by 2100). The SSP scenario exercises usefully articulated more 'middle of the road' baselines such as those produced under the SSP4/SSP1 trajectories that would bridge the current large gap between IP1 and the other IPs. Therefore, it is recommended that if WGIII moves forward with using illustrative pathways there are at least two baseline IPs (something similar to the current IP1 and an IP2 that is a more middle of the road baseline) alongside the 2' and 1.5' IPs. However, I hesitate to even recommend this because it would also be confusing in the context of current pledges, so it seems like there also needs to be a 'no new climate policies' (NPI) illustrative pathway for this scenario framework to be useful and relevant.	Taken into account. The IP selection was updated after FOD. There will be an IP associated with NPI	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
41407	4	21	4	32	A concise listing of the methods and assumptions used to select 5 out of 900 emission pathways is needed.	Taken into account. The IP selection was updated after FOD and will be much more detailed in SOD	Cheah Singfoong	Independent consultant, formerly more than 10 years with the National Renewable Energy Laboratory, USA	United States of America
46979	4	21	4	32	Caveats should be inserted about the limitations of the models, and assumptions reflected in the models that are used to produce the emissions pathways - and hence about the emissions pathways and their features. A non-expert audience must be told that the pathways are subject to fundamental caveats.	Taken into account. Better view on the limitations of the models will be provided	Frank Jotzo	ANU	Australia
11415	4	21	4	43	The first paragraph here talks about IPs and the second about SSPs but it is not explained how the two link to each other. Briefly explain here in the summary why different pathways are needed.	Taken into account. The IP selection was updated after FOD and will be much more detailed in SOD	Thomas Wiedmann	UNSW	Australia
14169	4	24	4	24	"input assumptions and parameters, and model structures"  Model structures are also derived from assumptions, please rephrase.	Editorial. This will be addressed in the next draft	Iñigo Capellán-Pérez	University of Valladolid	Spain
30071	4	26	4	28	This is more important statement than the current headline. Move it up to become the headline. The current headline is good as explanatory text.	Editorial. This will be considered in the new version of the executive summary	Bert Metz	European Climate Foundation	Netherlands
25509	4	28	4	32	Why no pathways reflecting a warming of ~3°C? Or the equivalent of the NDCs?	Taken into account. The IP selection was updated after FOD. There will be an IP associated with this temperature range	Sarah Connors	IPCC WGI TSU	France
14633	4	29	4	29	The use of the word "baseline" might be reconsidered here. Does this mean that IP1 is the chapter's best assessment/estimate of baseline emissions in absence of further climate policies? A bit more specific wording can make this unambiguous.	Taken into account. The distinction will be made in the next draft, as the number of IPs will increase	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
45669	4	31	4	31	indicate by when the temperature targets need to be achieved.	Taken into account. More details on timing are provided over the chapter	Machteld van den Broek	Utrecht University	Netherlands
1329	4	33	4	33	The term "in the absence of any new climate policies," can have various interpretations and I assume that the authors now implicitly assume that the long-term goals of Paris Agreement is not the new climate policies but can be.	Taken into account. Clarity will be improved and the IP selection will be further detailed	Shinichiro Fujimori	Kyoto University	Japan
10157	4	33	4	34	Similarly to the brackets on Energy (line 41) would be good to include from what current levels global emissions "may increase to 65 to 95 GtCO <sub>2</sub> -eq yr by 2050"	Editorial. This will be considered in the new version of the executive summary	Aglaia Obrekht	Environment and Climate Change Canada	Canada
14635	4	33	4	35	Ensure full consistency with WG1 assessment, and indicate whether this is the variation of median projections as a result of scenario uncertainty or a combination of scenario and geophysical uncertainty.	Taken into account. Clarity will be improved in this sense	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
39817	4	33	4	35	GHG emission is estimated by 2050, but the projected temperature increase is by the end of the century. Please use consistent time frames.	Taken into account, but that is why a range is given. Anyway, consistency will be improved for SOD	Hasegawa Toshihiro	National Agricultural and Food Research Organization	Japan
45665	4	33	4	38	What does 'compared to AR5' mean? Does it mean that new SSPs are developed since AR5, but similar to the SSPs in AR5?	It means that the analysis is more robust than in AR5. SSPs were not present in the AR5, they were developed in recent years	Machteld van den Broek	Utrecht University	Netherlands
46981	4	33	4	41	The highlighted key results for emissions and temperature outcomes under "existing policies" scenarios are implausibly high. The assumed global GDP growth range of 3.3-4.3% pa (2015-2050) is implausible high, it is also far too narrow a range to given the many uncertainties about future economic growth.	Taken into account, but please notice that the values for emissions come from the scenarios database (which will be updated)	Frank Jotzo	ANU	Australia

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
10097	4	33	4	43	The framing used in this summary item is confusing, because it is not straightforward how the global average temperature increase in 2100 is related to emissions in 2050. Therefore it would better to either use a comparison to cumulative emissions levels, (i.e. would use 40-70% of the cumulative emissions associated with 2.0°, and 20-50% of the cumulative emissions associated with 2.5 °C etc...). Or, this section could state something along the lines of, "If emissions continued growing at these rates from 2050-2100 then they would lead to 3.5 °C to 4.5 °C".	Accepted. This will be clarified	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
10099	4	33	4	43	It seems like a summary line item is needed to explicitly review findings associated with, "no new policy" type scenarios like those labeled NPI. Currently it seems as if no policy baselines are being included alongside no new policy baselines. Or if this is not the case it needs to be made clearer.	Accepted. This will be made clearer. The improvements taking place between FOD and SOD include a better categorization of scenarios and illustrative pathways	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
14171	4	33	4	43	"In the absence of any new climate policies, GHG emissions may increase to 65 to 95 GtCO <sub>2</sub> -eq yr <sup>-1</sup> by 2050, resulting in a global average temperature change of 3.5 to 4.5 °C by the end of the century (depending on the emission pathway)"  This is simply due to the fact that most IAMs and especially those used to run the SSPs do not consider climate impacts consistently with the state-of-the-art, cf. Capellán-Pérez et al 2020, please nuance or rephrase.  Diaz, D., Moore, F., 2017. Quantifying the economic risks of climate change. Nature Climate Change 7, 774–782. Dietz, S., Stern, N., 2015. Endogenous Growth, Convexity of Damage and Climate Risk: How Nordhaus' Framework Supports Deep Cuts in Carbon Emissions. The Economic Journal 125, 574–620. Capellán-Pérez, I., Blas, I. de, Nieto, J., Castro, C. de, Miguel, L.J., Carpintero, Ó., Mediavilla, M., Lobejón, L.F., Ferreras-Alonso, N., Rodrigo, P., Frechoso, F., Álvarez-Antelo, D., 2020. MEDEAS: a new modeling framework integrating global biophysical and socioeconomic constraints. Energy Environ. Sci. <a href="https://doi.org/10.1039/C9EE02627D">https://doi.org/10.1039/C9EE02627D</a>	Taken into account. This reference will be considered in the new draft.	Iñigo Capellán-Pérez	University of Valladolid	Spain
14173	4	33	4	43	"Main emissions drivers include population growth, reaching between 8.5-10 billion people by 2050, and the increase in the global GDP of 3.3-4.3% per year between 2015 and 2050"  This is highly misleading: it is customary to put the most important factor first, so here please put global GDP in first position to avoid giving the impression (maybe unintended but still worrying) that population is the main driver of emissions globally.	Taken into account. We will consider rephrasing it for SOD	Iñigo Capellán-Pérez	University of Valladolid	Spain
3203	4	34	4	35	The following information lacks clarity: resulting in a global average temperature change of 3.5 to 4.5 °C by the end of the century. This is because the base year for the temperature change has not been included in this information. It is suggested to clarify that the change in temperature refers in comparison to preindustrial level.	Taken into account. Clarity will be improved	Klaus Radunsky	retired from Umweltbundesamt	Austria
35613	4	34	4	35	Which year is the temperature increase compared to?	Pre-industrial levels. Clarity will be improved	Göran Finnveden	KTH Royal Institute of Technology	Sweden
30073	4	35	4	35	after "century" add "and rising thereafter"	Editorial. This will be considered in the new version of the executive summary	Bert Metz	European Climate Foundation	Netherlands
14637	4	35	4	38	This would be a statement I would expect in Chapter 1 where a framing is provided. Here I would expect assessment insights using this new framing and analytical tools. Consider moving this to Chapter 1 in order to streamline and prioritize assessment insights in the Chapter 3 ES.	Taken into account. We will coordinate with chapter 1	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
30075	4	35	4	43	This text reads as explanatory text for the SSPs. Does not fit here. Move to previous paragraph.	Editorial. This will be considered in the new version of the executive summary	Bert Metz	European Climate Foundation	Netherlands
27649	4	38	4	38	The link between the first two sentences is unclear. The SSPs are not defined and poorly distinguished from the just introduced IPs.	Taken into account. Clarity and coherence will be improved	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
10159	4	38	4	39	Similarly to the brackets on Energy (line 41) would be good to include from what are the current levels of population.	Taken into account. We will consider adding this information	Aglaia Obrecht	Environment and Climate Change Canada	Canada
32321	4	39	4	39	Will these GDP predictions be affected by current developments (i.e. virus)? How will the models capture that? Some text to touch on that here would be useful.	Accepted. Comments on the issue of COVID will be included, although they will not be the focus of the chapter	Penny Apostolaki	Barclays	United Kingdom (of Great Britain and Northern Ireland)
2695	4	41	4	43	The sentence: [Note that all climate estimates are still preliminary and will be updated using the most recent methodologies from WGI], I think needs a consideration. After WGI publishes the data, it needs to be placed in the report.	Accepted. The climate estimates have been updated and the sentence will be removed	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
14639	4	41	4	43	It is very encouraging to see this kind of integration taking place.	Thank you	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
40953	4	44	4	45	But the differences between pathways also depends on socioeconomic conditions, not only mitigation level.	Taken into account. We will consider adding this information	Jan Fuglestedt	CICERO	Norway
26983	4	44	4	46	A peak during the 21st century? This isn't very precise? Can a range of years/decades be used? Or remove and elevate the text on page 5 lines 1-3.	Taken into account. Rephrasing will be considered.	Thomas Longden	Australian National University	Australia
10101	4	44	5	3	This line item is briefly summarizing the general scenario characteristics but it would be more useful and clearer if there was also a statement in this line item or somewhere in the Chapter 3 executive summary about what happens in scenarios where fossil fuel combustion continues growing unabated as in the IP1, i.e. that they go above 3°C. Or, if this line item is trying to say that it is specifically focused on mitigation scenarios then it needs to more clearly say that, however, there are also large differences between emissions pathways irrespective of mitigation levels, as shown by the span between SSP5 and SSP1 baselines.	Taken into account. This will be made clearer, especially with the new illustrative pathways	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
14641	4	44	5	3	"Well below 2°C" needs to be defined in the ES for the numbers in the ES to be understandable. Please include such a description at the first occurrence of the use of the term in the ES.	Accepted. Text will be revised.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
30077	4	44	5	3	This paragraph should be deleted, as it discusses pathways above the Paris goals range. That distracts from the key issues. In addition, introducing C1, C3 requires explanation.	Taken into account. Explanation of the categories will be provided	Bert Metz	European Climate Foundation	Netherlands
16539	4	47	5	1	You can't claim to know what "well below 2°C" means. Simply mention all categories, e.g. C1, C2 etc., i.e. all that limit warming to 2°C and delete phrase "well below 2°C" by writing below 2°C. See for details my previous comment on "well below 2°C".	Taken into account. Text will be revised.	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
37177	4	47	5	1	"well below 2°C" can be used for categories C1 and C2, but not for C3 (see 1st comment).	Taken into account. Categorization will be clearer and rephrasing will be considered	Michiel Schaeffer	Climate Analytics	Netherlands
3205	4	1	8	20	The executive summary should contain some information related to the approach used in chapter 3. The introduction to chapter 4 clarifies that Chapter 3 is working backward from the long-term goals, including temperature, and assesses mitigation in the long-term (beyond 2050 up to 2100 or even 2300) to draw the near- and mid-term implications of long-term temperature and mitigations goals.	Taken into account. We will consider the addition of this information	Klaus Radunsky	retired from Umweltbundesamt	Austria
39811	4	1	8	20	There is no confidence language for any of the statements. Please provide. It would also be nice to know new findings from SR15.	Taken into account. Confidence language will be included for SOD	Hasegawa Toshihiro	National Agricultural and Food Research Organization	Japan

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
46991	4	1	8	20	Conveying uncertainty and limitations of IAM modelling assumptions: The summary, and also the chapter text, should place far more emphasis on uncertainty in assumptions about technology, future economic growth and structure, emissions trajectories and temperature outcomes. As is, the text creates the impression that we know to a high degree of reliability how the future will play out - we do not. The text should flag that IAMs tend to present trajectories that are internally consistent but may not accord with how economies and technologies work and will develop in future. This is crucial in order for non-modellers to be able to judge the reliability and proper use of the data and storylines provided.	Taken into account. For SOD, we will improve the text so it places emphasis on this uncertainty;	Frank Jotzo	ANU	Australia
30065	4	1	8	22	Overall comment: it is unhelpful to focus on emission reductions by the end of the century. The point of net zero (2050 for CO2 for 1.5C, 2070 for all GHGs for 1.5C) is much more relevant. It is also not helpful to mention the numbers for higher warming scenarios then for the "well below 2/ 1.5" Paris goals. This distracts from what the goal is. Unfortunately many paragraphs are vague about what temperature goal scenarios the numbers relate to. This needs to be changed.	Taken into account, clarity will be improved	Bert Metz	European Climate Foundation	Netherlands
41405	4	2	8	20	Consider including some figures to illustrate the points. Listing numbers after numbers does not clearly present the messages.	Figures are provided in the expanded chapter. In principle, there will be no figures in the executive summary	Cheah Singfoong	Independent consultant, formerly more than 10 years with the National Renewable Energy Laboratory, USA	United States of America
47029	4	1	65	10	The chapter should step back some way from its close adherence to the output from IAMs. In its synthesis and assessment, the chapter needs to step beyond the assumptions that IAM modellers choose to make. It needs to explain that IAM scenarios are a tool to understand future possibilities, and are not reliable predictions of the future. In many parts, the chapter simply summarizes/recounts what is in IAM scenarios and then presents this, implicitly or explicitly, as a best guess of what will happen. The chapter also needs to put uncertainty far more centrally. Projections are often provided in very narrow intervals that imply that there is little uncertainty about the future (eg range of 3.3% to 4.3%pa global GDP growth to 2050 as highlighted in the summary). The fact that IAM model assumptions cluster in a narrow range does not mean that we have confidence that the natural systems, technologies and economies will develop in such particular ways.	Taken into account. For SOD, we will improve the text so it places emphasis on this uncertainty.	Frank Jotzo	ANU	Australia
41567	4	1			The executive summary lacks a description of IAMs, including their strengths and limitations. This is crucial for the readers' ability to interpret the results that are presented throughout the chapter and should therefore appear in the summary. This does not need to be lengthy, but should introduce the core aspects of IAMs. (The first description of IAMs does not appear until page 13 (section 3.2.1)).	Taken into account. We will consider adding a more detailed description in the next version of the ES	Ida Andrea Braathen Sognaes	CICERO centre for international climate research	Norway
19763	4	2		11	This is a good introduction to the chapter.	Thank you	Nathan Gillett	Environment and Climate Change Canada	Canada
45507	4	2		11	Reduction of Greenhouse Gas (GHG) emissions consistent with the long-term goals of the Paris Agreements will require unprecedented efforts from all sectors across the world. ( Strongly agreed).	Taken into account. Confidence language will be included for SOD	Abiodun Adegoke	Samsung electronics West Africa	Nigeria
19765	4	8			I suggest using a word other than 'reduce' here, since any reduction in emissions will reduce the effects of climate change, but this sentence is talking about deep mitigation pathways that limit climate change to Paris goals. Perhaps 'limit', or 'limit climate change consistent with the Paris Agreement' or similar.	Taken into account. We will consider rephrasing it for SOD	Nathan Gillett	Environment and Climate Change Canada	Canada
19767	4	26		32	Is there any relationship between these IPs and the SSP scenarios?	The IP selection is being improved for SOD but, yes, they're based on the combination of different SSPs and emission targets.	Nathan Gillett	Environment and Climate Change Canada	Canada
31161	4	31			Chose ambition level for IP2&4 such to stay *well* below 2°C.	IPs will be improved and further detailed for SOD	Urs Ruth	Robert Bosch GmbH	Germany
45541	4	33			Please explain the origin of these ranges in quoted emissions, temperatures etc. are these uncertainties, or do they correspond to different SSPs etc?	Taken into account. Clarity will be improved	Daniel Crow	International Energy Agency	France
19769	4	34		35	The uncertainty in projected warming is not only because of the emissions pathways, it is also because of the uncertain transient sensitivity of the climate system. Is uncertainty in climate sensitivity accounted for in this estimate? Also writing 'global average temperature change by the end of the century' makes it sound as if these are warming levels for the end of the century relative to present day, but I think these are relative to pre-industrial - I suggest clarifying this.	Taken into account. Text will be clarified and transient sensitivity will be mentioned	Nathan Gillett	Environment and Climate Change Canada	Canada
35615	5	1	5	1	What are categories C1 and C#?	C1 and C3. This will be corrected for SOD.	Göran Finnveden	KTH Royal Institute of Technology	Sweden
45667	5	1	5	1	C1 and C3 are not known yet.	Accepted. This will be corrected for SOD	Machteld van den Broek	Utrecht University	Netherlands
10787	5	1	5	3	It would be helpful if readers know by when emissions must peak for the case of 1.5 degree shown in the Paris Agreement.	Taken into account. We will add this information	Mitsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
30079	5	4	5	5	a probability level needs to be attached, specifying a % chance of staying below a specific temperature level. "well below 2C" is too vague	Taken into account. Text will be made more precise	Bert Metz	European Climate Foundation	Netherlands
37179	5	4	5	5	normative (wrong) use of "well below 2°C" label - see 1st comment - change to correct use such as same page line 13, lines 28-29 and line 43	Taken into account. Text will be made more precise	Michiel Schaeffer	Climate Analytics	Netherlands
18553	5	4	5	6	up to 50GtCO2/yr by 2030 may appear in some models with no significant representation of inertia but these do not strike me as empirically plausible or remotely optimal trajectories. See my comment on exec sum p.5 line 31 below	Taken into account.	Michael Grubb	UCL - Institute of Sustainable Resources	United Kingdom (of Great Britain and Northern Ireland)
10789	5	4	5	9	As this chapter discusses long-term mitigation pathways compatible with Long-Term Goals, emissions in 2100 for both well-below 2 degree and 1.5 degree should be shown (both in gross and net emissions).	Taken into account.	Mitsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
2949	5	4	5	10	Cost-effective mitigation pathways are special set of all mitigation pathways. Should first say the ranges for all mitigation pathways of GHGs emissions and then focus on cost-effective ones. Also are the scenarios on lines 7-10 are cost-effective or all scenarios attempting to limit temperature to below 1.5C?	Taken into account. Text will be revised.	Mustafa Babiker	Aramco	Saudi Arabia
10791	5	4	5	10	Add after line 10 that "cost-effective mitigation pathways means to introduce uniform carbon pricing for all countries, including both developed and developing countries. In this sense, it may be rather optimistic this (uniform carbon pricing) to be realized by 2030, and in this case mitigation pathways may turn to be more mild reductions at first and more rapid reductions at later years.	Taken into account. Text will be revised.	Mitsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
16541	5	4	5	10	You can't claim to know what "well below 2°C" means. See for details my previous comment on "well below 2°C".	Taken into account. Text will be revised.	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
80	5	5	5	5	30-50 Gt-CO2eq yr-1 should be "30-50 Gt-CO2eq" ?	Taken into account. Text will be revised.	Govindasamy Bala	Indian Institute of Science	India
45671	5	7	5	8	"below 1.5" ?	Taken into account. Text will be revised.	Machteld van den Broek	Utrecht University	Netherlands
30081	5	7	5	9	It is a bad idea to only discuss 1.5C pathways in underlying text. Move it to the next paragraph that is about meeting the 1.5C target	Taken into account. Text will be revised.	Bert Metz	European Climate Foundation	Netherlands

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
27901	5	8	5	10	The pace of transformation for limiting temperature rise to 1.5 C should be 60-80% by 2030 and 80-100% by 2050, not 50-70% by 2030, 70-100% by 2050. The 80% by 2030 requirement is discussed on pages 117-118 of Jacobson, M.Z., M.A. Delucchi, Z.A.F. Bauer, S.C. Goodman, W.E. Chapman, M.A. Cameron, Alphabetical: C. Bozonant, L. Chobadi, H.A. Clonts, P. Enevoldsen, J.R. Erwin, S.N. Fohj, 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 <a href="http://web.stanford.edu/group/efmh/jacobson/Articles/I/CountriesWWS.pdf">http://web.stanford.edu/group/efmh/jacobson/Articles/I/CountriesWWS.pdf</a> . In addition, the IMF scenarios used to estimate the 50-70% number are based on the wrong assumptions that CCS and nuclear and DAC will help when this is incredibly improbable (with respect to CCS and DAC, please see 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; with respect to nuclear, please see <a href="https://web.stanford.edu/group/efmh/jacobson/Articles/I/NuclearVsWWS.pdf">https://web.stanford.edu/group/efmh/jacobson/Articles/I/NuclearVsWWS.pdf</a> ). Because new CCS, DAC, and nuclear will be no help at all prior to 2030 (due to the CO2 benefit of CCS and 10-19-year time-lag between planning and operation for nuclear), it will be necessary for more renewables to fulfill the gap (thus at least 80% by 2030) to avoid 1.5 C warming.	Taken into account. Text will be revised.	Mark Jacobson	Stanford University	United States of America
24113	5	9	5	9	replace "in" with "by". It puts the sentence in the right perspective.	Taken into account. We will consider rephrasing it for the next version of the executive summary	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
82	5	11	5	11	"CO2 emissions" should be "cumulative CO2 emissions" ?	Rejected. It refers to annual CO2 emissions	Govindasamy Bala	Indian Institute of Science	India
30083	5	11	5	11	Why only use a 50% probability level? The 66% probability level is also very policy relevant	Taken into account. Text will be revised.	Bert Metz	European Climate Foundation	Netherlands
30473	5	11	5	11	Why CO2 specific for the 1.5C? Would this confuse the policy maker, to refer to GHG in other sections, and here only CO2?	Taken into account. We will consider referring to GHG	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
35029	5	11	5	13	Delete the phrase which reads "a warming limit of 1.5°C..." completely and insert the phrase which reads "a warming limit of 2°C (66% probability) after the phrase "in terms of CO2 emissions". The philosophy behind this suggestion is the necessity of concentration on "well below 2°C" as target of the PA.	Rejected. The sentence refers to 1.5C scenarios	Taghavinejad Ehsan	NIOC	Iran
2951	5	11	5	14	To provide meaningful comparisons limit the comparison to the same probability range for both 1.5c and 2.0C warmings, i.e. either the 50% or the 66%.	Taken into account. We will consider this for the next version of the ES	Mustafa Babiker	Aramco	Saudi Arabia
10793	5	11	5	14	I don't understand what figures in brackets mean. For example do 2080 and 30GtCO2 apply for 55% probability and 2070 and 40GtCO2 apply for 66% probability?	Taken into account. Text will be revised.	Mitsutsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
26985	5	11	5	14	This is a strong statement!! Elevate it to the first part of the executive summary. Can you compare the limit of 30 GtCO2 in 2030 to the 2020 level? And make the carbon neutral statement stronger. That's neutrality across the globe, not just in first mover countries.	Taken into account. Text will be revised.	Thomas Longden	Australian National University	Australia
25511	5	11	5	30	There seems to be an overlap / duplication of information in Section 3.3 and 3.5. As two executive summary paragraphs cover carbon budgets	Taken into account. We will improve the text and avoid this duplication for SOD	Sarah Connors	IPCC WGI TSU	France
46983	5	12	5	25	"Carbon neutrality": better to avoid this somewhat confusing term; at a minimum define it clearly. (Is it net zero CO2? Net zero GHG? Also potential for confusion with "offsets" as "carbon neutral" is frequently used for organisations that offset their emissions) It is defined casually on p54111.	Taken into account. The distinctions between these two concepts will be clearer in SOD	Frank Jotzo	ANU	Australia
3157	5	13	5	14	Re: "A warming limit of 2°C (66% probability) implies carbon neutrality until 2080 (2070) for up to 30 (up to 40) GtCO2 in 2030". It does not sound reasonable that carbon neutrality could be achieved earlier in 2070 with higher emissions in 2030 (up to 40 GtCO2). Please clarify. The Section referenced should be 3.5 instead of 3.3.	Taken into account. Text will be revised.	Sai Ming LEE	Hong Kong Observatory	China
24635	5	13	5	14	The numbers in the parenthesis seem to be the case of 66% probability. It is not clear what case the numbers out of the parenthesis represent.	Taken into account. Text will be revised.	Young-Hwan Ahn	Sookmyung Women's University	Republic of Korea
30085	5	13	5	14	adding text on 2C pathways in a 1.5C paragraph does not make sense. remove it.	Taken into account. Text will be revised.	Bert Metz	European Climate Foundation	Netherlands
37181	5	13	5	14	very confusing use of brackets and pathway categories to an extent that makes the findings incomprehensible	Taken into account. Text will be revised.	Michiel Schaeffer	Climate Analytics	Netherlands
14643	5	15	5	15	"Transient" is unnecessary here. Also, more precise would be to indicate that it is the "remaining CO2 budget" (consistent with terminology in WG1 Chapter 5 Section 5), and that this runs from "today" (or any other specific start date) up to the time when net zero CO2 emissions are achieved.	Accepted. Terminology will be harmonised for SOD	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
14149	5	15	5	24	As said in the report elsewhere ("The volumes of CDR deployment assumed in IAM-based global emissions mitigation scenarios are significant if compared to current volumes of deployment, given that the feasibility of rapid and sustained upscaling is uncertain" I1p15 Chapter 12), there are many uncertainties with relation to the feasibility of large-scale CDR deployment in the future, hence when referring to them it is crucial to keep always this in mind. It has to be said, and the tense of the verb should be switched to conditional instead of present to avoid giving a sensation of certainty.  Please consider rephrasing (MODIFICATIONS IN CAPS LOCK), distinguish between potential impacts and eventual availability:  "The use of CDR technologies MAY allow for somewhat lower reductions in carbon emissions in the short-term. HOWEVER, THESE METHODS HAVE STILL NOT BEEN TESTED AT LARGE SCALE, MOREOVER, IN CASE OF AVAILABILITY, THEY MAY lead to considerable challenges with respect to land-use and issues related to timing of effort"	Taken into account. In the next draft, we will consider rephrasing to include this	Iñigo Capellán-Pérez	University of Valladolid	Spain
30087	5	15	5	24	This paragraph, and particularly the headline is incomprehensible. What is the point here? I suspect the idea is to explain the role of CDR before and after the point of net-zero emissions (in the short to medium term versus the long term. That is indeed relevant, as the message to policy makers is to implement CDR early on in order to avoid having to rely on huge amounts of CDR later. But then explain that properly, with the help of a graph	Taken into account. Clarity will be improved	Bert Metz	European Climate Foundation	Netherlands
14645	5	18	5	18	This is a confusing statement, as net zero CO2 will already lead to reducing concentrations and this statement suggests that without net negative CO2 emissions this would not be the case. One can either remove the reference to concentrations for clarity, or otherwise correct this to read: "(in order to speed up the natural reduction of atmospheric CO2 concentrations and therewith try to bring back temperatures below specific thresholds after an overshoot)"	Taken into account. Text will be revised.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
40955	5	19	5	19	I suggest you add a definition of "radiative forcing" the first time used. And be aware of the new concept used in WGI, which is "effective relative forcing". This new concept should be mentioned and explained somewhere in the chapter for clarification and consistency. (This is also an issue for the use of emulators / simple climate models; e.g., ERF is used in FaIR)	Taken into account. We will consider adding a definition.	Jan Fuglestedt	CICERO	Norway
14647	5	21	5	22	This appears a flawed statement to me. Unless this statement can be quantified and is accompanied by a confidence statement, it should be removed. The statement is also too strongly rooted in modelling speak without adequate assessment. What the statement is trying to say is that if CDR technologies are assumed to become successfully available in the next one to two decades, cost-optimal emission pathways as modelled in IAMs would delay some of the near-term emissions reductions to later. If this statement would be applied to reality it sounds entirely unlogical: if CDR technologies would be available and used today, they would arguably lead to stronger emissions reductions in the short term.	Accepted	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
10795	5	21	5	24	important point. Keep this sentence.	OK. Thank you	Mitsutsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11417	5	22	5	24	"However, it also leads to considerable challenges with respect to land-use, reliance on methods that have not been tested at large scale and issues related to timing of effort. (3.3)" > aren't costs a major challenge as well?	Yes. We will consider adding the word "costs" to the sentence	Thomas Wiedmann	UNSW	Australia
14649	5	25	5	30	like the clarity and the usefulness of the information in this statement, but am confused by the brackets and numbers. If 2040 corresponds to limiting warming to 1.5°C with 50% probability, what does 2050 correspond to? And why isn't that stated explicitly? Careful editing would could make this much better.	Taken into account. Clarity will be improved	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
14657	5	25	5	30	Please also include and contrast the information for when net zero GHG emissions are reached in these scenarios.	Taken into account. This information will be provided	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
26987	5	25	5	42	This is what I want to see up front. This is excellent and highly relevant discussion about how current policies are inadequate and must be emphasised. Statements about the limitations of IAMs should happen after the key results. For me, these are the key results of this chapter and are the types of results/analysis that IAMs are designed/suitable for. Elevate this!! It took me 1.5 pages to get hooked.. Thats much too late in an executive summary!!! I understand the need for a balanced discussion of IAMs, however, these clarifications should happen elsewhere and not spoil the Exec Summary.	Taken into account. Thank you. We will consider mentioning it earlier in the ES	Thomas Longden	Australian National University	Australia
30089	5	26	5	26	temperature goals are interpreted as peak warming limits. But that is not what the Paris Agreement text says. The Paris Agreement goals formulation does allow some overshoot of temperature, in my opinion. As most scenarios to stay below 1.5C do have some overshoot, it would be totally inconsistent and incredible to interpret the Paris 1.5 goal differently. Peak warming cannot exceed the ultimate temperature goal too much however, because doing so would require infeasible amounts of CDR. That is exactly the reason why in th SR 1.5 the low-or no-overshoot scenarios were use to provide policy relevant information. So the peak warming limit is a consequence of the need to stay below the Paris temperature limits by the end of the century	Taken into account. Text will be revised.	Bert Metz	European Climate Foundation	Netherlands
3159	5	27	5	28	Re: "A peak warming limit of 1.5°C (with 50% probability) implies carbon neutrality around 2050 (2040) with 20 (30) GtCO2 yr-1 in 2030". It does not sound reasonable that carbon neutrality could be achieved earlier in 2040 with higher emissions of 30 GtCO2 in 2030. Please clarify.	Taken into account. Text will be revised.	Sai Ming LEE	Hong Kong Observatory	China
37183	5	27	5	29	very confusing use of brackets and pathway categories to an extent that makes the findings incomprehensible	Taken into account. Clarity will be improved	Michiel Schaeffer	Climate Analytics	Netherlands
10797	5	27	5	30	What do figures in brackets mean?	Taken into account. Clarity will be improved. Numbers between brackets indicate the change in the values being described according to two different pathways	Mitsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
24637	5	27	5	30	The numbers in the parentheses seem to be the case of 50% and 66% probability, respectively. It is not clear what cases the numbers out of the parentheses represent.	Taken into account. Clarity will be improved. Numbers between brackets indicate the change in the values being described according to two different pathways	Young-Hwan Ahn	Sookmyung Women's University	Republic of Korea
30091	5	27	5	30	Presenting new emission reduction implications from a wrong peak warming interpretation makes it even more confusing. In earlier paragraphs other numbers were presented. The only solution is to delete this paragraph and discuss the implications for peak warming elsewhere as a consequence of meeting the end of century limits without undue reliance on CDR (see my remark above)	Taken into account. Restructuring will be considered. Values will be harmonised	Bert Metz	European Climate Foundation	Netherlands
35031	5	27	5	30	Lines 27-30 are in a way repetition of lines 11-14 on this page. In addition to that, some numbers do not match each other.	Taken into account. Restructuring will be considered. Values will be harmonised	Taghavinejad Ehsan	NIOC	Iran
35617	5	27	5	30	The text seems to be similar to the text two paragraphs above.	Taken into account. Restructuring will be considered. Values will be harmonised	Göran Finnveden	KTH Royal Institute of Technology	Sweden
84	5	28	5	28	"20 (30) GtCO2 yr-1 in 2030" should be "20 (30) GtCO2 by 2030"?	We mean "per year"	Govindasamy Bala	Indian Institute of Science	India
3161	5	28	5	29	Re: "a limit of 2°C (66% probability) implies carbon neutrality around 2080 (2065) for 30 (40) GtCO2 in 2030". It does not sound reasonable that carbon neutrality could be achieved earlier in 2065 with higher emissions of 40 GtCO2 in 2030. Please clarify.	Taken into account. Clarity will be improved	Sai Ming LEE	Hong Kong Observatory	China
1331	5	31	5	32	The description of "increases climate impacts" is not well discussed in the main text and I think it would be better to refer to WGII literature if the authors would like to address it.	Taken into account.	Shinichiro Fujimori	Kyoto University	Japan
14151	5	31	5	35	As said in the report elsewhere ("The volumes of CDR deployment assumed in IAM-based global emissions mitigation scenarios are significant if compared to current volumes of deployment, given that the feasibility of rapid and sustained upscaling is uncertain" l1p15 Chapter 12), there are many uncertainties with relation to the feasibility of large-scale CDR deployment in the future, hence when referring to them it is crucial to keep always this in mind. It has to be said, and the tense of the verb should be switched to conditional instead of present to avoid giving a sensation of certainty.  "Overshooting the target entails higher climate impact risks and requires larger CDR deployment" NUANCE, PLEASE, THIS ONLY WOULD BE POSSIBLE IF CDR IS FINALLY AVAILABLE!! AVOID GIVING AN IMPRESSION OF CERTAINTY WITH SUCH A DELICATE POINT.	Taken into account. In the next draft, we will consider rephrasing to include this	Iñigo Capellán-Pérez	University of Valladolid	Spain
30093	5	31	5	35	This is a rather weak text. Implications of weak near term action are also interim climate impacts and overreliance on unrealistic amounts of CDR (not just "larger CDR deployment")	Taken into account. Text will be improved	Bert Metz	European Climate Foundation	Netherlands
32389	5	31	5	35	Speed is a key metric, and climate solutions must be measured along this dimension as well as along the conventional metrics. With that the question that needs to be answered is how quickly a climate solution can deliver avoided warming, and SLCPs are part of that solution. With SLCPs providing avoided warming at 2050 of up to 0.6 °C and CO2 avoiding up to 0.1–0.3 °C; at 2100, SLCPs avoid 1.2 °C warming and CO2 avoids 1.6–1.9 °C. SCLP reductions are critical for vulnerable areas like the Arctic and because they can slow progression of tipping points and self-reinforcing feedbacks. See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250; Ramanathan, Molina, and Zaelke (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change.	Taken into account. Text will be revised.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32391	5	31	5	35	It is critical to slow feedbacks in the coming decade, including by cutting the SLCPs, as well as by protecting sinks, enhancing urban albedo, and other fast mitigation strategies. Molina M., et al. (2009) Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions, PROC. NAT'L ACAD. SCI. 106(49):20616–20621. See also Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595 ("In our view, the consideration of tipping points helps to define that we are in a climate emergency and strengthens this year's chorus of calls for urgent climate action — from schoolchildren to scientists, cities and countries."); and Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L ACAD. SCI. 115(33):8252–8259, 8254.	Taken into account. Feedbacks will be mentioned	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America

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32393	5	31	5	35	Any overshoot will cause some irreversible impacts, including SLR and glacial and ice sheet melt that will not be corrected when the overshoot is corrected. Tokarska K. B., et al. (2019) Path Independence of Carbon Budgets When Meeting a Stringent Global Mean Temperature Target After an Overshoot. EARTH'S FUTURE 7:1283–1295, 1283 (“Emission pathways that are consistent with meeting the Paris Agreement goal of holding global mean temperature rise well below 2 °C often assume a temperature overshoot. In such overshoot scenarios, a given temperature limit is first exceeded and later returned to, under the assumption of large-scale deliberate carbon dioxide removal from the atmosphere. Here we show that although such strategy might result in a reversal of global mean temperature, the carbon cycle exhibits path dependence. After an overshoot, more carbon is stored in the ocean and less on land compared to a scenario with the same cumulative CO2 emissions but no overshoot. The near-path independence of surface air temperature arises despite the path dependence in the carbon cycle, as it is offset by path dependence in the thermal response of the ocean. Such behavior has important implications for carbon budgets (i.e. the total amount of CO2 emissions consistent with holding warming to a given level), which do not differ much among scenarios that entail different levels of overshoot. Therefore, the concept of a carbon budget remains robust for scenarios with low levels of overshoot (up to 300 Pg C overshoot considered here) but should be used with caution for higher levels of overshoot, particularly for limiting the environmental change in dimensions other than global mean temperature rise.”); Solomon S., et al. (2010) Persistence of climate changes due to a range of greenhouse gases, PROC. NAT'L. ACAD. SCI. 107(43):18354–18359, 18356 (“The transfer of heat from the atmosphere to the ocean’s mixed layer (top 100 m or so) is thought to occur on timescales on the order of a decade or less (30), whereas multiple centuries are required to warm or cool the deep ocean (31), and changes in the great ice sheets and vegetation coverage may occur over many thousands of years (4).”).	Taken into account. Text will be revised.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32767	5	31	5	35	Speed is a key metric, and climate solutions must be measured along this dimension as well as along the conventional metrics. With that the question that needs to be answered is how quickly a climate solution can deliver avoided warming, and SLCs are part of that solution. With SLCs providing avoided warming at 2050 of up to 0.6 °C and CO2 avoiding up to 0.1–0.3 °C; at 2100, SLCs avoid 1.2 °C warming and CO2 avoids 1.6–1.9 °C. SLCP reductions are critical for vulnerable areas like the Arctic and because they can slow progression of tipping points and self-reinforcing feedbacks. See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250; Ramanathan, Molina, and Zaelke (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change.	Taken into account. We will try to address this important issue of speed	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
37185	5	31	5	35	Please assess the links between 21st century CDR requirements and 2030 emission levels and provide scaling estimates (e.g. every Gt more in 2030 is linked to a XX Gt commitment of CDR in emissions pathways in the literature)	Taken into account. We will try to provide this information.	Michiel Schaeffer	Climate Analytics	Netherlands
18555	5	31	5	38	A simplified foray underlining some related points about system dynamics with inertia and induced innovation, is forthcoming (revised) for WIRES Climate Change, but available in working paper form as: Grubb M, and C.Wieners (2020), Modeling Myths: On the Need for Dynamic Realism in DICE and other Equilibrium Models of Global Climate Mitigation, Institute for New Economic Thinking, Working Paper No. 112. <a href="https://www.inetconomics.org/research/research-papers/modeling-myths-on-the-need-for-dynamic-realism-in-dice-and-other-equilibrium-models-of-global-climate-mitigation">https://www.inetconomics.org/research/research-papers/modeling-myths-on-the-need-for-dynamic-realism-in-dice-and-other-equilibrium-models-of-global-climate-mitigation</a> . This critiques the lack of dynamic realism in many IAMs (albeit focused on DICE) and illustrates how inertia and induced innovation increases the optimal initial effort, particularly in a cost-benefit setting, using an adapted form of DICE (DICE-PACE). Such analysis might help to reinforce some of the messages already in the chapter about timing, urgency and the economic value of enhanced early action, and may also help to address possible criticisms about the relative lack of attention to explicit cost-benefit models in this chapter. The underlying empirical evidence on induced innovation is assessed in a major Systematic Review in submission to Environmental Research Letters and available on request.	Taken into account. Thank you for the references	Michael Grubb	UCL - Institute of Sustainable Resources	United Kingdom (of Great Britain and Northern Ireland)
3163	5	34	5	34	Suggest adding “which is tightly limited by techno-economic, political and sustainability constraints” at the end of the statement. Ref.: Line 32-33 of page 60.	Taken into account.	Sai Ming LEE	Hong Kong Observatory	China
14177	5	34	5	35	Please rephrase as follows:  “Overshooting the target entails higher climate impact risks and WOULD require larger CDR deployment”	Taken into account. Rephrasing will be considered.	Iñigo Capellán-Pérez	University of Valladolid	Spain
86	5	36	5	36	“emissions” should be “cumulative emissions” by 2030?	Rejected. Annual emissions	Govindasamy Bala	Indian Institute of Science	India
30475	5	36	5	36	very important point, please keep!	OK. Thank you	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
2953	5	36	5	42	Line 38: add whether the 2C challenge is combined with “no or low overshoot”?	Taken into account, but we usually refer to overshoot when talking about 1.5C scenarios	Mustafa Babiker	Aramco	Saudi Arabia
10103	5	36	5	42	If the NDCs are frozen by 2030 and followed through 2040 or 2050 what does this imply? Many energy policy scenarios run through 2040 or 2050 so it would be useful to have this for comparison.	Taken into account. This will be explored	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
14651	5	36	5	42	If supported by the evidence, it would be interesting to indicate how the challenges for limiting warming “well below 2°C” starting from NDCs in 2030 compare to limiting warming to 1.5°C from today.	Taken into account.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
30095	5	37	5	38	That is a good statement, but the underlying text should remind the reader that higher overshoot would lead to overreliance on unrealistic amounts of CDR (see SR 1.5)	Taken into account. Text will be detailed	Bert Metz	European Climate Foundation	Netherlands
24875	5	38	5	42	Delete “The greater the build-up ... after 2030.” as this argument is not based on the considered IPs	IPs will be updated and the text will be improved	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
2955	5	39	5	42	Qualify that fossil fuel infrastructure compatible with low carbon such as that related to CCUS may not result in lock-in for the low-carbon transition.	Taken into account.	Mustafa Babiker	Aramco	Saudi Arabia
24877	5	44	5	45	Delete “This helps them ... less disruption for society.” as this does not apply for all regions worldwide	Taken into account.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
88	5	45	5	45	I would believe that reducing emission rates so drastically also could be a disruption to society.	Taken into account	Govindasamy Bala	Indian Institute of Science	India
14175	5	45	5	45	“with less disruption for the society”; what do you mean with this? Be more clear	Taken into account. Clarity will be improved	Iñigo Capellán-Pérez	University of Valladolid	Spain
2957	5	43	6	2	This paragraph is too prescriptive and not really meaningful given the ambiguity of how to define “Accelerated Action Pathway”. I suggest delete or revise.	Taken into account. The paragraph will be revised	Mustafa Babiker	Aramco	Saudi Arabia
24879	5	47	6	2	Delete “However, a global mitigation regime ... carbon neutrality globally.” as this approach is not consistent with the Paris Agreement provisions	Taken into account. Sentence will be revised	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
24111	5	7	7	7	insert “rise” after “temperature.”	Editorial. Taken into account	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
19771	5	11		14	WGI includes assessment of the same thing - I suggest checking for consistency.	Taken into account. We will coordinate with WG1	Nathan Gillett	Environment and Climate Change Canada	Canada

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
19773	5	22		24	Isn't the land-use challenge conditional on the type of negative emissions technology used? For example, clean air carbon capture and storage may not imply land use challenges.	Taken into account. Distinction will be clearer	Nathan Gillett	Environment and Climate Change Canada	Canada
19779	5	36		42	Is it possible to associate one SSP more closely with the NDCs? I know the NDCs are only for 2030, but this would still be useful context for interpreting WGI projections under different SSPs, and in the SVR where the WGIII and WGI results are brought together.	Taken into account. This issue will be addressed with the help of the new illustrative pathways	Nathan Gillett	Environment and Climate Change Canada	Canada
19775	5	36			Some (all?) are NDCs are formulated as minimum emission reduction targets, so the text should clarify that it is the minimum emissions reductions consistent with the NDCs which limit 2030 emissions to these levels.	Taken into account	Nathan Gillett	Environment and Climate Change Canada	Canada
19777	5	44			Are these pathways actually below NDC emission levels? I think most of the NDCs are minimum emission reduction targets (emissions will reduce by at least x% by 2030), so lower emissions are still consistent with the NDCs.	Taken into account	Nathan Gillett	Environment and Climate Change Canada	Canada
30879	6	3	6	3	I suggest saying "Mitigation scenarios show reductions in energy and food demand," not "Mitigation scenarios show reductions in demand." The current phrasing is unclear.	Taken into account. Clarity will be improved	Jason Veyssey	Stockholm Environment Institute	United States of America
2959	6	3	6	5	Do you mean reduction in "energy " demand or demand for goods and services in general? If "energy" please indicate that clearly.	Taken into account. Clarity will be improved	Mustafa Babiker	Aramco	Saudi Arabia
37187	6	4	6	4	confusing language: "declines in services" may suggest a deterioration of the quality of services. Please use the terms correctly reflecting the findings in section 3.4 that seem limited to the aspect of demand reductions (there's doesn't seem to be an assessment of "services" in this chapter really?)	Taken into account. Clarity will be improved	Michiel Schaeffer	Climate Analytics	Netherlands
5085	6	6	6	6	The 50% reduction is relative to what/when?	Relative to the baseline scenarios. Clarity will be improved	Matthias Weitzel	European Commission, Joint Research Centre	Spain
15757	6	7	6	7	The feasibility of "a major livestock reduction" is highly uncertain. Recently WHO retired their support to the EAT Lancet diet, low in proteins, based on health issues and other reasons. For example: British Medical Journal BMJ reports WHO withdraw support for the "Planetary Diet" <a href="https://www.bmj.com/content/365/bmj.l1700">https://www.bmj.com/content/365/bmj.l1700</a> , so there seems to be some discussion on whether such a diet would be applicable to all the world's population and whether it is indeed healthy. I checked the WHO recommended diet at <a href="https://www.who.int/en/news-room/fact-sheets/detail/healthy-diet">https://www.who.int/en/news-room/fact-sheets/detail/healthy-diet</a> and there is no reference on recommended protein or carbohydrate intake. There are Other critics state that the "EAT Lancet report not backed by rigorous science: <a href="https://www.nutritioncoalition.us/news/eatlancet-report-one-sided">https://www.nutritioncoalition.us/news/eatlancet-report-one-sided</a> The US Dietary Guidelines, one key pillar of the EAT Lancet report, is also questioned: <a href="https://www.nutritioncoalition.us/there-is-concern-about-the-dietary-guidelines">https://www.nutritioncoalition.us/there-is-concern-about-the-dietary-guidelines</a> Moreover the EAT Lancet Planetary diet might not be affordable to an important part of poor people in subsaharan Africa, parts of Asia and South America <a href="https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(19)30447-4/fulltext">https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(19)30447-4/fulltext</a>	Taken into account.	EDUARDO PEDRO FRACASSI	ITBA Instituto Tecnológico de Buenos Aires	Argentina
30477	6	7	6	7	thank you for clarity over livestock consumption. Helpful to subsistence farmers/countries, the phrase 'animal intensive' to distinguish where the real problem lies.	Taken into account.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
30097	6	9	6	11	move to paragraph on buildings sector	Editorial. Shift will be considered	Bert Metz	European Climate Foundation	Netherlands
41569	6	12	6	14	Where it says "The energy supply sector will undergo...with almost all scenarios" it should say "The energy supply sector undergoes...in almost all scenarios". Scenarios are (as explained elsewhere in the chapter itself) not predictions or forecasts. This sentence, however, as it currently stands, appears as a predictive statement. This is misleading. (There are several examples of such predictive statements in the chapter).	Editorial. Taken into account	Ida Andrea Braathen Sognaes	CICERO centre for international climate research	Norway
20515	6	12	6	16	is the reason for this conclusion wrong PV cost assumptions in IAMS? which is now documented by Krey et al. ( <a href="https://www.sciencedirect.com/science/article/pii/S03060544218325039">https://www.sciencedirect.com/science/article/pii/S03060544218325039</a> ) with about 1150 USD/kWp PV investment cost assumptions in 2050 in practically all IAMS, while the real cost in the year 2020 are HALF of that, as shown by Vartiainen et al. ( <a href="https://onlinelibrary.wiley.com/doi/full/10.1002/pip.3189">https://onlinelibrary.wiley.com/doi/full/10.1002/pip.3189</a> ) - AND further PV cost reduction in the years from 2020 to 2050 will come on top, so that in 2050 on can assume wrong PV cost in IAMS by a factor of 4. This requires a major disclaimer on substantially distorted IAM results. Even worse, this leads to a block of CCU and Power-to-X since such low/zero-carbon solutions require low-cost electricity, which cannot be found in IAMS with wrong PV cost. This requires a major disclaimer.	Taken into account. Text will be revised.	Christian Breyer	LUT University	Finland
30881	6	12	6	19	The framing in this paragraph, particularly the statement that "The energy supply sector . . . can contribute with large negative emissions in mitigation scenarios," conveys an inappropriate degree of assuredness about the potential for large-scale negative emissions from energy supply. I suggest mitigating the language in the final sentence, such as by saying the energy supply sector "is envisioned to contribute large negative emissions in certain mitigation scenarios."	Taken into account.	Jason Veyssey	Stockholm Environment Institute	United States of America
14655	6	14	6	15	Please provide a point of reference for the statement "More rapid increase"	Editorial. Taken into account	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
90	6	15	6	16	Why such a big emphasis on CCS? It is costly because of transportation and storage. CCS appears like a fiction - we have been talking about this for decades with nothing to show for today.	Taken into account.	Govindasamy Bala	Indian Institute of Science	India
24663	6	15	6	17	The report states that carbon capture storage plays (CCS) a very important role in emissions reductions. This same argument is further reinforced in other sections of the chapter. Besides some key questions related to the techno-economic viability of CCS, the promotion of CCS inherently provides fertile ground for continued consumption of fossil fuels.	Taken into account.	Desta Mebratu	Centre for Complex Systems in Transition, Stellenbosch University	Ethiopia
27903	6	15	6	17	Please clarify that there is no evidence that CCS/DAC reduces CO2e any more than 10-20% (as opposed to the wrong claim of 90%) based on data from existing plants, whereas it increases air pollution and mining 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, <a href="https://web.stanford.edu/group/efmh/jacobson/Articles/Other/19-CCS-DAC.pdf">https://web.stanford.edu/group/efmh/jacobson/Articles/Other/19-CCS-DAC.pdf</a> . As such, scenarios built around CCS/DAC give the false impression that a solution is available when in fact it is not. This is a significant issue, because countries will depend on IPCC's incorrect claim that CCS/DAC are legitimate mitigation options when they are opportunity costs that increase emissions in comparison with spending the same money on direct mitigation. Sekera, J., and A. Lichtenberger, The carbon capture conundrum: Public need versus private gain, A public policy perspective on carbon dioxide capture, 2020, <a href="https://drive.google.com/file/d/1K-BIUOLUfS5SLVCS9NaDzq7JefmO-b/view">https://drive.google.com/file/d/1K-BIUOLUfS5SLVCS9NaDzq7JefmO-b/view</a>	Taken into account. Thank you for the references	Mark Jacobson	Stanford University	United States of America
30479	6	16	6	16	Possibly incorrect - the P1 Pathway in the SRI 5C states no CCS/BECCS, while this statement states 'limited', which is different. It is important to have this P1 pathway recognised, otherwise the CCS industry is claiming that wide scale CCS is inevitable, and many high emitters highlight not-yet proven to scale CCS instead of engaging on rapid FF reduction. This is a real concern for urgent action.	Taken into account.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
34367	6	17	6	17	Please add the following sentence: Carbon Capture and Utilisation (CCU) technologies can play a key role to replace fossil resources and thus to support a transformation of the energy systems (e.g. Klankermayer and Leitner, Science, 350, 629-630, 2015). The CCU concept can stimulate the energy transition by enabling energy storage through power-to-X approaches and contribute to a circular economy by converting waste emissions into resources. These technologies of growing interest are not considered in the scenarios discussed here, because of the lack of granularity of the models that does not allow accounting for the complexity of each CCU technologies and of all the sectors associated, but CCU should be considered in the portfolio of mitigation options (1)IEAGHG, 2019a: Putting CO2 to Use – Creating value from emissions, International Energy Agency, 2) CCES, 2019: Carbon Utilization – A vital and effective pathway for decarbonization, Center for Climate and Energy Solutions) 3) Bruhn et al., Environmental Science & Policy 60 (2016) 38–43	Taken into account. Thank you for the references	Célia Sapart	Université Libre de Bruxelles et Co2 Value Europe	Belgium
24881	6	17	6	19	Delete "The energy supply sector ... in mitigation scenarios"	Rejected, as no justification was provided for the deletion request	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria

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10799	6	19	6	19	Please add after line 19; "Especially for achieving 1.5 degree goal, early retirement of coal power plants would become unavoidable unless large volume of CCS will become available. Refer to the paper by Tong et al. 2019 "Committed emissions from existing energy infrastructure jeopardize 1.5 °C climate target. Nature Vol.572	Taken into account. Thank you for the reference	Mitsutsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
2961	6	20	6	26	In previous IPCC reports (4th and 5th assessments) Building has been characterized with large mitigation potentials. This paragraph seems to suggest that the potential is limited?	We say this because the sector does not go net negative, but the mitigation potential is wide	Mustafa Babiker	Aramco	Saudi Arabia
41571	6	20	6	39	As it stands, these paragraphs precede any description of IAMs and any explanation of the sampling of scenarios that are described. This makes it difficult to interpret the numbers that are presented.	Taken into account. We will consider adding a short description of IAMs	Ida Andrea Braathen Sognaes	CICERO centre for international climate research	Norway
30099	6	21	6	22	this suggests that bottom-up scenarios show a higher mitigation potential; why is that? Is that caused by the least cost approach in IAMs? This requires some explanation in the text of this paragraph	Yes, taken into account.	Bert Metz	European Climate Foundation	Netherlands
30101	6	25	6	25	what is "the highest temperature category"???	Taken into account. Will be clarified	Bert Metz	European Climate Foundation	Netherlands
30481	6	27	6	27	Will there be time to include research from this current C-19 virus travel reduction, on the mitigation potential of reducing travel?	This issue will be mentioned but it will not be the focus of the chapter	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
24883	6	27	6	28	Delete "The transport sector ... and 2050."	Rejected, as no justification was provided for the deletion request	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
30103	6	28	6	28	delete; higher warming scenarios are not important for policy makers that need to know what is needed to meet the Paris goals and could easily confuse the reader	Taken into account. Text will be revised.	Bert Metz	European Climate Foundation	Netherlands
37189	6	30	6	30	This is a redundant sentence: "However, emissions remain positive in all scenarios." Is there any literature that shows emissions can or should be negative in this sector? Emissions stay positive also in assessments other than from IAMs, unless indirect emissions are included from the power sector, which is not the case in Chapter 3, I assume	Taken into account. Editing will be considered	Michiel Schaeffer	Climate Analytics	Netherlands
30105	6	31	6	32	This is a feature of the overall scenario; should not be mentioned in a paragraph on transport	Taken into account. We will consider moving this part	Bert Metz	European Climate Foundation	Netherlands
24115	6	33	6	33	replace "conjunction" with "addition"	Editorial. Taken into account	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
30107	6	34	6	34	do you mean that scenarios have not included those options? If so, then comment on the role of demand reduction and modal shift in those scenarios that do include these options	Taken into account. Clarity will be improved	Bert Metz	European Climate Foundation	Netherlands
30109	6	35	6	36	it is important to limit the conclusions to wb2c/1.5 scenarios!	Taken into account	Bert Metz	European Climate Foundation	Netherlands
2597	6	35	6	39	In addition to CCS, another mitigation approach, successfully implemented by the semiconductor industry in respect to fluorinated GHG gases, has been the substitution of PFC process gases by less impactful alternatives, and by the widespread adoption of exhaust gas abatement equipment. This has been initiated by the World Semiconductor Council setting voluntary industry targets for 2010 and for 2020 which have been achieved and is set to be achieved respectively. This could be a model for action by other industry bodies in different industrial fields. <a href="http://www.semiconductorcouncil.org/wsc/">http://www.semiconductorcouncil.org/wsc/</a>	Taken into account. Thank you for the reference	Michael Czerniak	Atlas Copco - Edwards	United Kingdom (of Great Britain and Northern Ireland)
5087	6	38	6	39	A maximum value might not be informative as it could be driven by model outliers	Taken into account. More precise information will be provided	Matthias Weitzel	European Commission, Joint Research Centre	Spain
30111	6	40	6	41	This is too vague. Be specific and limit conclusions to the results of "WB2C/1.5" scenarios and do not focus on higher warming scenarios	Taken into account	Bert Metz	European Climate Foundation	Netherlands
30483	6	40	6	47	This ignores restoration, which the SRCCL recognises as significant even though climate modelling struggles to include. Recent research in nature based solutions, alongside updates on the widespread degradation of nature, makes restoration critical to address not only climate change but also unprecedented rates of species extinction.	Taken into account. We will add restoration	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
25853	6	45	6	46	It may be important to mention that the potential of trees to capture carbon through the following years has been overestimated by some researchers, including Bastin et al. (2019). In addition, it has also been observed a decline in the capacity of tropical forests to capture carbon (Hubau, 2020). Thus, the potential reductions from AFOLU may be overestimated and should be revised considering the information available at the moment: Bastin (2019; 10.1126/science.aax0848); Veldman (2019; 10.1126/science.aay7976); Grainger (2019; 10.1126/science.aay8334); Hubau (2020; 10.1038/s41586-020-2035-0)	Taken into account. Thank you for the references	Jorge Hoyos-Santillan	University of Magallanes	Chile
24117	6	46	6	46	Begin sentence with "Declines in CO2 and CH4 are steeper and more rapid than " .....	Editorial. Accepted	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
10073	6	32			Decarbonisation of the transport sector is predominately attributable to improvements in energy efficiency in conjunction with fuel switching away from fossil fuels, as well as the introduction of electric shipping DOI: 10.1109/TIA.2009.2013569 <a href="https://doi.org/10.3390/su10072243">https://doi.org/10.3390/su10072243</a>	Taken into account, thank you for the reference	Maria E. Mondejar	Technical University of Denmark	Sweden
20309	6	32			the wording 'decarbonisation' for the transport sector is physically and chemically wrong and shall be adjusted by 'defossilisation'. This affects the entire report and several chapters. The point is hydrocarbons are most likely still used in the transport sector, in particular in the transport modes marine and aviation, but based on either biofuels or synthetic fuels. In any case there are still hydrocarbon fuels used, but not anymore with fossil carbon, in particular for the Power-to-fuels route using CO2 via direct air capture. 'Decarbonisation' however is physically and chemically wrong.	We get your point, but the word "decarbonization" is widely used to refer to what you're calling defossilization.	Christian Breyer	LUT University	Finland
12657	6	40			Agriculture and LULUCF should be reported separately. Because most of the NDC has been reported Agriculture and LULUCF emissions/removals separately.	Taken into account	Eray Özdemir	General directorate of Forestry	Turkey
10161	7	2	7	3	Seems like the bracket ends in the wrong spot (should be after '....net zero CO2 emissions),...'	Editorial. Accepted.	Aglaia Obrekht	Environment and Climate Change Canada	Canada
30113	7	7	7	9	For policy makers it is more relevant to know what can be achieved in the AFOLU sector if all relevant options are included. So a selection of scenarios (only covering those with a wide range of option) should be used to present relevant numbers	Taken into account	Bert Metz	European Climate Foundation	Netherlands
30115	7	10	7	11	This is a nice general conclusion, but it would be more helpful to make a distinction between WB2C and 1.5C scenarios.	Taken into account. Distinction will be considered	Bert Metz	European Climate Foundation	Netherlands
30485	7	10	7	15	Again, it is important that policy makers are aware of the SR1.5C P1 pathway (in BECCS).	Taken into account	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
46985	7	10	7	15	Over-emphasis on BECCS. If NETs are deployed at scale, it is unlikely to be a large extent of BECCS - this is an artifact of IAMs placing too much emphasis on BECCS and ignoring many other NETs. Don't let the chapter's synthesis be confined by what is or is not represented in IAMs. The research and literature is far broader and inclusive than what IAM modelling groups have chosen to write into the models.	Taken into account	Frank Jotzo	ANU	Australia
30117	7	11	7	12	This is too negative. There are good reasons for scenarios to assume a limit for the speed at which CO2 emissions can be reduced. So a better formulation would be "with the degree of this reliance depending on the assumption at what speed CO2 emissions can be	Taken into account	Bert Metz	European Climate Foundation	Netherlands



Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
30119	7	12	7	15	This is unhelpful for policy makers. What is needed is a good indication of what feasible amounts of CDR would be. The problem with most IAMs is that they only have one CDR option, BECCS, even sometimes without having a land-use sequestration option. IAMs are therefore not a good basis to make statements about the limits to CDR use. What could be said is that IAMs have serious limitations as they do not incorporate the various CDR options that exist., that the amount of BECCS in scenarios should therefore not be interpreted as a realistic situation, that therefore BECCS should be more seen as the total CDR that is needed in the scenario. Also scenarios without land-use sequestration should be eliminated when drawing conclusions about CDR use.	Taken into account	Bert Metz	European Climate Foundation	Netherlands
45673	7	14	7	14	can it be specified what is 'more' demand-side mitigation and what are 'significant' reductions?	Taken into account. Clarity will be improved	Machteld van den Broek	Utrecht University	Netherlands
2963	7	16	7	17	What are the ranges for economy-wide mitigation costs associated with Paris climate target?	Thank for the comments. The answer to this question varies by model.	Mustafa Babiker	Aramco	Saudi Arabia
5089	7	16	7	17	Why is there a "but"?	Because earlier in the sentence, we say that the costs can be limited.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
10801	7	16	7	17	Despite the descriptions in these two lines, mitigation costs are not shown. Cost should definitely be shown in this chapter. For reference, costs were shown in AR5/WG3 Chapter 6 (Figure 6.21), SPM (Table SPM.2) and in SPM of the Synthesis Report (Figure SPM.13 and Table SPM.2). Without cost calculation, AR6 will never be policy relevant.	A better assessment of mitigation costs will be made in the new version of section 3.6	Mitsutsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
24885	7	16	7	17	Delete "Economy wide mitigation costs ... sustainable development goals." as this does not apply for all regions/countries	Taken into account. Text will be revised.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
30121	7	16	7	17	Should read "lifestyle and technology choices"; replace "but" in line 17 with "and"; the paragraph needs elaboration on what costs are and how these are influenced	Taken into account. Text will be revised.	Bert Metz	European Climate Foundation	Netherlands
30487	7	16	7	17	is this 'but' or 'yet'? Seems a positive, what you are saying?	Taken into account. Text will be revised.	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
2965	7	18	7	21	How large are the distributional implications (provide quantitative assessment)?	Taken into account. Text will be revised.	Mustafa Babiker	Aramco	Saudi Arabia
14157	7	18	7	21	Please expand this point since it is too coarse, how can policies be designed to achieve climate stabilization while minimizing adverse distributional impacts?	Taken into account	Iñigo Capellán-Pérez	University of Valladolid	Spain
30123	7	18	7	21	very unclear and no policy relevant message	Taken into account	Bert Metz	European Climate Foundation	Netherlands
46987	7	18	7	21	Policies can be designed to fully offset distributional impacts, not just to "minimize" them. The assumption underlying the present text - that climate stabilization must result in adverse distributional outcomes - is unfounded.	Taken into account. Text will be revised.	Frank Jotzo	ANU	Australia
10803	7	22	7	24	I wonder how authors of this chapter judge "economic cost - can be of the same order of magnitude as direct mitigation costs and benefits", without knowing mitigation cost. Delete from line 22 to line 27.	Taken into account. Text will be revised.	Mitsutsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
30125	7	22	7	24	More quantitative conclusions are needed. This is too general	Taken into account	Bert Metz	European Climate Foundation	Netherlands
30489	7	22	7	27	Could you add that 'benefits' include saving lives and livelihoods, avoiding 'non-economic losses' such as ... When this is specified, it helps focus the policy maker.	Taken into account. We will detail the benefits	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
46715	7	22	7	27	The summary in the paragraph does not seem to be justified in relation to what is referred to in 3.6. The conclusion in for example Scovronic et al. (2019) is a different one, stating "when both co-benefits and co-harms are taken fully into account, optimal climate policy results in immediate net benefits globally, overturning previous findings from cost-benefit models that omit these effects." Moreover, Karlsson et al. (2020) concludes that e.g. "Climate policy co-benefits in well-researched fields such as air quality and health are large, often equalling or exceeding mitigation costs." and that "In several areas, such as diet and energy security, co-benefits are sparsely researched, but emerging evidence points to high values.". Please note that a similar amendment need to be done on page. 66.	Taken into account. Text will be revised.	Mikael Karlsson	KTH Royal Institute of Technology	Sweden
46717	7	24	7	25	Please amend into: "Avoiding trade-offs and harvesting co-benefits implied by long-term mitigation pathways requires targeted policies."	Taken into account. Text will be revised.	Mikael Karlsson	KTH Royal Institute of Technology	Sweden
30127	7	26	7	27	what does that mean? net benefits or net costs?	Taken into account. This information will be added	Bert Metz	European Climate Foundation	Netherlands
719	7	28	7	34	is it possible to frame this with respect to avoided damage costs?	Taken into account. Text will be revised as we are working now on avoided damage costs to be included in the chapter.	Christa Clapp	CICERO	Norway
16543	7	28	7	34	You can't claim to know what "well below 2°C" means. See for details my previous comment on "well below 2°C".	Taken into account. Text will be revised.	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
46469	7	30	7	46	There is no mention of the tradeoffs for food, social, cultural and economic specific to vulnerable groups from mitigation activities, or the impacts on equity from mitigation initiatives. Issues such as Indigenous Peoples' rights to land, and the impacts on vulnerable groups such as low-income, smallholder farming households from large-scale mitigation initiatives such as afforestation or reforestation should be included in the ES.	Taken into account. We will consider mentioning it	Rachel Bezner Kerr	Cornell University	United States of America
30129	7	31	7	31	"more restricted peak temperature limits." What does that mean?	Taken into account. Text will be clarified	Bert Metz	European Climate Foundation	Netherlands
45675	7	31	7	31	what is "efficiency with more restricted peak temperature limits"	Taken into account. Text will be clarified	Machteld van den Broek	Utrecht University	Netherlands
10163	7	31	7	34	In brackets includes information on absolute numbers for the 2 degree scenario, but 2 degree scenario is not mentioned in the sentence (with percentage growth)	Accepted. Text will be made coherent	Aglaiá Obrecht	Environment and Climate Change Canada	Canada
30131	7	32	7	32	What does "category 2 " mean??	Editorial. Categorisation will be made clearer in the next draft	Bert Metz	European Climate Foundation	Netherlands
37191	7	32	7	32	normative (wrong) use of "well below 2°C" label - see 1st comment - change to correct use such as page 5 line 13, lines 28-29 and line 43	Taken into account. Text will be revised.	Michiel Schaeffer	Climate Analytics	Netherlands
30133	7	35	7	39	Unclear what this paragraph aims to say. It looks like the sentence "Ambitious mitigation ..." is the key message here. So that could be the headline. It could then be elaborated how scenarios look like that are achieving SDGs and meet WB2C/1.5C. Policy makers would have something to work with then. Section 3.7 has data to specify this (and if not, then look for other literature)	Taken into account. Clarity will be improved	Bert Metz	European Climate Foundation	Netherlands
30135	7	40	7	41	Unclear. Drop the headline statement, it is too general	Taken into account	Bert Metz	European Climate Foundation	Netherlands
2967	7	40	7	46	Food and biodiversity are also affected by large scale afforestation and not only large scale BECCS deployment?	Taken into account	Mustafa Babiker	Aramco	Saudi Arabia
19331	7	40	7	46	Adding to the heading of "The SDG framework can serve as a template...", it is crucial to highlight the following sentence of "Areas with anticipated trade-offs include food and biodiversity..., energy affordability/access, and mineral resource extraction" not to underestimate negative effect.	Taken into account	Sumie Nakayama	Tokyo Institute of Technology	Japan
19345	7	40	7	46	Adding to the heading of "The SDG framework can serve as a template...", it is crucial to highlight the following sentence of "Areas with anticipated trade-offs include food and biodiversity..., energy affordability/access, and mineral resource extraction" not to underestimate negative effect. And it should be reflected in the Executive Summary that such trade-offs.	Duplicated comment	Sumie Nakayama	Tokyo Institute of Technology	Japan
19347	7	40	7	46	Adding to the heading of "The SDG framework can serve as a template...", it is crucial to highlight the following sentence of "Areas with anticipated trade-offs include food and biodiversity..., energy affordability/access, and mineral resource extraction" not to underestimate negative effect. It is important to retain this aspect in the Executive Summary.	Duplicated comment	Sumie Nakayama	Tokyo Institute of Technology	Japan
30137	7	41	7	46	This could be shown in a more elaborate and useful way by using the diagram (or similar ones ) that was used in SR1.5 (figure SPM.4)	Taken into account	Bert Metz	European Climate Foundation	Netherlands

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
14155	7	42	7	42	In a similar way, please nuance when mentioning BECCS: as said in the report elsewhere ("The volumes of CDR deployment assumed in IAM-based global emissions mitigation scenarios are significant if compared to current volumes of deployment, given that the feasibility of rapid and sustained upscaling is uncertain" (1p15 Chapter 12), there are many uncertainties with relation to the feasibility of large-scale CDR deployment in the future, hence when referring to them it is crucial to keep always this in mind. It has to be said, and the tense of the verb should be switched to conditional instead of present to avoid giving a sensation of certainty.  for example in this case write "from POTENTIAL large-scale BECCS deployment"	Taken into account. We will consider adding the word	Iñigo Capellán-Pérez	University of Valladolid	Spain
44529	7	42	7	42	I guess the problem arises from "bioenergy" use as such, not specifically from "BECCS"	Taken into account	Oliver Geden	German Institute for International and Security Affairs	Germany
46719	7	43	7	44	Please amend into: "Areas with anticipated co-benefits include health, especially regarding air pollution and diet, clean energy access and water availability"	Taken into account	Mikael Karlsson	KTH Royal Institute of Technology	Sweden
14159	7	45	7	45	"some sustainable areas show mixed evidence, such as economic prosperity and employment" However, this SDG does not exist, the one I think you refer is "decent work and economic growth". Please rephrase since there are many evidences showing that after a point, further economic growth is not related with economic prosperity (cf. Easterlin Paradox, e.g., Jackson 2009).  Jackson, T., 2009. Prosperity without Growth: Economics for a Finite Planet, Reprint. ed. Routledge.	Taken into account	Iñigo Capellán-Pérez	University of Valladolid	Spain
10165	7	45	7	46	Sentence is not clear: "mixed evidence such as economic prosperity and employment"?	Taken into account. Clarity will be improved	Aglaia Obrekht	Environment and Climate Change Canada	Canada
44137	7	40	8	4	The 'trade-offs' mentioned throughout the report must emphasize the need for change in the market systems which depend on over consumption. Commodifying the suffering and death of human beings into 'trade-offs' is what Naomi Klein argues is, a 'toxic idea has always been intimately tied to imperialism, with disposable peripheries being harnessed to feed a glittering centre, and it is bound up too with notions of racial superiority because in order to have sacrifice zones, you need to have people and cultures who count so little that they are considered deserving of sacrifice... it goes a long way toward explaining how the climate crisis challenges not only capitalism, but the underlying civilizational narratives about endless growth and progress within which we are all, in one way or another, still trapped"(Naomi Klein This Changes Everything 170) Reliance on policy design is problematic framing. Expanding the time horizon of trade-offs in the immediate to include historical reparations might have a better chance of framing a sustainable, longer term response. The problematic reliance on strategic policies which do not exist and do not have any history of working to lower emissions while promoting SDGs is frustrating. The report acknowledge the lack of precedence and lack of success in Paris Climate goals thus far yet still relies on same policy framing.	Taken into account. Thank you for the reflection	Emily Clark	Goldsmiths	United Kingdom (of Great Britain and Northern Ireland)
26237	7	11			I would agains suggest to stick with either NET or CDR terminoloty throughtout the report	Accepted. Terminology will be harmonised for SOD	Sara Budinis	International Energy Agency	France
30491	8	1	8	4	'don't understand what you wish to say - as the examples are a mix of good and bad things, and this makes for a confusing sentence. Maybe, 'avoid food deprivation', and 'compensated with employment and energy access'. Separate to clarify.	Taken into account. Clarity will be improved	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
24119	8	3	8	3	replace "deprivation" with "availability"	Accepted	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
10167	8	3	8	4	'these areas include' - what is meant by 'areas'? Areas of tradeoffs? Poly design? Additional policies?	Taken into account. Clarity will be improved	Aglaia Obrekht	Environment and Climate Change Canada	Canada
30139	8	3	8	4	Please elaborate with specific examples of measures that can avoid trade-offs	Accepted. Examples will be provided	Bert Metz	European Climate Foundation	Netherlands
2969	8	5	8	9	How living standards are measured? The statement needs qualification.	Taken into account. Sentence will be detailed	Mustafa Babiker	Aramco	Saudi Arabia
14161	8	5	8	9	Please add the following nuance (IN CAPS LOCK) which is very important as aforementioned:  Mitigation strategies which focus on low-energy and land based resources have overall lower trade-offs, LESS UNCERTAINTIES and negative consequences on sustainable development than pathways involving either high emissions and impacts, and those involving high consumption and emissions compensated by large quantities of BECCS.	Taken into account. We will consider adding it	Iñigo Capellán-Pérez	University of Valladolid	Spain
30141	8	6	8	7	it looks like this is referring only to efficient energy end-use, but low carbon energy supply would also be the right approach , isnt it?	Taken into account	Bert Metz	European Climate Foundation	Netherlands
30143	8	10	8	16	Feasibility is a crucial issue in drawing conclusions from IAM studies. It should be possible to draw more useful conclusions for policy makers. The SSP concept might be one way to show the limits of feasibility, as done in SR 1.5: some scenarios are feasible for SSP1, but no longer feasible for other SSPs. But then this should not be shown in one separate summary paragraph, but integrated in all other relevant paragraphs of the summary: 'when conclusions are drawn on what Paris 'compatible scenarios imply, a distinction should each time be made under what SSP assumptions this is valid. Other approaches to feasibility analysis could use socio-economic limits on various rates of change, derived from historic studies.	Taken into account	Bert Metz	European Climate Foundation	Netherlands
30493	8	10	8	20	It would help policy makers to have 'rights-based approaches', or 'people centered' or public participation included here in terms of healthy and supported forms of transformation.	Taken into account	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
14163	8	14	8	15	"Different enabling factors can reduce or avoid specific feasibility concerns." Please expand and say which are the main enabling factors.	Accepted. Enabling factors will be detailed	Iñigo Capellán-Pérez	University of Valladolid	Spain
46989	8	17	8	20	Mention of policy instruments in this summary should be extended or deleted. As is, the text does not help the reader understand the issues around assuming carbon pricing as the main/only instrument. There should be clarification that most models relevant to Ch3 do not aim to represent the specifics of policy instruments and assume a carbon price as a simple representation of many other different policy instruments.	Taken into account. We will extend the analysis	Frank Jotzo	ANU	Australia
4637	8	18	8	20	By affirming that using carbon pricing as the most efficient instrument to regulate emissions in the majority of scenarios exploring climate stabilization pathways in the past, you neither confirm such use nor discuss its real efficiency (which is partially disputable on my opinion).	Taken into account	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
24887	8	18	8	20	Delete "The majority of scenarios ... to regulate emissions." as this argument is not consistent with sustainable development	Taken into account. Text will be revised.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
30145	8	18	8	20	This is factually correct, but not something policy makers can work with. What should be added is that this policy instrument (uniform carbon tax) is not used in any practical situation, nor is it likely it will be used; that is udes by modellers as a convenient way to simulate a least cost approach. Then follow with an elaboration of policy instruments that can speed up transitions. That is what policy makers want to know.	Taken into account	Bert Metz	European Climate Foundation	Netherlands
46619	8	19	8	19	"focused on uniform carbon pricing as the most efficient instrument". Is this the most efficient instrument? See comment on P97 L29-33.	Taken into account	Florian Leblanc	Centre International de Recherche sur l'Environnement et le Développement	France
44533	9	2	9	36	Using "goals" in plural form (not your idea I know, it stems from the ch3 title) is a bit irritating since you tend to use "goals" as synonyms for targeted pathway levels - while the Paris Agreement talks only of one "Long-Term Temperature Goal" (see ch14). I guess you should clarify what the "goals" (plural form) are, it could for example encompass other PA goals beyond mitigation	Taken into account. Rephrasing will be considered.	Oliver Geden	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
35937	9	5	9	5	replace "a more global view and on issues" with "a more global view as well as issues"?	Taken into account. Rephrasing will be considered.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
14661	9	9	9	12	Cross-reference WG1 Section 5.5. Please clarify this statement as to avoid confusion between the concept of carbon neutrality and the idea of net zero greenhouse gas emissions as expressed in the Paris Agreement's text " a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases"	Taken into account. Text will be clarified	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
40959	9	9	9	12	I think a reference to Art.4 of the PA is needed here.	Accepted. Reference will be added	Jan Fuglestedt	CICERO	Norway
44531	9	9	9	17	An example for net zero CO2 vs. GHGs, again with the slightly misleading PA Art 4.1 quote	Taken into account. Distinction between concepts will be provided	Oliver Geden	German Institute for International and Security Affairs	Germany
40957	9	10	9	10	I suggest deleting "of carbon neutrality" since you introduce an undefined and similar concept to "balance" later in the same sentence.	Accepted	Jan Fuglestedt	CICERO	Norway
35939	9	14	9	14	indicate Sustainable Development Goal (SDG) for that first quotation	Accepted	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
35941	9	14	9	14	the assessment of possible and plausible, they are different but they are both determinant and structuring, leading to feasibility	Agreed. Section 3.8 discusses feasibility	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
12439	9	14	9	17	The following wording is very relevant: In addition, the assessment of possible social, economic, technical, political, and geophysical "feasibility" concerns of alternative pathways help to identify critical enabling conditions that would need to fall into place so that stringent climate goals become attainable. [Note that the latter assessment is still incomplete and under development]. In this context it seems important to clarify that at the point in time by when global 'carbon neutrality' is required in order to meet a given temperature goal, so-called residual GHG emissions are likely to be compensated by NET technologies only and that compensation by credits such as from mitigation projects would not be appropriate any more due to technological or economic or other barriers.	Taken into account. Text will be revised.	Klaus Radunsky	retired from Umweltbundesamt	Austria
2697	9	16	9	17	The sentence: [Note that the latter assessment is still incomplete and under development], I think needs a consideration before publishing the final report.	Accepted. The sentence will be removed in the next draft	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
35943	9	25	9	28	this passage is a bit redundant with section 3.1.2 and could be integrated	Taken into account.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
46621	9	25	9	28	The word "integration" is ambiguous. The chapter indeed rely on integrated modelling assessment, but IAM do not integrate as much bottom-up informations as in specific models and as described in the sectoral chapters (See for example the sentence P42L22-24 on the differences found in top-down versus bottom-up comparison studies).	Taken into account, but please note that text refers to sectoral models as bottom-up models	Florian Leblanc	Centre International de Recherche sur l'Environnement et le Développement	France
2699	9	38	9	38	"Chapter 3 links to many other chapters in the report." seems better to be "Chapter 3 is linked to many other chapters in the report."	Editorial. Taken into account	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
2701	9	40	9	41	The sentence: [Note that some of these connections require further coordination and are not fully implemented yet], I think needs a consideration before publishing the final report.	Accepted. The sentence will be removed in the next draft	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
41409	9	42	10	18	Do Chapter 3 and Chapter 4 use consistent climate models and carbon budgets? As in Annex C? Please clarify what are being done. Include the answers both in this chapter and the Executive Summary.	Thankyou for the comments. Yes, both Chapter 3 and 4 use consistent climate models and carbon budgets, as they rely on basically the same literature. New text will try to make this more clear.	Cheah Singfoong	Independent consultant, formerly more than 10 years with the National Renewable Energy Laboratory, USA	United States of America
40961	10	3	10	5	Yes, bringing the information from Ch3 and Ch4 will be very useful. But where in the WGIII report will that be? In TS? In SPM?	Thank you for the comment. For are still discussing this, but probably because of space limitation it would if better in the TS.	Jan Fuglestedt	CICERO	Norway
40963	10	13	10	15	Yes, very important that you emphasize the links related to Carbon budgets and climate models. It is essential that WGIII authors continue the contact with WGI authors on these issues. Regarding REMAINING CARBON BUDGETS: This chapter contains results that will be useful for the calculation of remaining carbon budgets. This will be treated in WGI and may be updated again in SyR based on more scenario results available for non-CO2 in WGIII. Thus, to secure flexibility and availability of data needed for presentation of remaining carbon budgets in SyR, I hope Ch3 will provide a clear and transparent documentation of relevant carbon budget data; e.g. in Annex or Supplementary Material. You may use the Supplementary Material to Ch2 in SR1.5 as an example of information needed and how to present that. Close contact with WGI authors on this issue is essential in order for securing flexibility and consistency. Regarding SIMPLE CLIMATE MODELS: RCMP can be useful here, as described in Annex C. Please keep in touch with WGI authors on this. (Bureau members can help with coordination.)	Taken into account. Thank you	Jan Fuglestedt	CICERO	Norway
2703	10	15	10	15	The sentence: [finalized by WGI in December 2019 but not in time to integrate into this FOD] needs considerations before publishing the report.	Accepted. The sentence will be removed in the next draft	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
32323	10	15	10	15	It sounds like missing an opportunity to use the latest material from WGI. Some text to explain what that means in terms of the accuracy / misalignment of results (if any) here and what WGI might present would be useful	Taken into account. Text will be revised to try to incorporate this great suggestion.	Penny Apostolaki	Barclays	United Kingdom (of Great Britain and Northern Ireland)
46623	10	23	10	24	The IP's do not as "representative" of the whole set of scenarios. According to table 3.3 P24, C5 scenarios (below 2.5") accounts for 29% of all mitigation scenarios (excluding C7), and C5 & C6 account for 43% of all scenarios (excluding C7). Also some modeling teams/paper deliberately choose a higher target in their scenario design with the argument that they are more 'plausible' or 'realistic' (see for example, <a href="http://dx.doi.org/10.1016/j.enpol.2013.05.118">http://dx.doi.org/10.1016/j.enpol.2013.05.118</a> ).	Taken into account. IPs in FOD are preliminary. For SOD, a new set of IPs will be used, aiming at providing a good representation of the whole set.	Florian Leblanc	Centre International de Recherche sur l'Environnement et le Développement	France
35945	10	26	10	26	comma after assessment?	Editorial. Taken into account	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
2705	10	33	10	35	The sentence: [Note that the assessment of the scenarios in the database is preliminary. Many more scenarios will be submitted throughout the assessment process. Statistics will thus change and are subject to further bias corrections] needs considerations before publishing the report.	Accepted. The sentence will be removed in the next draft	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
41581	10	35	10	35	The process of "bias correction" should be explained in future drafts.	Accepted. Explanation will be provided.	Ida Andrea Braathen Sognaes	CICERO centre for international climate research	Norway
32193	10	44	10	44	Please mention full statement of the referred portion from Article 4 between 'as soon as possible' and 'and to undertake'	Accepted - text removed	LOKESH CHANDRA DUBE	NATCOM Cell, Ministry of Environment, Forest and Climate Change, Government of India	India
40965	10	36	20	8	Section 3.2 is very useful for scene setting and overview.	Noted	Jan Fuglestedt	CICERO	Norway
36763	10	6			Change "important other" to 'Other important'	Editorial	Lazarus Chapungu	Great Zimbabwe University	Zimbabwe
41575	10	26			The selection method for the scenarios should be discussed (see also comment 6 and 7).	Taken into account - IP process	Ida Andrea Braathen Sognaes	CICERO centre for international climate research	Norway

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41577	10	26			What is meant by "a diverse set of studies" should be explained and made concrete. What is it that is diverse? (see also comment 7).	Taken into account	Ida Andrea Braathen Sognaes	CICERO centre for international climate research	Norway
41579	10	26			How the collection of scenarios improve our "understanding the uncertainties of the scenario space" should be explained or discussed. This is also related to sampling methods and diversity (comments 5 and 6).	Taken into account - scenario selection	Ida Andrea Braathen Sognaes	CICERO centre for international climate research	Norway
20261	11	27	4	12	Emission pathways are defined as "plausible representation of the future based on coherent and internally consistent set of assumptions". This is extremely vague. In order to make the scenarios plausible and consistent, all models optimize something. Optimization is required to make models plausible, because producers, governments and consumers optimize something. Optimization is also a requirement to make models consistent over time. The chapter should be clearer on what is optimized in the different scenarios. Here are the 4 most likely criteria: a) A mix of political feasibility and minimized costs. This leads to higher realism, but less transparency (unless the political constraints are clearly communicated). b) Discounted abatement costs in the period 2020-2100 for a given temperature target in 2100. This leads to large negative emissions in 2100, especially when the discount rate is high. These negative emissions are partly the result of the fact that optimization is indifferent to what happens after 2100 and are therefore time-inconsistent. c) Discounted abatement costs in the period 2020-infinity for a never to exceed temperature target. This is better than B), but the model is indifferent to the timing of the damages, which makes the model insufficiently ambitious at the start and too ambitious in the long run. (Dietz, S., & Venmans, F. M. J. (2019). Cumulative carbon emissions and economic policy: in search of general principles. Journal of Environmental Economics and Management, 96, 108–129.) d) Welfare over the period 2020-infinity. This is in theory leading to time-consistent paths, but is flawed with methodological difficulties: very large role for the discount rate, very large uncertainty for the damage function and difficult to integrate all the sources of uncertainty. The report should contain a brief discussion about the drawbacks of these targets. My motivation for this point is that the large negative emissions in most of the ambitious scenarios are not efficient. Gollier (2019. The cost-efficiency carbon pricing puzzle, TSE working paper) showed that roughly 80% of the IPCC AR5 trajectories had carbon prices increasing at a rate larger than the risk-adjusted interest rate, violating my above criterion C. In other words, the same temperature target can be obtained at lower discounted costs and/or at higher welfare. Somewhere, this should be mentioned. At the minimum, the report should be more transparent no what is optimized. (This remark also applies to section 1.5.2.1)	Taken into account - scenario selection	Frank Venmans	UMons	Belgium
40967	11	1	11	4	As suggested in a general comment to the whole chapter, a box clarifying the use of the concepts "balance", "net zero", "neutrality" etc is needed. Here you refer to "balance" in Art4, but say that you use net zero as an operationalization of the concept. This may not be obvious for readers. And you refer to SR1.5 regarding use of net zero CO2, but that chapter also has considered net zero GHG and its timing - which also may be worth attention; see table 2.4 in SR1.5	Taken into account - net-zero	Jan Fuglestedt	CICERO	Norway
14663	11	4	11	5	SR1.5 does not explicitly take net zero CO2 as a more direct formulation of Article 4, and given that the Paris Agreement text explicitly mentioned a balance between anthropogenic sources and sinks of greenhouse gas emissions, suggesting that net zero CO2 corresponds to Article 4 would be inaccurate. This can be resolved by highlighting the implications for both net zero CO2 (first) and net zero GHG (in a later year or decade).	Accepted - text removed	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
44535	11	4	11	5	net-zero GHG is the more direct operationalization of Art 4	Accepted - text removed	Oliver Geden	German Institute for International and Security Affairs	Germany
24121	11	5	11	13	We are in chapter 3. Reference to the same chapter should be "this chapter" instead of "chapter 3" which appears 3 times in this section	Editorial	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
35947	11	7	11	10	quotations in italics	Editorial	Sandrine Selse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
35949	11	7	11	10	"longer term goal"	Editorial	Sandrine Selse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
14665	11	13	11	14	Within the UNFCCC, the entirety of Article 2.1.a is referred to as "the long-term temperature goal". There is thus one goal, not several. This comes back several times in the chapter text.	Accepted - text removed	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
16545	11	19	11	26	In contrast to what some scientific literature claims, the ambiguity comes NOT from the definition of pre-industrial levels. The Structured Expert Dialogue (SED <a href="https://unfccc.int/7521.php">https://unfccc.int/7521.php</a> ) I have co-chaired has clearly shown that at the times of the Paris Agreement that climate change risks, e.g. the 5 RfCs, which the PA attempts to avoid are based on a pre-industrial level approximated by the mean between 1850 and 1900 (cf. Fischlin et al., 2015, e.g. page 49, para. 33 and footnote 23). The only ambiguity lies with the limit "well below 2°C" as I have explained in earlier comments. If pre-industrial should be better quantified (e.g. AR6 WGII) then nothing changes in terms of those limits, since they could be recalibrated accordingly, since the PA is based on a fixed (frozen in time) relationship between temperature limits and hereby avoided impacts regardless of any later "number games".  Cited References: ----- Fischlin, A., Ji, Z., Vladu, F. & Bisiaux, A., 2015. Report on the Structured Expert Dialogue on the 2013–2015 Review of the United Nations Framework Convention on Climate Change (UNFCCC). UNFCCC, Subsidiary Body for Implementation (SBI) and Subsidiary Body for Scientific and Technological Advice (SBSTA), Bonn, Germany. Final Report FCCC/SB/2015/INF.1, 182pp. <a href="http://unfccc.int/resource/docs/2015/sb/eng/inf01.pdf">http://unfccc.int/resource/docs/2015/sb/eng/inf01.pdf</a> Fi215	Accepted - text removed	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
40969	11	22	11	22	suggest adding more references than just one paper on the issue of temperature definition. See box 2.3 in WGI SOD.	Accepted - text removed	Jan Fuglestedt	CICERO	Norway
32161	11	22	11	23	Worth also mentioning Wigley 2018 as well, which also notes the inconsistency between articles 2 and 4.	Accepted - text removed	Michelle Cain	University of Oxford	United Kingdom (of Great Britain and Northern Ireland)
40971	11	23	11	23	The paper by Fuglestedt at al also discusses the consistency between Art 2 nad Art 4, and could be added together with Tanaka and O'Neill. In addition, Wigley 2018 (Climatic Change) also discusses this and could be added.	Accepted - text removed	Jan Fuglestedt	CICERO	Norway
16547	11	24	11	26	Here you argue rightly that you do not want to interpret the LTGG of the PA. Yet despite this promise you do exactly this by introducing the scenario category "well below 2°C" in this chapter. See for details my previous comment on "well below 2°C".  On page 3-12 line 16 you write that a backcasting approach can be used, which is fine. But the other way round is policy prescriptive. See for details my previous comment on "well below 2°C".	Accepted - text removed	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
35951	11	31	11	35	is the scenario in essence or definition plausible or is it a choice of the modeller or decision-maker, etc.?	Taken into account - scenario selection	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
14181	11	32	11	36	<p>Scenarios typically capture interactions and processes driving or limiting changes in key driving forces such as population, GDP, technology, lifestyles, and policy, and the consequences on energy use, land use, and emissions. Scenarios are generally not predictions or forecasts, but rather plausible representations of the future based on coherent and internally consistent set of assumptions</p> <p>However, it is extremely surprising that the variable which is identified as the most important driver of GHG emissions in Chapter 2 is considered as exogenous in climate scenarios. This requires an explanation since an obvious policy to reduce GHG emissions derived from this empirical fact would be to design societies which are not dependent on GDP growth (cf. Hicel and Kallis 2019; Parrique et al 2019; Demaria et al 2013). Similar comment for population and the modelling of climate change impacts (cf. Dietz and Stern 2015; Diaz &amp; Moore 2017).</p> <p>Hicel, J., Kallis, G., 2019. Is Green Growth Possible? New Political Economy 0, 1–18. <a href="https://doi.org/10.1080/13563467.2019.1598964">https://doi.org/10.1080/13563467.2019.1598964</a></p> <p>Parrique, T., Barth, J., Briens, F., Kerschner, C., Kraus-Polk, A., Kuokkanen, A., Spangenberg, J.H., 2019. Decoupling debunked - Evidence and arguments against green growth as a sole strategy for sustainability. European Environmental Bureau (EEB).</p> <p>Demaria, F., Schneider, F., Sekulova, F., Martinez-Alier, J., 2013. What is Degrowth? From an Activist Slogan to a Social Movement. Environmental Values 22, 191–215. <a href="https://doi.org/10.3197/096327113X13581561725194">https://doi.org/10.3197/096327113X13581561725194</a></p> <p>Diaz, D., Moore, F., 2017. Quantifying the economic risks of climate change. Nature Climate Change 7, 774–782.</p> <p>Dietz, S., Stern, N., 2015. Endogenous Growth, Convexity of Damage and Climate Risk: How Nordhaus' Framework Supports Deep Cuts in Carbon Emissions. The Economic Journal 125, 574–620.</p>	Taken into account - scenario selection	Iñigo Capellán-Pérez	University of Valladolid	Spain
40973	11	44	11	44	Useful that you relate the two words "baseline" and "reference". But you can be even clearer and say that you will use "baseline" and not "reference" in the rest of the chapter (as far as I can see). Please also check consistency across chapters.	Taken into account - baselines	Jan Fuglestedt	CICERO	Norway
27653	11	43	12	21	The paragraph 11/43-12/18 is slightly confusing as introduce too many variants of scenarios and paths including possible uses in a not very structured manner. A reorganisation might be helpful. A short explanation of backcasting might be useful. The lines 18-21 might arguably profit from being included in the preceding paragraph.	Taken into account	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
6141	11	43	12	34	The discussion about the baseline is very relevant, and therefore, I think it should be enlarged, discussing the validity of no-climate-policy baselines as counterfactuals, which is heavily contested, in particular in the case of RCP8.5, which is considered not realistic by many. First, because the baseline will always include climate policies, and second because there is already unstoppable technological evolution that must be included in the baseline (even if we do not term that climate policy)	Taken into account - baselines	Linares Pedro	Universidad Pontificia Comillas	Spain
14667	11	27	13	20	This section provides a good overview of the use and concepts of emissions pathways but I can find an assessment by the author team of the evidence and their confidence in these pathways as tools to assess the questions that this chapter addresses.	Taken into account - IP process	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
27651	11	27	13	20	The presentation of so many pathways, scenarios, etc. is neither very well organized nor very clear. More convincing presentations exist in the literature, inclusive if I am not mistaken in IPCC publications. Is it necessary to reinvent the wheel every time?	Taken into account	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
45037	11	4			Please clarify that net-zero CO2 is only a part of what is covered in Article 4 - what's currently written here is both wrong and confusing as it equates net-zero CO2 with the "balance of sources and sinks" in Article 4!	Accepted - text removed	Andy Reisinger	NZAGRC	New Zealand
37193	11	22			<p>The "balance" as well as "consistency between Article 2 and 4" can be made an issue if interpretations are taken that divert from the approach taken in the AR5 on which the Agreement is based. If the Paris Agreement is interpreted in the metrics based on the Paris Agreement (temperature as well as GWP), Article 2 and 4 provide a fully consistent set.</p> <p>See Schlessner, C.-F., Nauels, A., Schaeffer, M., Hare, W., &amp; Rogelj, J. (2019). Inconsistencies when applying novel metrics for emissions accounting to the Paris Agreement. Environmental Research Letters, (December 2016), 0–22. <a href="https://doi.org/10.1088/1748-9326/ab56e7">https://doi.org/10.1088/1748-9326/ab56e7</a></p>	Accepted - text removed	Michiel Schaeffer	Climate Analytics	Netherlands
46929	11	43			Please be aware that a special issue is under review and planned for publication in June 2020 in Journal of Global Economic Analysis (vol 2 2020) on how to make baseline scenarios. The introductory paper is Dellink, R, D.Y. van der Mensbrugge and B. Saveyn (2020): Shaping baseline scenarios of economic activity with CGE models: introduction to the special issue. A draft can be requested from Dominique Y van der Mensbrugge (vandermd@purdue.edu). One draft of the paper addressing energy and emissions projections is already now available in the CESifo Working Paper series: Fæhn, T., G. Bachner, R. Beach, J. Chateau, S. Fujimori, M. Ghosh, M. Hamdi-Cherif, E. Lanzi, S. Paltsev, T. Vandyck, B. Cunha, R. Garaffa, K. Steininger (2020): Capturing key energy and emission trends in CGE models: Assessment of status and remaining challenges, CESifo Working Paper no. 8072; see: <a href="https://www.cesifo.org/en/publikationen/2020/working-paper/capturing-key-energy-and-emission-trends-cge-models-assessment">https://www.cesifo.org/en/publikationen/2020/working-paper/capturing-key-energy-and-emission-trends-cge-models-assessment</a>	Taken into account - baselines	Taran Fæhn	reserach institute	Norway
1291	11				Please define baseline, scenario and pathway in a unique and clear way. You cannot say "Pathways show the temporal evolution of different natural or human systems and may 29 build on quantitative or qualitative scenarios of potential futures. A scenario is an internally consistent, plausible, and integrated description of a possible future of the human–environment system (IPCC 31 2000), and could be a qualitative narrative, quantitative projection, or both." and then say: "The most comprehensive scenarios in the literature often comprise narratives (qualitative descriptions of how the future may unfold), which are then translated into quantitative pathways using models"	Taken into account	VALENTINA BOSETTI	BOCCONI -eiee	Italy
10105	12	1	12	18	It would be clearer to specify here that the mitigation scenarios are depicting changes to a corresponding baseline, i.e. the mitigation scenario is showing a change from a specific baseline. Otherwise it sounds like any mitigation scenario can be compared to any baseline, which would be not internally consistent and would make for incoherent comparisons.	Taken into account - baselines	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
14183	12	4	12	6	<p>"The most common baseline in the climate scenario literature is a no-climate-policy baseline, which acts as a counterfactual to highlight the level of emissions that would occur without further climate policy effort"</p> <p>And WITHOUT climate change impacts feedbacking damages to society (cf. BAU scenario in Capellán-Pérez et al 2020 and Giraud et al 2016 which integrating this is qualitatively different from most BAUs in the literature)</p> <p>Giraud, G., Mc Isaac, F., Bovari, E., Zatssepina, E., 2016. Coping with the Collapse: A Stock-Flow Consistent Monetary Macro-dynamics of Global Warming. AFD Research Papers.</p> <p>Capellán-Pérez, I., Blas, I. de, Nieto, J., Castro, C. de, Miguel, L.J., Carpintero, Ó., Mediavilla, M., Lobejón, L.F., Ferreras-Alonso, N., Rodrigo, P., Frechoso, F., Álvarez-Antelo, D., 2020. MEDEAS: a new modeling framework integrating global biophysical and socioeconomic constraints. Energy Environ. Sci. <a href="https://doi.org/10.1039/C9EE02627D">https://doi.org/10.1039/C9EE02627D</a></p>	Taken into account - baselines	Iñigo Capellán-Pérez	University of Valladolid	Spain
27655	12	8	12	10	The sentence is not clear.	Editorial	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31961	12	15	12	16	When applied to a long-term target such as 'well below 2°C', a backcasting approach can be used to determine how the system changes from the baseline to the target (mitigation pathway), but also to propose contingency measures and strategies for staying on course (Van Der Voorn et al. 2020) > 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). <a href="https://doi.org/10.1007/s10113-020-01618-5">https://doi.org/10.1007/s10113-020-01618-5</a>	Accepted - text removed	Tom van der Voorn	Institute for Environmental Systems Research	Netherlands
10107	12	15	12	18	It is good that probabilistic emissions pathways are noted here, but the current text should at least make an attempt to explain some of the methodological issues with probabilistic scenarios otherwise this portion is a non-sequitur	Accepted - text removed	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
5091	12	16	12	18	It would be good to provide a reference	Editorial	Matthias Weitzel	European Commission, Joint Research Centre	Spain
40975	12	17	12	18	Regarding "probabilistic emissions pathways": What does it mean that these are not well represented in the climate scenario literature? I think some more explanation is needed here; with references to some key publications on this topic.	Accepted - text removed	Jan Fuglestedt	CICERO	Norway
14185	12	19	12	20	"Thus, the baseline is critical to determine mitigation challenges and costs"  Hence, it is not very comprehensible why baseline scenarios have been excluded from the AR6 database as done in previous reports? As shown in the AR5 there are also important divergences among BAU which are relevant. In the light of these facts, it is strongly suggested to include also in the database the baselines to amend this gap. The database should include baselines to allow for transparency, for example Pielke et al 2008 shown that there was a significant level of built-in of GHG mitigation already in baselines, or the BAU depicted by Capellán-Pérez et al 2020 is substantially different from most of the BAUs.  Pielke, R., Wigley, T., Green, C., 2008. Dangerous assumptions. Nature 452, 531–532. <a href="https://doi.org/10.1038/452531a">https://doi.org/10.1038/452531a</a> Capellán-Pérez, I., Blas, I. de, Nieto, J., Castro, C. de, Miguel, L.J., Carpintero, O., Mediavilla, M., Lobejón, L.F., Ferreras-Alonso, N., Rodrigo, P., Frechoso, F., Álvarez-Antelo, D., 2020. MEDEAS: a new modeling framework integrating global biophysical and socioeconomic constraints. Energy Environ. Sci. <a href="https://doi.org/10.1039/C9EE02627D">https://doi.org/10.1039/C9EE02627D</a>	Taken into account - baselines	Iñigo Capellán-Pérez	University of Valladolid	Spain
40317	12	19	12	34	This is a very dangerous characterization that treats mitigation, CDR and SRM (!!) as a triad of options on equal terms. This is particularly worrisome given that WGI highlights the difficulties and uncertainties around CDR from a geophysical and biogeochemical perspective, and many concerns around the devastating impacts and in fact undesirability of large-scale CDR are flagged throughout the report. Both CDR and SRM are very contentious issues and subject to very controversial discussions in various multilateral and UN fora, and such a characterization of how CDR and SRM relates to mitigation has the potential for significant tensions. In particular, the statement in lines 33-34 is highly problematic in that it gives a very misleading impression that SRM was an established and proven-to-work option for temperature reduction. It is entirely unclear how SRM would work outside of computer models, and what the impacts and side-effects would be. It seems very dangerous to include such a casual statement on SRM here.	Taken into account - SRM	Linda Schneider	Heinrich Boell Foundation	Germany
44537	12	19	12	34	In case you keep this macro-policy discussion (including SRM) you might refer to the discussion of SRM governance in ch14 and to some literature covering all three macro-level elements (conventional abatement - CDR - SRM), which comes mostly from the SRM community. Maybe better to go with this one <a href="https://www.sciencedirect.com/science/article/abs/pii/S0959378012001197">https://www.sciencedirect.com/science/article/abs/pii/S0959378012001197</a>	Taken into account - SRM	Oliver Geden	German Institute for International and Security Affairs	Germany
10169	12	20	12	21	Please substantiate the claim that 'the baseline may not be defined in forecasting or system dynamic type models'. Is it because the SD models are not able to capture the CCS, DAC, SRM, CDR, etc? That would depend on the model and how it parametrizes these mechanisms. Also, it is unlikely that the baseline would include these mechanisms of reducing GHG emissions.	Accepted - text removed	Aglaia Obrekht	Environment and Climate Change Canada	Canada
14187	12	21	12	27	"Broadly, a mitigation scenario can incorporate three main changes from a baseline scenario"  A 4th should be added with relation to demand-side response/behavioral/lifestyle changes (see references in Appendix C)	Taken into account - SRM	Iñigo Capellán-Pérez	University of Valladolid	Spain
39581	12	21	12	34	It is extremely concerning and scientifically not sound that IPCC incorporate in mitigation scenarios technologies that are ranging from non-existent (all SRM technologies) to almost non-existent because they are not proved to function at any viable commercial scale, and definitely not at the large scale necessary to play a role in a scientifically sound credible scenario. (Anderson & Peters, 2016; Karta & Dooley, 2016)	Taken into account - SRM	SILVIA RIBEIRO	ETC Group	Mexico
39583	12	21	12	34	It is extremely concerning and scientifically not sound that IPCC incorporate in mitigation scenarios technologies that are ranging from non-existent (all SRM technologies) to almost non-existent because they are not proved to function at any viable commercial scale, and definitely not at the large scale necessary to play a role in a scientifically sound credible scenario. (Anderson & Peters, 2016; Karta & Dooley, 2016) References: Anderson, K. and Peters, G. (2016) The trouble with negative emissions, Science [online], 354 (6309), pp182-3. Available from: <a href="https://science.sciencemag.org/content/354/6309/182">https://science.sciencemag.org/content/354/6309/182</a> // Kartha, Sivan and Kate Dooley (2016) The risks of relying on tomorrow's 'negative emissions' to guide today's mitigation action, Stockholm Environment Institute, SEI Working Paper No. 2016-08	Taken into account - SRM	SILVIA RIBEIRO	ETC Group	Mexico
39585	12	21	12	34	Options that are really feasible, from economic, social and ecological point of view, such as reforestation and ecosystem restoration, shouldn't be lumped in any scenario as "carbon dioxide removal" with risky, uncertain and unproven technologies, as all the others mentioned, such as BECCS and DAC.	Taken into account - SRM	SILVIA RIBEIRO	ETC Group	Mexico
39587	12	21	12	34	We are already witnessing a deviation of resources and political attention to REAL mitigation, that means reductions of GHG emissions, because of the illusion that BECCS or DAC are available. None of them are available or feasible, because they are not technically or economically viable, due to their high energy demand (DAC) or the extreme impacts on biodiversity and competition with food systems (BECCS) (Biofuelwatch 2020, Schneider, 2019) References: Biofuelwatch – BW (2020) Biomass with CCS (BECCS) [online]. Available from: <a href="https://www.biofuelwatch.org.uk/category/reports/beccs/">https://www.biofuelwatch.org.uk/category/reports/beccs/</a> // Schneider, L. (2019) Fixing the climate? How geoengineering threatens to undermine the SDGs and climate justice, Development [online] 62, pp29-36	Taken into account - SRM	SILVIA RIBEIRO	ETC Group	Mexico
39589	12	21	12	34	In the case of SRM, all technologies are theoretical, speculative and unproven. All carry unsurmountable challenges in terms of unequal and unfair distribution of impacts, and most articles proposing these techniques, are biased towards its development and deployment because of commercial interest of the researchers and proponents (ETC group et al, 2018; Oldham, 2014)	Taken into account - SRM	SILVIA RIBEIRO	ETC Group	Mexico
39591	12	21	12	34	References: Paul Oldham et al, "Mapping the landscape of climate engineering," Philosophical Transactions of the Royal Society, Vol. 372, 2014, p. 2. Available at <a href="http://rsta.royalsocietypublishing.org/content/372/2031/20140065">http://rsta.royalsocietypublishing.org/content/372/2031/20140065</a> ; //	Taken into account - SRM	SILVIA RIBEIRO	ETC Group	Mexico
39593	12	21	12	34	ETC group, Heinrich Böll Foundation, Biofuelwatch (2018) The Big Bad Fix, The case against climate geoengineering, pp 30-32 [online]. Available from <a href="https://www.etcgroup.org/content/big-bad-fix">https://www.etcgroup.org/content/big-bad-fix</a>	Taken into account - SRM	SILVIA RIBEIRO	ETC Group	Mexico
38783	12	23	12	25	Some readers may be unfamiliar with how CCS, BECCS, and DAC fit into CDR. Given the general categorical discussion between CDR and SRM, it would be useful from both a scientific and communication standpoint to be clear in how the aforementioned technologies are CDR.	Taken into account - SRM	Julian Reyes	Personal Capacity	United States of America

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
43379	12	24	12	25	The list is somewhat incorrect: Direct Air Capture by itself does not constitute a CDR; Direct Air Carbon Capture and Storage (DACCS) does;  see e.g. Honegger, M., & Reiner, D. (2018). The political economy of negative emissions technologies: consequences for international policy design. Climate Policy, 18(3), 306-321.	Taken into account - SRM	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
46993	12	24	12	26	List of NETs is incomplete. Add other NET examples to avoid misperceptions that there is only BECCs and DAC.	Taken into account - SRM	Frank Jotzo	ANU	Australia
39595	12	25	12	27	All SRM techniques are theoretical and speculative, shouldn't be taken into account in a scientifically sound scenario. Delete SRM from all scenarios	Taken into account - SRM	SILVIA RIBEIRO	ETC Group	Mexico
24123	12	26	12	26	insert "reduce" between "intervention" and "incoming"	Editorial	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
43381	12	26	12	26	Solar Radiation Modification was introduced as a term instead of Solar Radiation Management in SR1.5; the same term should be used consistently in AR6! Also SRM is commonly used to describe deliberate alterations affecting either incoming solar radiation or outgoing infrared radiation. For the purpose of a complete categorisation, this should be included here.	Taken into account - SRM	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
24125	12	27	12	27	insert "methods" between "abatement" and "to"	Editorial	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
40977	12	27	12	28	Seems odd with one reference for this statement about residual emission. I suggest adding some more key studies here.	Taken into account - net-zero	Jan Fuglestedt	CICERO	Norway
27657	12	27	12	34	The fragment is poorly formulated	Editorial	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
43383	12	29	12	29	...for CO2 but not for other GHG...	Editorial	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
43385	12	29	12	29	This is not correct. Net-zero CO2 emissions does not avoid further increase in average temperature! Other residual ghg emissions need to be compensated for by additional removals i.e. net-negative CO2 emissions!	Taken into account - net-zero	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
40069	12	29	12	31	Please reword "To avoid ... residual emissions" as follows: "To avoid a further increase in average temperature (without SRM) all climate forcers need to be brought to zero, i.e. greenhouse gas emissions and reinforcing effects. This means CO2 emissions need to become negative."	Taken into account - net-zero	Axel Michaelowa	University of Zurich	Switzerland
43545	12	29	12	31	Please reword "To avoid ... residual emissions" as follows: "To avoid a further increase in average temperature (without SRM) all climate forcers need to be brought to zero, i.e. greenhouse gas emissions and reinforcing effects. This means CO2 emissions need to become negative."	Taken into account - net-zero	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
45543	12	30	12	30	suggest "net CO2 emissions should be zero" given the context	Taken into account - net-zero	Daniel Crow	International Energy Agency	France
35973	12	31	12	31	indicate Carbon Dioxide Removal (CDR) for that first quotation (outside the executive summary)	Taken into account - net-zero	Sandrine Selosse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
43387	12	33	12	33	This list can be made more useful and complete by adding the following: Scenarios of SRM application can also be designed to shave off the peak of warming that would otherwise result from overshoot-and-return of GHG-budgets.  MacMartin, D. G., Ricke, K. L., & Keith, D. W. (2018). Solar geoengineering as part of an overall strategy for meeting the 1.5 C Paris target. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 376(2119), 20160454.  Keith, D. W., & MacMartin, D. G. (2015). A temporary, moderate and responsive scenario for solar geoengineering. Nature Climate Change, 5(3), 201-206.	Taken into account - SRM	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
3221	12	33	12	34	The statement "It is also possible to use SRM to reduce temperature further beyond what is done by conventional abatement and CDR" could raise wrong expectations without further qualification. E.g. some/almost all authors considering SRM come to the following conclusions: there are many risks associated with SRM; SRM cannot substitute for mitigation and/or CDR; before any deployment of SRM at scale governance issues need to be resolved. Just to highlight some. It is furthermore suggested to include in a box the risks associated with SRM.	Taken into account - SRM	Klaus Radunsky	retired from Umweltbundesamt	Austria
37195	12	33	12	34	delete sentence "It is also possible to use SRM to reduce temperature further beyond what is done by conventional abatement and CDR", because the simple statement of "it is also possible" comes with a long list of caveats. Replace by reference to WG1 assessment of SRM, e.g. "See Working Group I assessment chapter X for considerations and concerns related to SRM for reducing temperature further beyond what is done by conventional abatement and CDR"	Taken into account - SRM	Michiel Schaeffer	Climate Analytics	Netherlands
39597	12	33	12	34	There is no basis/evidence to affirm that SRM would actually reduce temperature. This statement should be deleted, as well as all references to SRM that take it as a real option -they are just speculative.	Taken into account - SRM	SILVIA RIBEIRO	ETC Group	Mexico
40071	12	33	12	34	Replace "It is also possible ..." by: "Alternatively SRM could be applied to shave off the peak of warming " (Keith and MacMartin 2015, MacMartin et al. 2018). MacMartin, D. G., Ricke, K. L., & Keith, D. W. (2018). Solar geoengineering as part of an overall strategy for meeting the 1.5 C Paris target. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 376(2119), 20160454.; Keith, D. W., & MacMartin, D. G. (2015). A temporary, moderate and responsive scenario for solar geoengineering. Nature Climate Change, 5(3), 201-206.	Taken into account - SRM	Axel Michaelowa	University of Zurich	Switzerland
40979	12	33	12	34	This sentence is too simple and needs more nuances. It also sounds as if you have done an assessment here. What is meant by possible here? Geophysically, technological, in terms on international coordination and governance...? I suggest consulting with the xWG team on SRM.	Taken into account - SRM	Jan Fuglestedt	CICERO	Norway
43547	12	33	12	34	Replace "It is also possible ..." by: "Alternatively SRM could be applied to shave off the peak of warming " (Keith and MacMartin 2015, MacMartin et al. 2018). MacMartin, D. G., Ricke, K. L., & Keith, D. W. (2018). Solar geoengineering as part of an overall strategy for meeting the 1.5 C Paris target. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 376(2119), 20160454.; Keith, D. W., & MacMartin, D. G. (2015). A temporary, moderate and responsive scenario for solar geoengineering. Nature Climate Change, 5(3), 201-206.	Taken into account - SRM	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
36765	12	23			Change "including with Carbon Capture ..." to "including Carbon capture ....."	Editorial	Lazarus Chapungu	Great Zimbabwe University	Zimbabwe
16519	12	34			"the share of nuclear energy is just 1%", it is better to check the number again	Editorial	Lining WANG	Economics and Technology Research Institute, CNPC	China
2707	13	1	13	1	The word "Abatement" in the figure is not easily readable. I think the color needs modification.	Editorial	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
35953	13	1	13	1	The colours in the graph are not easily distinguishable. The word "abatement" is not very visible/readable	Editorial	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
43389	13	1	13	1	Why is there no illustration of the potential uses of SRM (see commentary above on peak-shaving or slowing the rate of warming)?	Taken into account - SRM	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
35955	13	1	13	9	repetition with what is written above. This passage would be better placed in the text than in the title of the graph.	Editorial	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
44539	13	1	13	9	Would it be possible to show LUC (in this figure, but maybe also in other, more granular figures) not as a net value, but disaggregated as LUC emissions and LUC removals? I know that's usually not done (I don't know why) but it would more clearly show that getting LUC into the negative does not simply require more afforestation	Editorial	Oliver Geden	German Institute for International and Security Affairs	Germany
10109	13	1	13	22	I'm glad to see that there is an attempt to show that the scenarios considered in this chapter are not fully comprehensive of the possible scenario space, however there are more comprehensive approaches to doing this an attempt should be made to visualize this with analytical rigor - for example using a graphic scenario mapping example as shown in this paper: <a href="https://doi.org/10.1088/1748-9326/aaa494">https://doi.org/10.1088/1748-9326/aaa494</a>	Taken into account - scenario selection	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
20575	13	2	13	2	Minor comment: The leading line for the "BECCS" label falls on the dotted black line which I assume is the "Net emissions", while I assume the green area is the BECCS mitigation contribution. This may lead to some confusion amongst readers not familiar with this (or equivalent) figures.	Editorial	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
24127	13	2	13	9	The title to the figure 3.1 should read "Mitigation Pathways 2000-2100" The rest of the current Title should be moved into the body of the chapter to explain what is in the figure.	Editorial	Alfred Ofoosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
37197	13	8	13	9	Since SRM does not help to reduce emissions, it is incorrect to mention "It is also possible to include Solar Radiation Management (SRM), not shown in the figure." Delete this sentence. Note emissions have adverse effects incl. ocean acidification that are not addressed by SRM.	Taken into account - SRM	Michiel Schaeffer	Climate Analytics	Netherlands
39599	13	8	13	9	As argued in the comments above, SRM should not be included in any scenario. This comment at the end of the paragraph is unnecessary and should be deleted.	Taken into account - SRM	SILVIA RIBEIRO	ETC Group	Mexico
40981	13	8	13	9	This sentence is too simple and needs more nuances. It also sounds as if you have done an assessment here. What is meant by possible here? Geophysically, technological, in terms on international coordination and governance...? I suggest consulting with the xWG team on SRM.	Taken into account - SRM	Jan Fuglestedt	CICERO	Norway
9969	13	10	13	20	The way IAMs are framed allows various interpretations, allowing for different levels of detail for the climate/emissions module within the framework of a model. As such, there are models that do not fall into the partial or general equilibrium modelling category, as reflected in earlier or more recent (than AR5 cycle & literature) reviews, e.g.: - Schwanz, V. J. (2013). Evaluating integrated assessment models of global climate change. Environmental modelling & software, 50, 120-131. - Wei, Y. M., Mi, Z. F., & Huang, Z. (2015). Climate policy modeling: an online SCI-E and SSCI based literature review. Omega, 57, 70-84. - Stanton, E. A., Ackerman, F., & Kartha, S. (2009). Inside the integrated assessment models: Four issues in climate economics. Climate and Development, 1(2), 166-184.  For a more recent and complete overview, targeted at various audiences (of different level of expertise) with references to the advantages and disadvantages, structure, and other aspects (e.g. uncertainty and technological change), can be found in: - Nikas, A., Doukas, H., & Papandreou, A. (2019). A detailed overview and consistent classification of climate-economy models. in Understanding Risks and Uncertainties in Energy and Climate Policy (pp. 1-54). Springer, Cham.	Taken into account - scenario selection	Haris Doukas	School of Electrical and Computer Engineering, National Technical University of Athens	Greece
27659	13	16	13	17	The sentence is unclear	Editorial	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
27661	13	22	13	28	The fragment is poorly formulated	Editorial	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
40983	13	24	13	24	Would be useful if you explain what is meant by "grey literature". (Not clear to all readers)	Taken into account	Jan Fuglestedt	CICERO	Norway
10805	13		13		At the beginning (p.4) of Chapter 2 of WG3, global GHG emissions in 2018 is described as "S8 (±5.8) GtCO2eq in 2018 (medium confidence)". Whereas in Figure 3.1, it seems that GHG emissions in 2018 is less than 58GtCO2eq. Please contact Chapter 2 team and show uniform figures throughout the report. If this chapter has any particular reason to use another figure, make it clear with reasons.	Taken into account	Mitsutsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
27669	13	21	14	2	The presentation is difficult to follow, in part because of the reference to the "solution space". Wouldn't it been more forward to say e.g. that, while a very large number of possible futures have been explored in simulations, many others were not? And so on. At a later place I express my concern with the unfamiliar use (unfamiliar at least for the general public and a large part of the scientific community) of "solving" and "solution".	Taken into account - scenario selection	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
14189	13	22	14	12	There are also scenarios which have been framed theoretically but (still) not quantitatively, this should also be reflected, cf, DeMaria et al 2013; Cosme et al 2017  Demaria, F., Schneider, F., Sekulova, F., Martinez-Alier, J., 2013. What is Degrowth? From an Activist Slogan to a Social Movement. Environmental Values 22, 191–215. <a href="https://doi.org/10.3197/096327113X13581561725194">https://doi.org/10.3197/096327113X13581561725194</a> Cosme, I., Santos, R., O'Neill, D.W., 2017. Assessing the degrowth discourse: A review and analysis of academic degrowth policy proposals. Journal of Cleaner Production 149, 321–334. <a href="https://doi.org/10.1016/j.jclepro.2017.02.016">https://doi.org/10.1016/j.jclepro.2017.02.016</a>	Taken into account - scenario selection	Iñigo Capellán-Pérez	University of Valladolid	Spain
14669	13	21	17	9	The description of the SSP framework and scenario resources is useful. However, currently lacking is an assessment of the adequacy of these tools to address the questions this chapter has been asked to assess. Is the SSP framework an adequate framework? Are the scenarios as they are modelled adequate scenarios? Probably the answer in both cases is yes, but some reflection and evidence to support this would be helpful, together with potential limitations.	Taken into account - scenario selection	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
17189	13	21	17	9	Please include a table with the core characteristics of the SSPs. Later in the text, the differences are important to understand the comparisons and the IPs, so it would be helpful to present the SSPs here not only "by name". too.	Taken into account - scenario selection	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
30883	13	21	17	9	Section 3.2.3 would be stronger if it included an assessment of potential biases caused by the AR's scenario sampling approach. The section correctly notes that published scenarios are not the result of "well-designed sampling" of possible scenarios: that is, IPCC does not determine what scenarios are published. The AR team does, however, choose which published scenarios to include and emphasize. A critical examination of this choice would help readers better evaluate the results in Chapter 3.	Taken into account - scenario selection	Jason Veysey	Stockholm Environment Institute	United States of America
5093	13	1			Would it make sense to provide a scenario that is in line with the NDCs? I.e. something between the Baseline and a strong reduction scenario? This would also be related to Chapter 4, where gaps are assessed between current policies and NDC scenarios.	Taken into account - IP process	Matthias Weitzel	European Commission, Joint Research Centre	Spain
20327	13	20			there is reference to 'Annex C' which is MOST important for a detailed review, but Annex C is not available for review, only the chapters. This is not acceptable, since the basis fo the IPx is now hidden. Disclosure, in particular also for review is essential!	Taken into account - IP process	Christian Breyer	LUT University	Finland
36767	13	27			There is need for further elaboration on the unexplored scenarios and if possible provide examples or at least "hypothetical" examples for clarity purposes.	Taken into account - scenario selection	Lazarus Chapungu	Great Zimbabwe University	Zimbabwe



Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
27875	14	1	14	2	Suggest that the wording of this sentence is changed to read either 'play a greater part' or 'have greater weight', as it is unclear at the moment.	Editorial	Jenkins Rhosanna	University of East Anglia	United Kingdom (of Great Britain and Northern Ireland)
26093	14	4	14	4	Coupled Model Intercomparison Project', not 'Community Model Intercomparison Project'.	Editorial	Junichi Tsutsui	Central Research Institute of Electric Power Industry	Japan
35963	14	4	14	4	Coupled Model Intercomparison Project Phase 6 (CMIP6) instead of Community Model Inter-comparison Project (CMIP6)	Editorial	Sandrine Selse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
40985	14	12	14	12	Add "both" after "from" ?	Editorial	Jan Fuglestedt	CICERO	Norway
4639	14	14	14	19	Text in Figure 3.2 appears lengthy. Moving part of it in the main body text may give more relevance to its content.	Editorial	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
24129	14	14	14	21	The figure 3.2. should have a Title. The explanation should not be a part of the title.	Editorial	Alfred Oforu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
36769	14	14	14	21	Is it possible to show the " unexplored " scenarios in this figure? That would provide a complete picture of scenario space. The figure on its own must tell us a complete story of the scenario space.	Taken into account - scenario selection	Lazarus Chapungu	Great Zimbabwe University	Zimbabwe
2709	14	19	14	21	The sentence: [Note: This figure will be built on during LAM3, incorporating more nuance and more accurately indicating the scenario space and model inter-comparisons] needs considerations before publishing the report.	Editorial	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
35957	14	22	14	22	indicate Shared Socioeconomic Pathways (SSPs) for that first quotation (outside the executive summary) and a duration (ongoing for example)	Editorial	Sandrine Selse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
9971	14	22	15	1	Table 3.1: It is very encouraging to include model inter-comparisons to be carried out in ongoing projects, such as ENGAGE. The PARIS REINFORCE project should also be included: - PARIS REINFORCE; Delivering on the Paris Agreement: A demand-driven, integrated assessment modelling approach, including inter alia model inter-comparisons based on a large number of IAMs; 2019-2022; (Doukas et al., 2018); <a href="https://paris-reinforce.eu/">https://paris-reinforce.eu/</a>  Key reference here: - Doukas, H., Nikas, A., González-Eguino, M., Arto, I., & Anger-Kraavi, A. (2018). From integrated to integrative: Delivering on the Paris Agreement. Sustainability, 10(7), 2299.	Taken into account	Haris Doukas	School of Electrical and Computer Engineering, National Technical University of Athens	Greece
27663	14	1	18	27	It would be fair to note that a fundamental limit to IAMs stems from the fact that they are based on historical trends and designed to capture gradual (and, arguably, only limited) changes. They are not the most appropriate tool to account for technological disruptions and behavioural, organisational or political changes, and tipping points, and thus arguably tend to understate the potential for both favourable and (very) unfavourable developments. I make related, more developed comments in my review of Chapter 17. More generally, wouldn't it be appropriate to include a paragraph on the existing critics of IAMs – a recent review article being Gambhir (2019). A. Gambhir et al. (2019), A Review of Criticisms of Integrated Assessment Models and Proposed Approaches to Address These, through the Lens of BECCS. Energies 2019, 12, 1747.	Taken into account - scenario selection	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
35959	15	8	15	8	comma after (inequality)	Editorial	Sandrine Selse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
40987	15	9	15	9	Re "storytelling": I think this can be misunderstood by readers who are not familiar with this concept in the academic literature. Reformulate?	Taken into account - scenario selection	Jan Fuglestedt	CICERO	Norway
35961	15	16	15	16	indicate Representative Concentration Pathways (RCPs) here rather than on the next page	Editorial	Sandrine Selse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
11899	16	1	16	6	This illustration could also be accompanied with the relationship between SSPx-y and to what extend each SSPx-y will fulfill the Paris Agreement and sustainable development Goals.	Editorial	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
11901	16	1	16	6	Please consider to provide a simplified version of this figure to be used in the SPM. Please also explain what Tier 1 and Tier 2 refer to.	Editorial	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
43837	16	1	16	6	Figure 3.3 what do the Ter 1 and Tier 2 represent?	Editorial	Hans Poertner and Elvira Poloczanska	Alfred-Wegener-Institut	Germany
24131	16	2	16	6	Explanations should not be part of the title to the figure	Editorial	Alfred Oforu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
45545	16	7	16	23	This would be a natural place to introduce the correspondence between RCPs and temperature rise.	Editorial	Daniel Crow	International Energy Agency	France
40989	16	11	16	11	Can you briefly explain why not feasible? Or point to the section where this is discussed?	Taken into account - scenario selection	Jan Fuglestedt	CICERO	Norway
26095	16	11	16	12	The numbers of radiative forcing used in labeling the RCPs are nominal forcing levels. Scenario outcomes often provide different forcing levels from the nominal values, and they are not necessarily stabilized by 2100. Moreover, estimated forcing depends on modeling schemes, and I guess that a version of MAGICC is used for harmonization currently. These matters should be described to improve understanding of scenario exercises in the RCP and SSP-RCP frameworks.	Taken into account - scenario selection	Junichi Tsutsui	Central Research Institute of Electric Power Industry	Japan
40991	16	13	16	17	Can the baseline cases be shown more clearly in the figure?	Taken into account - scenario selection	Jan Fuglestedt	CICERO	Norway
31165	16	2			Explain "Tier1" and "Tier2".	Editorial	Urs Ruth	Robert Bosch GmbH	Germany
31167	16	2			Give warming level in 2100 for the forcing levels shown (i.e. for 1.9, 2.6, 3.4, 4.5, 6.0, 7.0 and 8.5 Wm-2)	Editorial	Urs Ruth	Robert Bosch GmbH	Germany
31171	16	2			Place IP1 ... IP5 (introduced in section 3.2.5) in this diagram! Or: introduce additional table in section 3.2.5, stating the SSPx and the 2100 forcing level for each IP.	Editorial	Urs Ruth	Robert Bosch GmbH	Germany
37199	17	1	17	3	Add "in current IAMs" as follows: "In some worlds, it is not possible to reach RCP2.6 or RCP1.9 (roughly 1.8°C and 1.4°C in 2100, respectively) in current IAMs, such as in a world with regional rivalry (SSP3). Reasoning: specific IAM configurations or different interpretations of SSP3 may make reaching such RCPs possible (e.g. market forcing spilling over despite "regional rivalry" allowing rapid reductions in RE technology costs)	Taken into account - scenario selection	Michiel Schaeffer	Climate Analytics	Netherlands
10807	17	3	17	3	Though it is described that the mitigation costs will also vary in each model and across each SSP, I could not find mitigation cost figures. Please show how costs are different by SSPs.	Accepted - different section	Mitsutsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
2711	17	5	17	5	Colors for "mitigation... and adaptation..." are not easily readable. I think they need modification.	Editorial	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
35965	17	5	17	5	text in grey is not easily readable	Editorial	Sandrine Selse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
17181	17	5	17	9	Please explain why some lines are drawn thick. Is this e.g. the model runs mean or median?	Editorial	Joachim Rock	Thuener-Institute of Forest Ecosystems	Germany
24133	17	6	17	9	Separate title of figure from the explanations	Editorial	Alfred Ofoosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
40993	17	15	17	16	It is not clear whether this is one integrated database, or two separate since you write "a complementary database". Can you re-write and make it clearer?	Editorial	Jan Fuglestad	CICERO	Norway
15499	17	10	18	27	As a frequent user of scenarios in the IPCC databases, I would like to see even more emphasis placed on harmonizing key assumptions of the scenarios (e.g. base year) and even more transparency in the database about these key assumptions. More emphasis on transparency in emissions results -- e.g. gross versus net CO2 emissions, quantity and types of CO2 removal, and gross CO2 emissions by each fossil fuel, would be welcome.	Taken into account - scenario selection	Peter Erickson	Stockholm Environment Institute	United States of America
31169	17	6			In panel for SSP5: Color code for 8.5 Wm-2 is missing. Should be compatible with categories in Figure 3.3.	Editorial	Urs Ruth	Robert Bosch GmbH	Germany
5095	18	1	18	1	What is the definition of high/low overshoot?	Editorial	Matthias Weitzel	European Commission, Joint Research Centre	Spain
16551	18	1	18	2	You can't claim to know what "well below 2°C" means. Here the policy prescriptiveness gets its worst!!!! "Well below 2°C" and "Below 2°C" have to be merged!!! See for details my previous comment on "well below 2°C".	Accepted - text removed	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
35967	18	14	18	14	comma after industry	Editorial	Sandrine Selse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
27665	18	16	18	18	In addition, it might be useful to document the key underlying assumptions, the differences between models and to give at least a flavour of the main uncertainties and sensitivities of the results to model assumptions?	Taken into account - scenario selection	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
31577	18	17	18	19	Table 3.2 The five Illustrative Pathways (IPs) considered in IPCC WG3 only uses the models developed mainly by European researchers. Table 3.2 needs to include also other models developed by different organizations and regions, since it is important to consider the regional balance of the studies in the IPCC report. For example, please refer to the following study. Fujimori et al., 2017 SSP3: AIM implementation of Shared Socioeconomic Pathways. Global Environmental Change Volume 42, Pages 268-283 <a href="https://www.sciencedirect.com/science/article/pii/S0959378016300838">https://www.sciencedirect.com/science/article/pii/S0959378016300838</a>	Taken into account - IP process	KANAKO MORITA	Forestry and Forest Products Research Institute	Japan
2971	18	19	18	24	This is very important as one of the pitfalls of previous IPCC assessments is the equal treatment (weighting) of all scenarios independent of the source model.	Taken into account - scenario selection	Mustafa Babiker	Aramco	Saudi Arabia
35969	18	22	18	22	REMIND-MAgPIE or ReMIND-MAgPIE	Editorial	Sandrine Selse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
2713	18	23	18	24	The sentence: [Note that adjustments of the ensemble to reflect the differences in model representation will be conducted in the Second Order Draft] needs considerations before publishing the report.	Editorial	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
2715	18	25	18	27	The sentence: [The AR6 scenario database will be open for submission of new scenarios until January 2021. It is expected to grow considerably in the number of submitted scenarios for the SOD. The overview on the scenario database in this section will be updated accordingly] needs considerations before publishing the report.	Editorial	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
40995	18	29	18	29	I suggest changing "AR" to "reports" since then it is more clear that SRs are included.	Editorial	Jan Fuglestad	CICERO	Norway
10111	18	29	18	47	As noted in above comments on Row 16 and 17 of this spreadsheet above there are a number of issues with the IP framing as proposed in Chapter 3 currently. However, at a minimum in describing the current IP1 it should be made clear that in this baseline total fossil fuel combustion more than doubles by 2100 from levels today. Otherwise there is no way to relate changes in the baseline system to today's current system for those reading it.	Taken into account - IP process	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
14671	18	35	18	36	This can further reference IPCC AR6 WG1 Chapter 1 more specifically.	Taken into account	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
40997	18	35	18	37	I suggest you add a sentence about what WGII is doing (e.g. often have to use older scenarios due to the lag in literature; but please check handshake between WGI and WGII in AR6).	Taken into account	Jan Fuglestad	CICERO	Norway
37201	18	36	18	36	O'Neil et al. 2016 defines the experimental design for the CMIP6 scenario selection, it would also be useful to cite Gidden et al. 2019, which provides the resulting scenario emissions trajectories relied upon by WG1.	Taken into account - IP process	Michiel Schaeffer	Climate Analytics	Netherlands
37203	18	38	18	45	recognizing that the selected scenarios are preliminary for the FOD, the text as written is not sufficient to describe why these particular model/scenario combinations were selected. the reader is left to divine what makes these combinations 'special'. For example, a reader may assume that because MESSAGE, REMIND, and AIM provide the most scenarios assessed, they are chosen as indicative pathways. However, AIM is missing from the set in favor of IMAGE. It is also not clear from the scenario name which SSP IP4 and IP5 are based upon. Are these the marker scenarios for the SSPs (e.g., is REMIND based on SSP5)? In the paragraph on pg3-18ln29-37, a clear reasoning is provided for each of the selected scenarios in prior assessments and it is critical here as well.	Taken into account - IP process	Michiel Schaeffer	Climate Analytics	Netherlands
40999	18	39	18	39	Even if you say "illustrative" you may stress that these IPs are not recommendations or predictions etc.	Taken into account - IP process	Jan Fuglestad	CICERO	Norway
10171	18	43	18	45	there is confusion in description of scenarios IP4 and IP5 throughout the text. In these lines it says that IP2 and IP4 lead to 2 degree scenario, but according to table 3.2 IP4 is a 1.5 degree scenario. IP5 is a 2 degree scenario.	Taken into account - IP process	Aglaia Obrekht	Environment and Climate Change Canada	Canada
14191	18	28	19	15	There is a problem with the IPs described here, given that for example the BAU reference scenario from Capellán-Pérez et al 2020 would not fit in any of these categories given that it is a BAU scenario with relatively low emission levels by 2100. It is suggested to create a new category where a BAU is compatible with "relatively low" temperature increases by the end of the century due to the consideration of substantial climate change damages in a BAU scenario.  Capellán-Pérez, I., Blas, I. de, Nieto, J., Castro, C. de, Miguel, L.J., Carpintero, Ó., Mediavilla, M., Lobejón, L.F., Ferreras-Alonso, N., Rodrigo, P., Frechoso, F., Álvarez-Antelo, D., 2020. MEDEAS: a new modeling framework integrating global biophysical and socioeconomic constraints. Energy Environ. Sci. <a href="https://doi.org/10.1039/C9EE02627D">https://doi.org/10.1039/C9EE02627D</a>	Taken into account - IP process	Iñigo Capellán-Pérez	University of Valladolid	Spain
19257	18	28	19	19	Understand the justifications for illustrative pathways, but the paragraphs don't justify this particular choice of models. SSPs and related projects have multiple models but why do you feature only European models? And why 3 scenarios from a single model? I think a more diversity would enrich the analysis. SR15 had more models, in fact for P1-P4.	Taken into account - IP process	Masahiro Sugiyama	University of Tokyo	Japan
28729	18	38	19	15	There seems to be regional imbalance in the representation of illustrative pathways, which are only provided by three EU modeling teams. There are more world leading teams in America and Asia continent which would be better to consider to be used.	Taken into account - IP process	Shinichiro Fujimori	Kyoto University	Japan
39631	18	46	19	15	Please provide justification why one IAM model is used for IP1 to IP3 and not for other two illustrative pathways. In the same manner why other IAM models results are not included for five illustrative pathways.	Taken into account - IP process	shivika mittal	ahmedabad university	India
1333	18	28	21	3	How IPs are selected are unclear and needs justification.	Taken into account - IP process	Shinichiro Fujimori	Kyoto University	Japan

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
28765	18	28	21	3	For analyzing illustrative pathways, models developed only by European research institutes are used. Since the IPCC is an organization that assesses literature from all over the country, it is better to include non-Europe model results. If there are no papers on RCP / SSP outside of Europe, it is unavoidable, but at least AIM published a paper, and provides one of the illustrative pathways for SR on 1.5°C. (https://www.sciencedirect.com/science/article/pii/S0959378016300838).	Taken into account - IP process	Mikiko Kainuma	Institute for Global Environmental Strategies	Japan
31309	18	28	21	3	In my understanding, here in the draft, the concept of 'illustrative pathways' is utilized as a device for enhancing the communication between scientific community and policymakers. It might be true that policymakers cannot get any message if they are given a collection of graphs for 690 scenarios assessed. However, I feel that the process or criteria for deciding the number of IPs as well as the exemplified sets of models and scenarios are unclear or arbitrary. Comparing IP1 (SSP2-BaU) - IP2 (SSP2-2C) - IP3 (SSP2-1.5C) is understandable considering the relevance to the long-term targets in the Paris Agreement. However, if the primary purpose of adding IP4 and IP5 is to communicate experts' view on the large diversity of scenarios reaching the same long-term target among the models (and/or assumed model parameters) with non-experts (policymakers), for example, it might be more unbiased and natural that 3 graphs (IP1-IP2-IP3) are created based on each of the models and put them all here without specifying just one of them as 'illustrative'. The 5 IPs are highlighted also in the figures following this section (e.g. Fig. 3.8, 3.11, 3.36 and 3.37) for several times. Without explaining the processes and criteria for the selection of 5 IPs, roles of the highlighted marks in the following figures are not also clearly understood. (Even without the highlighted marks for the 5 IPs in the figures, the discussion based on the graphs can make sense.)	Taken into account - IP process	KIYOSHI TAKAHASHI	NATIONAL INSTITUTE FOR ENVIRONMENTAL STUDIES	Japan
31173	18	28			This is a very important comment: One additional IP should be explored in more detail: Having an energy system as large as IP3, but providing NET-emissions through DAC-CCS instead of through BE-CCS. Reason: Environmental NGOs strongly claim that the high amount of BE-CCS will not be feasible, while industrial NGOs strongly claim that a down-sized energy system as in IP5 will not be possible. The only way out is to leave the pathway of cost-optimal scenarios and to use more expensive NETs than BE-CCS. These could include enhanced weathering and DAC-CCS. Such variants of IP3 must be explored in more detail!	Taken into account - IP process	Urs Ruth	Robert Bosch GmbH	Germany
45547	18	28			The difference between SSPs and IPs is not explained very well. Please re-write this to develop the notion of what an IP is.	Taken into account - IP process	Daniel Crow	International Energy Agency	France
35971	19	5	19	5	"middle of the road" instead of "middle-of-the-road"	Taken into account - IP process	Sandrine Sellose	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
10175	19	9	19	10	Reverse the order of 2 and 1.5 to align to the order of pathways IP4 and IP5.	Taken into account - IP process	Aglaia Obrekht	Environment and Climate Change Canada	Canada
28727	19	9	19	15	Which SSPs were used for IP4 and 5 are not mentioned.	Taken into account - IP process	Shinichiro Fujimori	Kyoto University	Japan
37205	19	10	19	10	these are not "goals" but "limits" (also not "targets"). The temperature levels are to be avoided, warming is meant to be kept below. A goal in the context of Paris Agreement is also different: a "goal" in Art 2 refers to the whole formulation of "well below 2°C" AND (simultaneously) pursuing the 1.5°C limit. There is no 2°C or 1.5°C goal, there's legally one goal (with two levels, or limits, if you will)	Accepted - text removed	Michiel Schaeffer	Climate Analytics	Netherlands
32325	19	10	19	11	Although carbon removal has been reduced all the models seem to assume that CCS is available from 2021 or soon after (Fig 3-5) . How realistic is that? And what does that mean for the overall robustness of the predictions?	Taken into account - IP process	Penny Apostolaki	Barclays	United Kingdom (of Great Britain and Northern Ireland)
24889	19	11	19	11	Replace "IP5" with "IP4"	Taken into account - IP process	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
32327	19	11	19	12	Do you mean "IP4"? It is the IP4 that leads to the 2 degrees not the IP5	Taken into account - IP process	Penny Apostolaki	Barclays	United Kingdom (of Great Britain and Northern Ireland)
17183	19	11	19	15	IP 4 is missing, IP 5 is mentioned two times. Please check and correct.	Taken into account - IP process	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
45549	19	12	19	12	Typo - IP5 is repeated twice in the same sentence	Taken into account - IP process	Daniel Crow	International Energy Agency	France
10177	19	14	19	14	"IP5 is illustrative of pronounced..." - should be IP4 instead of IP5.	Taken into account - IP process	Aglaia Obrekht	Environment and Climate Change Canada	Canada
37207	19	14	19	14	reference here to IP5 should be IP4	Taken into account - IP process	Michiel Schaeffer	Climate Analytics	Netherlands
41001	19	17	19	17	As stated, this may need reconsiderations. Please also consider the scenarios suggested by the xWG team.	Taken into account - IP process	Jan Fuglested	CICERO	Norway
2717	19	17	19	18	"[These are only preliminary and subject to change]." needs considerations.	Taken into account - IP process	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
2973	19	17	19	20	Table 3.2: Why not using the same model to generate all the illustrative pathways?	Taken into account - IP process	Mustafa Babiker	Aramco	Saudi Arabia
5097	19	17			Have you considered given the IPs some more intuitive names (e.g. "Baseline", "2C", "bridging",...) than IP1 though IP5?	Taken into account - IP process	Matthias Weitzel	European Commission, Joint Research Centre	Spain
36125	20	0	20	0	text in grey and yellow is not easily readable	Taken into account - IP process	Sandrine Sellose	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
2719	20	1	20	1	In the figure, All "FFCCS"s need to be modified because the color is not readable.	Taken into account - IP process	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
17185	20	1	20	6	Please consider changing the colour of "FFCCS". This light grey is hardly visible and thus not legible. And please include the abbreviation in the text below the graphs.	Taken into account - IP process	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
10173	20	5	20	6	description of the Figure says that the middle row is IP2 and IP3, but it should be IP2 and IP5; the bottom row is IP3 and IP4. Little table in the top right corner of the Figure is also wrong. In the right column it should be IP5 on the top and IP4 on the bottom.	Taken into account - IP process	Aglaia Obrekht	Environment and Climate Change Canada	Canada
31917	20	31	20	34	Neither of these statements are true: GWP* has been applied to the full range of scenarios available (see Allen et al, 2018) and the choice of reference level from which to calculate changes in CH4 emissions does not depend on a value-judgement. Allen et al (2018) proposed 20 years to best reproduce temperature outcomes: designing a metric to reproduce a temperature outcome is not a value judgment, unless you refer to the decision to focus on temperature in the Paris Agreement itself, in which case this remark is not in any way specific to GWP*.	Taken into account	Myles Allen	University of Oxford	United Kingdom (of Great Britain and Northern Ireland)
30147	20		20		It is misleading to use BECCS as the only option for CDR, even if many models only have that option. Better to classify it as Technological CDR or something like that.	Taken into account	Bert Metz	European Climate Foundation	Netherlands
16471	20	1	21	1	Explain why emissions drop to net-negative but then return to net-zero in IP5 in Figure 3.5. In Figure 3.6, why does coal consumption rebound in IP2? Solar energy is really substantial and unbelievable in IP4. Why do we use three different models but not the same one to run all these IPs? The rationale, characteristics and assumptions of these models themselves are different, which make hard to understand to what degree the changes of strategies and societal choices affect the pathways. I think the comparison doesn't mean using different models to run different assumptions but using different models to run the same assumptions or using the same model to run different assumptions.	Taken into account - IP process	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
32329	20		21		The result in these figures start from 2008 or even 2000. Why do they start from that far back and not from a more recent period? Is it that we do not have the actual numbers for carbon dioxide emissions from 2000 to 2019? Please, add an explanation for this choice.	Editorial	Penny Apostolaki	Barclays	United Kingdom (of Great Britain and Northern Ireland)
20311	20	1			IP1...IP5 the scenario names need to be added to the diagrams in the figure for faster orientation, it takes quite long to find the right diagram for the right ipx	Taken into account - IP process	Christian Breyer	LUT University	Finland
20313	20	1			CDR seems to be done mainly by BECCS, why not DACCS? Is the wrong PV cost assumption in the IAMs and sceptical DAC assumptions the reason? Clarification is needed. More comments are linked to this first one. Articles highlighting the risk of BECCS and why DACCS may be more favourable are: <a href="https://pubs.rsc.org/en/Content/ArticleLanding/2019/EE/C8EE03682A">https://pubs.rsc.org/en/Content/ArticleLanding/2019/EE/C8EE03682A</a> ; <a href="https://www.cell.com/joule/fulltext/S2542-4351(19)30413-1">https://www.cell.com/joule/fulltext/S2542-4351(19)30413-1</a> - more comments are provided in these fundamental articles	Taken into account - IP process	Christian Breyer	LUT University	Finland
20315	20	1			why fossil fuel CCS plays an important role in all scenarios? Ram et al. ( <a href="http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf">http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf</a> ) show that zero GHG emissions are possible with fossil CCS ; why fossil CCS should be lower in cost than very high shares of renewables? Is the reason the wrong PV cost assumptions in all used IPx? In Krey et al. ( <a href="https://www.sciencedirect.com/science/article/pii/S0360544218325039">https://www.sciencedirect.com/science/article/pii/S0360544218325039</a> ) the displayed PV cost are fully wrong, as clearly stated by Vartiainen et al. ( <a href="https://onlinelibrary.wiley.com/doi/full/10.1002/pip.3189">https://onlinelibrary.wiley.com/doi/full/10.1002/pip.3189</a> ) - comments on the applied PV cost are required. The consequences are drastically as already shown by Creutzig et al. ( <a href="https://www.nature.com/articles/nenergy2017140">https://www.nature.com/articles/nenergy2017140</a> ) and also Ram et al. ( <a href="http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf">http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf</a> ) - the wrong PV cost require a massive disclaimer in the chapter 3, since results strongly underestimate the potential of PV and thus lead to fossil CCS and other solutions	Taken into account - IP process	Christian Breyer	LUT University	Finland
2721	21	1	21	1	In the figure, All "Other"s and "Wind"s need to be modified because the color is not readable.	Editorial	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
10181	21	1	21	1	'other' and 'wind' categories are barely visible. Why is the solar wedge so big on the IP5 chart?	Editorial	Aglaia Obrekht	Environment and Climate Change Canada	Canada
18069	21	1	21	1	Some of these graphs show the yearly use of amounts of energy from biomass combustion that can have very high GHG emissions related to land-use and land-cover change. For example, Kalt et al. (2020; Env Res Lett, <a href="https://doi.org/10.1088/1748-9326/ab6c2e">https://doi.org/10.1088/1748-9326/ab6c2e</a> ; <a href="https://iopscience.iop.org/article/10.1088/1748-9326/ab6c2e">https://iopscience.iop.org/article/10.1088/1748-9326/ab6c2e</a> ) show that GHG emissions per unit of bioenergy rise sharply when exceeding certain low-GHG potentials, which according to this article do not exceed c100 EJ/yr in 2050. Is there robust evidence that these GHG costs of sourcing bioenergy are robustly and adequately included in the IAM runs underlying these scenario calculations? If not, I think some caveats are in place in order to avoid misinterpretation of these graphs	Taken into account - IP process	Helmut Haberl	Institute of Social Ecology, University of Natural Resources and Life Sciences, Vienna	Austria
35977	21	1	21	1	light colors are not easily readable	Editorial	Sandrine Sellose	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
17187	21	1	21	3	Please consider changing the colour of "Other" and "wind". This light grey / mint is hardly visible and thus not legible.	Editorial	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
10179	21	2	21	3	Same problems as in comment 9.	Editorial	Aglaia Obrekht	Environment and Climate Change Canada	Canada
19259	21	5	21	20	Can you describe how some models achieve negative emissions toward the end of the century in the industry sector? Also this section needs to be linked up with Chapter 11 (industry), which critically evaluate modeling of the industry sector.	Taken into account - IP process	Masahiro Sugiyama	University of Tokyo	Japan
35979	21	7	21	7	"have" instead of "haves"	Editorial	Sandrine Sellose	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
24135	21	12	21	12	Interchange "production" and "consumption" Logically food is produced before it is consumed	Editorial	Alfred Ofoosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
16209	21	12	21	13	Consider changing "Greenhouse gas emissions mainly originate from the consumption and production of energy, agriculture and land use (change) and industrial activities." to "Greenhouse gas emissions mainly originate from the consumption and production of energy, agriculture and land use (change) and industrial and military activities." or something similar for increased accuracy. Not including the military sector is a gross oversight.	Taken into account. Text will be revised.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
24665	21	12	22	27	In a world where billions of dollars is invested in unsustainable infrastructure every year, the transition in infrastructural development should have been considered as one of the key socio-economic drivers of emission scenarios. The issue of promoting the development of transformational infrastructure is particularly critical for Region's like Africa where most of the economic infrastructure is yet to be built.	Infrastructure??	Desta Mebratu	Centre for Complex Systems in Transition, Stellenbosch University	Ethiopia
20237	21	12	24	14	The coronavirus outbreak in 2020 may lead to an economic depression, therefore, the scenario of economic growth should be updated and adjusted.	COVID attention.	Thi Lan Huong Huynh	Viet Nam Institute of Meteorology, Hydrology and Climate change	Vietnam
20317	21	1			fig. 3.6 shows the misery of the wrong PV cost assumptions. In 2050 no scenario finds realistic solar PV shares, and the reason is wrong PV cost in the used IAMs - massive disclaimers are needed that wrong PV cost have been applied, leading to strongly distorted results. The credibility of the entire chapter is at risk - see previous comment for all references, mainly Krey et al. ( <a href="https://www.sciencedirect.com/science/article/pii/S0360544218325039">https://www.sciencedirect.com/science/article/pii/S0360544218325039</a> ), Vartiainen et al. ( <a href="https://onlinelibrary.wiley.com/doi/full/10.1002/pip.3189">https://onlinelibrary.wiley.com/doi/full/10.1002/pip.3189</a> ), Creutzig et al. ( <a href="https://www.nature.com/articles/nenergy2017140">https://www.nature.com/articles/nenergy2017140</a> ), and Ram et al. ( <a href="http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf">http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf</a> ) - we are talking here on a category one failure in the entire chapter. Ram et al. clearly show what is a scenario result with realistic PV cost, Creutzig et al. is similar.	Attention to PV story.	Christian Breyer	LUT University	Finland
36771	21	7			Change " new scenarios have been published" to new scenarios have been published	Editorial	Lazarus Chapungu	Great Zimbabwe University	Zimbabwe
25795	22	5	22	5	The limits of the population development of the SSP scenarios are between 8.5 and 10 billion as indicated in the summary and not reaching up 11 billion.	Editorial. Accepted	Andreas Pfennig	University of Liège	Belgium
25797	22	6	22	7	The characterization 'somewhat on the low side' grossly downplays that 4 of 5 SSPs have population development clearly below the 95% probability range of the current UN scenarios. More specifically 109 of the 127 scenarios which are available at <a href="https://tntcat.iiasa.ac.at/SspDb/dsd">https://tntcat.iiasa.ac.at/SspDb/dsd</a> are outside this range, 55 even below the low variant. This is relatively unrealistic. Especially, since also the 'middle of the road' scenario SSP2 is outside this range, the variation of the SSP is about an unrealistic case. See a discussion of population projections at <a href="https://doi.org/10.1002/cben.201900006">https://doi.org/10.1002/cben.201900006</a> , A. Pfennig: Sustainable Bio- or CO2 economy: Chances, Risks, and Systems Perspective. ChemBioEng Reviews, Volume6, Issue3, Pages 90-104.	Check population text.	Andreas Pfennig	University of Liège	Belgium
41003	22	7	22	9	Re "a wider range is possible": this sounds a bit obvious. Can you say a bit more?	Taken into account. Text will be detailed	Jan Fuglestedt	CICERO	Norway
25799	22	12	22	12	The general trend of UN population projections has not been downward during the last 20 years. On the contrary, the updates have a clear upward trend, which has been systematically overlooked in developing the SSPs. See a discussion at <a href="https://doi.org/10.1002/cben.201900006">https://doi.org/10.1002/cben.201900006</a> , A. Pfennig: Sustainable Bio- or CO2 economy: Chances, Risks, and Systems Perspective. ChemBioEng Reviews, Volume6, Issue3, Pages 90-104.	Check population text.	Andreas Pfennig	University of Liège	Belgium
25801	22	13	22	13	The UN did not upward correct the population 2050 in the last 2019 update. Instead, it was a downward correction from 9771822753 to 9735033900.	Check population text.	Andreas Pfennig	University of Liège	Belgium

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
25803	22	13	22	15	This summarizing sentence wrongly depicts UN projections and SSPs to be on similar lines, even though this is obviously not so. See above and details of evaluation again at <a href="https://doi.org/10.1002/cben.201900006">https://doi.org/10.1002/cben.201900006</a> , A. Pfennig: Sustainable Bio- or CO2 economy: Chances, Risks, and Systems Perspective. <i>ChemBioEng Reviews</i> , Volume 6, Issue 3, Pages 90-104.	Check population text.	Andreas Pfennig	University of Liège	Belgium
46471	22	16	22	28	A key dimension related to economic growth scenarios is the amount of redistribution or equity considerations, not just the rate or stability. See FAO 2018 <i>The future of food and agriculture – Alternative pathways to 2050</i> . Food and Agriculture Organization of 40 the United Nations, Rome, p. 64-67 for examples where scenarios take equity trends into account.	More attention to equity as driver	Rachel Bezner Kerr	Cornell University	United States of America
36773	22	22	22	23	Change "...literature emphasises the need to stabilisation...of income" to "...literature emphasises stabilisation of..."	Editorial. Accepted	Lazarus Chapungu	Great Zimbabwe University	Zimbabwe
10113	22	22	22	29	It is interesting that degrowth and rapid growth of Kallis and Christensen et al. are noted here. It is also worth noting that there are arguments like in the book <i>Fully Grown</i> by the economist Dietrich Vollrath which persuasively suggests that slow growth is a sign of a mature economy, and that economies become rich and then saturate in growth, and that this type of possibility is not addressed in the narratives of the SSPs or other typical IAM narratives.	Taken into account	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
41005	22	26	22	26	Can't see a, b, c and d in fig.	Editorial. Accepted	Jan Fuglestedt	CICERO	Norway
16727	22	16	23	28	Key references of this debate are: Demaria, F., Schneider, F., Sekulova, F. and Martinez-Alier, J. (2013). What is degrowth? From an activist slogan to a social movement. <i>Environmental Values</i> 22 (2): 191-215. D'Alisa, G., Demaria, F., Kallis, G. (eds) (2014) <i>Degrowth: a vocabulary for a new era</i> . Abingdon, UK: Routledge. Kallis, G., Paulson, S., D'Alisa, G., Demaria, F. (2020) <i>The case for degrowth</i> . Cambridge: Polity Press. Anderson, K. & A. Bows-Larkin (2013.) "Avoiding Dangerous Climate Change Demands De-Growth Strategies from Wealthier Nations". Available at <a href="https://kevinanderson.info/blog/avoiding-dangerous-climate-change-demands-de-growth-strategies-from-wealthier-nations/">https://kevinanderson.info/blog/avoiding-dangerous-climate-change-demands-de-growth-strategies-from-wealthier-nations/</a> [Accessed November 19, 2019].  Degrowth fight against climate change does not rest with shrinking GDPs. Interactions among different proposals are vital: investments in Green New Deals that mobilize energy transitions and restore ecosystems that absorb carbon; guarantees of low-carbon public services to all; carbon fees and dividends; reduced working hours that reduce emissions; and support for low-carbon community economies and lifestyles. Related degrowth-minded proposals include a moratorium on new fossil fuel development; ban of fossil fuel advertising; phase-out of fossil fuel production, with just transition for workers in dependent industries; frequent flier levies; embargos on expansion of road networks and airports; policies for car-free cities; tight emission standards for new cars and power stations; passive-house standards for new houses; and efficiency standards for rented properties.  For an explorations of these scenarios with macroeconomic tools, see the article in <i>Nature Sustainability</i> titled "Feasible Alternatives to Green Growth" by Simone D'Alessandro et al. This is based upon the EUROGREEN model, a system dynamics, ecological macroeconomics model that simulates policies and scenarios for low-carbon transition with social equity based on initial values and parameters of the French economy (2014-2050) due to data availability, particularly on the distribution of wealth. Moreover, the reactions to different policies are likely to reflect, to a great extent, what we would expect for the EURO area in general. Climate change and increasing inequality have emerged as the main challenges facing our societies over the past few decades. Their impact is highly visible and well recognized by overall civil societies way beyond the academic circles that first alerted us of these concrete threats to contemporary standards of living, peace and democracy. A wide range of public policies from basic income programs to radical decarbonization plans, usually as bold and massive as the challenges they aim to overcome, have been proposed, questioned and not rarely deemed economically and politically unfeasible. The EUROGREEN model explores the viability, effectiveness and possible synergies between alternative policy options to low-carbon transition and social justice. See: <a href="https://degrowth.org/2018/10/29/eurogreen-an-ecological-macroeconomic-model-to-test-degrowth-policies/">https://degrowth.org/2018/10/29/eurogreen-an-ecological-macroeconomic-model-to-test-degrowth-policies/</a>	Green growth/degrowth links	Federico Demaria	Environmental Science and Technology Institute, Autonomous University of Barcelona	Spain
16211	22	3	24	14	In Subsection 3.3.1.1 Population and economic trends, consider adding a brief treatment of military emissions globally, and how these are connected to economic trends regionally, for clarity.	Don't have access to relevant literature.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
36775	22	16	24	14	There is need to consider the spatial variation of the influence of the socio-economic drivers of emissions scenarios. The drivers' level of influence may vary between the global south and the global north (Or between specific regions) and I think this should be flagged out in this section. As it stands, it appears we are using the assumption that all region specific factors are constant...and the world operates as one unit.	More attention to different regions	Lazarus Chapungu	Great Zimbabwe University	Zimbabwe
45509	22	3		15	Population and economic trends along with the GDP have consistently increase overtime. Rhe future trends of population growth might grow beyond 9.7 billion projected by the United Nationin 2019. Rhe economic tend to reduce with increase in population, thereforeby 2050,the population will put the environment into great risk if not properly checked, formulated and controlled. The extents differs.	Taken into account	Abiodun Adegoke	Samsung electronics West Africa	Nigeria
9693	23	1	23	5	Maybe also add one figure for the Ocean?	Rejected. Not applicable to this figure	Nathalie Hilmi	Centre Scientifique de Monaco	France
17191	23	1	23	5	Please explain "PPP" (panel middle - left column).	Editorial. Accepted	Joachim Rock	Thuener-Institute of Forest Ecosystems	Germany
24137	23	2	23	5	References to the graphs must be made clearer. In the current format one may lose the graph a specific statement refers to.	Editorial. Accepted	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
10183	23	8	23	8	According to figure 3.7 the final energy demand reaches almost 1200 EJ by 2100, not 800-900 as written in the text.	Editorial. Accepted	Aglaia Obrekh	Environment and Climate Change Canada	Canada
35981	23	8	23	9	800-900 EJ yr-1 on the same line	Editorial. Accepted	Sandrine Selosse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
10115	23	12	23	13	Good to see that the IEA scenarios are highlighted here, but it needs to be made clearer that the IEA scenarios are below SSP2 through 2040	Editorial. Accepted	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
5099	23	13	23	13	LED scenario is not defined/referenced	Editorial. Accepted	Matthias Weitzel	European Commission, Joint Research Centre	Spain
46625	23	13	23	13	Final Energy levels for SSP1 and LED could be specified.	Accepted	Florian Leblanc	Centre International de Recherche sur l'Environnement et le Développement	France
24891	23		23		The legend of Figure 3.7 needs to be corrected	Editorial. Accepted	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
20319	23	1			fig. 3.7 shows the most likely population scenario according to UN as reference - why not a single SSP reflects that? Comments on that are required	More attention to population	Christian Breyer	LUT University	Finland
31175	23	2			Regarding Population: I find it extremely irritating that all SSPs except SSP3 are significantly below the heavy dotted reference line, which I believe should be UN-Medium. This should be emphasized very clearly (also in the executive summary!) and discussed more strongly than merely stating SSPs are "somewhat on the low side". Even better: SSPs should be corrected upwards, because this will have profound implications on GDP, energy demand and GHG-emissions.	More attention to population. Is UN more likely than SSP2?!	Urs Ruth	Robert Bosch GmbH	Germany
31177	23	2			It is not clear from the caption, which references are shown in which panel. Please make clear.	Editorial. Accepted	Urs Ruth	Robert Bosch GmbH	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
35983	24	1	24	3	Decoupling between greenhouse gas (GHG) emissions and real gross domestic product (GDP) seems to have also been debated by some authors, is there any point to this work?	Decoupling	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
10117	24	3	24	4	The sentence "The factors are more important..." needs a citation.	Editorial. Accepted	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
41007	24	11	24	11	something wrong with language here	Editorial. Accepted	Jan Fuglested	CICERO	Norway
41009	24	11	24	14	add reference to Annex C here?	Editorial. Accepted	Jan Fuglested	CICERO	Norway
14193	24	21	24	22	Please add together with MAGICC, FAIR and HECTOR the SCMs C-ROADS (Sterman et al 2012; <a href="https://www.climateinteractive.org/tools/c-roads/">https://www.climateinteractive.org/tools/c-roads/</a> ); Sterman, J., Fiddaman, T., Franck, T., Jones, A., McCauley, S., Rice, P., Sawin, E., Siegel, L., 2012. Climate interactive: the C-ROADS climate policy model. System Dynamics Review 28, 295–305. <a href="https://doi.org/10.1002/sdr.1474">https://doi.org/10.1002/sdr.1474</a>	Taken into account. Other climate models are also being used	Iñigo Capellán-Pérez	University of Valladolid	Spain
41013	24	24	24	32	Important text, and yes, needs updating when more studies with model assessments are ready (e.g. RCMP)	Taken into account. Other climate models are also being used	Jan Fuglested	CICERO	Norway
41011	24	26	24	26	I don't think "WGI research" is the right description. I would rather say something with the research community providing model studies that are used by WGI.	Editorial. Accepted	Jan Fuglested	CICERO	Norway
31957	24	31	24	32	I appreciate this will be unpopular, but classifying scenarios purely on the basis of MAGICC is unsustainable: it is not just MAGICC per se (which is still a closed-source model, and hence should not be used in headline assessments of the IPCC when equivalent-performance, more transparent and open-source alternatives are available), but a particular implementation of MAGICC which indicates anthropogenic warming is currently proceeding at about 0.3C per decade through a combination of a high TCRE and adjustment from the "concentration-driven" to "emissions-driven" mode. Is the simulation of warming to the present with this version of MAGICC consistent with the assessment of historical warming and historical forcing in WG1 (I strongly suspect not, but this problem is consistently brushed under the carpet by expressing everything relative to a recent reference period)? A much more transparent approach would be to note that future anthropogenic warming over a multi-decade period is given by a very simple equation: $\Delta T = TCRE \times [\text{Sum}_t(E\_LLCP(t) + 4 \times E\_SLCP(t) - 3.75 \times E\_SCLP(t-20)) + \Delta T_{\text{other}}]$ where $E\_LLCP(t)$ and $E\_SLCP(t)$ are emissions in year t of long-lived and short-lived climate pollutants respectively, both in units of TtCO2-e using GWP100, and $\Delta T_{\text{other}}$ is other radiative forcing in W/m2. The AR5 range on TCRE was 0.23-0.68°C/TtCO2, but this may well be updated. This formula reproduces the behaviour of simple climate models like MAGICC surprisingly well (certainly as well as MAGICC reproduces the behaviour of more complex models). If used to classify scenarios, it is much more transparent than relying on a specific simple model: you just pick a percentile of the revised TCRE distribution, a current level of warming, and everything else follows. See Jenkins et al (2020), submitted, but available on the WG1 TSU website.	Classification	Myles Allen	University of Oxford	United Kingdom (of Great Britain and Northern Ireland)
5101	24	32	24	32	Which version of MAGICC?	We are now using version 7.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
46995	24	33	24	33	Categorisation wrt GDP: Adjust categories. It's not useful to list 106 scenarios in (<50), 14 in (50-70) and none in (>70). Give eg (40-50) and (30-40) ranges. Similarly for some other variable. Bounds should be chosen so that the > or < categories should always only have a relatively small number of scenarios in them.	Taken into account. Text will be revised.	Frank Jotzo	ANU	Australia
20239	24	16	25	6	The coronavirus outbreak in 2020 may lead to the emission reduction at global level, e.g. in 2 weeks the GHG emissions from China have reduced by 100 million CO2e. Therefore, the emission scenario should be updated.	COVID attention.	Thi Lan Huong Huynh	Viet Nam Institute of Meteorology, Hydrology and Climate change	Vietnam
10119	24	32	25	1	This table is helpful but there needs to be more descriptive analysis of the AR6 WGIII database, i.e. median, range, etc..	Taken into account. Text will be revised.	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
10121	24	32	25	1	There are simply too many categories here for a useful taxonomy, there should not be 7 categories because it makes all the proceeding analysis and figures far too low resolution and muddled. There needs to be fewer temperature categories such as C1 - 1.5° OS and no OS, C2 - below 2° 50% chance, C3 below 3° 50% chance, C4 - above 3° C with 50% chance; perhaps there can be as many as 5 categories but 4 is preferred. Also it is unclear how all these categories link back to the SSPs and work done in other WGI and WGII chapters. If these categories are being used throughout AR6 then fine, but I thought the reason to have the SSPs was to provide an overall framework for the scenarios?	Too many categories; relation with SSP/RCP.	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
12349	24	33	25	1	Table 3-3-High CCS (electricity) does not seem to have any number of scenarios. In addition, medium or low categories of CCS is not included. In the text page 25 line 4 it is claimed that most scenarios show a high share of renewables and a high share of CCS: How is this related?	Taken into account. Text will be revised.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
16553	24	33	25	1	Table 3.3: You can't claim to know what "well below 2°C" means. Here the policy prescriptiveness gets its worst!!! "Well below 2°C" and "Below 2°C" have to be merged!!! See for details my previous comment on "well below 2°C".	Taken into account	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
25805	24	33	25	1	The UN WPP2019 gives for the 95% percentile range between 9.4 and 12.6 billion, the 80% percentile between 9.9 and 10.7 billion. This shows again that there is a gross mismatch between the SSPs and the UN projections. What is termed medium in table 3.3 is well below the lower bound according to UN.	Population	Andreas Pfennig	University of Liège	Belgium
30885	24	33	25	1	Some entries in the table do not have scenario numbers. Does this mean they are 0 or that the numbers have not been added yet?	Taken into account. Text will be revised.	Jasmin Kemper	IEA Greenhouse Gas R&D Programme (IEAGHG)	United Kingdom (of Great Britain and Northern Ireland)
44541	24	33	25	1	Category "Negative emissions": I guess this is about "Net negative" volumes, and if this is the case, you should clearly say so	Taken into account. Text will be revised.	Oliver Geden	German Institute for International and Security Affairs	Germany
44543	24	33	25	1	Probabilities: there seems to be a trend towards 50% probabilities/chances/likelihoods, and I guess you should explain that somewhere (50% has been the standard for 1.5C for quite some time, but not for the levels above, and this might come under scrutiny during the next UNFCCC Structured Expert Dialogue <a href="https://www.nature.com/articles/s41558-020-0729-9">https://www.nature.com/articles/s41558-020-0729-9</a> ). In general, I think it would be helpful to explain the concept of scenario probabilities as such since there are popular misconceptions even among scientists (detectable in metaphors like "you wouldn't board a plane that would crash with a 50 or 33% probability" etc.). It might be enough to touch upon the probability issue in ch3 and refer to Annex C for details	Probability explanation	Oliver Geden	German Institute for International and Security Affairs	Germany
5103	24	33			There seem to be scenarios missing in the GDP category as the ranges are comprehensive, but the total number of scenarios is much lower than the total number of scenarios. I assume that most scenarios report GDP, so it should not be a missing value issue.	Taken into account. Text will be revised.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
16505	24	33			it is better to add all "in 2100" for population's subset	Thank you. Text will be revised.	Lining WANG	Economics and Technology Research Institute, CNPC	China

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
37209	24	33			This classification is highly policy prescriptive (see comment on whole chapter on classification of 'well below 2C' pathways. Concretely, see 1st comment, I propose changing C3 & C4 labels to factual labeling, instead of normative, by using "below 2°C" with 'likely below 2°C' for C3, change C4 to "as likely as not below 2°C" and add a 'very likely below 2°C' category as C5. On a similar note, the C2 'high OS 1.5°C' category needs to be revised. The focus on 2100 probabilities is artificial and not rooted in any policy context. Following SR1.5 Ch 3 Table SM2.12, this category has a 'likely' change to exceed 1.5°C. It should therefore be called 'likely above 1.5°C overshoot pathways'. Also note that the 'high overshoot' 1.5°C category was omitted from the SR1.5 SPM for reasons of requiring unrealistically high CDR deployments.	Categorisation	Michiel Schaeffer	Climate Analytics	Netherlands
37211	24	33			It seems that the scenario classification of 'low OS pathways' has been changed from the SR1.5 (comparing Table 3.3 and SR1.5 Ch 3 Table 2.SM11). All other things being equal as far as I can see (including the MAGICC version used), this still leads to very different outcomes in terms of scenario classification (compare Table 2.SM12). Is that correct?  I think rather than introducing new temperature thresholds (1.6°C) the definition should be revised back to the SR1.5 based on probabilities and calibrated IPCC language. So no-to-low-OS are "as likely as not" to keep warming below 1.5°C. Whereas 'high OS' pathways are 'likely to overshoot 1.5°C'.	Categorisation	Michiel Schaeffer	Climate Analytics	Netherlands
17193	25	1	25	1	Technology share: how do you distinguish "renewables ... (electricity)" from "high bioenergy"? Especially if a system uses CHPplants, this seems hardly possible.	Taken into account. Text will be revised.	Joachim Rock	Thuener-Institute of Forest Ecosystems	Germany
20577	25	1	25	1	I find table 3.3 extremely interesting and insightful. I'm thinking that perhaps, on the "Technology Share" section it would be nice to have something concerning electrification in order to highlight the importance (or not) of electricity as a final energy carrier in scenarios, particularly mitigation scenarios. Perhaps an indicator such as "Electrification (% Final consumption)".	Taken into account. Text will be revised.	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
20579	25	1	25	1	It would be helpful to also add the proportion of scenarios, together with the % (#) of scenarios in the last column.	Taken into account. Text will be revised.	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
27667	25	2	25	6	I am concerned that some readers, by mistake or by strategy, might assimilate rare scenarios with low probability scenarios. It would perhaps be appropriate to mention that a lower frequency of certain type of outcomes does not necessarily imply that they are technically low probability. E.g., the relative lack of interest for high temperature outcomes may not mean that such outcome are unlikely to happen because some unexplained mechanism will save us from them but rather because they are in a sense too straightforward and too unacceptable to justify diverting limited resources investigating them. See also the lines about model selection bias etc. Likewise, the small number of paths without overshooting means I technically and politically feasible, what could and should be achieved. What is relevant all the path are feasible analysis concentrates on path that appear reasonably good and politically feasible menu of choices, all technologically realistic to the same extent menu biased toward choices that appear good and politically feasible selection bias lead by the desired response classify by goals???	Probability explanation; usefull comment	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
30887	25	4	25	4	It would be helpful to quantify those high shares.	Taken into account. Text will be revised.	Jasmin Kemper	IEA Greenhouse Gas R&D Programme (IEAGHG)	United Kingdom (of Great Britain and Northern Ireland)
41015	25	5	25	6	Could this be discussed in terms of temperature instead (even if the RF at the end of century is a label)?	Taken into account. Text will be revised.	Jan Fuglestedt	CICERO	Norway
41017	25	14	25	14	It would be very simple and useful if you can specify which gases are included and which metric is used when you define 'GHG balance'. I see this is stated in figure 3.8, but a short mentioning in text is also needed. See also separate comment on this.	Taken into account. Text will be revised.	Jan Fuglestedt	CICERO	Norway
5109	25	14	25	15	The 20 year difference between net zero for CO2 and GHGs are not very obvious (also in page 31, line 6)	Taken into account. Text will be revised.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
5107	25	15	25	15	"Net CDR" might not be the most intuitive naming, maybe better use "net negative"?	Taken into account. Text will be revised.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
10185	25		25		Table 3.3. Technology Share: currently for High CCS shows blank. it would probably also make sense to add 'Low CCS' (under 10GtCO2/yr). Any amount of CCS is still important as a mitigation option. High Nuclear - it would be interesting to know whether any of the scenarios are considering the small modular nuclear reactors, and if so, what sort of penetration, and in which sectors (i.e. for industrial use or only by utilities??)	Taken into account. Text will be revised.	Aglia Obrecht	Environment and Climate Change Canada	Canada
32331	25		25		"not 3 many high energy consumption scenarios, such as SSP5, are assessed in the literature" The table says 287 which does sound many to me.	Taken into account. Text will be revised.	Penny Apostolaki	Barclays	United Kingdom (of Great Britain and Northern Ireland)
46997	25	8	27	11	Uncertainty about temperature outcomes: the text should prominently mention that there is substantial uncertainty about how emissions trajectories translate into temperature. As is, the text creates a false illusion of certainty. This includes potential tipping points and positive feedback loops. Must link back to WGI work-in-progress. The statement at p26126 "should be regarded as indicative" is far too short, weak and buried in the weeds.	More attention to uncertainty	Frank Jotzo	ANU	Australia
5105	25	1			"Technology share" might not be the best choice for naming, as some criteria are not shares. Maybe just use "Technologies"?	Taken into account. Text will be revised.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
20321	25	1			Table 3.3: categories for technology share to be improved, a 'very high (>95%)' renewables category is a must criterion for a revised version. 75% renewables is not sufficient, but nowadays renewables are the least cost solution in a fast growing base of application. Several ESMs find 100% renewables globally, but they are not represented by the inappropriate grouping. All global ESM with 100% renewables are listed in this article by Breyer et al. <a href="https://www.iaee.org/eeep/article/305">https://www.iaee.org/eeep/article/305</a>	100% renewable scenarios (category). See reference	Christian Breyer	LUT University	Finland
10187	26	1	26	2	Figure 3.8 - missing the initial year on the chart (is it 2015?) would be good to see 2030 on the axis as well.	Taken into account. Figure will be revised.	Aglia Obrecht	Environment and Climate Change Canada	Canada
10123	26	2	26	5	Figure 3.8 very clearly shows the massive gap between IP1 and the other IPs. This needs to be fixed before publication per other comments in this spreadsheet if the IP method is going to play a role in this chapter.	Taken into account. Figure will be revised.	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
5113	26	8	26	8	It is not really a "peak", as this would imply a decline afterwards which is not the case. "Maximum temperature" would be more fitting	Taken into account. Text will be revised.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
41019	26	8	26	8	Re "further increase...": I think this deserves more than being mentioned in parantheses.	Taken into account. Text will be revised.	Jan Fuglestedt	CICERO	Norway
16555	26	9	26	9	Use a neutral category designator that is NOT called "well below 2°C". See for details my previous comment on "well below 2°C".	Well below 2 deg is too policy prescriptive	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
26097	26	20	26	27	I am expecting that the harmonization of climate scenarios will be updated to reflect the WGI AR6. In that case, methodological differences should be elaborated so that readers can understand how the updates lead to different outcomes of the categorization of emissions scenarios.	Correct	Junichi Tsutsui	Central Research Institute of Electric Power Industry	Japan
4641	26	27	26	27	Change "considerably uncertainty" with "considerable uncertainty"	Editorial. Accepted.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
5111	26	1			With the overlapping color ranges, it is a bit difficult to see where the different categories end up. It might be better to plot the ranges next to the figure (as in Fig 3.9)	Editorial. Taken into account.	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
47665	26	2			Fig 3.8 - Lables C1 -C8 need to be explained. In figure legend. Not intuitive that e.g. C7 corresponds to above 3C	Editorial. Taken into account. Clarity will be improved	raphael Slade	Imperial College	United Kingdom (of Great Britain and Northern Ireland)
17195	27	5	27	8	Please add what the dark part in each coloured column in the right panel should indicate - is this a percentile range?	Editorial. Taken into account. Clarity will be improved	Joachim Rock	Thuener-Institute of Forest Ecosystems	Germany
41021	27	6	27	8	Fig 3.9 is important. Would be good if you clearly state reference period for temp change and that you have used GSAT (which I assume you have).	Taken into account.	Jan Fuglested	CICERO	Norway
16473	27	9	27	9	Can we also provide the timings of net-zero emissions and the emissions levels in 2100?	Taken into account. We will consider adding the information.	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
16557	27	9	27	10	Table 3.4: You can't claim to know what "well below 2°C" means. Here the policy prescriptiveness gets its worst!!! "Well below 2°C" and "Below 2°C" have to be merged!!! See for details my previous comment on "well below 2°C".	Well below 2 deg is too policy prescriptive	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
14673	27	9	27	11	Particular effort will be necessary to compare the cumulative CO2 emissions until net zero with the remaining carbon budget estimates provided in AR6 WG1 Chapter 5 Section 5. Including a placeholder for a short discussion of this in the next draft can ensure that this is taken up between the approval of the WG1 report and the finalisation of the WG3 report.	Agree	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
14675	27	9	27	11	This table should include two additional columns that inform the evolution of other GHGs, either by including total GHG emissions or by providing information about, for example, N2O and CH4 in addition of CO2.	Taken into account. We will consider adding the information.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
32333	27		27		Will it be possible to produce a Table like Table 3.4 but for all GHGs?	Taken into account. We will consider adding the information.	Penny Apostolaki	Barclays	United Kingdom (of Great Britain and Northern Ireland)
5115	27	9			It might be helpful to use the format of this table to provide numbers for year of first reaching net zero CO2/GHG, as this is hard to see from Figure 3.8	Taken into account. We will consider adding the information.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
47667	27	10			"os = overshoot" - OS doesn't appear in figure	Taken into account. We will consider adding the information.	raphael Slade	Imperial College	United Kingdom (of Great Britain and Northern Ireland)
37213	28	1	28	1	the categories of interest really are those with warming up to at most 2.5°C. The overall quasi-linearity is interesting but most interesting is the dependencies in the WG3 scenarios in the C1-C3 of the linearity on various influences. Since the text particularly mentions non-CO2, this needs to be illustrated for C1-C3 in the figure, perhaps an additional panel or inset?	Taken into account.	Michiel Schaeffer	Climate Analytics	Netherlands
35985	28	1	28	3	"Emission strategies mostly rely on reducing CO2 emissions. This is shown in Figure 3.10, by comparing the 2100 emissions for different gases for the different scenario categories.": CO2 emissions are also the largest, relative to other GHGs. At first glance, this does not seem surprising	Taken into account.	Sandrine Selse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
47001	28	1	28	24	Methane: this discussion deserves more space and in-depth synthesis. It is more important than some of the other issues that are given more space in this section.	More methane?	Frank Jotzo	ANU	Australia
5117	28	5	28	6	Remove one "also"	Editorial. Accepted	Matthias Weitzel	European Commission, Joint Research Centre	Spain
14677	28	7	28	7	Arguably also well below 2°C or 1.5°C scenarios are "below 2.5°C", but this statement currently is slightly ambiguous in that regard. Please rephrase for it to be perfectly unambiguous.	Taken into account. We will rephrase it.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
17197	28	14	28	24	Please elaborate why reducing short-lived forcers (SLF) should have little value, since the damage they do stacks over time. For example, if they contribute to a reduction in sea ice extent, this will not reverse if the SLF is degraded / removed, as long as the emission of these forcers continues.	Taken into account.	Joachim Rock	Thuener-Institute of Forest Ecosystems	Germany
47669	28	14	28	24	discussionon GSPs - cross ref x chapter box in chpt 2 (or annex b wherever it ends up)	Taken into account. Text will be revised.	raphael Slade	Imperial College	United Kingdom (of Great Britain and Northern Ireland)
41367	28	14	28	28	In this para you may add a reference to cross chapter box 2.2	Editorial. Accepted.	Jan Fuglested	CICERO	Norway
41365	28	18	28	18	Please insert "change" before "potential", for consistency with literature	Editorial. Accepted.	Jan Fuglested	CICERO	Norway
5119	28	23	28	24	As a reference for the dependence on mitigation cost on non-CO2 abatement, you might consider this reference: <a href="https://doi.org/10.1016/j.eneco.2019.07.004">https://doi.org/10.1016/j.eneco.2019.07.004</a>	Taken into account. Thank you for the reference.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
26309	28	24	28	24	Tanaka and O'Neill (2018, 10.1038/s41558-018-0097-x) directly showed the temperature consequence of using GWP100, GTP100, and GWP20 to implement the next zero GHG target. There are other related literature discussed in Box 2.2. This paragraph needs to be linked to Box 2.2, which discusses metric issues in details.	GWPs	Tanaka Katsumasa	Laboratoire des Sciences du Climat et de l'Environnement (LSCE), CEA, FRANCE; National Institute for Environmental Studies (NIES), JAPAN	France
20583	28	26	28	26	What exactly does "Median values across scenarios..." mean? Is it the median of the "Total" net emissions? Median for CO2? The median of each individual gas per scenario category (i.e. each gas represents a different scenario projection per scenario category?). Please be clear.	Taken into account. Clarity will be improved.	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
24893	28	28	28	28	Replace "Figure 3.8" with "Figure 3.10"	Editorial. Accepted	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
32395	28	28	28	33	The comment about the "near-linear relationship" is misleading, for among other reasons that it does not account for feedbacks such as loss of Arctic summer sea ice, nor emissions of methane, CO2, and N2O from thawing permafrost, nor the possibility of a methane burst from methane hydrates in the shallow seabed of the Eastern Siberian Shelf. See generally Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259, 8254 & 8256 (discussing biophysical feedbacks and tipping cascades; note in particular Table S2 in SI, and subsequent discussion.) See also Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Pistone K., et al. (2014) Observational determination of albedo decrease caused by vanishing Arctic sea ice, Proc. Nat'l. Acad. Sci. 111(9):3322–3326; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, ENVIRONMENTAL RESEARCH LETTERS 9:1–9; Schaefer K., et al. (2011) Amount and timing of permafrost carbon release in response to climate warming, TELLUS SERIES B CHEMICAL & PHYSICAL METEOROLOGY 63(2):165–180; Wilkerson J., et al. (2019) Permafrost nitrous oxide emissions observed on a landscape scale using the airborne eddy-covariance method, ATMOS. CHEM. PHYS. 19:4257–4268; Whiteman G., Hope C., & Wadhams P. (2013) Vast costs of Arctic change, NATURE 499(7459):401–403. Nor does the focus on the linear relationship adequately account for the fact that looking forward, cutting non-CO2 SLCFs has greater potential by a factor of 2X or more to slow warming at mid-century than CO2 mitigation, and can provide comparable mitigation at end of century to what CO2 mitigation can provide. Shindell D., et al. (2012) Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security, SCIENCE 335(6065):183–189; Xu Y. & Ramanathan V. (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, PROC. NAT'L. ACAD. SCI. 114(39):10315–10323; Report of the Committee to Prevent Extreme Climate Change (Chairs: V. Ramanathan, M. L. Molina, and D. Zaelke) (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change.	Taken into account. We will consider adding information on feedbacks. Thank you for the references	Durwood Zaelke	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
41023	28	29	28	30	More references are needed for this, I think, and you can refer to AR5 WGI and SR1.5	Editorial. Accepted	Jan Fuglested	CICERO	Norway
46999	28	30	28	33	Citations for emissions-temperature relationship: surely this should like to (more recent) science literature, not just a couple of older modelling related papers as is the case here.	Editorial. Accepted	Frank Jotzo	ANU	Australia
24139	28	31	28	33	The meaning of the sentence does not come out. It must be made clear.	Editorial. Accepted. Text will be clearer.	Alfred Ofose Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
41025	28	31	28	33	Not sure if the role of non-CO2 is clear from that figure.	Taken into account.	Jan Fuglested	CICERO	Norway
10523	28	1			This section should explicitly cross-reference the cross-chapter box on GHG metrics (Box 2.2), subject to further discussions about changes and location of that box, and attempt to offer some conclusions or summary on the extent to which alternative metrics would change the overall picture presented in this chapter on the evolution of non-CO2 gases in mitigation pathways. Lines 14-24 flag that GHG metrics matter - but that is not entirely helpful since it leaves it open how much they matter (compared to other issues) and hence whether conclusions from this chapter could be fundamentally different if only researchers were choosing a different metric.	Taken into account.	Andy Reisinger	NZAGRC	New Zealand
10527	28	1			It would be good to have additional insight, building on but going beyond SR15, on the degree to which non-CO2 emissions change the available CO2 budget for a given temperature goal. This would be relevant in section 3.3.3.4 for example, as well as on page 29.	Carbon budgets and SLFCs	Andy Reisinger	NZAGRC	New Zealand
14679	29	1	29	3	I would also include a panel with cumulative emissions until net zero CO2 and peak warming, or merge with Figure 3.13.	Taken into account. We will consider adding this information.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
14681	29	1	29	3	Please specify from when cumulative emissions are counted and until when.	Editorial. Accepted.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
26099	29	1	29	3	The relationship between the temperature increase and cumulative CO2 emissions would be useful for those in temperature-peak years as well as in 2100.	Editorial. Taken into account.	Junichi Tsutsui	Central Research Institute of Electric Power Industry	Japan
41027	29	4	29	4	I suggest adding "over time" after "emissions" to make it more clear.	Editorial. Accepted.	Jan Fuglested	CICERO	Norway
20323	29	4	29	26	literature criticising BECCS and highlighting DACCS is ignored and requires revision: Creutzig et al. ( <a href="https://pubs.rsc.org/en/Content/ArticleLanding/2019/EE/C8EE03682A">https://pubs.rsc.org/en/Content/ArticleLanding/2019/EE/C8EE03682A</a> ) and Breyer et al. ( <a href="https://www.cell.com/joule/fulltext/S2542-4351(19)30413-1">https://www.cell.com/joule/fulltext/S2542-4351(19)30413-1</a> ) are missing	Add BECCS critique; add DAC	Christian Breyer	LUT University	Finland
24141	29	4	29	26	Once there are EMISSIONS they always add to the GHG concentrations in the atmosphere. The opposite of emissions are SINKS which by the nature of their actions reduce the GHG concentrations in the atmosphere. A reduction in emission levels cannot be described as a negative emission. The terms "positive emissions" and "negative emissions" therefore tend to create confusion in readers minds and must be avoided. I have not seen this term being used until now. Chapter 4 deals with the long term perspective and does not use these terms.	Taken into account.	Alfred Ofose Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
27401	29	4	29	26	The timing of the emissions is important, in reference to 1.5 °C report: to avoid overshoot, early success-strategies are required. Land use follows the concept of rapid-out/slow-in (10.1126/science.1084460) thus in many strategies -other than re- or afforestation - (e.g. bioenergy, the basis of beccs) a source is only followed after a parity time by net-positive effects. This is particularly true if large stocks are depleted (grassland and forest soils or biomass in forests) and needs the caveat added. There is a lot of literature on this, but key is probably: 10.1111/gcbb.12643, 10.5849/jof.14-016, 10.1111/gcbb.12327). Furthermore, biophysical effects of land use need to be factored in (10.1126/science.aad7270, 10.1038/s41586-018-0577-1).	Bioenergy	Karlheinz Erb	Institute of Social Ecology, Univ. of Natural Resources and Life Sciences Vienna	Austria
44545	29	4	29	26	Would it be possible to give an indication what share of overall CDR is net negative (to compensate for carbon budget overshoot) and what share simply offsets residual emissions throughout the century? This would counteract the popular misunderstanding that CDR is something you only need to make up for "delayed mitigation" (although there could be delayed mitigation in the 'residual' category as well)	CDR- net negative or not	Oliver Geden	German Institute for International and Security Affairs	Germany
32397	29	10	29	14	BECCS is not carbon negative in the near-term because bioenergy leaves a carbon deficit for several decades to a century—far longer than the window of a decade or two available for slowing feedbacks and avoiding crashing through the 1.5C guardrail. See, e.g., IPCC AR5 WG III (2014) 11.13.4 GHG emission estimates of bioenergy production systems ("The combustion of biomass generates gross GHG emissions roughly equivalent to the combustion of fossil fuels. If bioenergy production is to generate a net reduction in emissions, it must do so by offsetting those emissions through increased net carbon uptake of biota and soils...Hence, the total climate forcing of bioenergy depends on feedstock, site-specific climate and ecosystems, management conditions, production pathways, end use, and on the interdependencies with energy and land markets...For example, in the specific case of existing forests that may continue to grow if not used for bioenergy, some studies employing counterfactual baselines show that forest bioenergy systems can temporarily have higher cumulative CO2 emissions than a fossil reference system (for a time period ranging from a few decades up to several centuries"). Subsequent analysis since AR5 further strengthens the case that bioenergy is not carbon neutral in the critical next decade or two. Danielle Venton, Core Concept: Can bioenergy with carbon capture and storage make an impact?, PNAS (2016); Mary S. Booth, Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy, Environ. Res. Lett. 13 (21 February 2018); Sterman J. D., et al. (2018) Does replacing coal with wood lower CO2 emissions? Dynamic lifecycle analysis of wood bioenergy, Eenvtl. Research Letters 13(015007):1–10, 1 ("We simulate substitution of wood for coal in power generation, estimating the parameters governing NPP and other fluxes using data for forests in the eastern US and using published estimates for supply chain emissions. Because combustion and processing efficiencies for wood are less than coal, the immediate impact of substituting wood for coal is an increase in atmospheric CO2 relative to coal. The payback time for this carbon debt ranges from 44–104 years after clear-cut, depending on forest type—assuming the land remains forest. Surprisingly, replanting hardwood forests with fast-growing pine plantations raises the CO2 impact of wood because the equilibrium carbon density of plantations is lower than natural forests. Further, projected growth in wood harvest for bioenergy would increase atmospheric CO2 for at least a century because new carbon debt continuously exceeds NPP. Assuming biofuels are carbon neutral may worsen irreversible impacts of climate change before benefits accrue. Instead, explicit dynamic models should be used to assess the climate impacts of biofuels."). In addition, the CCS part of BECCS has not been demonstrated at scale or at acceptable cost, nor has it won over the support it would need from the public. See Gregory Nemet et al., Negative emissions—Part 3: Innovation and upscaling, Environ. Res. Lett. (May 2018); European Academies Science Advisory Council, Negative emission technologies: What role in meeting Paris Agreement targets? (Feb 2018) ("CCS plants in Europe have been shelved so that whatever experience is being gained globally is outside Europe. The loss in momentum in implementing CCS technologies not only has serious implications for mitigation pathways, but also one of the most commonly cited NETs [negative emissions technologies] (BECCS) assumes the availability of cost effective 'off-the-shelf' CCS, while another (direct air capture) relies on the widespread availability of CO2 storage.	Taken into account. Thank you for the references	Durwood Zaelke	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
32397	29	10	29	14	Comment continued...  At present, economic incentives for deploying CCS are inadequate (whether through the very low carbon price or targeted government support), while those for NET development are lacking.”; Andersen & Peters, The Trouble with Negative Emissions, Science (Oct 2016). One study estimates that current rate of increase in CCS is 100 times lower than needed to meet the 2C target. See Haszeldine et al. (April 2018), Negative emissions technologies and carbon capture and storage to achieve the Paris Agreement commitments, Philosophical Transactions of the Royal Society. Thus, BECCS should not be presented as a viable CDR strategy. Moreover, even if BECCS were carbon negative (which it is not), other CDR technologies can provide significant removal potentials without the sustainability, land use, and time-delay issues associated with BECCS. Soil carbon sequestration is one alternative. One study found that carbon losses from human agriculture accounted for about 113 Gt C (~415 Gt CO <sub>2</sub> ). With best management practices, two thirds of losses may be recoverable, setting a theoretical maximum of 276 Gt CO <sub>2</sub> that can be sequestered in soils. See Sanderman et al., Soil carbon debt of 12,000 years of human land use, PNAS (2017) and Correction for Sanderman et al., Soil carbon debt of 12,000 years of human land use. Another analysis calculated that natural climate solutions may be able to provide up to 37% of cost-effective CO <sub>2</sub> mitigation needed through 2030 for a >66% chance of holding warming to below 2 °C. Griscom, M., et al. (2017) Natural Climate Solutions, Proc. Natl. Acad. Sci. 114(44): 11645–11650, 1645 [“We identify and quantify “natural climate solutions” (NCS): 20 conservation, restoration, and improved land management actions that increase carbon storage and/or avoid greenhouse gas emissions across global forests, wetlands, grasslands, and agricultural lands. We find that the maximum potential of NCS—when constrained by food security, fiber security, and biodiversity conservation—is 23.8 petagrams of CO <sub>2</sub> equivalent (PgCO <sub>2</sub> e) y <sup>-1</sup> (95% CI 20.3–37.4). This is >30% higher than prior estimates, which did not include the full range of options and safeguards considered here. About half of this maximum (11.3 PgCO <sub>2</sub> e y <sup>-1</sup> ) represents cost-effective climate mitigation, assuming the social cost of CO <sub>2</sub> pollution is ≥100 USD MgCO <sub>2</sub> e <sup>-1</sup> by 2030. Natural climate solutions can provide 37% of cost-effective CO <sub>2</sub> mitigation needed through 2030 for a >66% chance of holding warming to below 2 °C.”]. An additional natural climate solution, not considered in the previous study, is “proforestation” – growing existing forests to their full ecological potential, a strategy that may be more effective, immediate, and low-cost compared to more traditional strategies of reforestation and afforestation. Moomaw, W.R., Masino, S.A., & Faison, E.K. (2019) Intact Forests in the United States: Proforestation Mitigates Climate Change and Serves the Greatest Good, Front. For. Glob. Change 2(27): 1–10, 1 (“The recent 1.5 Degree Warming Report by the Intergovernmental Panel on Climate Change identifies reforestation and afforestation as important strategies to increase negative emissions, but they face significant challenges: afforestation requires an enormous amount of additional land, and neither strategy can remove sufficient carbon by growing young trees during the critical next decade(s). In contrast, growing existing forests intact to their ecological potential—termed proforestation—is a more effective, immediate, and low-cost approach that could be mobilized across suitable forests of all types. Proforestation serves the greatest public good by maximizing co-benefits such as nature-based biological carbon sequestration and unparalleled ecosystem services such as biodiversity enhancement, water and air quality, flood and erosion control, public health benefits, low impact recreation, and scenic beauty.”].				
32399	29	10	29	14	Another alternative is Direct Air Capture (DAC). DAC has few limitations on the amount that may be removed. Cost is the limiting factor but costs are coming down. One DAC company, Carbon Engineering, is conducting air-to-fuel pilot demonstrations and plans to run a commercial validation project over the next decade. The company estimated DAC costs using its method as ranging between \$94-232/ton CO <sub>2</sub> captured. David Keith et al., A Process for Capturing CO <sub>2</sub> from the Atmosphere, Joule (June 2018).	Taken into account. Thank you for the references	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
35987	29	11	29	11	bio-energy-and-carbon-capture-and-storage: bioenergy and carbon capture and storage or bio-energy and carbon capture and storage	Editorial. Taken into account.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
10525	29	20	29	26	It would be useful to bring in the conclusions from SRCCL here.	Taken into account.	Andy Reisinger	NZAGRC	New Zealand
32401	29	21	29	26	BECCS is not carbon negative in the near-term because bioenergy leaves a carbon deficit for several decades to a century—far longer than the window of a decade or two available for slowing feedbacks and avoiding crashing through the 1.5C guardrail. See, e.g., IPCC AR5 WG III (2014) 11.13.4 GHG emission estimates of bioenergy production systems (“The combustion of biomass generates gross GHG emissions roughly equivalent to the combustion of fossil fuels. If bioenergy production is to generate a net reduction in emissions, it must do so by offsetting those emissions through increased net carbon uptake of biota and soils...Hence, the total climate forcing of bioenergy depends on feedstock, site-specific climate and ecosystems, management conditions, production pathways, end use, and on the interdependencies with energy and land markets...For example, in the specific case of existing forests that may continue to grow if not used for bioenergy, some studies employing counterfactual baselines show that forest bioenergy systems can temporarily have higher cumulative CO <sub>2</sub> emissions than a fossil reference system (for a time period ranging from a few decades up to several centuries”). Subsequent analysis since AR5 further strengthens the case that bioenergy is not carbon neutral in the critical next decade or two. Danielle Venton, Core Concept: Can bioenergy with carbon capture and storage make an impact?, PNAS (2016); Mary S. Booth, Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy, Environ. Res. Lett. 13 (21 February 2018); Sterman J. D., et al. (2018) Does replacing coal with wood lower CO <sub>2</sub> emissions? Dynamic lifecycle analysis of wood bioenergy, Environ. Res. Lett. 13(015007):1–10, 1 (“We simulate substitution of wood for coal in power generation, estimating the parameters governing NPP and other fluxes using data for forests in the eastern US and using published estimates for supply chain emissions. Because combustion and processing efficiencies for wood are less than coal, the immediate impact of substituting wood for coal is an increase in atmospheric CO <sub>2</sub> relative to coal. The payback time for this carbon debt ranges from 44–104 years after clear-cut, depending on forest type—assuming the land remains forest. Surprisingly, replanting hardwood forests with fast-growing pine plantations raises the CO <sub>2</sub> impact of wood because the equilibrium carbon density of plantations is lower than natural forests. Further, projected growth in wood harvest for bioenergy would increase atmospheric CO <sub>2</sub> for at least a century because new carbon debt continuously exceeds NPP. Assuming biofuels are carbon neutral may worsen irreversible impacts of climate change before benefits accrue. Instead, explicit dynamic models should be used to assess the climate impacts of biofuels.”).	Taken into account. Thank you for the references.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32403	29	21	29	26	In addition, the CCS part of BECCS has not been demonstrated at scale or at acceptable cost, nor has it won over the support it would need from the public. See Gregory Nemet et al., Negative emissions—Part 3: Innovation and upscaling, Environ. Res. Lett. (May 2018); European Academies Science Advisory Council, Negative emission technologies: What role in meeting Paris Agreement targets? (Feb 2018) (“CCS plans in Europe have been shelved so that whatever experience is being gained globally is outside Europe. The loss in momentum in implementing CCS technologies not only has serious implications for mitigation pathways, but also one of the most commonly cited NETs [negative emissions technologies] (BECCS) assumes the availability of cost effective ‘off-the-shelf’ CCS, while another (direct air capture) relies on the widespread availability of CO <sub>2</sub> storage. At present, economic incentives for deploying CCS are inadequate (whether through the very low carbon price or targeted government support), while those for NET development are lacking.”); Andersen & Peters, The Trouble with Negative Emissions, Science (Oct 2016). One study estimates that current rate of increase in CCS is 100 times lower than needed to meet the 2C target. See Haszeldine et al. (April 2018), Negative emissions technologies and carbon capture and storage to achieve the Paris Agreement commitments, Philosophical Transactions of the Royal Society. Thus, BECCS should not be presented as a viable CDR strategy.	Taken into account.	Durwood Zaelke	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
2259	29	22	29	26	Why is only BECCS considered here and throughout the chapter? Other CDR techniques that avoid some of the problems associated with BECCS are gaining interest. These include soil carbon sequestration, biochar, enhanced weathering, which can be deployed in agriculture and hence do not compete for land needed for food production (on the contrary, they may increase food production). See e.g. <a href="https://iopscience.iop.org/article/10.1088/1748-9326/aabf9f/meta">https://iopscience.iop.org/article/10.1088/1748-9326/aabf9f/meta</a> ; <a href="https://www.nature.com/articles/s41477-018-0108-y">https://www.nature.com/articles/s41477-018-0108-y</a> ; <a href="https://www.nature.com/articles/s41561-017-0026-z">https://www.nature.com/articles/s41561-017-0026-z</a>	Other negative emissions	Sara Vicca	University of Antwerp	Belgium
41029	29	23	29	26	I think you can add more nuance instead of just saying "significantly criticized". You can say there many questions and unresolved issues etc. I also suggest more references that can reflect some of the discussions.	Editorial. Taken into account.	Jan Fuglestedt	CICERO	Norway
35989	29	25	29	25	other possible quotation in this sense: Sandrine Sèlosse. Bioenergy with Carbon Capture and Storage: how carbon storage and biomass resources potentials can impact the development of the BECCS. Bioenergy with Carbon Capture and Storage. 1st Edition. Editors: Jose Carlos Magalhães Pires Ana Luisa da Cunha Gonçalves. Elsevier. ISBN: 9780128162293. 318p, 2019	Taken into account. Thank you for the reference	Sandrine Sèlosse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
44547	29	26	29	26	Not sure if Peters and Geden 2017 talk about these issues. A better reference would probably be Geden and Löschel 2018 ( <a href="https://www.nature.com/articles/s41561-017-0026-z">https://www.nature.com/articles/s41561-017-0026-z</a> )	Taken into account. Replacing will be considered	Oliver Geden	German Institute for International and Security Affairs	Germany
20581	30	2	30	2	Please add in the caption how figure 3.12 has been drawn based on the multiple individual projections per C# category. I assume it is the median scenario (as stated in the caption to figure 3.10), but this should be repeated in every figure for clarity.  I believe this comment is also valid for other figures (3.16, 3.17?)	Editorial. Accepted.	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
38785	30	3	30	6	First, it is unclear if the sentence is completed (no period), or if there was additional language to be added. Second, are there specific types of "stringent emission reduction" to reach net CDR? In other words, are these represented in any current SSPs, or is this something new? Third, what kind of lifestyle change would be necessary? And how would that assumed lifestyle change (one could argue this is difficult) factor into temporally evolving CO2 emissions?	Taken into account. This information will be provided.	Julian Reyes	Personal Capacity	United States of America
32405	30	3	30	10	Any overshoot will cause some irreversible impacts, including SLR and glacial and ice sheet melt that will not be corrected when the overshoot is corrected. Tokarska K. B., et al. (2019) Path Independence of Carbon Budgets When Meeting a Stringent Global Mean Temperature Target After an Overshoot. EARTH'S FUTURE 7:1283–1295, 1283 ("Emission pathways that are consistent with meeting the Paris Agreement goal of holding global mean temperature rise well below 2 °C often assume a temperature overshoot. In such overshoot scenarios, a given temperature limit is first exceeded and later returned to, under the assumption of large-scale deliberate carbon dioxide removal from the atmosphere. Here we show that although such strategy might result in a reversal of global mean temperature, the carbon cycle exhibits path dependence. After an overshoot, more carbon is stored in the ocean and less on land compared to a scenario with the same cumulative CO2 emissions but no overshoot. The near-path independence of surface air temperature arises despite the path dependence in the carbon cycle, as it is offset by path dependence in the thermal response of the ocean. Such behavior has important implications for carbon budgets (i.e. the total amount of CO2 emissions consistent with holding warming to a given level), which do not differ much among scenarios that entail different levels of overshoot. Therefore, the concept of a carbon budget remains robust for scenarios with low levels of overshoot (up to 300 Pg C overshoot considered here) but should be used with caution for higher levels of overshoot, particularly for limiting the environmental change in dimensions other than global mean temperature rise."); Solomon S., et al. (2010) Persistence of climate changes due to a range of greenhouse gases. PROC. NAT'L. ACAD. SCI. 107(43):18354–18359, 18356 ("The transfer of heat from the atmosphere to the ocean's mixed layer (top 100 m or so) is thought to occur on timescales on the order of a decade or less (30), whereas multiple centuries are required to warm or cool the deep ocean (31), and changes in the great ice sheets and vegetation coverage may occur over many thousands of years (4).").	Overshoot	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32407	30	3	30	10	Speed is a key metric, and climate solutions must be measured along this dimension as well as along the conventional metrics. The question that needs to be answered is how quickly a climate solution can deliver avoided warming. Molina M., et al. (2009) Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions, PROC. NAT'L. ACAD. SCI. 106(49):20616–20621. It is important to note that SLCPs are a critical part of that solution, and that cutting them can avoid warming at 2050 of up to 0.6 °C, while cutting CO2 can avoid between 0.1–0.3 °C; at 2100, SLCPs avoid 1.2 °C warming and CO2 avoids 1.6–1.9 °C. SLCIP reductions are critical for vulnerable areas like the Arctic and because they can slow progression of tipping points and self-reinforcing feedbacks. See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250; Ramanathan, Molina, and Zaelke (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change.	Taken into account. Thank you for the reference.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32409	30	3	30	10	It is critical to slow feedbacks in the coming decade, including by cutting the SLCPs, as well as by protecting sinks, enhancing urban albedo, and other fast mitigation strategies. Molina M., et al. (2009) Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions, PROC. NAT'L. ACAD. SCI. 106(49):20616–20621; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595; and Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595, 592 ("In our view, the consideration of tipping points helps to define that we are in a climate emergency and strengthens this year's chorus of calls for urgent climate action — from schoolchildren to scientists, cities and countries.").	Taken into account. Thank you for the reference.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32411	30	3	30	10	It also may be possible to reduce atmospheric methane concentrations. Jackson R.B., Solomon E.I., Canadell J.G., Cargnello M., & Field C.B., Methane removal and atmospheric restoration, NATURE SUSTAINABILITY 2, 436–438 (2019) ("In contrast to negative emissions scenarios for CO2 that typically assume hundreds of billions of tonnes removed over decades and do not restore the atmosphere to preindustrial levels, methane concentrations could be restored to ~750 ppb by removing ~3.2 of the 5.3 Gt of CH4 currently in the atmosphere. Rather than capturing and storing the methane, the 3.2 Gt of CH4 could be oxidized to CO2, a thermodynamically favourable reaction .... In total, the reaction would yield 8.2 additional Gt of atmospheric CO2, equivalent to a few months of current industrial CO2 emissions, but it would eliminate approximately one sixth of total radiative forcing. As a result, methane removal or conversion would strongly complement current CO2 and CH4 emissions-reduction activities. The reduction in short-term warming, attributable to methane's high radiative forcing and relatively short lifetime, would also provide more time to adapt to warming from long-lived greenhouse gases such as CO2 and N2O.").	Taken into account. Thank you for the reference.	Durwood Zaelke	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
32769	30	3	30	10	Speed is a key metric, and climate solutions must be measured along this dimension as well as along the conventional metrics. With that the question that needs to be answered is how quickly a climate solution can deliver avoided warming, and SLCPs are part of that solution. With SLCPs providing avoided warming at 2050 of up to 0.6 °C and CO2 avoiding up to 0.1–0.3 °C; at 2100, SLCPs avoid 1.2 °C warming and CO2 avoids 1.6–1.9 °C. SLCIP reductions are critical for vulnerable areas like the Arctic and because they can slow progression of tipping points and self-reinforcing feedbacks. See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250; Ramanathan, Molina, and Zaelke (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change.	Taken into account. Thank you for the reference.	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
20585	30	5	30	6	I'm not sure if "Grubler et al. 2018 falls under "lifestyle change". In my impression the scenario depends heavily on technological advances and energy efficiency (where the advances themselves perhaps foster changes in lifestyle).	Taken into account. The reference will be revised.	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
10189	30	6	30	7	"by the left graph" - should be expanded to clarify that it is from Figure 3.13	Editorial. Accepted.	Aglaia Obrekht	Environment and Climate Change Canada	Canada
10191	30	6	30	7	the conclusion that CDR has no impact on the peak temperature as shown in the figure is not evident. Please explain.	Accepted. Better explanation will be provided	Aglaia Obrekht	Environment and Climate Change Canada	Canada
37215	30	7	30	7	this is not informative enough: "CDR can have a strong impact on end-of-century temperature". On the one hand this seems almost trivial, on the other hand, what's more interesting is that the right-hand panel of fig 3.13 shows 1.5°C and 2°C are achieved with anything from very large to virtually zero CDR. The only thing the figure seems to show is that only for 1.5°C and 2°C pathways do the models see a need for substantive CDR.	Taken into account.	Michiel Schaeffer	Climate Analytics	Netherlands
37217	30	10	30	10	the link with near-term action is not apparent from fig 3.13	Accepted. The link will be better explored	Michiel Schaeffer	Climate Analytics	Netherlands
26311	30	14	30	14	This subsection, if this will be kept like this, needs a caveat that the analysis does not consider a possibility of large overshoot (I guess, partly due to the limited temporal scope till 2100). Large overshoot scenarios (e.g. peak warming at 2.5C or 3C) are still relevant, given the current baseline heading to a 3C warming by the end of this century (Hausfather and Peters, 2020, Nature). The timings of net zero CO2 and GHG emissions would be affected by the possibility of overshoot (Wigley, 2018, Climatic Change; Tanaka and O'Neill, 2018, Nature Climate Change).	Taken into account. Overshoot will be explored.	Tanaka Katsumasa	Laboratoire des Sciences du Climat et de l'Environnement (LSCE), CEA, FRANCE; National Institute for Environmental Studies (NIES), JAPAN	France
44553	30	14	31	9	Would it be possible to extend this net zero section, dealing not only with the timing but also with the "structural elements" of net zero, e.g. by providing some information and a figure dealing with residual emissions and removals at the time of net zero? It would not only be interesting to show overall levels of residual emissions in the first net zero year for one (or more) ambitious IPs but also to show what kind of emissions are assumed to be hard/impossible to abate	Taken into account. Section will be expanded.	Oliver Geden	German Institute for International and Security Affairs	Germany
32335	30		50		For about 20 pages results are presented without a reference to the IPs. Is it possible to add the IPs in the graphs?	Taken into account. The IPs will be much better explored in the next draft.	Penny Apostolaki	Barclays	United Kingdom (of Great Britain and Northern Ireland)
2261	30	6			consider adding a reference to <a href="https://www.nature.com/articles/s41893-019-0331-1">https://www.nature.com/articles/s41893-019-0331-1</a>	Thank you for the reference.	Sara Vicca	University of Antwerp	Belgium
45039	30	12			Clarify if this is net-zero CO2 only or net-zero all GHGs.	Editorial. Accepted.	Andy Reisinger	NZAGRC	New Zealand
5121	30	14			This section is relatively short given the importance it has for some of the key conclusions in the exec. summary	Taken into account. Section will be expanded.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
38787	30	18			The Paris Agreement does not state any "targets" related to the temperature goals (see Article 2). Please refer to goals of the Paris Agreement as the chapter and other WG reports do.	Taken into account. Rephrasing will be considered.	Julian Reyes	Personal Capacity	United States of America
45041	31	2	31	3	3 degrees means net-zero CO2 by end of century, not net-zero all GHGs, right? Please clarify to avoid confusion (I know this is stated at the end of the para, but please add "CO2" after "net zero".	Taken into account. Section will be expanded.	Andy Reisinger	NZAGRC	New Zealand
37219	31	3	31	4	2°C and 1.5°C are not targets, these are limits. One does not aim to "hit" a 2°C target, but aims at holding warming below 2°C	Editorial. Accepted.	Michiel Schaeffer	Climate Analytics	Netherlands
26101	31	5	31	6	Due to the limitation of GWP and its potential problems, as described in Box 2.2, the timing of net-zero GHG emissions should be treated with some caution.	Taken into account.	Junichi Tsutsui	Central Research Institute of Electric Power Industry	Japan
41031	31	5	31	6	You may add a ref to table 2.4 in ch2 of SR1.5 showing this.	Editorial. Accepted.	Jan Fuglested	CICERO	Norway
5123	31	11	31	14	Potentially refer to the definitions of Table 3.3 to avoid confusion on the definition	Editorial. Accepted.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
6143	31	14	31	15	There seems to be some inconsistency in the sentence about the share of renewables, with lower shares (40%) for scenarios reaching 1.5°C	Editorial. Accepted.	Linares Pedro	Universidad Pontificia Comillas	Spain
41587	31	14	31	41	"The share of renewables, for instance, needs to be around 20-50% for scenarios reaching 2.5°C" should be changed to "The share of renewables, for instance, is around 20-50% for scenarios reaching 2.5°C". The scenarios in the literature do not necessarily span the full range of possibilities and thus cannot be used to define feasibility boundaries. What is presented in this sentence is the range of the scenarios that are collected, not the ultimate requirements for reaching 2.5°C (RE could be higher or lower depending on other measures and developments).	Taken into account. Rephrasing will be considered.	Ida Andrea Braathen Sognaes	CICERO centre for international climate research	Norway
4643	31	15	31	15	I suggest to double-check the consistency between the data introduced in "40-70% for scenarios reaching 2°C and above 40% for scenarios reaching 1.5°C"	Editorial. Accepted.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
10193	31	15	31	15	since there is almost no difference in amount of shares of renewables between 2 degree and 1.5 degree, why not just combine the two: 'over 40% for scenarios reaching either 2 or 1.5 degrees'. Surprised though that there is no difference between 2degree and 1.5 degree scenarios for share of renewables	Taken into account. Text will be revised.	Aglaia Obrekht	Environment and Climate Change Canada	Canada
37221	31	15	31	15	need to split 2°C and 1.5°C categories in C1-4. Lumping together C1 & 2 and also C3 & 4 makes the results impossible to take into account for implementation of the Paris Agreement. The figures split these categories, which is good, and the text statements should do as well. In addition, particularly C4 is completely irrelevant for Paris Agreement to which the text refers.	Taken into account. We will consider adopting this division.	Michiel Schaeffer	Climate Analytics	Netherlands
35993	31	16	31	17	"a considerable amount of CCS is applied": how is the potential for carbon storage considered? It would seem that it is not limiting?	Taken into account.	Sandrine Selosse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
38789	31	5			: Are there emissions levels in the Paris Agreement? Or are these emissions levels in line with achieving the temperature goals of the Paris Agreement?	Taken into account. Text will be improved.	Julian Reyes	Personal Capacity	United States of America
10529	31	7			For many readers, the key issue they are interested in is hard to extract from this figure - which is the question, when do CO2 and all-GHG reach net zero for different temperature goals. Readers have to rely on their colour-decoding skills to get that information clearly. Can you change what's the x and y axis and what's shown by colour coding to make that information more easily visible? I.e. right now the figures show the correlation between cumulative emissions and net-zero emissions, with temperature in colour - can you show the correlation between net-zero emissions and temperature, with cumulative emissions in colour? That would strike me as more policy relevant.	Taken into account.	Andy Reisinger	NZAGRC	New Zealand
16507	31	15			Suggests give a range for the share of renewables in 1.5 scenario	Editorial. Taken into account.	Lining WANG	Economics and Technology Research Institute, CNPC	China

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
15501	32	1	32	3	Consider including "Share fossil fuels in 2050" as a pane in Figure 3.15, since such statistics are mentioned in the text but not clearly shown in Figure 3.15.	Editorial. Taken into account.	Peter Erickson	Stockholm Environment Institute	United States of America
20587	32	2	32	2	Are the panels shown in figure 3.15 equivalent to the categories highlighted in Table 3.3. That is, is the "Share renewables in 2050" only accounting for electricity production (as stated in the table), or TPES, or TFC? It would be good if these were all consistently and clearly labeled.  If it is based on renewables in electricity, perhaps consider looking into reneables as a % of TFC, as i think that is more appropriate.	Taken into account.	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
5125	32	4	32	5	Please check the figure numbers, I think this should be 3.15 and 3.16	Editorial. Accepted	Matthias Weitzel	European Commission, Joint Research Centre	Spain
24895	32	4	32	13	The paragraph refers to Figures 3.15, 3.16 and not to Figures 3.14 and 3.15	Editorial. Accepted	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
10195	32	5	32	5	points to Figure 3.15, but should be pointing to Figure 3.16	Editorial. Accepted	Aglaia Obrekht	Environment and Climate Change Canada	Canada
16559	32	6	32	6	You can't claim to know what "well below 2°C" means. See for details my previous comment on "well below 2°C".	Taken into account. Text will be revised.	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
24143	32	8	32	10	This sentence is not clear at all. If possible break into two sentences to bring out the true meaning.	Taken into account. Clarity will be improved.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
5127	32	10	32	11	I think this sentence is a strong policy message that could go to the exec. summary	Taken into account. We will consider having it in the ES.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
37223	32	11	32	11	unclear what is 2°C target category here. Also 2°C is not a target ...	Taken into account. Categorization will be clearer and rephrasing will be considered	Michiel Schaeffer	Climate Analytics	Netherlands
43563	32	12	32	13	"It should be noted that nuclear does not reach more than around 20% of total TPES even in highnuclear scenarios." this applies also to large hydro scenarios but it is not mentioned. This sentence is obvious and perhaps not needed, there should be a clear reason why "it should be noted".	Taken into account.	Adam Blazowski	FOTA4Climate.org	Poland
44753	32	12	32	13	"It should be noted that nuclear does not reach more than around 20% of total TPES even in high-nuclear scenarios." I am not sure what the point is of this sentence. It could be useful to explain that none of the scenarios are dominated by nuclear. But we have no scenario dominated by hydro (for obvious reasons), so why should it be emphasized for nuclear?	Taken into account	Daniel Westlén	Liberal party Swedish parliament	Sweden
32665	32	12	32	16	DELETE (because is not what has been demonstrated in SR1.5) : « It should be noted that nuclear does not reach more than around 20% of total TPES even in high-nuclear scenarios ». REPLACE BY : It should be noted that nuclear is reaching more than 20 % of total TPES, in particular in high nuclear scenarios (Berger et al., 2017a, 2017b)	Taken into account	Jean-Luc SALANAVE	Ecole Centrale-Supelec, Paris, France (professor, energy systems)	France
17199	32	13	32	13	What is TPES?	Editorial. Total primary energy supply. Acronym will be expanded.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
17201	32	4	33	2	Do the scenarios shown in figure 3.16 deliver the same services, benefits etc. for societies and people? If not, a different level of energy use is associated with a different level in welfare and the figure "compares apples and oranges". Please amend text to clarify this issue.	Taken into account.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
31179	32	2			Share renewable in 2050: What share is given? Share in electricity generation? Share in TPED? Share in TFC? Please specify.	Editorial. Taken into account. Information will be provided	Urs Ruth	Robert Bosch GmbH	Germany
5129	33	2	33	2	In the figure caption, mention Primary Energy	Editorial. Taken into account. Information will be provided	Matthias Weitzel	European Commission, Joint Research Centre	Spain
10197	33	7	33	8	In scenario C8 there is a considerable source of emission in brown. It is missing from the legend. Why are there differences for 2010 emissions for different scenarios (C1 seems to have lowest 2010 emissions, C8 has the highest), given that 2010 is historical?	Accepted. Error will be corrected	Aglaia Obrekht	Environment and Climate Change Canada	Canada
36031	33	7	33	9	recall what C1...C7 stands for	Editorial. Error will be corrected.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
17203	33	8	33	9	Please explain what "R5..." means and what the brown part of the columns of "C8" refer to.	Editorial. Error will be corrected.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
20589	33	9	33	9	Given that this figure is based (I think, based on the caption of figure 3.10, but it is very unclear) on the median projection of scenarios within each emission category, and given that models disagree a lot on regional projections, I think that this figure is inappropriate and even misleading. It gives the impression that pathways within an emission category agree concerning regional emissions. A plot showing the range of emissions per region and emission category would be much more appropriate.	Misleading figure	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
24897	33		33		The legend of Figure 3.17 needs to be corrected, emissions by region should also be presented using per capita and cumulative emissions	Editorial. Error will be corrected.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
36653	33		33		Fig 3.16 The title needs to be explicit	Editorial. Taken into account.	NARESH KUMAR SOORA	Indian Agricultural Research Institute	India
36655	33		33		Fig 3.17 The title needs to be explicit	Editorial. Taken into account.	NARESH KUMAR SOORA	Indian Agricultural Research Institute	India
16509	33	1			because it is already 2020 now, the numbers in the figure for 2020 are still very different. This is a little confused.	Editorial. Taken into account. This will be updated.	Lining WANG	Economics and Technology Research Institute, CNPC	China
20325	33	1			Fig. 3.16 shows a structural misbalance of the IPx which requires a major revision. The entire class of global 100% RE scenarios is FULLY ignored, which is not acceptable. They are published in peer-reviewed journals, and are for at least one candidate submitted to the AR6 scenarios database, but no IP reflects this. Breyer et al. ( <a href="https://www.iaee.org/eeep/article/305">https://www.iaee.org/eeep/article/305</a> ) shows an overview to all known global 100% renewable scenarios, while Ram et al. ( <a href="http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf">http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf</a> ) is uploaded and it covers the energy system in high detail. To emphasises this HUGE misery, the ESMs achieve 100% RE in 2050, the highest renewable scenarios does even not show something comparable in year 2100. Ram et al. can even show that the 100% RE 2050 system has the same specific energy cost as the present energy system.	We will discuss the 100% RE scenarios	Christian Breyer	LUT University	Finland
2975	33				Figure 3.17: The dark brown region are not indicated on the legend key	Editorial. Error will be corrected.	Mustafa Babiker	Aramco	Saudi Arabia
26103	34	1	34	1	I understand that 3.3.4 deals with climate feedbacks on emissions and mitigation. The title 'Implications of carbon budget uncertainty' is not suitable for that limited scope.	Taken into account. Text will be improved.	Junichi Tsutsui	Central Research Institute of Electric Power Industry	Japan
44549	34	1	34	1	It seems to me that 3.3.4 is not dealing with "carbon budget uncertainty", but maybe I misunderstood the meaning of it (but there's not much about uncertainty in the text)	Taken into account. Text will be improved.	Oliver Geden	German Institute for International and Security Affairs	Germany
41033	34	1	34	2	To me it seems to be a mismatch between the title of section 3.3.4 and the sub sections.	Taken into account. Text will be improved.	Jan Fuglestedt	CICERO	Norway
16213	34	1	34	38	In Section 3.3.4 Implications of Carbon Budget Uncertainty, consider adding a subsection related to war and its impact on carbon emissions. Climate change is a major driver of war in regional settings, e.g. from drought, and the impact of refugees and other strains to regional economic systems can create situations where both military emissions and emissions from energy, transportation, industry and land use change can fall far afield from model assumptions.	Taken into account.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
2977	34	1	34	48	The section titled "Implications of carbon budget uncertainty" but the text is mainly on the impacts of climate change. Need first to report on the uncertainty of the carbon budget and its magnitude and direction; and then its climate implications -- then you can discuss the implication of climate impacts on the sectors mentioned in the section.	Taken into account. Text will be improved.	Mustafa Babiker	Aramco	Saudi Arabia

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
10125	34	1	34	48	I was glad to see that Section 3.3.4 exists as carbon cycle and carbon budget uncertainties are an important topic for understanding climate policy targets and the implications of emission scenarios but this section needs to be entirely re-written and rethought because it is currently missing the point and reads like it was an outlined section that received short attention when writing commenced. A useful section on carbon budget uncertainties would provide details on the MAGICC carbon cycle parameterizations for emission scenarios detailed in Chapter 3, a better description of the probabilities for each temperature goal (i.e. 50% vs. 66% chance of 2°), or if the IP approach is maintained in a future draft, there could be a systematic exploration of the carbon cycle/carbon budget uncertainty for each IP scenario.	Txs. We will try to improve the section	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
14683	34	1	34	48	The title of this section doesn't seem to match the content. The content describes how climate change affects (mostly baseline) emissions or land use. A suggested alternative could be: Climate change affecting societal emissions and mitigation action ( -- probably not the best suggestion)	Taken into account. Text will be improved.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
14685	34	1	34	48	This section (as most of the chapter) is very descriptive providing a review of evidence but lacking an assessment of these numbers. The section doesn't provide the reader with the expected insight in whether there is high or low confidence in the accuracy of these numbers, where their strengths and limitations lie, etc.	Will try to improve	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
17205	34	1	34	48	In this sub-chapter, too many references are made to single studies or single scenarios. If - as claimed above - several hundred scenarios have been assessed here, a sentence "... find that climate-induced GDP loss reduces CO2 emissions by 304 PgC ... in a scenario ..." (p. 3-34, 46 - 48) is much to detailed (there is only one noteworthy study?) and this indicates that either the scenarios do not cover this aspect or that they have not been assessed thoroughly enough.	We are trying to use references as well as statistics on the scenario ranges to also reflect the insights from individual studies.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
20591	34	1	34	48	Section 3.3.4 is called "Implications of carbon budget uncertainty", but the entire section discusses impacts of climate change on energy, land, and economic systems. Nothing on the implications of carbon budget uncertainty on emission pathways and climate response uncertainties (as one would expect from the chapter structure) is presented. Please re-consider the section heading or the chapter structure.	Taken into account. Text will be improved.	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
24639	34	1	34	48	The title of the subsection 3.3.4 is "Implication of carbon budget uncertainty". But, most contents cover only the impact of emissions not the carbon budget uncertainty. More contents about uncertainty need to be added.	Taken into account. Text will be improved.	Young-Hwan Ahn	Sookmyung Women's University	Republic of Korea
46627	34	1	34	48	Is it possible to mentioned to which extent the described impacts are currently taken into account for scenarios in the database. For example, are Calvin et al. (2013) and Kyle et al. (2014) included in the database ?	Will do	Florian Leblanc	Centre International de Recherche sur l'Environnement et le Développement	France
41035	34	2	34	17	At LAM2 contact between the energy chapter and Alex Ruane, CLA of ch 12 in WGI, was established. Such a connection seems useful here. So I suggest you contact the CLAs of WGIII Energy chapter for coordination on this issue	Will check with Jan.	Jan Fuglested	CICERO	Norway
5131	34	7	34	12	Duplicate information, please streamline	Editorial. Taken into account	Matthias Weitzel	European Commission, Joint Research Centre	Spain
24145	34	12	34	15	The meaning of the sentence is missing. Please rephrase	Editorial. Taken into account	Alfred Ofoosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
9695	34	18	34	18	it would be nice to have a subsection on the ocean too.	Seems too much detail	Nathalie Hilmi	Centre Scientifique de Monaco	France
41037	34	18	34	43	suggest you get in touch with Ch5 in WGI for consistency checks.	Will check with Jan.	Jan Fuglested	CICERO	Norway
25857	34	24	34	25	This will only remain true if there is sufficient water available. However, commercial plantations (e.g., Pinus spp, Eucalyptus spp., Persea spp.) require large amounts of water, affecting the development of native forests communities. This is relevant as native forests have been recognized as better alternatives for carbon capture than commercial plantations (Lewis 2019; 10.1038/d41586-019-01026-8, and Carey 2020; 10.1073/pnas.2000425117). Furthermore, several countries have included reforestation and afforestation of native forests as NDCs.	Will try to include alternative view	Jorge Hoyos-Santillan	University of Magallanes	Chile
25855	34	25	34	27	"Prolonged droughts" should be included among the potential disturbance events in forests.	Txs. We will try to improve the section	Jorge Hoyos-Santillan	University of Magallanes	Chile
38791	34	29	34	30	This statement needs a citation, and seems reaching given that there other constraints on agriculture including both biophysical and socio-economic ones. For example, nutrient availability via fertilizer and water availability are also constraints on potential increase in agricultural area. This statement leaves out the basic effect of CO2 on crops, and both CO2 and temperature on crops. Furthermore, an increase in agricultural area may not necessarily mean the quality of the crop is good enough. There are studies that indicate a faster growing season for some major crops would result in lower quality food which would have negative implications for food security.	Taken into account. Reference will be added.	Julian Reyes	Personal Capacity	United States of America
24147	34	31	34	31	"fertilization" is more applicable to biological processes. Replic with "fertiliser application"	Rejected. The term is widely used in the literature.	Alfred Ofoosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
39697	34	35	34	37	The reported results are lacking appropriate inclusion of sustainable bioenergy production options, including residues and wastes from increased use of biomaterials to replace mineral and fossil materials. For references, see comment no. 1.	Taken into account.	Uwe Fritsche	IINAS	Germany
4645	34	37	34	39	It could be interesting to understand why the same author (Calvin) foresees both negligible and larger changes (even if in two papers with different co-authors and a 6-year distance in between). At a first read this may sound as inconsistent.	Taken into account.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
20593	34	37	34	39	Please note the forthcoming paper by Gernaat et al. which investigates the climate impacts on renewable energy supply and how this may affect mitigation strategies of different regions. The analysis uses harmonised maps of climate impacts from the ISIMIP project, as well as spatially explicit and biophysical representation of renewable energy supply. It shows a significant sensitivity for bioenergy potentials.  Reference: Gernaat et al. "Climate impacts on renewable energy supply" (under review for publication in Nature Climate Change)	Yes we will include	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
9697	34	44	34	48	This section is just placeholder	Taken into account. Section will be expanded.	Nathalie Hilmi	Centre Scientifique de Monaco	France
24899	34	44	34	48	Section 3.3.4.3 should be substantially expanded	Taken into account. Section will be expanded.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
43331	34			47	Comment relevant for ch. 3.3.4, 3.4.5 and for the executive summary. In the whole chapter, there is no mention of the large gap of about 5 GtCO2 yr-1 (for the period 2005-2014) in global anthropogenic land-related CO2 emission estimates between country GHGs and global models (Grassi et al. 2018, IPCC SRCCL 2019). The latter include bookkeeping models, Dynamic Global Vegetation Models (DGVMs) and Integrated Assessment Models (IAMs). These differences may hamper a meaningful comparability between IAMs' mitigation pathways and collective countries efforts under the global stocktake. I suggest that SOD includes an explicit mention to this topic (also in the executive summary), e.g. noting that "AFOLU CO2 estimates presented here are not necessarily comparable with countries estimates" (like in SPMof IPCC 1.5 SR) and using some text used in Grassi et al. 2018 or IPCC SRCCL SPM paragraph A3.3. A reference can be done to Ch 7.8, which treats this issue more extensively. Then, hopefully, the final draft may quote new papers that address the issue.	We will add a comments on this	Giacomo Grassi	Joint Research Centre, European Commission	Italy
5135	34	1			Units are not in line with the rest of the chapter (PgC vs Gt CO2)	Editorial. Taken into account.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
16511	34	1			the title of 3.3.4 implication of carbon budget is not suitable for the context. May it changes to uncertainties of climate responses	Taken into account.	Lining WANG	Economics and Technology Research Institute, CNPC	China
5133	34	2			The section (except the last paragraph) doesn't have a strong link with the rest of the chapter	Taken into account. Section will be expanded.	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
5137	34	2			I suggest adding a paragraph on the different timing of reaching certain milestones across different sectors (as discussed e.g. in DOI: 10.1126/science.aah3443 and <a href="https://doi.org/10.1038/s41558-019-0453-5">https://doi.org/10.1038/s41558-019-0453-5</a> ), as sectors are different with respect to their abatement costs, hard to abate emissions, etc. Part of this is picked up later in the section, e.g. p. 37, l. 5 ("The energy supply sector decarbonizes first"). This could be discussed in the introduction of this section (alternatively in 3.4.7.2, or around figure 3.34)	This is an important point. But we hope to discuss this in the next section	Matthias Weitzel	European Commission, Joint Research Centre	Spain
10199	35	28	25	28	Unclear what '844%' stands for? Is it supposed to be a range? Is it missing a hyphen?	Editorial. Error will be corrected.	Aglaia Obrekht	Environment and Climate Change Canada	Canada
12399	35	15	27	11	Suggest to include CCS at same level for both coal, gas as for biomass. Suggest not to include more CCS on biomass than on fossil fuels.	BECCS has a larger impact on the scenarios -and forms a larger part of the literature.	María Malene Kvalevåg	Norwegian Environment Agency	Norway
9699	35	1	35	24	Too many acronyms. Difficult to read.	Editorial. Taken into account.	Nathalie Hilmi	Centre Scientifique de Monaco	France
16481	35	2	35	2	For the whole section, I want a table to summary key indicators of transformations under 2C and 1.5C. These indicates may conclude but be not limited to the primary energy mix, the electricity mix, the electrification rate, the phasing-out of coal power plants and fossil-fuel liquid, the CCS and BECCS scales, the net-zero emissions timing of supply-side, for the years 2050 and 2100. This kind of table will be very useful for future comparisons.	Taken into account.	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
4647	35	15	35	17	Use either "towards" or "to" in phrase "transition towards to non-fossil fuels".	Editorial. Taken into account.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
24149	35	15	35	18	believe the authors are talking of consumption scenarios or paths. The sentence must be made clearer. If possible break it.	Editorial. Taken into account. Clarity will be improved	Alfred Ofoosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
32413	35	15	35	24	There are CDR technologies other than BECCS. BECCS is not carbon negative and should not be included as a CDR strategy, let alone used as the prototypical negative emission technology. Bioenergy leaves a carbon deficit for several decades to a century—far longer than the window of a decade or two available for slowing feedbacks and avoiding crashing through the 1.5C guardrail, or the 2050 window for net zero emissions. See, e.g., IPCC AR5 WG III (2014) 11.13.4 GHG emission estimates of bioenergy production systems ("The combustion of biomass generates gross GHG emissions roughly equivalent to the combustion of fossil fuels. If bioenergy production is to generate a net reduction in emissions, it must do so by offsetting those emissions through increased net carbon uptake of biota and soils...Hence, the total climate forcing of bioenergy depends on feedstock, site-specific climate and ecosystems, management conditions, production pathways, end use, and on the interdependencies with energy and land markets...For example, in the specific case of existing forests that may continue to grow if not used for bioenergy, some studies employing counterfactual baselines show that forest bioenergy systems can temporarily have higher cumulative CO2 emissions than a fossil reference system (for a time period ranging from a few decades up to several centuries"). Subsequent analysis since AR5 further strengthens the case that BECCS is not carbon neutral nor net negative in the critical next decade or two. Danielle Venton, Core Concept: Can bioenergy with carbon capture and storage make an impact?, PNAS (2016); Mary S. Booth, Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy, ENVIRON. RES. LETT. 13 (21 February 2018); Sterman J. D., et al. (2018) Does replacing coal with wood lower CO2 emissions? Dynamic lifecycle analysis of wood bioenergy, ENVTL. RESEARCH LETTERS 13(015007):1–10, 1 ("We simulate substitution of wood for coal in power generation, estimating the parameters governing NPP and other fluxes using data for forests in the eastern US and using published estimates for supply chain emissions. Because combustion and processing efficiencies for wood are less than coal, the immediate impact of substituting wood for coal is an increase in atmospheric CO2 relative to coal. The payback time for this carbon debt ranges from 44–104 years after clear-cut, depending on forest type—assuming the land remains forest. Surprisingly, replanting hardwood forests with fast-growing pine plantations raises the CO2 impact of wood because the equilibrium carbon density of plantations is lower than natural forests. Further, projected growth in wood harvest for bioenergy would increase atmospheric CO2 for at least a century because new carbon debt continuously exceeds NPP. Assuming biofuels are carbon neutral may worsen irreversible impacts of climate change before benefits accrue. Instead, explicit dynamic models should be used to assess the climate impacts of biofuels.").	Yes - this is a good point. We will try to add, but please note that BECCS is the largest part of the negative emissions in IAMs	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32415	35	15	35	24	Further, CCS has not been perfected at scale nor has it received social acceptability. Governance gaps exist on four key CDR issues: the scale and speed of implementation, the incentives needed to scale-up CDR, the tradeoffs between Sustainable Development Goals and CDR implementation, and the risks if CDR options are not implemented. See Climate Geoengineering Governance Initiative (C2G2), Governing large-scale carbon dioxide removal: are we ready? (2018); Gregory Nemet et al., Negative emissions—Part 3: Innovation and upscaling, Environ. Res. Lett. (May 2018); European Academies Science Advisory Council, Negative emission technologies: What role in meeting Paris Agreement targets? (Feb 2018) ("CCS plans in Europe have been shelved so that whatever experience is being gained globally is outside Europe. The loss in momentum in implementing CCS technologies not only has serious implications for mitigation pathways, but also one of the most commonly cited NETs [negative emissions technologies] (BECCS) assumes the availability of cost effective 'off-the-shelf' CCS, while another (direct air capture) relies on the widespread availability of CO2 storage. At present, economic incentives for deploying CCS are inadequate (whether through the very low carbon price or targeted government support), while those for NET development are lacking."); Andersen & Peters, The Trouble with Negative Emissions, Science (Oct 2016). One study estimates that current rate of increase in CCS is 100 times lower than needed to meet the 2C target. See Haszeldine et al. (April 2018), Negative emissions technologies and carbon capture and storage to achieve the Paris Agreement commitments, Philosophical Transactions of the Royal Society.	Txs for this. We will try to add further nuance.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32417	35	15	35	24	It also is possible to reduce atmospheric methane concentrations. Jackson R.B., Solomon E.J., Canadell J.G., Cargnello M., & Field C.B., Methane removal and atmospheric restoration, NATURE SUSTAINABILITY 2, 436–438 (2019) ("In contrast to negative emissions scenarios for CO2 that typically assume hundreds of billions of tonnes removed over decades and do not restore the atmosphere to preindustrial levels, methane concentrations could be restored to ~750 ppb by removing ~3.2 of the 5.3 Gt of CH4 currently in the atmosphere. Rather than capturing and storing the methane, the 3.2 Gt of CH4 could be oxidized to CO2, a thermodynamically favourable reaction .... In total, the reaction would yield 8.2 additional Gt of atmospheric CO2, equivalent to a few months of current industrial CO2 emissions, but it would eliminate approximately one sixth of total radiative forcing. As a result, methane removal or conversion would strongly complement current CO2 and CH4 emissions-reduction activities. The reduction in short-term warming, attributable to methane's high radiative forcing and relatively short lifetime, would also provide more time to adapt to warming from long-lived greenhouse gases such as CO2 and N2O.").	Txs. We will try oadd.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
46629	35	20	35	21	At least 'energy efficiency' is missing from the list.	Taken into account.	Florian Leblanc	Centre International de Recherche sur l'Environnement et le Développement	France
43703	35	25	35	31	How does the annual growth rate of 9% brake down for wind and solar? How is this gauged in historical growth rates up to 2020? What is the reason that the low-carbon technology with the strongest growth rate is discussed only so briefly? Here on historical growth rates vs IAM scenarios: <a href="https://www.nature.com/articles/enenergy2017140">https://www.nature.com/articles/enenergy2017140</a> and here up-to-date cost estimates: <a href="https://onlinelibrary.wiley.com/doi/pdf/10.1002/ptp.3189">https://onlinelibrary.wiley.com/doi/pdf/10.1002/ptp.3189</a> . Fig. 2.25 and 2.25 appear also reasonable for calibration of models. Model that don't match the observed dynamics may be excluded from display as solution spaces are likely to be considerably biased. That guess may be wrong of course, but a check would be good.	We will try to add more info - but please note that this is not the chapter on the energy system. The things we specifically highlight are really impacting the overall strategy	Felix Creutzig	MCC Berlin	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
4649	35	28	35	28	"844%" appears inconsistent, likely being a typo.	Editorial. Error will be corrected.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
9583	35	28	35	30	Please, specify whether the mentioned need for bioenergy is primary or secondary energy.	Taken into account. Information will be provided.	Jesper Kløverpris	Novozymes	Denmark
20595	35	29	35	30	Why is the annual growth rate for bioenergy demand presented as an average which omitting the range of results (which are shown for the rest of the results)? The range is more interesting than the average result. Also, specifically for bioenergy, it is probably most interesting to focus on "modern bioenergy".	Agree will change	Vassilis Daoglou	Copernicus Institute of Sustainable Development	Netherlands
45553	35	30	35	31	Nuclear increases are likely driven by political considerations more than techno-economics. Through this sections inputs are portrayed as outputs. This is misleading in the context of IAMs.	In IAMs nuclear is often an output.	Daniel Crow	International Energy Agency	France
35997	35	32	35	34	"total fossil fuels decrease from 489 EJ yr-1 (435-585 EJ yr-1) in 2020 to 223 EJ yr-1" : 223 EJ in which year?	Editorial. Taken into account. Clarity will be improved	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
36551	35	32	35	40	Clarification; Fossil fuels seem to play still important role but what is role of CCS for the use of fossil fuels as the assumption?	Taken into account. The role of CCS will be further explored.	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
15503	35	14	37	11	Please consider providing more resolution on primary energy consumption for individual fossil fuels in 2-degree and 1.5-degree scenarios. Figure 3.18 and the text provides results for coal, but no results for oil or gas are presented. Please consider including these.	Taken into account. We will consider adding this information.	Peter Erickson	Stockholm Environment Institute	United States of America
17055	35		46		Would be useful to give data not only for 2030 and 2050, but also for 2040. The AR6 report will be used in the period 2021 to, say, 2025. Then 2040 probably becomes a very important policy target year (as 2030 was in the past decade).	Taken into account. We will consider adding this information.	Kornelis Blok	Delft University of Technology	Netherlands
44919	35	3	53	31	3.4 'Integrating sectoral analysis into systems transformations. Including a section on the benefits of synergistic climate and biodiversity action in land, forests and other ecosystems would provide a useful context for unpacking the importance of maintaining and enhancing ecosystem integrity and stability to maximise stability and longevity of ecosystem carbon stocks and improve longevity of sequestration through restoration action. Doing this would involve looking at conservation and ecological restoration strategies aimed at maximising resilience and resistance to threats, e.g. improved conservation management of primary and other natural ecosystems (and particularly carbon dense ecosystems); prioritising restoration that buffers and reconnects primary ecosystems; preventing fragmentation of natural ecosystems; encouraging restoration based on natural regeneration of degraded ecosystems using landscape scale connectivity/permeability approaches to maintain or restore ecological processes at all scales. Assumptions based on forestry practice also need to be re-assessed in relation to biodiverse, natural forests as the superior benefits, both in terms of the quantum of carbon sequestration and stability of carbon storage, from allowing natural wood production forests to recover to their biological potential become increasingly evident (Moomaw et al 2019, Keith et al 2010, Dean et al 2012, Keith et al 2009). Also noteworthy (and relevant also to later discussion on the economics of long term mitigation and development pathways) is increasing evidence of 'disastrous' interactions between forest management widely considered to be sustainable with increasing severity and intensity of fire associated with climate change, leading to ecosystem collapse in Australia's most carbon dense and productive forest ecosystem (Lindenmayer and Sato 2018)	This is about benefit or role of forest management for climate mitigation. This should be included in chapter 7.	Virginia Young	Australian Rainforest Conservation Society, Griffith University, CAN Ecosystems	Australia
46221	35	3	53	31	3.4 'Integrating sectoral analysis into systems transformations. Including a section on the benefits of synergistic climate and biodiversity action in land, forests and other ecosystems would provide a useful context for unpacking the importance of maintaining and enhancing ecosystem integrity and stability to maximise stability and longevity of ecosystem carbon stocks and improve longevity of sequestration through restoration action. Doing this would involve looking at conservation and ecological restoration strategies aimed at maximising resilience and resistance to threats, e.g. improved conservation management of primary and other natural ecosystems (and particularly carbon dense ecosystems); prioritising restoration that buffers and reconnects primary ecosystems; preventing fragmentation of natural ecosystems; encouraging restoration based on natural regeneration of degraded ecosystems using landscape scale connectivity/permeability approaches to maintain or restore ecological processes at all scales. Assumptions based on forestry practice also need to be re-assessed in relation to biodiverse, natural forests as the superior benefits, both in terms of the quantum of carbon sequestration and stability of carbon storage, from allowing natural wood production forests to recover to their biological potential become increasingly evident (Moomaw et al 2019 Intact Forests in the United States:Proforestation mitigates Climate Change and Serves the Greatest Good, Frontiers in Forests and Global Change; Keith et al 2014, 'Managing Temperate forests for carbon storage:Impacts of logging versus forest protection on carbon stocks,'). Also noteworthy (and relevant also to later discussion on the economics of long term mitigation and development pathways) is increasing evidence of 'disastrous' interactions between forest management widely considered to be sustainable with increasing severity and intensity of fire associated with climate change, leading to ecosystem collapse in Australia's most carbon dense and productive forest ecosystem (Lindenmayer and Sato, 'Hidden Collapse is driven by fire and logging in a socioecological forest ecosystem', PNAS 2018)	Duplicate comment	Virginia Young	Australian Rainforest Conservation Society, Griffith University, CAN Ecosystems	Australia
16215	35	2			In Section 3.4 Integrating sectoral analysis into systems transformations, consider adding a subsection that looks at the treatment of military emissions in long-term emissions and mitigation pathways. If no pathways currently treat military emissions, it is important to state this so that future work can be done on this.	Partially accepted. The subsections are structured to align with the sectoral chapters (6-11), so we have not added a specific subsection on military. However, we have noted where military is included in IAMs.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
45043	35	2			At the beginning of this section, it would be useful to clarify that there is no good a priori reason why each sector has to reach net-zero CO2 or net-zero all GHGs, as long as collectively those outcomes are achieved. Given the somewhat partisan interests of individual sectors, we need to avoid the impression that sectors that are impossible to decarbonise fully are somehow "the problem", whereas sectors where reaching net zero and even going negative are somehow automatically climate heroes. Yes seeing whether a sector can or can't go to net-zero emissions is a useful reference point, but please make sure this isn't seen or misunderstood as being somehow a desirable, let alone sufficient, performance benchmark for each sector regardless of its mitigation potential.	Accepted. We have added a discussion of this to the introduction to the section.	Andy Reisinger	NZAGRC	New Zealand
37879	35	14			This section 3.4.1 should be stronger linked to the relevant scientific literature on low carbon transformation pathways, e.g. Rogelj et al., 2018 ( <a href="https://www.nature.com/articles/s41558-018-0091-3">https://www.nature.com/articles/s41558-018-0091-3</a> ); Luderer et al. 2018 ( <a href="http://www.nature.com/articles/s41558-018-0198-6">http://www.nature.com/articles/s41558-018-0198-6</a> ).	consider, energy transition already was discussed in previous assessment report, and already got concrete pictures for its transition	Gunnar Luderer	Potsdam Institute for Climate Impact Research	Germany
37881	35	14			This section 3.4.1 would benefit from a stronger intergration with Chapter 6, especially section 6.7	accept	Gunnar Luderer	Potsdam Institute for Climate Impact Research	Germany
45551	35	14			This section describes scenario outcomes without sufficient acknowledgement of the role of constraints in modelling. The supply mix in most scenarios will be affected implicitly by constraints on renewables growth rates and assumptions around nuclear, and this must be pointed out.	Author will discuss about this	Daniel Crow	International Energy Agency	France
5139	35	25			How useful are ranges across all scenarios? Given the different representation in the scenario database, it might be preferable to use categories (applies throughout this section, it is done in Fig 3.18)	Accepted	Matthias Weitzel	European Commission, Joint Research Centre	Spain
5965	35				an incorrect juxtaposition between fossil fuels and carbon-neutral energies referring only to combustion processes. Some renewable applications produce a pernicious effect on environment (and hence on climate) because of waste, although with no emissions into atmosphere. Fossil fuels represent different categories, since some energies a low-carbon and some are carbon-intensive. In some cases, a switch to low carbon energy can be more beneficial than a switch to carbon-energy with unsolved waste issues. Thus the classification should be somehow different	Noted. The implications of different fuel types are discussed in Chapter 6.	Belyi Andrei	University of Eastern Finland, Centre for Climate Change, Energy and Environmental Law	Estonia



Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
45679	36	1	26	4	Compared to other technologies, the ranges of nuclear are very small + huge outliers. What drives the contribution of nuclear in most models and how is this different from the models on which the outliers are based?	consider	Machteld van den Broek	Utrecht University	Netherlands
45677	36	1	34	4	why does the category with low overshoot, has in general higher primary energy use than the one with high overshoot.	Noted. The text has been revised and scenario categories updated	Machteld van den Broek	Utrecht University	Netherlands
45555	36	1	36	1	Fig 3.18 is unreadable because the scale is so small (particularly nuclear)	accept	Daniel Crow	International Energy Agency	France
4651	36	9	36	11	9 EJ yr-1 (~0-51 EJ yr-1) in 1.5 degrees low overshoot scenarios in 2050 appears inconsistent with both 1.5 high overshoot scenarios (smaller than low overshoot ones) and 2 degrees low overshoot scenarios (equal to the 1.5 degree one).	Noted. The text has been revised and scenario categories updated	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
10201	36	10	36	10	How can it be 4EJ in high overshoot scenarios, and 9EJ in low overshoot scenarios?	Noted. The text has been revised and scenario categories updated	Aglia Obrekht	Environment and Climate Change Canada	Canada
35999	36	10	36	11	(~0-51 EJ yr-1) on the same line	accept	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
12351	36	15	36	15	Use fig 3.19 upper or change figure text 3.19 to 3.19a	accept	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
12353	36	17	36	17	Use fig 3.19 middle or change figure text 3.19 to 3.19b	accept	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
10203	36	20	36	26	Do these scenarios account for higher emissions of black carbon from BECCS? It would be interesting to see a discussion of tradeoffs (CO2 reductions vs. black carbon emissions), as well as of the geographical location, since proximity to the Arctic is important for implications of black carbon emissions.	Noted. Most models include black carbon. Details of models are discussed in the annex	Aglia Obrekht	Environment and Climate Change Canada	Canada
47003	36	20	36	26	BECCS: Please mention other NETs, and the fact that they tend not to be represented in IAMs. Explain that this choice in assumptions by IAM modellers drives what is represented in scenarios, and hence in this Chapter.	Noted. Other CDR options are covered in sections 3.4.6 and 3.4.7	Frank Jotzo	ANU	Australia
12355	36	21	36	21	Use fig 3.19 bottom or change figure text 3.19 to 3.19c	accept	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
18071	36	20	37	4	Are land-system feedbacks of sourcing biomass for bioenergy adequately represented in calculations of climate-benefits of BECCS? See eg. Kalt et al. (2020; Env Res Lett, <a href="https://doi.org/10.1088/1748-9326/ab6c2e">https://doi.org/10.1088/1748-9326/ab6c2e</a> ; <a href="https://iopscience.iop.org/article/10.1088/1748-9326/ab6c2e">https://iopscience.iop.org/article/10.1088/1748-9326/ab6c2e</a> ) who show that GHG emissions per unit bioenergy rise sharply above c100 EJ/yr and eventually reach very high levels (beyond the fossil-fuel reference) when trying to exceed low-GHG potentials for sourcing bioenergy.	Accept. This is discussed in section 3.4.7	Helmut Haberl	Institute of Social Ecology, University of Natural Resources and Life Sciences, Vienna	Austria
5141	36	1			The text on p. 35 does not correspond to the categories shown, e.g. biomass is discussed in the text. The coal subfigure is repeated in fig. 3.19	accept	Matthias Weitzel	European Commission, Joint Research Centre	Spain
37877	36	13		19	feel the discussion of CCS needs more detail. What is CCS mostly used for? Power generation from fossils? BECCS? DACCS? Industrial processes? This discussion is crucial for informing policy makers about strategic priorities in CCS development and deployment.	accept	Gunnar Luderer	Potsdam Institute for Climate Impact Research	Germany
45557	37	1	37	1	Fig 3.19 is unreadable because the scale is so small (particularly gas)	accept	Daniel Crow	International Energy Agency	France
30889	37	2	37	2	I suggest replacing the term "CCS utilization" with, e.g., "CCS deployment", as the original term could be easily confused with CO2 utilization.	accept	Jasmin Kemper	IEA Greenhouse Gas R&D Programme (IEAGHG)	United Kingdom (of Great Britain and Northern Ireland)
16475	37	5	37	8	Please discuss power sector in much more details. At least, key information needs to be provided, e.g. the phasing-out timing of conventional coal power plants, the electricity mix in 2050, the net-zero emissions timing of this sector. What is the difference between 2C scenarios and 1.5C scenarios in power sector?	accept	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
22397	37	9	37	11	In fact hydrogen is now considered as a very important option for low carbon scenario, it would be better for the report to go deeper in the review and assessment of hydrogen development and prospect in a multiple dimension and a global context. Current narratives on this subject remain to be further fleshed out with more substantive discussions.	accept	Xiusheng Zhao	Tsinghua University	China
44551	37	10	37	11	It would be interesting to know the shares of both renewables-based hydrogen and nuclear-based hydrogen	accept	Oliver Geden	German Institute for International and Security Affairs	Germany
37225	37	0			Please add an ES statement based on the total bioenergy requirements in Fig. 3.19 and expand the respective figure and analysis. As most of the sustainability concerns relate to bioenergy deployment rather than BECCS, it is important to assess this aspect in detail. Judging from Fig. 3.19 it seems that bioenergy is broadly deployed in all scenarios categories and the median appears to be more affected by socio-economic and model assumptions than by warming target between C1 and C5 in a systematic fashion. It is also remarkable that total bioenergy without CCS is outweighing BECCS in all scenarios in 2050. The right-hand panel of fig 3.13 shows 1.5°C and 2°C are achieved with anything from very large to virtually zero CDR. The main thing the figure seems to show is that only for 1.5°C and 2°C pathways do the models see a need for substantive CDR, while other warming targets may be achievable without. However, then it is of high policy relevance to provide implications of what this without may mean in terms of 2030 emission reductions. I suggest a 2-d plot with total 2050 (panel b 2100) bioenergy deployment vs. 2030 emission reductions with colour coding for peak warming and symbols for end of century warming (or alternatively, the C categories) including sustainability thresholds.	Taken into account. Text will be revised.	Michiel Schaeffer	Climate Analytics	Netherlands
5971	37				very speculative projection of electricity-based hydrogen. So far electricity-generated hydrogen constitutes 0.2% of all hydrogen. An economy of scale would require a massive increase in electricity production.	There is detailed analysis in chapter 6 on this, and IAMs considered economy of electrolytic of hydrogen in the model with future price of electricity	Belyi Andrei	University of Eastern Finland, Centre for Climate Change, Energy and Environmental Law	Estonia
10205	38	5	38	7	Is it worth mentioning why energy demands are increasing so high? Is it because of the population growth, or developing countries catching up to developed countries in terms life style standards?	accept	Aglia Obrekht	Environment and Climate Change Canada	Canada

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
20597	38	3	40	9	The section on buildings is very broad and simply summarizes some numerical results from the scenario databases. No insight is given on the drivers of energy demand in buildings (and the energy services provided), and the mechanisms through which energy demand (and emissions) are reduced in mitigation scenarios. I think an outline of these is crucial in order to provide an understanding of the key issues concerning this sector (as has been done in the transport and industry sections). There are relevant publications which give insights on these important issues. More specifically:  - Drivers of building energy demand and the role of economic development: Floorspace, heating demand, cooling demand (particularly important considering the projected electricity demand of warmer "developing" regions") - The role of fuel switching and technology in mitigation scenarios - The role of efficiency improvement in building envelopes - Differences in energy demand/intensity and emission mitigation potential across urban/rural buildings and income levels (the building sector is extremely diverse)  Relevant references: - Daioglou, V., B.J. van Ruijven & D. van Vuuren. (2012), Model projections for household energy use in developing countries. <i>Energy</i> 37(1), 601-615. - Krey, V., B.C. O'Neill, B. J. van Ruijven et al. (2012), Urban and rural energy use and carbon dioxide emissions in Asia. <i>Energy Economics</i> 34, S272-283 - Knobloch, F., H. Pollitt, U. Chewprecha et al. (2019) Simulating the deep decarbonisation of residential heating for limiting global warming to 1.5°C. <i>Energy Efficiency</i> 12 (2), 521-550 - Edelenbosch, O., D. Rovelli, A. Levesque et al. (submitted), Long term, cross country effects of buildings insulation policies. - Kamei, M., K. Hanaki & K. Kurisu (2016), Tokyo's long-term socioeconomic pathways: Towards a sustainable future., <i>Sustainable Cities and Society</i> (27), 73-82	The assessment of the buildings sector in the FOD was influenced by the very limited availability of sectorally relevant indicators in the scenario database. A request has gone out to modeling teams with detailed building sector representation to provide more indicators to fill this gap in subsequent drafts.	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
39453	38	3	40	9	The representation of behavioral change and social (bottom-up) dynamics to building demand scenario is missing. In building sector, the behavioral change potential can be as high as 50% over long periods of time. There is a range in the energy savings achievable in buildings due to behavioral changes, depending on the type of end use. Thus, it is important to study and assess "bottom-up" dynamics in transitioning to low-carbon economy. see Niamir et al. 2020 ( <a href="https://doi.org/10.1007/s10584-019-02566-8">https://doi.org/10.1007/s10584-019-02566-8</a> ); Niamir 2019 ( <a href="https://doi.org/10.3990/1.9789036547123">https://doi.org/10.3990/1.9789036547123</a> )	Thanks for the suggestion, we will take this work into account in subsequent versions of the chapter	Leila Niamir	MCC	Germany
5143	38	4			Clarify that this is not due to climate impacts (as discussed in sect. 3.3.4.1), but rather due to mitigation and other scenario assumptions (economic growth, population,...)	will be updated in next version	Matthias Weitzel	European Commission, Joint Research Centre	Spain
16477	39	3	39	3	I'm interested in C1 and C3. I find the CO2 emissions increase from 2050 to 2100 in C1. By 2100, the emissions in C1 (1.5C) are overall higher than in C3 (2C). It's amazing that building emissions under 2C and 1.5C are still around 50% of 2010 levels but not near-zero. Why?	This might be due to the selection of scenarios/models in each of the categories that have provided data to the scenario database. Will be explored and updated in next version	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
45559	39	5	39	5	It is striking that the C1 range & median for CO2 emissions is larger than the C2. Any non-monotonic indicators are always interesting. This could be discussed and explained	This might be due to the selection of scenarios/models in each of the categories that have provided data to the scenario database. Will be explored and updated in next version	Daniel Crow	International Energy Agency	France
45681	39	5	39	5	Why does the category with low overshoot, has in general higher final energy use than the one with high overshoot.	This might be due to the selection of scenarios/models in each of the categories that have provided data to the scenario database. Will be explored and updated in next version	Machteld van den Broek	Utrecht University	Netherlands
24151	39	5	39	8	Separate title of figure 3.21 from explanations	will be updated in next version	Alfred Ofoosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
5145	40	4	40	4	net zero carbon or net zero GHG?	will be updated in next version	Matthias Weitzel	European Commission, Joint Research Centre	Spain
24901	40	16	40	21	Delete "Due to the long-lived nature ... (Gota et al. 2019)." as the arguments contradict with the analysis that follows	Noted. Sentence has been revised.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
6145	40	18	40	18	Date missing in Gota et al	Accepted.	Linares Pedro	Universidad Pontificia Comillas	Spain
36001	40	18	40	18	year of the publication? 2019?	Accepted.	Sandrine Selosse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
16479	40	29	40	32	Please explain why transport energy remains increase toward 2100, which contradicts general understandings. Do not just tell us conclusions.	Accepted. More explanations have been added	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
41187	40	10	42	35	I think the text should be clearer about how the transport sector as a whole is treated - and that the various sub sectors such as road transport, aviation, shipping, trains - are not - as far as I understand - modelled separately. The text should in my view do more of a critical assessment of what the models can say about transport in addition to what is said line 11-12, page 42. Table 2.SM.6 in SR1.5 was useful, and you could refer to a similar one here.	Accepted. Many models do include the specific subsectors and modes. A discussion of what is and is not in the models, and what they can and cannot say, has been added.	Jan Fuglestedt	CICERO	Norway
41189	40	10	42	35	I suggest a stronger coordination with chapter 10. At least some more references to ch10.	Accepted.	Jan Fuglestedt	CICERO	Norway
43839	40	10			Does transport include shipping?	Accepted. Yes, shipping is included.	Hans Poertner and Elvira Poloczanska	Alfred-Wegener-Institut	Germany
5147	41	3	41	7	color the lines according to the category that they belong to? The current coloring scheme does not seem to convey any information	Accepted. This figure has been completely redone	Matthias Weitzel	European Commission, Joint Research Centre	Spain
26989	41	3	41	9	The discussion of these figures (Fig 3.23 and 3.24) needs to tackle the issue of why there are notable differences in the 2020 estimates. This is likely due to the different profile of the transport sectors modelled in the IAMs. Note that this is an issue that prevails throughout transport comparisons. Section 8.9.1 Long term stabilization goals — integrated and sectoral perspectives of the last WG3 report also had this issue. It wasn't directly discussed, but is obvious in the large range of estimates present in Fig 8.9. It's an important point to make here as the 2020 numbers will be seen as present day estimates and readers will wonder what is going on with the 2020 estimates.	Partially accepted. Discussion of near-term is covered by Chapter 4 and more detail on transport is in Chapter 10. However, we have adjusted the figures to be relative to historical to address this.	Thomas Longden	Australian National University	Australia
26991	41	3	41	9	There are a range of reasons why the initial numbers will differ in 2020. A key citation that discusses this states: "With respect to the final energy use in the overall economy, differences across models occur based on different base years, differing national data used for calibration, and differences in model assumptions about population growth, economic growth and autonomous energy intensity reductions." Robert C. Pietzcker, Thomas Longden, Wenying Chen, Sha Fu, Elmar Kriegler, Page Kyle, Gunnar Luderer, Long-term transport energy demand and climate policy: Alternative visions on transport decarbonization in energy-economy models, <i>Energy</i> , Volume 64, 2014. <a href="https://doi-org.virtual.anu.edu.au/10.1016/j.energy.2013.08.059">https://doi-org.virtual.anu.edu.au/10.1016/j.energy.2013.08.059</a>	Accepted. We have added this citation.	Thomas Longden	Australian National University	Australia

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31181	41	4	41	8	Figures 3.23 and 3.24: Please highlight the Scenarios IP1 .. IP5 in the figures, or give additional figures showing IP1 .. IP5.	Accepted. This figure has been completely redone. Additionally, a figure showing transport energy in the IPs has been added to section 3.4.7.	Urs Ruth	Robert Bosch GmbH	Germany
31183	41	4	41	8	Figures 3.23 and 3.24: Please also provide a figure showing how global passenger transport demand and global freight transport demand evolve until 2100 in scenarios IP1 .. IP5. These parameters are the key ones for deriving total energy demand or CO2 emissions from transport, and w/o presenting the transport demand in the scenarios the figures shown are meaningless. Also the modal splits (and changes thereof) need to be shown for IP1 .. IP5.	Rejected. The detailed analysis of the transport sector, including passenger and freight, is covered in Chapter 10. Due to space limitations and to minimize overlap, we focus only on high level characteristics here.	Urs Ruth	Robert Bosch GmbH	Germany
26993	41	10	41	13	This statement is true. But it is important to note that technological innovations in electric vehicles are directly modelled in some IAMs. And experiments that change demand have been conducted. WITCH is one example that has electrification in LDVs and freight with experiments that change pkm and tkm run. While they may not be in the scenarios uploaded to the AR6 database, they do exist and are important. <a href="https://doi.org/10.1016/j.enpol.2014.04.034">https://doi.org/10.1016/j.enpol.2014.04.034</a> <a href="https://doi.org/10.1016/j.trd.2016.10.007">https://doi.org/10.1016/j.trd.2016.10.007</a>	Accepted. This caveat and these references have been added.	Thomas Longden	Australian National University	Australia
11499	41	10	41	15	This discussion is extremely important BUT is missing in chapter 10.	Noted. We have worked on coordination/consistency with Chapter 10	Sudhir Gota	Independent Consultant/Researcher	India
26995	41	13	42	19	The discussion of reduced demand concerns me a bit. Yes, this is one avenue that could lead to emission reductions. However, whether large decreases are feasible at a national and global level is my concern. Also, you rely heavily on one paper for this discussion. I often like to compare this discussion to energy efficiency improvements that should happen (as they save people money) but dont. Isn't this true for mobility demand in transport where rebound effects are much more prevalent than pkm and tkm reductions. Avoid and shift measures may have negative costs, but there is inertia in getting them implemented as there is a strong preference for personal mobility. The findings of a peak car relationship is highly contentious and I am doubtful that deep reductions in pkm and tkm will occur in the next few decades. Its important that a balance between existing technological progress in electrification of LDVs and some exciting developments in commuting, be balanced with a long history of inertia in travel demand.	Accepted. The revised text includes more nuance.	Thomas Longden	Australian National University	Australia
28209	41	16	42	1	Sentence is not clear. First part indicates that non-technology has NO impact, second half says that it has considerable impact	Accepted. Sentence has been revised.	Cornie Huizenga	CESG	Germany
26999	42	4	42	8	This is a big statement - 1.5 degree requires transport decarbonisation by 2050. The Gota et al study has 2050 as the last year. Is there any end-point bias here that may be impacting this result? The models used cannot account for foresight and decarbonisation between the pre-2050/post-2050 period. This is a bit of an issue, even though the emission pathways used may be consistent with achieving a 1.5 degree target. How this target is achieved will depend on assumptions about breakthroughs in electric vehicles and hydrogen in freight. What do the IAMs in the AR6 database show on this matter? Are there scenarios consistent with low carbon in 2100 (i.e. 1.5 or 2 degrees) that have deep transport decarbonisation happening after 2050?	Accepted. More discussion of pre-/post-2050 dynamics in the scenarios has been added.	Thomas Longden	Australian National University	Australia
27001	42	4	42	8	Related to the issue above (assessments of 1.5 degree targets using models that stop at 2050 compared to models that continue to 2100) the following quotation is useful: "It can be concluded that amongst the models studied, the hypothesis that the transport sector is more difficult to decarbonize than the non-transport sectors with a carbon price of plausible size is confirmed when looking at the time period before 2060. In the long run, however, the three global models achieve deep emission reductions by 90% and more in the strong climate policy scenario. This almost complete decarbonization hinges on the use of advanced vehicle technologies in combination with carbon-free primary energy sources; especially biomass combined with CCS plays a crucial role. The extent to which earlier mitigation is possible strongly depends on the choice of technologies implemented and the structure of the model, with both partial-equilibrium models proving to be less flexible." <a href="https://doi.org/10.1016/j.energy.2013.08.059">https://doi.org/10.1016/j.energy.2013.08.059</a>	Accepted. This reference has been added.	Thomas Longden	Australian National University	Australia
27009	42	4	42	8	Total decarbonisation of the transport sector is also consistent with the finding in section 10.7.1. Is this study an outlier? Note that page 61 of chapter 10 states: "This suggests that without an explicit temperature target, the transport policy scenarios examined by the GTMs can only bring transport emissions down to a pathway that is consistent with the above 3.5°C increase". Is this inconsistent with the statement on page 42 lines 33-35 where scenarios achieving 1.5 degrees are achieved using bottom-up transport models. This mis-match between policy as usual scenarios and a 1.5 degree target makes me a bit skeptical about these so-called 'optimistic scenarios' mentioned on page 42.	Accepted. This section has been revised to be more consistent with Chapter 10 and to draw from a broader literature base.	Thomas Longden	Australian National University	Australia
28211	42	4	42	8	See in this context also <a href="http://www.ppmc-transport.org/actionable-vision-of-decarbonization-of-transport/">http://www.ppmc-transport.org/actionable-vision-of-decarbonization-of-transport/</a> which represents an extensively peer reviewed road map for decarbonization of the transport sector.	Noted.	Cornie Huizenga	CESG	Germany
1335	42	10	42	19	Zhang et al. (2018a,b) show the importance of the transport related policies and behavior changes.  1.Zhang R, Fujimori S, Hanaoka T. The contribution of transport policies to the mitigation potential and cost of 2 °C and 1.5 °C goals. Environmental Research Letters 2018, 13(5): 054008.  2.Zhang R, Fujimori S, Dai H, Hanaoka T. Contribution of the transport sector to climate change mitigation: Insights from a global passenger transport model coupled with a computable general equilibrium model. Applied Energy 2018, 211: 76-88.	Accepted. These reference have been added.	Shinichiro Fujimori	Kyoto University	Japan
24903	42	11	42	16	Delete "Given the aggregated disposition ... (Creutzig, 2016)." as the analysis is not consistent with the SSPs considered in the AR	Accepted. This sentence has been revised.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
26997	42	15	42	19	This statement about whether models account for behavioural change is true of a great range of models. Is it being overemphasised in the transport discussion? For example, are similar statements being made in this report about energy efficiency improvements across all areas/sectors and for final energy as an aggregate? How likely are decreases in pkm and tkm when most countries show year on year growth? Are decreases in pkm/tkm reasonable in the short/medium-term or in less developed countries?	Accepted. This text has been revised.	Thomas Longden	Australian National University	Australia
27003	42	20	42	24	Again, the issue of time matters here.. How many of the bottom-up models go out to 2100? Arent you concerned that there is end-point bias?	Accepted. This text has been revised.	Thomas Longden	Australian National University	Australia
27005	42	20	42	35	This whole section only cites two studies. That seems like a lot of emphasis on these two studies. Is there wide divergence between 'top-down' and 'bottom-up' models when larger numbers of models are compared? What about the harmonisation of input parameters mentioned in Yeh et al 2017? Because section 8.9.1 in the last AR5 report compared models and states: "A diversity of transformation pathways highlights the possible range of decarbonization options for transport (Section 6.8). Results from both integrated and sectoral models up until 2050 closely match each other. Projected GHG emissions vary greatly in the long term integrated sce-narios, reflecting a wide range in assumptions explored such as future population, economic growth, policies, technology development, and acceptance (Section 6.2.3). Without policy interventions, a continuation of current travel demand trends could lead to a more than dou-bling of transport-related CO2 emissions by 2050 and more than a tripling by 2100 in the highest scenario projections (Figure 8.9). The convergence of results between integrated and sectoral model studies suggests that through substantial, sustained , and directed policy inter-ventions, transport emissions can be consistent with limiting long-term concentrations to 430 – 530 ppm CO2eq."	Accepted. This text has been revised.	Thomas Longden	Australian National University	Australia
27007	42	22	42	24	Is the statement about considerable differences too strong? Looking at those studies, there are lots of similarities in the results. How can you make this statement without further work on harmonising inputs into the models and considering the results in section 10.7? For example, Figure 10.18 and 10.19 dont show large differences between IAMs and sectoral models.	Accepted. This text has been revised.	Thomas Longden	Australian National University	Australia

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
36005	42	26	42	26	modal split instead of modal split	Accepted.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
16483	43	1	43	1	A technical problem: how did you calculate industrial CO2 emissions? Since "the representation of the industry sector is very aggregate in most IAMs", how did you determine the CO2 sourced from feedstock? For power, building and transportation sectors, the calculation is easy because all fuels are combusted. Could you please give a note?	Accepted. We use the definitions of industrial CO2 from the scenario database. That definition has been noted.	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
16513	43	13	43	15	emissions reduction in industry is also highly related with structure change, for example depending more on heavy industry would emit more CO2	Accepted.	Lining WANG	Economics and Technology Research Institute, CNPC	China
24153	43	14	43	14	insert after "savings" "achieved through efficiency and conservation"	Accepted.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
34369	43	15	43	15	Please add: Large reduction in the absolute amount of greenhouse gas emissions could be achieved by the coupling of highly concentrated CO2 sources from CO2-emitting sectors with carbon-free hydrogen or electrons from renewable power in so called "Power-to-fuel" scenarios. Power to fuel is the concept enabling the production of hydrocarbon fuels (e-fuels) using renewable energy and CO2 captures from point source or ambient air (REFERENCES: 1) Artz et al., 2019: Sustainable Conversion of Carbon Dioxide: An Integrated Review of Catalysis and Life Cycle, Assessment, Chem. Rev., 118, 2, 434-504, 2) EWG&LUT, 2019: Global Energy System Based On 100% Renewable Energy, Energy Watch Group & LUT University, 3) SDSN & FEEM, 2019: Roadmap to 2050 - A Manual for Nations to Decarbonize by Mid-Century, Sustainable Development Solutions Network & Fondazione Eni Enrico Mattei. 4) Sternberg and Bardow, Energy Environ. Sci, 2015 (DOI: 10.1039/c4ee03051f)	Noted. This section describes options deployed in long-term mitigation pathways.	Célia Sapart	Université Libre de Bruxelles et Co2 Value Europe	Belgium
24155	43	19	43	45	why don't we call it CO2 removal instead of negative emission?	Accepted.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
4653	43	23	43	24	Do "450 CO2eq scenario" (line 23) and "carbon budget of 200 GtCO2" (line 24) represent the same concept with two carbon budget scenarios? If so I would suggest to use either "CO2eq scenario" or "GtCO2 carbon budget" in both cases, so to avoid possible misinterpretations.	Noted. These are not necessarily equivalent. We cannot harmonize the unit either due to differences in the underlying literature. However, given the potential confusion from this, we have altered the text to remove this.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
10207	43	28	43	28	"across all IAM scenarios assessed, scenarios show up to 40% reduction" - it contradicts the top left chart in Figure 3.25. In fact final energy demands are increasing in most of the scenarios from 2010 levels. Also, seems to contradict the next sentence.	Accepted. We have updated the text and numbers throughout to ensure consistency.	Aglia Obrekht	Environment and Climate Change Canada	Canada
5149	44	1	44	4	Median of categories might be more useful than maximum values	Accepted.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
10209	44	1	44	4	what about use of hydrogen in industrial applications?	Accepted.	Aglia Obrekht	Environment and Climate Change Canada	Canada
12357	44	2	44	3	Please consider to include the required growth in overall electricity production for the most stringent mitigation scenarios where 82% of the industrial final energy is produced from electricity	Accepted.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
20599	44	5	44	7	IAMs besides the industrial sector mentioned the chemical industry (which incorporated fertilizer production) is also poorly represented. The only IAM I know to include this sector is the IMAGE model. The relevant publication is:  Daigloglu, V., A. Faajj, D. Saygin et al. (2014). Energy demand and emissions of the non-energy sector. Energy Environ. Sci. (7), 482-498	Accepted.	Vassilis Daigloglu	Copernicus Institute of Sustainable Development	Netherlands
8807	44	9	44	11	This sentence could be misleading as from other chapters it is shown that the industry sector seems to be the fastest growing GHG emitting sector with a large reduction potential whilst its detailed modelling and analysis results in lower potentials. Suggest this is either revised and/or supported with other references.	Accepted. We have added additional references noting when they support or contradict this sentence.	Saygin Değer	SHURA Energy Transition Center	Turkey
12359	44	14	44	14	Please consider to give a reference to which IEA ETP it is referred to here. A new IEA ETP is published in 2020.	Accepted.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
28725	44	21	44	21	Fig 3.26 and Fig 3.34 seem to be duplicated.	Accepted.	Shinichiro Fujimori	Kyoto University	Japan
2599	44	24	44	26	Another factor that contributes to delays to implementing mitigating measures impacting future mitigation is the high GWP and long atmospheric lifetimes ("tens of thousands of years) of some of the gases emitted, specifically PFC (F-gases) from aluminium and rare earth smelting and semiconductor manufacture. Rare earth used in high-strength magnets in wind turbine generators and the electric motors of electric vehicles. Rare earth smelting is particularly important since Neodymium (Nd) is integral to 2 "green technologies", namely the high-strength magnets used in both wind turbine generators and the motors of electric vehicles, hence its production is predicted to increase by more than an order of magnitude. <a href="https://motherboard.vice.com/en_us/article/a3mavb/we-dont-mine-enough-rare-earth-metals-to-replace-fossil-fuels-with-renewable-energy">https://motherboard.vice.com/en_us/article/a3mavb/we-dont-mine-enough-rare-earth-metals-to-replace-fossil-fuels-with-renewable-energy</a>	Noted. We are referring to delays in reducing emissions not delays due to long lifetimes.	Michael Czerniak	Atlas Copco - Edwards	United Kingdom (of Great Britain and Northern Ireland)
25859	44	27	44	27	There is not a single mention of peatlands as part of the AFOLU sector in this section. Peatlands hold 610 Gt of carbon worldwide and have a massive capacity to accumulate carbon. Therefore, peatlands are some of the most important carbon reservoirs and sinks in the planet. Their inclusion as AFOLU would contribute to their protection and the preservation of their carbon sink status. Recently, there have been several calls for the inclusion of peatlands as NDC (e.g., Hoyos, 2019; 10.1126/science.aa29244; Gewin, 2020; 10.1038/d41586-020-00355-3)	We added peatland discussion as "Peatlands, which is included in forest or other natural land in this analysis, currently hold 600-700 Gt of carbon worldwide, which exceeds that of global vegetation (-560 GtC)11 and emit at least 2 billion tonnes of carbon dioxide annually largely throughout peat fires and oxidation of the buried carbon. Therefore, present peatland preservation is important to reserve carbon."	Jorge Hoyos-Santillan	University of Magallanes	Chile
11579	44	28	44	28	I think Agriculture, Forestry and Other Land Use should be mentioned here in the first line to avoid confusion of the abbreviated title i.e. Scenarios from integrated models suggest a substantial and essential role of Agriculture, Forestry and Other Land Use (AFOLU)	Accepted. We have added the abbreviation to the section title	John Devaey	Trinity College Dublin	Ireland
10211	44	29	44	31	Is it emissions reductions or emissions that are 'declining towards zero'?	Accepted.	Aglia Obrekht	Environment and Climate Change Canada	Canada
17207	44	29	44	31	Please check: if emission reductions decline, this means that the emissions remain stable.	Accepted.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
41191	44	31	44	31	Are CH4 and N2O also approaching zero?	Accepted.	Jan Fuglestedt	CICERO	Norway
5975	44	27	47	11	Because of important role of "forests" it should be more highlighted. I could be done by concentrating more on different types of forests in different climate zones.	Some models used in the analysis considered different types of forests in different climate zones but data was collected in common temperate with limited number of variables. Currently, we cannot deal with such details due to word limitation. More details can be treated in Chapter 7.	Mostafa Jafari	Head of TPS for LFCCs/ and IPCC LA	Iran
11581	44	27	47	11	Figures in this section need substantial editing - color are not clear and resolution is not high enough	Accepted.	John Devaey	Trinity College Dublin	Ireland
16491	44	27	47	11	Because of important role of "forests" it should be more highlighted. It could be done by concentrating more on different types of forests in different climate zones.	same as Comment ID 5975.	Mostafa Jafari	Head of TPS for LFCCs/ and IPCC LA	Iran

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41197	44	27	47	11	In my view, the section needs to do more assessment of models results - what they are telling us of relevance for the development of mitigation strategies. As it is now it gives description of model results.	As analysis on the development of mitigation strategies, we have done regression analysis for a figure. As results, it shows for example that "earlier decisions on the extent of emission reduction actions for the agricultural sector will be needed. In the overshoot scenarios, increases in agricultural productivity through technological transfers to developing countries where land productivity is relatively low will be required." We have added to the draft.	Jan Fuglested	CICERO	Norway
44555	44	27	47	11	Would it be possible to indicate gross LUC emissions and gross LUC removals, going beyond net LUC numbers?	Accepted.	Oliver Geden	German Institute for International and Security Affairs	Germany
46473	44	48	47	5	It is not clear whether the scenarios used take into account the use of fertilizer, pesticides and other fossil fuel uses within agriculture; a range of consumer preferences (not just meat consumption) and food loss and waste into account. The scenarios used in FAO 2018 do take these dimensions into account. See FAO 2018 The future of food and agriculture – Alternative pathways to 2050. Food and Agriculture Organization the United Nations, Rome	Most of the models consider emissions from fertilizer use and other fossil fuel in agriculture but not consider pesticides. Socioeconomic conditions, including the population demographics, GDP, consumer preferences, food loss and waste are varied in each model according to qualitative narratives in shared socioeconomic pathway through 2100. Currently, this section cannot deal with such details due to word limitation. More details can be treated in supplementary materials.	Rachel Bezner Kerr	Cornell University	United States of America
5151	44	21			This figure is extremely useful and could be extended/repeated in other sectors (at least those where net zero is achieved, e.g. not in the transport/building sectors, but for example in the electricity sector or energy supply sector).	Accepted. This has been added for all sectors in section 3.4.7	Matthias Weitzel	European Commission, Joint Research Centre	Spain
17209	45	5	45	6	Please check; do you mean "avoided deforestation"? Deforestation itself usually increases emissions.	Accepted.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
10215	45	9	45	11	Similar to what was done in the Transport sector section (p.3-42, lines 20-35) it would be good to understand the differences and the implications of the models used for AFOLU sector, i.e. are the IAM models more optimistic than forest specific bottom up models in terms of potential for emissions reductions/sinks. It is my impression that even though the IAM models have 'limited portfolio of land-based mitigation measures', they are still more optimistic than the bottom up models. But it could also be related to the fact that bottom up models can better reflect the impacts of natural disturbances, as compared to IAM models. Do IAM models account for the time it takes for a tree to grow to its full size at which point it can absorb a significant amount of CO2?	Roe et al (2019) shows the opposite where the bottom-up assessment shows higher mitigation potential than top-down assessment including IAM. Whether IAM models account for the forest growing period and carbon sink dynamics depends on models.	Aglia Obrecht	Environment and Climate Change Canada	Canada
36007	45	12	45	12	Carbon sequestration BECCS instead of CCS Biomass?	Accepted.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
36009	45	12	45	12	Primary Energy Modern Biomass instead of Biomass Modern	Noted. Text has been removed.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
41193	45	12	45	15	In the upper left panel you have N2O and CH4 in title but unit is Mt CO2/yr. I hope this is not meant to be CO2eq. This is an example of the importance of using the mass units for the gas in question, and avoiding CO2eq. Especially when it ends up as using CO2 for N2O and CH4.	Accepted.	Jan Fuglested	CICERO	Norway
46631	45	13	45	13	Could CH4 and N2O be split for AFOLU ?	Noted. These are discussed separately in text	Florian Leblanc	Centre International de Recherche sur l'Environnement et le Développement	France
17211	45	13	45	15	Please check graph. First, what is the difference between "above 2C" and "higher 2C"? Second, carbon sequestration is given as negative values. A negative sequestration is an emission. Are the CCS-related changes in C stocks really net emissions?	Noted. Figures were redone in response to other comments	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
18073	45	13	45	15	To what extent are GHG emissions from sourcing biomass for bioenergy reflected in the high-bioenergy scenarios, see Kalt et al. (2020; Env Res Lett, <a href="https://doi.org/10.1088/1748-9326/ab6c2e">https://doi.org/10.1088/1748-9326/ab6c2e</a> ; <a href="https://iopscience.iop.org/article/10.1088/1748-9326/ab6c2e">https://iopscience.iop.org/article/10.1088/1748-9326/ab6c2e</a> ). Are alternative options of using the land for C sequestration adequately reflected, see Kalt et al., 2019. Global Change Biology Bioenergy, 11, 1283–1297. doi:10.1111/gcb.12626	In the scenarios used in the analysis, GHG emissions from changes in land use for bioenergy is considered and the levels of emissions vary across models. The emissions from land use changes are aggregated and it is not easy to extract only that from land use change from bioenergy.	Helmut Haberl	Institute of Social Ecology, University of Natural Resources and Life Sciences, Vienna	Austria
9871	45	16	45	19	By highlighting the importance of a decrease in livestock products, the sentence makes sense is consistent with existing literature (eg. Kim et al., 2019; Springmann et al., 2018). However, it seems inconsistent with the associated figure 3.28 where livestock production increases substantially in all scenarios. BTW, "tDM/yr" is an unusual unit for livestock production: it may be worth converting into kcal or explaining what it means (eg. milk powder, bone free dried (?) meat, ...).	We meant that decrease in mitigation scenarios compared to baseline scenario, not to present period (e.g. 2010). This point was unclear in original text and now we clearly mention this in text as "food consumption reductions particularly in livestock-based products in the two (1.5 and 2C) scenarios compared to the scenario without climate mitigation due to increased food price and carbon-price-induced shifts in agricultural systems and consumption of GHG-intensive ruminant meats and crops." For unit of tDM/yr, currently data was collected in aggregated commodity category with the unit and not easy to convert it tin to kcal but the consumption side is available in kcal.	Valentin Bellassen	INRAE	France
10213	45	16	45	27	Are the scenarios accounting for increased frequency of natural disturbances associated with the climate change?	The current scenarios are not consider increased frequency of natural disturbances associated with the climate change.	Aglia Obrecht	Environment and Climate Change Canada	Canada
9099	45	19	45	19	"land use" seems need to be written as "land-use"	Rejected. Land use is correct in this context.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
17213	45	19	45	21	Please check: how are "natural forests" defined? If this is identical to "primary" or "virgin" forests, their area cannot increase beyond what is covered by this land use today. If this is meant to include "un.managed forests": these are not necessarily "natural" and the term used incorrectly, too.	Natural forest was incorrect. The category 'Forest' includes both primary and secondary forest including afforestation. Thus the area can increase. Afforestation was shown in a panel and included in Forest panel, which make duplication. Now to avoid duplication we drop afforestation panel and show Forest panel only. We modified the part accordingly.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
41195	45	25	45	26	Re grouping the gases as "GHG": It would be very useful to know the role of CH4, N2O and CO2 here. These behave very differently, and have very different sources and mitigation options.	Noted. This text was removed in this draft.	Jan Fuglested	CICERO	Norway
12659	45	6			related measures such as deforestation, restoration and afforestation/reforestation	Noted. This text was changed in response to other comments.	Eray Özdemir	General Directorate of Forestry	Turkey
17215	46	1	46	2	Please check graph. What is the difference between "above 2C" and "higher 2C"?	Noted. Figures were redone in response to other comments	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
36013	46	4	46	4	change the form of chart names	Noted. Figures were redone in response to other comments	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France

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17217	46	4	46	5	Please explain how the model scenarios can generate forest area without afforestation (the y-axis is positive) and how you come to include this in a separate panel in this figure besides "afforestation and reforestation". Please be aware that afforestation refers to land area that has been without forest cover for a comparatively long period of time or that has not been forest in historical times at all, whereas reforestation refers to area that is temporarily unstocked (not covered by standing trees) due to e.g. disturbances or regular timber harvest (see IPCC definitions for details). Thus, forest area can only be increased by afforestation. So what is given in the bottom-left panel of figure 3.29?	The category 'Forest' includes both primary and secondary forest including afforestation. Thus the area can increase. But as mentioned in the response to Comment #17213, because afforestation is shown in a panel and included in Forest panel, which make duplication, we drop afforestation panel and show Forest panel only.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
47739	46	4	46	5	It would be helpful to plot the actual baseline value on these plots (with zoomed in y-axis to properly display changes). It is important that we understand whether these are large changes compared to today -- could show as % change but a few percent may be misinterpreted as trivial even if it is a huge and important quantity	Noted. Figures were redone in response to other comments	Alex Ruane	NASA Goddard Institute for Space Studies	United States of America
4655	46	6	46	6	Typo: "scenarios suggests" to be changed with "scenarios suggest".	Accepted.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
27671	46	6	46	8	Please check the sentence	Accepted.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
36011	46	8	46	12	If livestock-based consumption declines but crop-based consumption remains similar, even as the population increases, how is the reduced feed change in livestock compensated for? One can intuitively imagine an increase in the demand for plant proteins and therefore for crops... is food substitution taken into account in the models? considering that this has an impact on land use and emissions (without denying the fact that the worst environmental impact lies in livestock). Are there any specifics about this?	In the model, substitution across commodities are considered through commodity prices and its impacts on land use and emissions are also considered and a part of reduction in livestock are compensated by crop products. but still food price and land pressure are high and leads decrease in total food consumption. Some existing studies show this results (e.g. Hasegawa et al.,2018, Fujimori et al., 2019 etc.) We have explained this in text.	Sandrine Sellose	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
9101	46	11	46	11	"1.5 and 2°C" needs to be written as "1.5°C and 2°C"	Noted.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
10531	46	1			I'm puzzled why Figure 3.28 shows a more or less constant amount of livestock production in 2050 across the different mitigation scenario categories, but a consistent decline in pasture land (figure 3.29, top right panel) with increasing mitigation stringency. If pasture land declines significantly, does this mean that in mitigation scenarios livestock systematically shifts towards intensive management that uses feed crops rather than pasture? Would be helpful to have this clarified in text. Also in Figure 3.28, food price panel, why does the price suddenly drop down again for "below 1.5°C" scenarios - is this an artefact of having so few scenarios with very specific assumptions? If yes, this scenario category should be deleted from the figure since this is rather misleading.	For FOD, we used the scenario data set for SR1.5C but now we replace it by the AR6 data set. Then, the livestock production decreases in mitigation scenarios and pasture land area shows similar trend. This decrease in pasture area means increase in intensive management that uses feed crops. Drop in price was seen in 1.5C with no or low OS because of limited numbers of scenarios. With new scenarios for AR6, the price is increased in 1.5C.	Andy Reisinger	NZAGRC	New Zealand
9585	47	3	47	4	The report needs to discuss total primary bioenergy required for different scenarios (not just differences or areas required for feedstock production).	We included the number in main text with Figure 3.28 as "Total primary bioenergy of 70-120 EJ/year and 150 EJ/year is required in 2050 and 2100, respectively for 1.5 and 2 C scenarios."	Jesper Kløverpris	Novozymes	Denmark
36015	47	7	47	7	change the form of chart names. Legends are difficult to read.	Noted. Figures were redone in response to other comments	Sandrine Sellose	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
17219	47	7	47	11	figure 3.30: Please check - the uppermost panel in the right column shows negative carbon sequestration, which would mean these are emissions.	Noted. Figures were redone in response to other comments	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
9587	47	8	47	11	Caption (figure text) needs to be improved/expanded. The figure is not only showing AFOLU emissions and sink in near-term (2030 and 2050) and cumulative CO2 emissions. It is also showing energy and land use. In addition; the figure needs to be mentioned and discussed in the text.	Accepted. Captions have been expanded	Jesper Kløverpris	Novozymes	Denmark
9103	47	10	47	10	"2 °C" has a redundant space and needs to be "2°C"	Accepted.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
15759	47	17	47	20	Perhaps it would be a good idea to include some research on the ways in which DAC projects could be financed in the long term. Some articles to quote: <a href="https://www.sciencedirect.com/science/article/pii/S0959652619307772">https://www.sciencedirect.com/science/article/pii/S0959652619307772</a> and <a href="https://link.springer.com/article/10.1007/s11027-019-9847-y">https://link.springer.com/article/10.1007/s11027-019-9847-y</a> and also this post <a href="https://www.greenbiz.com/article/case-investing-direct-air-capture-just-got-clearer">https://www.greenbiz.com/article/case-investing-direct-air-capture-just-got-clearer</a> and <a href="https://www.cell.com/joule/pdf/S2542-4351(18)30225-3.pdf">https://www.cell.com/joule/pdf/S2542-4351(18)30225-3.pdf</a>	Partially accepted. We have added a reference to Chapter 12 where these issues are discussed.	EDUARDO PEDRO FRACASSI	ITBA Instituto Tecnológico de Buenos Aires	Argentina
15761	47	17	47	20	It would be valuable to investigate the direct capture of Methane CH4 from the air. Published on Nature Sustainability at Jackson, R.B., Solomon, E.I., Canadell, J.G. et al. Methane removal and atmospheric restoration. Nat Sustain 2, 436–438 (2019). <a href="https://doi.org/10.1038/s41893-019-0299-x">https://doi.org/10.1038/s41893-019-0299-x</a> at <a href="https://www.nature.com/articles/s41893-019-0299-x">https://www.nature.com/articles/s41893-019-0299-x</a>	Partially accepted. We have added a sentence noting that these options exist.	EDUARDO PEDRO FRACASSI	ITBA Instituto Tecnológico de Buenos Aires	Argentina
5153	47	19	47	20	This seems relatively old, are there newer studies available that might have updated cost information? Not sure if this is reported in the scenario database, but DAC does play a role in some models even though it might not be highlighted in a dedicated paper. It is also mentioned in p. 50, I.30	Accepted. We have added more recent studies	Matthias Weitzel	European Commission, Joint Research Centre	Spain
41199	47	20	47	20	Re "ppm CO2-eq": You need to say what temperature level this refers to. As it is now, this is unconnected to the rest of the scenarios.	Accepted.	Jan Fuglestedt	CICERO	Norway
24905	47		47		The legend in the upper panels of Figure 3.30 to be presented correctly	Noted. Figures were redone in response to other comments	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
4657	47	12	48	8	All section 3.4.6 (Other Carbon Dioxide Removal Options) appears weak in details when compared to the other sections in sub-chapter 3.4. Information on DAC is very limited, with only three reference texts and no explanation on the limits/opportunities of this mitigation option. I would suggest to extend the section with additional information, if possible. In case of additional information unavailability I would cut the section rather than leaving it as it currently is.	Accepted. We have extended the discussion to include more references and other CDR options.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
36019	47	12	48	8	The level of deployment of DAC is also sensitive to costs and public perceptions as discussed in: Matthias Honegger & David Reiner (2017): The political economy of negative emissions technologies: consequences for international policy design, Climate Policy. <a href="https://doi.org/10.1080/14693062.2017.1413322">https://doi.org/10.1080/14693062.2017.1413322</a> . Is also mentioned the availability of other decarbonization options.	Accepted.	Sandrine Sellose	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
44557	47	12	48	8	Probably better to use DACCS instead of DAC because it's only a carbon removal technology when combined with geological storage	Accepted.	Oliver Geden	German Institute for International and Security Affairs	Germany
47005	47	12	48	8	Other CDR options: This section seems to say that the only other CDR option other than BECCs is DAC. This is of course wrong - a large emerging literature shows other options - eg silicate weathering, fostering oceanic CO2 uptake etc. This is a serious omission. Also, this section is far too short. In fact, non-BECCS technologies should be discussed all through the text, not in a "also" section at the end.	Accepted. We have added a discussion of other CDR options	Frank Jotzo	ANU	Australia
12361	47	12	48	13	Please consider to include information on how use of different energy supply influences the total effects from DAC, if it is implemented on a large scale. E.g. use of renewable energy vs fossil fuels.	Accepted.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
40073	47	13	48	8	Replace "DAC" by "DACCS" in the whole section. Reason: DAC by itself does not constitute a CDR; Direct Air Carbon Capture and Storage (DACCS) does; see e.g. Honegger, M., & Reiner, D. (2018). The political economy of negative emissions technologies: consequences for international policy design. Climate Policy, 18(3), 306-321.	Accepted.	Axel Michaelowa	University of Zurich	Switzerland

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
43391	47	13	48	8	Careful, this is a crucial distinction: Direct Air Capture by itself does not constitute a CDR; Direct Air Carbon Capture and Storage (DACCS) does; see e.g. Honegger, M., & Reiner, D. (2018). The political economy of negative emissions technologies: consequences for international policy design. <i>Climate Policy</i> , 18(3), 306-321.	Accepted.	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
43549	47	13	48	8	Replace "DAC" by "DACCS" in the whole section. Reason: DAC by itself does not constitute a CDR; Direct Air Carbon Capture and Storage (DACCS) does; see e.g. Honegger, M., & Reiner, D. (2018). The political economy of negative emissions technologies: consequences for international policy design. <i>Climate Policy</i> , 18(3), 306-321.	Accepted.	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
20259	47		48		In Section 3.4.6. Other carbon dioxide removal options, should mitigation options in waste sector be added as waste sector has yet to be mentioned in the previous sections?	Noted. Waste is now covered in industry.	Thi Lan Huong Huynh	Viet Nam Institute of Meteorology, Hydrology and Climate change	Vietnam
44559	48	1	48	3	This is an example of possible differences between scenarios and the real world. In scenarios the inclusion of DACCS (or: more CDR) does shift conventional mitigation, in the real world it could also (partly) be used to achieve net zero earlier. If you keep that sentence, you probably should start with "In scenarios, the inclusion of"	Accepted.	Oliver Geden	German Institute for International and Security Affairs	Germany
41201	48	3	48	4	Even if obvious to the authors, I think you need to say why it can increase near term emissions.	Accepted. This is stated in the previous sentence.	Jan Fuglestedt	CICERO	Norway
41203	48	6	48	6	The point you make about discount rate is important. I think you need to stress this more here - and also in other places of the chapter.	Accepted.	Jan Fuglestedt	CICERO	Norway
2979	48	12	48	13	What is the socially and politically acceptable carbon price? Is there is one?	Accepted. This phrase has been removed.	Mustafa Babiker	Aramco	Saudi Arabia
40075	48	23	48	24	Add after "...its feasibility": ", especially regarding the ability to introduce policy instruments for their implementation (Honegger and Reiner 2018, Cox and Edwards 2019, Anderson and Peters ...". Honegger, M., & Reiner, D. (2018). The political economy of negative emissions technologies: consequences for international policy design. <i>Climate Policy</i> , 18(3), 306-321. Cox, E., & Edwards, N. R. (2019). Beyond carbon pricing: policy levers for negative emissions technologies. <i>Climate Policy</i> , 19(9), 1144-1156.	Accepted. These reference have been added.	Axel Michaelowa	University of Zurich	Switzerland
43393	48	23	48	24	...its feasibility and the corresponding need for policy instruments for their implementation  Honegger, M., & Reiner, D. (2018). The political economy of negative emissions technologies: consequences for international policy design. <i>Climate Policy</i> , 18(3), 306-321.  Cox, E., & Edwards, N. R. (2019). Beyond carbon pricing: policy levers for negative emissions technologies. <i>Climate Policy</i> , 19(9), 1144-1156.	Accepted. These reference have been added.	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
43551	48	23	48	24	Add after "...its feasibility": ", especially regarding the ability to introduce policy instruments for their implementation (Honegger and Reiner 2018, Cox and Edwards 2019, Anderson and Peters ...". Honegger, M., & Reiner, D. (2018). The political economy of negative emissions technologies: consequences for international policy design. <i>Climate Policy</i> , 18(3), 306-321. Cox, E., & Edwards, N. R. (2019). Beyond carbon pricing: policy levers for negative emissions technologies. <i>Climate Policy</i> , 19(9), 1144-1156.	Accepted. These reference have been added.	Matthias Honegger	Perspectives Climate Research gGmbH	Germany
20517	48	26	48	27	a paragraph on CCU/PTX is missing. IAMs are strongly distorted in low cost electricity since PV cost are wrong as documented by Krey et al. ( <a href="https://www.sciencedirect.com/science/article/pii/S0360544218325039">https://www.sciencedirect.com/science/article/pii/S0360544218325039</a> ) vs Vartiainen et al. ( <a href="https://onlinelibrary.wiley.com/doi/full/10.1002/ptp.3189">https://onlinelibrary.wiley.com/doi/full/10.1002/ptp.3189</a> ): since CCU/PTX requires further investment cost and the efficiency for respective synthetic fuels/chemicals is at around 50% e.g. Fashi et al. ( <a href="https://www.mdpi.com/2071-1050/9/2/306">https://www.mdpi.com/2071-1050/9/2/306</a> ), low cost electricity is mandatory so that CO2 neutrals fuels/chemicals can become competitive - all this is important for achieving a zero GHG emission system as shown by Ram et al. ( <a href="http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf">http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf</a> )	Rejected. Such a paragraph belongs in Chapter 6.	Christian Breyer	LUT University	Finland
36021	48	33	48	33	Additional reference regarding lifestyle change: Thomas Le Gallic, Edi Assoumou, Nadia Maizi. Investigating long-term lifestyle changes: A methodological proposal based on a statistical model. Sustainable Development, Wiley-Blackwell, 2018, Special Issue: How are new sustainable development approaches responding to societal challenges?, 26 (2), pp.159 - 171	Accepted.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
24157	48	33	48	34	insert "accelerated electrification and meeting energy demand from renewable sources" after "GHG and"	Noted. Text reflects this suggestion.	Alfred Oforu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
9701	49	4	49	5	The figure is not clear. Please, improve the resolution.	Accepted.	Nathalie Hilmi	Centre Scientifique de Monaco	France
9105	49	5	49	5	The figure is not readable and needs a revision.	Accepted.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
36025	49	5	49	5	the figure 3.31 is unreadable	Accepted.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
17221	49	5	49	14	Figure is not legible, replace.	Accepted.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
9703	49	6	49	10	definitions of Global South and Global North in the glossary?	Noted. We have removed reference to the Global South and North	Nathalie Hilmi	Centre Scientifique de Monaco	France
9107	49	13	49	14	"[Similar figure to that of Fig 3.5, reproduced from (Kriegler et al. 2018e), will be inserted here]" needs considerations.	Accepted.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
24907	49		49		Figure 3.31 should not present results for the "Global South" and "Global North", as the conclusions are misleading in regard to regional impacts	Accepted. We have removed reference to the Global South and North	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
2981	49				Figure3.31: 1- How decent standard of living is defined? 2- Is the classification "South" and "North" among the agreed to classifications in the regional classifications for AR6?	Accepted. We have revised the caption to be clearer.	Mustafa Babiker	Aramco	Saudi Arabia
36777	49				The resolution of the figures should be improved to enable clear interpretation.	Accepted.	Lazarus Chapungu	Great Zimbabwe University	Zimbabwe
27011	50	3	50	13	This is a very important section. And I don't believe the balance between opportunities for lower demand and unrealistic demand scenarios has been made in other parts of this chapter. I specifically refer to transport, where there is a substantial discussion on 'avoid and shift' measures. Or 'optimistic scenarios' achieving deep decarbonisation in sectoral models that are not consistent with the discussion in Chapter 10 where policy as usual scenarios have decreases that are limited to 3.5 degrees. Are demand-side measures being over-emphasised in some sectoral discussions?	Accepted. The text has been revised to provide a better balance.	Thomas Longden	Australian National University	Australia
6147	50	7	50	7	I cannot see why it is not desirable to capture the nuances of demand side measures with IAMs (if possible). Not using IAMs would make it more difficult to understand rebound effects and other consequences of demand side measures. This argument should be made stronger if finally included.	Noted. This sentence has been revised	Linares Pedro	Universidad Pontificia Comillas	Spain
4659	50	13	50	13	Citation "Geels et al, INPRESS" is likely a mistake as it should refer to "Geels et al, 2016" (see your own references list).	Noted.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
41205	50	26	50	26	Looks odd to have one reference for this general statemet. I suggest adding one or two or deleting th e reference.	Accepted.	Jan Fuglestedt	CICERO	Norway
36027	50	33	50	33	Bioenergy and CCS or BECCS?	Noted. We are referring to both bioenergy and bioenergy with CCS.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France

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16485	50	33	50	35	Please also cite Pan et al. (2018; The role of biomass in China's long-term mitigation toward the Paris climate goals; doi: <a href="https://doi.org/10.1088/1748-9326/aaf06c">https://doi.org/10.1088/1748-9326/aaf06c</a> ) which is the first study on the sectoral applications of bioenergy and BECCS toward 2C/1.5C in China.	Accepted.	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
36029	50	36	50	36	Bioenergy and CCS or BECCS?	Noted. We are referring to both bioenergy and bioenergy with CCS.	Sandrine Selosse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
17223	50	41	50	43	Delete "reforestation and", as reforestation is part of forest management and does not constitute a change in land use. It should thus not be attributed to LUC. If the models do not distinguish afforestation and reforestation, avoid the term "LUC" in this context. Use land use or LULUCF instead.	Rejected. SRCC treated reforestation and forest restoration as options that could require land use change (see Figure SPM.3b). We follow that convention.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
44561	50	23	53	31	Why does this (excellent) section focus on CO2 only? I'm sure there are good reasons for this but maybe you could devote some sentences to this, incl. how the picture would change if you'd look at Kyoto-GHG? This would be particularly important for Figure 3.34 because real-world sectoral targets would be GHG targets (in sectors where there are significant volumes of non-CO2 GHGs), derived from the PA Art 4 requirement.	Accepted. We have added non-CO2 to the text.	Oliver Geden	German Institute for International and Security Affairs	Germany
16487	51	1	51	1	Are other energy conversions (liquid, gas and hydrogen productions) included in 'Supply' or 'Other' in Figure 3.33? Other conversions are very important user of BECCS, but they are never mentioned in section 3.4. Again, the chapter is weak in discussing energy conversions even electricity production.	Accepted. We have added definitions of each category	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
17225	51	1	51	4	Please add IP denotation to panels.	Accepted.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
24159	51	2	51	4	The figure 3.23 must have a title. The explanationms should be seperated from th etitle. It could me moved to a footnote	Rejected. This is the convention used throughout the report.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
24161	51	7	51	9	The 1.5oC scenario is supposed to be more stringent than the 2oC scenario.	Taken into account. The IPs have been updated from the FOD to the SOD. The 1.5C is more stringent than the 2C	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
45561	52	1	52	1	These figures would benefit from horizontal lines and more numbers on the y-axis	Accepted.	Daniel Crow	International Energy Agency	France
14687	52	1	52	5	The idea behind this figure is excellent! Carefull consideration of whether a representative subset of scenarios wouldn't also be able to do the job might help to make the figure easier to read.	Accepted.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
17057	52	1	52	5	Very nice picture! For the top picture, I would rather provide 2050 numbers instead of 2100.	Accepted.	Kornelis Blok	Delft University of Technology	Netherlands
14689	53	1	53	4	Extremely useful visualisation. The dark areas are a bit heavy on the eye, and maybe switching the colour scale from dark to light (which transparent, or hashed being "never") might clear this up a bit.	Accepted.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
17227	53	1	53	4	Revise figure. The 2010s are over and gone, anything that the scenarios think has had to happen then has either happened in reality or the scenario is biased from the start.	Accepted.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
24163	53	2	53	4	Separate title of figure from the explanations	Rejected. This is the convention used throughout the report.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
27013	53	7	53	11	This is a very important issue with respect to the timing of decarbonisation in sectoral models and IAMs. Especially in the period before/after 2050. For example, it was noted in previous research that: "In the first half of the century, transport decarbonization lags 10–30 years behind mitigation efforts in the non-transport sectors in all models when subject to the same monetary incentives to decarbonize. This trend is persistent in GCAM, whereas it is reversed in the second half of the century in REMIND and WITCH-T. All three models achieve substantial transport emission reductions of 90% and more in stringent climate policy scenarios... In the long run, however, the three global models achieve deep emission reductions by 90% and more in the strong climate policy scenario. This almost complete decarbonization hinges on the use of advanced vehicle technologies in combination with carbon-free primary energy sources; especially biomass combined with CCS plays a crucial role. The extent to which earlier mitigation is possible strongly depends on the choice of technologies implemented and the structure of the model, with both partial-equilibrium models proving to be less flexible." <a href="https://doi.org/10.1016/j.energy.2013.08.059">https://doi.org/10.1016/j.energy.2013.08.059</a>	Accepted. We have added this reference	Thomas Longden	Australian National University	Australia
24165	53	17	53	17	Bionenergy is one way of reducing transport sector emissions but other more effective ways such as electric vehicles and hydrogen exist and could be more effective. Please add these.	Taken into account. This is discussed in a previous subsection.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
36553	53	17	53	20	Supply potential of biomass feed stock for bioenergy in relation to AFOLU is important but how does AR5 deal the demand from paper and pulp industry and chemical industry for bio degradable plastics? It seems that demand for bio degradable plastics is increasing due to the marine pollution by micro plastics.	Noted. Paper, pulp, and plastic are covered in the industry subsection and chapter.	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
20601	53	17	53	21	The authors make an important argument here but do not provide any references. The paper by Daioglou et al. (2019) nicely highlights this by presenting bioenergy use across three SSP baselines and their mitigation scenarios, indicating that the tradeoff bioenergy faces between mitigation in the energy system and increased emissions in the land system depends a lot on scenario naratives, especially land management, zoning, diversion of residues (i.e. as livestock feed), and yields.  The argument on lines 21 to 24 highlighting that bioenergy may increase AFOLU emissions is also presented in this paper (see especially figure 9 in that paper).  Daioglou, V., J. Doelman, B. Wicke et al. (2019), Integrated assessment of biomass supply and demand in climate change mitigation scenarios. Global Environmental Change (54), 88-101	Accepted.	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands



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39695	53	21	53	24	This statement ignores that there are various bioenergy options without negative AFOLU impacts - and even positive ones (i.e. improve above- and below-ground carbon, see following references: Englund, Oskar et al. (2020) Beneficial land use change: Strategic expansion of new biomass plantations can reduce environmental impacts from EU agriculture. Global Environmental Change 60: 101990; Schulze, Ernst et al. (2020) The climate change mitigation effect of bioenergy from sustainably managed forests in Central Europe. GCB Bioenergy 12 (3): 186-197 <a href="https://doi.org/10.1111/gcb.12672">https://doi.org/10.1111/gcb.12672</a> ; Cossel, Moritz von et al. (2019) Marginal Agricultural Land Low-Input Systems for Biomass Production. Energies 12: 3123; Kalt, Gerald et al. (2019) Natural climate solutions versus bioenergy: Can carbon benefits of natural succession compete with bioenergy from short rotation coppice? GCB Bioenergy 11 (11): 1283-1297 <a href="https://doi.org/10.1111/gcb.12626">https://doi.org/10.1111/gcb.12626</a> ; Meerbeek, Koenraad van; Muys, Bart & Herm, Martin (2019) Lignocellulosic biomass for bioenergy beyond intensive cropland and forests. Renewable and Sustainable Energy Reviews 102: 139-149; Rahman, Syed et al. (2019) Integrating bioenergy and food production on degraded landscapes in Indonesia for improved socioeconomic and environmental outcomes. Food Energy Secur. 2019: e00165 <a href="https://doi.org/10.1002/fes3.165">https://doi.org/10.1002/fes3.165</a> ; Borchard, Nils et al. (2018) Screening potential bioenergy production of tree species in degraded and marginal land in the tropics. Forests 9 (10): 594; Fernando, Ana et al. (2018) Environmental impact assessment of perennial crops cultivation on marginal soils in the Mediterranean Region. Biomass and Bioenergy 111: 174-186; Gerwin, Werner (2018) Assessment and quantification of marginal lands for biomass production in Europe using soil quality indicators. SOIL Discuss. <a href="https://doi.org/10.5194/soil-2018-14">https://doi.org/10.5194/soil-2018-14</a> ; Kumar, S. & Ghosh, P. (2018) Sustainable bio-energy potential of perennial energy grass from reclaimed coalmine spoil (marginal sites) of India. Renewable Energy 123: 475-485 Pulighe, Giuseppe et al (2018) Ongoing and emerging issues for sustainable bioenergy production on marginal lands in the Mediterranean regions. Renewable and Sustainable Energy Reviews 103: 58-70; Tang, C. et al. (2018) Bioethanol potential of energy sorghum grown on marginal and arable lands. Frontiers in Plant Science 9: 440; Whitaker, Jeanette et al. (2018) Consensus, uncertainties and challenges for perennial bioenergy crops and land use. GCB Bioenergy 10 (3): 150-164; Awasthi, A.; Singh, K. & Singh, R. (2017) A concept of diverse perennial cropping systems for integrated bioenergy production and ecological restoration of marginal lands in India. Ecological Engineering 105: 58-65; Borchard, Nils et al. (2017) Sustainable forest management for land rehabilitation and provision of biomass-energy. CIFOR Brief 41. Bongor <a href="http://www.cifor.org/publications/pdf_files/Brief/6384-brief.pdf">http://www.cifor.org/publications/pdf_files/Brief/6384-brief.pdf</a> ; Fritsche, Uwe R. et al. (2017) Energy and land. Working Paper for the UNCCD Global Land Outlook. Darmstadt etc. <a href="http://www.inas.org/tl_files/inas/downloads/land/IINAS_2017_UNCCD-IRENA_Energy-Land_paper.pdf">http://www.inas.org/tl_files/inas/downloads/land/IINAS_2017_UNCCD-IRENA_Energy-Land_paper.pdf</a> ; IRENA (2017) Bioenergy from degraded land in Africa. International Renewable Energy Agency. Abu Dhabi <a href="http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Dec/IRENA_Bioenergy_Africa_degraded_land_2017.pdf">http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Dec/IRENA_Bioenergy_Africa_degraded_land_2017.pdf</a> ;	Accepted. We have added an additional sentence presenting the alternative.	Uwe Fritsche	IINAS	Germany
18075	53	25	53	31	Perhaps these papers can be relevant in this context to better corroborate the assessment of AFOLU/BECCS and its land-system feedbacks Kalt et al. (2020; Env Res Lett, <a href="https://doi.org/10.1088/1748-9326/ab6c2e">https://doi.org/10.1088/1748-9326/ab6c2e</a> ; <a href="https://iopscience.iop.org/article/10.1088/1748-9326/ab6c2e">https://iopscience.iop.org/article/10.1088/1748-9326/ab6c2e</a> ). Kalt et al., 2019. Global Change Biology Bioenergy, 11, 1283–1297. doi: 10.1111/gcb.12626, Erb et al., 2018 Nature 553, 73–76. <a href="https://doi.org/10.1038/nature25138">https://doi.org/10.1038/nature25138</a> .	Noted	Helmut Haberl	Institute of Social Ecology, University of Natural Resources and Life Sciences, Vienna	Austria
41209	54	11	54	11	Here you introduce another concept; carbon neutrality. I think the chapter needs a clearer presentation and use of these concepts.	Accepted. Concept of net zero CO2 emissions is introduced in Section 3.3(?) and use of the concept in the Chapter, including Section 3.5 is harmonized. The term "carbon neutrality" will no longer be used.	Jan Fuglestedt	CICERO	Norway
14691	54	11	54	17	This section should also say something about the time of net zero GHG emissions, even if only very shortly to clarify and contrast with the timing of carbon neutrality.	Taken into account. GHG neutrality is addressed in Section 3.3 and the cross-chapter box on GHG neutrality. Section 3.5 SOD is now cross-referencing them.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
41589	54	14	54	15	Is this (1.5C implying <30GtCO2 in 2030) the case for cost-effective pathways, or for all possible pathways? I.e. is it a statement about what is necessary for pathways to be optimal, or an absolute statement in the sense that no pathways can reach 1.5C if emissions are >30 GtCO2 in 2030?	Taken into account. We agree that this is an important distinction. This statement is for immediate action pathways and will be taken from Section 3.3. What is necessary is discussed in Section 3.5.1.	Ida Andrea Braathen Sognnaes	CICERO centre for international climate research	Norway
24641	54	14	54	17	The numbers in the parentheses seem to be the case of 50% and 66% probability, respectively. It is not clear what cases the numbers out of the parentheses represent.	Taken into account. The numbers in brackets refer to higher emissions in 2030 (40 instead of 30 GtCO2). Will revise wording to be clearer in the SOD.	Young-Hwan Ahn	Sookmyung Women's University	Republic of Korea
3165	54	15	54	17	Re: "A warming limit of 2°C (66% probability) implies carbon neutrality until 2080 (2070) for up to 30 (up to 40) GtCO2 in 2030". It does not sound reasonable that carbon neutrality could be achieved earlier in 2070 with higher emissions in 2030 (up to 40 GtCO2). Please clarify.	Noted. This is the property of a finite carbon budget. If more is emitted before 2030, less can be emitted thereafter. We agree that this increases mitigation challenges which is an important point the Section wants to convey.	Sai Ming LEE	Hong Kong Observatory	China
41211	54	23	54	23	Re "increases climate impacts": Yes, but this is also outside the field if WGIII. I suggest "increases temperature"	Taken into account. Wording is revised.	Jan Fuglestedt	CICERO	Norway
24909	54	27	54	30	Delete "The larger is ... after 2030." as this argument is not based on the scenario analysis of Chapters 3 and 4	Rejected. This is based on the the assessment of the scenario data and the scientific literature as discussed in Section 3.5.2	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
44969	54	31	54	33	The 2030 gap of 10 Gt is against the 2 C target. It should be clarified that against the 1,5 C the gap reaches approximately 20 Gt.	Noted. We have clarified that the emissions gain refers to accelerated action pathways relative to the NDCs, not to 1.5-2°C pathways (see Section 3.5.3).	Jorge Pina	ENEL	Spain
14693	54	33	54	33	Consider describing "carbon lock-ins" with a slightly longer description or maybe an example.	Noted. This is a summary of key messages, a detailed discussion of carbon lock-in is given in Section 3.5.2.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
24911	54	34	54	38	Delete "Ambitious regulatory policy ... carbon neutrality globally," as this argument is not consistent with sustainable development in all countries/regions	Noted. Sustainable development implications are discussed in Section 3.7 and Chapter 17.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
9705	54	35	54	35	carbon pricing: what about other instruments such as carbon taxes, cut of subsidies...?	Noted. Carbon pricing can be administered in various ways including carbon taxes.	Nathalie Hilmi	Centre Scientifique de Monaco	France
14695	54	43	54	43	Rogelj et al (2013) "Probabilistic cost estimates for climate change mitigation" also assessed delay until 2030 for the 1.5°C limit. Also Luderer et al (2013) speaks to this although less directly.	Accepted. Will reference these early studies on 1.5°C in the SOD.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
41207	54	10	55	4	This "Local ES" is useful.	Noted. Thank you for pointing this out.	Jan Fuglestedt	CICERO	Norway
34799	54	59	59		Socio-demographic drivers, etc. were listed in these pages. I think there need to add a bit of natural drivers of CO2 emission. For insance, plant respiration, wild fire, bush burning, decay of dead animal-plant, etc.	Noted. Drivers of anthropogenic emissions are assessed in Sections 3.2 and 3.3.	Onema Adojoh	Missouri University of Science and Technology, Rolla, USA	United States of America
18557	54	1	66	16	It will be important that this section (a) is well dovetailed with Chapter 4, and (b) takes account of the wider literature on system dynamics. See my comments on the Exec Summary and associated references, and for example Aghion, P., C. Hepburn, A. Teytelboym, and D. Zhengelis (2019). Path dependence, innovation and the economics of climate change. Handbook on Green Growth, 67–83. <a href="https://doi.org/10.4337/9781788110686.00011">https://doi.org/10.4337/9781788110686.00011</a> . Also, on the policy implications in relation to sectoral strategies, see Vogt-Schilb, Adrien; Meunier; Guy Hallegatte, Stéphane (2018). When starting with the most expensive option makes sense: Optimal timing, cost and sectoral allocation of abatement investment, Journal of Environmental Economics and Management, <a href="https://doi.org/10.1016/j.jeem.2017.12.001">https://doi.org/10.1016/j.jeem.2017.12.001</a> 0095-0696/&	Taken into account. We agree that coordination with Chap. 4 is critical, will be done for SOD. A discussion on path dependency and related literature will be included in Section 3.5.2 and 3.5.3 to the extent it relates to increased mitigation challenges from delayed near term action and accelerating action. See Section 3.8 for a broad view on how path dependency relates to feasibility.	Michael Grubb	UCL - Institute of Sustainable Resources	United Kingdom (of Great Britain and Northern Ireland)

IPCC AR6 WGIII - First Order Draft Review Comments and Responses - Chapter 3

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
36779	54	1	66	19	Different scenarios for fossil fuel infrastructure build up versus costs of reducing emission...up to 2030 will be helpful in understanding the levels of infrastructure build up that may make it difficult to cut emissions. Not sure if we can come up with projections from development pathways across the globe.	Taken into account. The discussion of carbon lock-in in Section 3.5.2 will be overhauled.	Lazarus Chapungu	Great Zimbabwe University	Zimbabwe
38793	54	22			Please clarify what kind of 'targets'. If referring to the temperature goals of the Paris Agreement, please state as such.	Accepted. We have clarified that the Paris climate goals are referred to.	Julian Reyes	Personal Capacity	United States of America
32195	55	1	55	4	Paris Agreement (Art. 4) recognizes that peaking will take longer for developing country Parties. Was this considered in analysis?	Taken into account. We will include a discussion of the variation of peak year vs. net zero year across regions in the scenarios.	LOKESH CHANDRA DUBE	NATCOM Cell, Ministry of Environment, Forest and Climate Change, Government of India	India
9109	55	2	55	4	"[References to be added in the SOD, e.g. modelling work on scenarios constrained by peak budgets and scenarios with updated near and medium term developments etc. It is expected that most of these studies become available by the time of SOD]" needs considerations.	Accepted. Considered in the SOD.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
41213	55	5	55	6	Here you use two concepts - carbon neutrality and net zero. I suggest you introduce and clarify these concepts and then use them in a more consistent way throughout the chapter.	Accepted. Concept of net zero CO2 emissions is introduced in Section 3.3(?) and use of the concept in the Chapter, including Section 3.5 is harmonized. The term "carbon neutrality" will no longer be used.	Jan Fuglestedt	CICERO	Norway
45139	55	5	55	6	This statement "Since the Special Report on 1.5°C Global Warming, there has been increased attention on achieving carbon neutrality, that is, net zero CO2 emissions, nationally and globally" and related content can be revised to also include the local level with possible connection to the opportunities of urban systems for climate mitigation.	Rejected. We agree that the local level is very important in this context but the Chapter and this section focuses on global mitigation pathways.	Siir Kilkis	The Scientific and Technological Research Council of Turkey	Turkey
41215	55	5	55	15	You need to tell about the role of non-CO2 here also. SR1.5 has a main focus on net zero CO2, but also included net zero GHG emissions. More information is needed here, especially since PA talks about GHG balance.	Noted. This paragraph will be moved to Section 3.3	Jan Fuglestedt	CICERO	Norway
44563	55	5	55	15	"increased attention on carbon neutrality": does this refer to the scenario literature or the climate policy debate? If scenario literature, please say so explicitly. If climate policy debate, I'd disagree. The focus there is on net zero GHG, not net zero CO2, although many actors don't really know the difference, including by directly comparing the IPCC's global CO2 neutrality year with national GHG neutrality targets, ignoring residual non CO2 emissions and the need for more CDR	Noted. This refers to the scenario literature.	Oliver Geden	German Institute for International and Security Affairs	Germany
30149	55	18	55	21	There is a newer estimate for the remaining CO2 budget that is 235 Gt for a 66% chance of staying below 1.5C, starting from 2020. See <a href="https://constrain-eu.org/assets/docs/CONSTRAIN-Zero%20In%20On%20The%20Remaining%20Carbon%20Budget%20&amp;%20Decadal%20Warming%20Rates.pdf">https://constrain-eu.org/assets/docs/CONSTRAIN-Zero%20In%20On%20The%20Remaining%20Carbon%20Budget%20&amp;%20Decadal%20Warming%20Rates.pdf</a>	Noted. Thank you for the reference. This will be harmonized with the assessment of remaining carbon budgets by WG1 AR6.	Bert Metz	European Climate Foundation	Netherlands
41217	55	18	55	29	reference is given to SR1.5 where the impact of temperature measure - GSAT vs GMST - was given attention. I think you could reflect these two ways of measuring global temperature and the impact on remaining Carbon budget also here.	Noted. This is material for Section 3.3 and the planned box on temperature classification.	Jan Fuglestedt	CICERO	Norway
9111	55	22	55	22	"[to be updated to WG1 AR6 estimates once available]." needs considerations.	Accepted. Considered in the SOD.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
9113	55	24	55	24	"[cf. Chapter 2, update to new estimates for more recent years in SOD]" needs considerations.	Accepted. Considered in the SOD.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
9115	55	32	55	33	"[Brief reference on potential risk of asymmetric carbon cycle response based on WG1 AR6 to be added in SOD]" needs considerations.	Accepted. Considered in the SOD.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
14697	55	32	55	33	AR6 WG1 Chapter 5, sections 5 and 6 only identify asymmetry for very large pulse emissions and removals which are almost an order of magnitude larger than current annual CO2 emissions. Their applicability to the emissions pathways considered here is thus limited. This will require careful wording.	Taken into account. Will consult with WG1 and check whether this point should be better addressed in Section 3.3.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
41219	55	32	55	33	Very good that you will coordinate with WG1 chapter 5 here	Noted	Jan Fuglestedt	CICERO	Norway
41221	55	35	55	35	Seems strange with one reference to such a general finding. I suggest adding more, e.g. IPCC - or deleting	Accepted. Will provide more references in the SOD.	Jan Fuglestedt	CICERO	Norway
41223	55	38	55	38	Re residual emissions: What about CH4 here?	Noted: CH4 emissions need to be stabilized at low levels, but do not need to be fully compensated.	Jan Fuglestedt	CICERO	Norway
45563	55	39	55	40	compensating for N2O and earth system feedback CO2 is little understood and important. This reference is tantalising! Should include a ref to the literature and more details pls!	Accepted. This may be moved to Section 3.3 and references will be included (Fuglestedt et al., 2018; Rogelj et al., 2018, 2019).	Daniel Crow	International Energy Agency	France
14705	55	16	66	19	This section focusses very strongly on quite high-level emission pathway characteristics. Interesting additional perspectives could to highlight how the rate of upscaling of CDR, as well as the dependence on CDR to reach net zero CO2 in a specific year (like 2050) changes with delay. Not only results delay of mitigation action in an initially slower and then accelerated reliance on CDR, lock-in into carbon-intensive infrastructure due to delay and the challenges to phase these out rapidly thereafter also result in more CDR being required to reach net zero CO2.	Taken into account. See assessment in Section 3.5.2	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
38795	55	18			Please clarify what kind of 'targets'. If referring to the temperature goals of the Paris Agreement, please state as such.	Accepted. We have clarified that the Paris climate goals are referred to.	Julian Reyes	Personal Capacity	United States of America
17403	55	30		41	It is necessary to explain about reasons of changes in slope of 20 GtCO2 between 2030 to 2050. (refer to Figure 3.35 )	Taken into account. Figure caption 3.35 will be rewritten for clarity. The reason is the goal to reach net zero emissions by 2050.	Zeyaeyan Sadegh	Islamic Republic of Iran Meteorological Organization (IRIMO)	Iran
41225	56	1	56	16	Some more reference in caption to dotted line could be useful	Taken into account. Dotted lines may be removed.	Jan Fuglestedt	CICERO	Norway
10809	56	2	56	3	In the footnote to Figure 3.35, near term is defined as until 2030, medium term as until the time of carbon neutrality and long term as until 2100. On the other hand, in Chapter 2 there is following sentence, i.e. "WGIII refers to the period from now up to 2030 as near-term; mid-term from 2030 up to 2050; and long-term from 2050 and beyond (the long-term is assessed in chapter 3)". This is confusing and consistent definition should be introduced and used throughout WG3.	Accepted. We will follow the definition of Chapter 2 and use different terms for the time to and from net zero CO2 emissions.	Mitsutsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
36033	56	2	56	16	some of the explanations could be incorporated in the text and not as a footnote?	Taken into account. Caption will be shortened and some elements moved into the text.	Sandrine Selosse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
44565	56	2	56	16	Not sure this figure works well, it's quite complicated. An indicator might be that the caption uses the same amount of space as the figure itself	Accepted. Figure will be simplified.	Oliver Geden	German Institute for International and Security Affairs	Germany
9117	56	6	56	7	"[to be updated to include more recent estimates in the SOD]" needs considerations.	Accepted. Will be considered in the SOD.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
26105	56	17	56	28	The trade-off relationship between the carbon budget and non-CO2 forcing is a major cross-WG issue. Non-CO2 warming contribution, like the one assessed in SR15, is based on the WGIII scenario database while its temperature outcome is produced with the WG1 methodology. Fully considering the both WGs' insights in a consistent manner is crucial for implications from this subsection.	Taken into account. The main discussion in this paragraph will be moved to Section 3.3 but we agree with the general point that this trade-off is very relevant for Section 3.5 and to be taken up in Section 3.5.1.	Junichi Tsutsui	Central Research Institute of Electric Power Industry	Japan

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
32419	56	17	56	28	Speed is a key metric, and climate solutions must be measured along this dimension as well as along the conventional metrics. The question that needs to be answered is how quickly a climate solution can deliver avoided warming. Molina M., et al. (2009) Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions, PROC. NAT'L ACAD. SCI. 106(49):20616–20621. It is important to note that SLCPs are a critical part of such solutions, and that cutting them can avoid warming at 2050 of up to 0.6 °C, while cutting CO2 can avoid between 0.1–0.3 °C; at 2100, SLCPs avoid 1.2 °C warming and CO2 avoids 1.6–1.9 °C. SLCIP reductions are critical for vulnerable areas like the Arctic and because they can slow progression of tipping points and self-reinforcing feedbacks. See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250; Ramanathan, Molina, and Zaelke (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change.	Taken into account. We agree that SLCPs play an important role in the timing of the warming, but simple comparisons of warming reduction potentials between SLCPs and CO2 do not take into account that a significant portion of SLCIP emissions is correlated with CO2.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32421	56	17	56	28	It is critical to slow feedbacks in the coming decade, including by cutting the SLCPs, as well as by protecting sinks, enhancing urban albedo, and other fast mitigation strategies, to complement reductions in CO2. Molina M., et al. (2009) Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions, PROC. NAT'L ACAD. SCI. 106(49):20616–20621. See also Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595 (“In our view, the consideration of tipping points helps to define that we are in a climate emergency and strengthens this year’s chorus of calls for urgent climate action — from schoolchildren to scientists, cities and countries.”); and Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L ACAD. SCI. 115(33):8252–8259, 8254.	Taken into account. The role of SLCPs in limiting peak warming is assessed in Section 3.5.1	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32423	56	17	56	28	Any overshoot will cause some irreversible impacts, including SLR and glacial and ice sheet melt that will not be corrected when the overshoot is corrected. Tokarska K. B., et al. (2019) Path Independence of Carbon Budgets When Meeting a Stringent Global Mean Temperature Target After an Overshoot, EARTH'S FUTURE 7:1283–1295, 1283 (“Emission pathways that are consistent with meeting the Paris Agreement goal of holding global mean temperature rise well below 2 °C often assume a temperature overshoot. In such overshoot scenarios, a given temperature limit is first exceeded and later returned to, under the assumption of large-scale deliberate carbon dioxide removal from the atmosphere. Here we show that although such strategy might result in a reversal of global mean temperature, the carbon cycle exhibits path dependence. After an overshoot, more carbon is stored in the ocean and less on land compared to a scenario with the same cumulative CO2 emissions but no overshoot. The near-path independence of surface air temperature arises despite the path dependence in the carbon cycle, as it is offset by path dependence in the thermal response of the ocean. Such behavior has important implications for carbon budgets (i.e. the total amount of CO2 emissions consistent with holding warming to a given level), which do not differ much among scenarios that entail different levels of overshoot. Therefore, the concept of a carbon budget remains robust for scenarios with low levels of overshoot (up to 300 Pg C overshoot considered here) but should be used with caution for higher levels of overshoot, particularly for limiting the environmental change in dimensions other than global mean temperature rise.”); Solomon S., et al. (2010) Persistence of climate changes due to a range of greenhouse gases, PROC. NAT'L ACAD. SCI. 107(43):18354–18359, 18356 (“The transfer of heat from the atmosphere to the ocean’s mixed layer (top 100 m or so) is thought to occur on timescales on the order of a decade or less (30), whereas multiple centuries are required to warm or cool the deep ocean (31), and changes in the great ice sheets and vegetation coverage may occur over many thousands of years (4).”).	Accept. Reference will be included at the place where the carbon cycle and climate response to overshoot will be discussed in SOD (Section 3.3 or 3.5)	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32771	56	17	56	28	Speed is a key metric, and climate solutions must be measured along this dimension as well as along the conventional metrics. With that the question that needs to be answered is how quickly a climate solution can deliver avoided warming, and SLCPs are part of that solution. With SLCPs providing avoided warming at 2050 of up to 0.6 °C and CO2 avoiding up to 0.1–0.3 °C; at 2100, SLCPs avoid 1.2 °C warming and CO2 avoids 1.6–1.9 °C. SLCIP reductions are critical for vulnerable areas like the Arctic and because they can slow progression of tipping points and self-reinforcing feedbacks. See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250; Ramanathan, Molina, and Zaelke (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change.	Taken into account. We agree that SLCPs play an important role in the timing of the warming, but simple comparisons of warming reduction potentials between SLCPs and CO2 do not take into account that a significant portion of SLCIP emissions is correlated with CO2.	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
9707	56	18	56	18	section 3.3 and figure 3.10	Editorial	Nathalie Hilmi	Centre Scientifique de Monaco	France
14699	56	19	56	19	Maybe say “slightly” different times, and try to provide an assessment of the magnitude of this variation: one decade, two decades, half a year...?	Accepted. Paragraph will be moved to Section 3.3	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
14701	56	27	56	28	WG1 AR6 will not provide an update on the requirement for methane emission reduction as such as far as I am aware. If needed, please ensure this to be highlighted in the WG1 SOD review.	Noted	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
9119	56	28	56	28	“[to be updated in SOD based on WG1 AR6]” needs considerations.	Accepted. Will be considered in the SOD.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
18559	56				Fig 3.35 - there is tremendous merit in simplicity but I wonder if this figure has gone one step too far, or could otherwise be adapted to show three 'stylised' approaches to timing: exponential reduction at constant percentage rates; linear reduction, illustrating the accelerating % declines this implies; and deferred abatement, which of course hugely exacerbates that characteristic. It is notable that some IAMs (including cost-benefit models such as DICE) structurally tend to defer abatement, and because they have essentially temporal independence (no inertia, induced innovation or path dependence), end up with wholly implausible rates of reduction after decades of insufficient abatement (as charted for DICE in the Grubb & Wieners (2020) WIRES / INET working paper cited above).	Taken into account. Figure will be revised. The argument on IAMs mostly refers to CBA IAM. This Chapter focuses on mitigation pathway analysis with detailed process IAMs.	Michael Grubb	UCL - Institute of Sustainable Resources	United Kingdom (of Great Britain and Northern Ireland)
30151	57	8	57	10	a distinction should be made between scenarios with a 50% and 66% chance	Noted. We will follow the assessment in Section 3.3 and Section 4.	Bert Metz	European Climate Foundation	Netherlands
14703	57	14	57	15	Consider a more precise wording here. For example, are these the “intended” NDCs or the actual NDCs? If the latter the “intended” can be dropped.	Taken into account. Intended is dropped.	Joeri Rogelj	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
15505	57	18	57	29	Consider supplementing the discussion of the “emissions gap” here (and elsewhere) with the analogous fossil fuel “production gap”, as in the SEI, UNEP et al. 2019. The Production Gap Report 2019. <a href="http://productiongap.org">http://productiongap.org</a> . This discussion could also specify low-carbon primary energy use for coal, oil, and gas in more detail than currently, as in other comments above.	To be discussed	Peter Erickson	Stockholm Environment Institute	United States of America
24913	57	21	57	29	Delete point (v) and in point (vi) delete “, including increased risk of stranded assets in fossil fuel infrastructure” as these are not based on the scenario analysis of Chapters 3 and 4	Rejected. The assessment is based on the scenario analysis and the scenario literature.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
24167	57	30	57	30	“paragraphs” after “in the following”	No longer relevant, as sentence was removed.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
24169	57	34	57	39	The meaning of the sentence is lost. Please edit.	Accepted. Sentence was revised for clarity	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
32425	57	41	57	48	Overshooting the 1.5 °C goal risks speeding feedbacks and increasing risk of passing tipping points—a large cluster of which exist between 1.5 and 2 °C of warming (Drijfhout et al 2015); this would amplify warming and jeopardize limiting warming to 1.5 °C (Xu and Ramanathan 2017). Further, it can take millennia for CO2 levels to go down. Solomon S., et al. (2009) Irreversible climate change due to carbon dioxide emissions, PNAS 106: 1704–1709; Cheng et al (2019) How fast are the oceans warming?, Science (Perspectives), 363(6423):128–129. Low probability, high impact risks are important to the conversation on uncertainty because they highlight the extent of the potential risk, which is important to consideration of adaptation measures. With climate impacts continuing to accelerate, generally ahead of model predictions (Ripple W. J., et al. (2019) World Scientists’ Warning of a Climate Emergency, BIOSCIENCE bio088:1–5), it is important to include discussion of the fat tail risk, including for both mitigation and for adaptation policies. At the same time, we are quickly approaching—and possibly have already passed—some tipping points that demand swift climate mitigation that can lessen the need for more drastic adaptation measures. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences; Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011) Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change, Review of Environmental Economics and Policy 5(2):275-292; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595, 592 (“In our view, the consideration of tipping points helps to define that we are in a climate emergency and strengthens this year’s chorus of calls for urgent climate action — from schoolchildren to scientists, cities and countries.”); Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT’L. ACAD. SCI. 115(33):8252–8259, 8254; and Ripple W. J., et al. (2019) World Scientists’ Warning of a Climate Emergency, BIOSCIENCE bio088:1–5, 1 (“Especially disturbing are concurrent trends in the vital signs of climatic impacts (figure 2, supplemental file S2). Three abundant atmospheric GHGs (CO2, methane, and nitrous oxide) continue to increase (see figure S1 for ominous 2019 spike in CO2), as does global surface temperature (figure 2a–2d). Globally, ice has been rapidly disappearing, evidenced by declining trends in minimum summer Arctic sea ice, Greenland and Antarctic ice sheets, and glacier thickness worldwide (figure 2e–2h). Ocean heat content, ocean acidity, sea level, area burned in the United States, and extreme weather and associated damage costs have all been trending upward (figure 2i–2n). Climate change is predicted to greatly affect marine, freshwater, and terrestrial life, from plankton and corals to fishes and forests (IPCC 2018, 2019). These issues highlight the urgent need for action.”); UNEP (2019) Emissions Gap Report 2019, xx (“Dramatic strengthening of the NDCs is needed in 2020. Countries must increase their NDC ambitions threefold to achieve the well below 2°C goal and more than fivefold to achieve the 1.5°C goal. ...Further delaying the reductions needed to meet the goals would imply future emission reductions and removal of CO2 from the atmosphere at such a magnitude that it would result in a serious deviation from current available pathways. This, together with necessary adaptation actions, risks seriously damaging the global economy and undermining food security and biodiversity.”).	Noted. Climate impacts of overshooting 1.5°C is a topic of WGII	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32427	57	41	57	48	Any overshoot will cause some irreversible impacts, including SLR and glacial and ice sheet melt that will not be corrected when the overshoot is corrected. Tokarska K. B., et al. (2019) Path Independence of Carbon Budgets When Meeting a Stringent Global Mean Temperature Target After an Overshoot, EARTH’S FUTURE 7:1283–1295, 1283 (“Emission pathways that are consistent with meeting the Paris Agreement goal of holding global mean temperature rise well below 2 °C often assume a temperature overshoot. In such overshoot scenarios, a given temperature limit is first exceeded and later returned to, under the assumption of large-scale deliberate carbon dioxide removal from the atmosphere. Here we show that although such strategy might result in a reversal of global mean temperature, the carbon cycle exhibits path dependence. After an overshoot, more carbon is stored in the ocean and less on land compared to a scenario with the same cumulative CO2 emissions but no overshoot. The near-path independence of surface air temperature arises despite the path dependence in the carbon cycle, as it is offset by path dependence in the thermal response of the ocean. Such behavior has important implications for carbon budgets (i.e. the total amount of CO2 emissions consistent with holding warming to a given level), which do not differ much among scenarios that entail different levels of overshoot. Therefore, the concept of a carbon budget remains robust for scenarios with low levels of overshoot (up to 300 Pg C overshoot considered here) but should be used with caution for higher levels of overshoot, particularly for limiting the environmental change in dimensions other than global mean temperature rise.”); Solomon S., et al. (2010) Persistence of climate changes due to a range of greenhouse gases, PROC. NAT’L. ACAD. SCI. 107(43):18354–18359, 18356 (“The transfer of heat from the atmosphere to the ocean’s mixed layer (top 100 m or so) is thought to occur on timescales on the order of a decade or less (30), whereas multiple centuries are required to warm or cool the deep ocean (31), and changes in the great ice sheets and vegetation coverage may occur over many thousands of years (4).”).	Noted. Climate impacts of overshooting 1.5°C is a topic of WGII	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32773	57	41	57	48	Overshooting the 1.5 °C goal risks offsetting feedbacks and tipping points—a large cluster of which exist between 1.5 and 2 °C of warming (Drijfhout et al 2015)—that could amplify warming and jeopardize successfully limiting warming to 1.5 °C (Xu and Ramanathan 2017). Further, it can take millennia for CO2 levels to go down. Solomon S., et al. (2009) Irreversible climate change due to carbon dioxide emissions, PNAS 106: 1704–1709; Cheng et al (2019) How fast are the oceans warming?, Science (Perspectives), 363(6423):128–129. Low probability, high impact risks are important to the conversation on uncertainty because they highlight the extent of the potential risk, which is important to consideration of adaptation measures. At the same time, we are quickly approaching—and possibly have already passed—some tipping points that demand swift climate mitigation that can lessen the need for more drastic adaptation measures. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences; Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595. Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595, 592 (“In our view, the consideration of tipping points helps to define that we are in a climate emergency and strengthens this year’s chorus of calls for urgent climate action — from schoolchildren to scientists, cities and countries.”); Ripple W. J., et al. (2019) World Scientists’ Warning of a Climate Emergency, BIOSCIENCE bio088:1–5, 1 (“Especially disturbing are concurrent trends in the vital signs of climatic impacts (figure 2, supplemental file S2). Three abundant atmospheric GHGs (CO2, methane, and nitrous oxide) continue to increase (see figure S1 for ominous 2019 spike in CO2), as does global surface temperature (figure 2a–2d). Globally, ice has been rapidly disappearing, evidenced by declining trends in minimum summer Arctic sea ice, Greenland and Antarctic ice sheets, and glacier thickness worldwide (figure 2e–2h). Ocean heat content, ocean acidity, sea level, area burned in the United States, and extreme weather and associated damage costs have all been trending upward (figure 2i–2n). Climate change is predicted to greatly affect marine, freshwater, and terrestrial life, from plankton and corals to fishes and forests (IPCC 2018, 2019). These issues highlight the urgent need for action.”); UNEP (2019) Emissions Gap Report 2019, xx (“Dramatic strengthening of the NDCs is needed in 2020. Countries must increase their NDC ambitions threefold to achieve the well below 2°C goal and more than fivefold to achieve the 1.5°C goal. ...Further delaying the reductions needed to meet the goals would imply future emission reductions and removal of CO2 from the atmosphere at such a magnitude that it would result in a serious deviation from current available pathways. This, together with necessary adaptation actions, risks seriously damaging the global economy and undermining food security and biodiversity.”); Richter-Menge J., et al. (eds.) (2019) ARCTIC REPORT CARD 2019.	Noted. Climate impacts of overshooting 1.5°C is a topic of WGII	Kristin Campbell	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
9121	57	43	57	48	"Tentative: Extend discussion..."s need considerations.	Editorial	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
44567	57	45	57	47	I guess this is not about gross CDR, but 15/700 Gt mark net negative emissions (total CDR being higher). This should be more clearly distinguished. Maybe somewhere in chapter 3 there could be table showing both cases	Taken into account. Gross CDR is meant, but the bigger point is that these concepts need to be carefully introduced in earlier Sections or Chapters. CDR is always meant as "gross CDR", the others are "net negative emissions" (which is only part of CDR as explained in SR1.5).	Oliver Geden	German Institute for International and Security Affairs	Germany
41227	57	47	57	48	Very good that you will coordinate with WGI here. TSU or bureau can help finding relevant authors	Noted	Jan Fuglestvedt	CICERO	Norway
17229	58	1	58	11	Please revise this figure. Neither is clear what the model names stand for, nor are the "red circular edges" identifiable. In addition, what does the upper red line indicate? The y-axis is termed "peak warming", not "peak warming contribution from CO2", so it does not seem to make sense to refer to non-CO2 here.	Accepted. Figure will be revised.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
24171	58	2	58	11	Move the explanatory notes to a box or into the body of the text.	Taken into account. Figure caption will be shortened.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
9123	58	10	58	11	"Based on the preliminary version of the AR6 database. Analysis and figure to be updated for SOD]" needs considerations.	Agreed. Analysis and figure updated in the SOD.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
24173	58	12	58	13	This sentence needs to be rephrased. The meaning does not come out.	Accepted. Sentence will be revised for clarity	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
24175	58	18	58	22	very convoluting sentences. Please break it into simpler sentences.	Accepted. Sentence will be revised for clarity	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
9125	58	26	58	29	"[Numbers preliminary. To be updated based on new literature and analysis of AR6 scenario database for SOD. This will include a new study on the impact of peak warming limits on mitigation pathways that is expected to become available by the time of SOD]" needs considerations.	Agreed. Will be considered in the SOD.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
36037	59	1	59	1	for these graphs, the red circular edge is difficult to see.	Accepted. Figure will be revised	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
44569	59	1	59	1	Not sure this figure works well, it's quite complicated. An indicator might be that the caption uses the same amount of space as the figure itself	Accepted. Figure will be revised	Oliver Geden	German Institute for International and Security Affairs	Germany
24177	60	1	60	20	assign each of the explanations to its corresponding figure on page 59	Taken into account. Figure will be revised.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
9127	60	19	60	20	"Based on the preliminary version of the AR6 database. Analysis and figure to be updated for SOD]" needs considerations.	Accepted. Analysis is updated in the SOD.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
8809	60	21	60	21	I would propose that the discussion here is better linked with the stranded assets discussion in 3.6.3.2	Accepted. Discussion on carbon lock-in and stranded assets in 3.5.2 and 3.6.3.2 will be merged and placed in Section 3.5.2	Saygın Değer	SHURA Energy Transition Center	Turkey
3223	60	30	60	33	The statement "This is due to the fact that 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 (Minx et al. 2018; Fuss et al. 2018; Nemet et al. 2018)" should be more explicitly clarified. Given the relevance of this statement and the significant number of references to CDR in chapter 3 it is suggested to include e.g. a box, explaining the assumptions of the writing team with respect to the amount of CDR that seems feasible/practical based on the current literature, including all the factors mentioned qualitatively. The most relevant parameter in the long-term might be the willingness to pay - because the cheap options of CDR such as afforestation are far too small compared to the level of CDR assumed in many scenarios. And this again boils down to a governance issue - because if the rich prefer to adapt and the poor who suffer most cannot pay it would require strong governance, e.g. based upon polluter pays principle, to deploy CDR at scale, based on the approaches such as DAR, that offer the level of CDR assumed in many scenarios. And it would be important to include reference/information from the SR report on land on the nexus between food security and BECCS. These linkages need to be addressed more explicitly and in more quantitative terms - it is the task of the IPCC to inform the policy level on those issues - because the experts that study all those issues in detail know these facts - I strongly encourage the IPCC authors to add clarity with respect to those limitations of CDR. And it might be important to also inform about the time horizons required for CDR at the scale required and affordable. It might well be in the range of several decades. And if there is the desire to avoid overshooting of temperature the only remaining option once the GHG emissions have happened, to control temperature via SRM as already mentioned on page 12.	Taken into account. Assessment of the role of CDR for trade-offs between near- and long-term action in Section 3.5.2 will be extended and coordinated with discussion of CDR in Section 3.4. Assumptions about CDR vary widely between pathways. Reference to Chapter 12 which provides a bottom-up assessment of CDR technologies.	Klaus Radunsky	retired from Umweltbundesamt	Austria
41229	60	40	60	40	I think you could add "at the global scale" after "12% per year"	Accepted.	Jan Fuglestvedt	CICERO	Norway
41231	60	41	60	41	If correct, you may add "over shorter time periods" after "historically"	Noted. This may not hold generally for all cases, so decided to keep as is.	Jan Fuglestvedt	CICERO	Norway
1337	60	21	61	34	Fujimori et al. (2016) discusses NDC implications for the long-term goals which are 1) more negative emissions related are needed if go through NDC and then 2 degree, 2) reduction speed would be challenges for the near to mid-term for the same scenario.  Fujimori S, Su X, Liu J-Y, Hasegawa T, Takahashi K, Masui T, et al. Implication of Paris Agreement in the context of long-term climate mitigation goals. Springerplus 2016, 5	Accepted. Important reference, will be added.	Shinichiro Fujimori	Kyoto University	Japan
25829	60	43	61	10	an explicit mention of carbon lock in here would be helpful	Taken into account. A detailed discussion of carbon lock-in was included in the SOD	Jonathan Buonocore	Harvard University	United States of America
25831	60	43	61	10	There's some grammatical issues with this section	Editorial	Jonathan Buonocore	Harvard University	United States of America
24915	61	3	61	34	Delete "Not only require ... Krieger et al. 2013), as these arguments are not based on an analysis consistent with sustainable development	Rejected. The findings are based on the assessment of the scenario data and the scientific literature relevant for the relationship between near-term action and long term targets. Sustainable development implications are assessed in Section 3.7.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
32337	61	15	61	17	Is there a figure you can provide here to show the lock-in and its increase in recent years? Also, is it possible to show the geographical spread of that increasing trend?	This is treated in chapter 2, that has figures showing emissions associated with existing long-lived infrastructure, their evolution in recent years and their distribution between sectors and geographies.	Penny Apostolaki	Barclays	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
46475	61	15	61	17	There is also a substantial lock-in in the agriculture and food system, through reliance on fossil fuels for agricultural production (ie fertilizers, pesticides, mechanization). Transitions to a low-carbon economy will require substantial shifts in infrastructure and system design of agriculture and food systems to reduce reliance on fertilizers and pesticides. What about consideration of alternative agricultural systems e.g. agroecology, diverse farming systems? See for example for co-benefits comparison review by Garibaldi, L. A., Gemmill-Herren, B., D'Annolfo, R., Graeb, B. E., Cunningham, S. A., & Breeze, T. D. (2017). Farming Approaches for Greater Biodiversity, Livelihoods, and Food Security. <i>Trends in Ecology &amp; Evolution</i> , 32(1), 68–80. <a href="https://doi.org/10.1016/j.tree.2016.10.001">aph. https://doi.org/10.1016/j.tree.2016.10.001</a> and Kremen, C., & Merenlender, A. M. (2018). Landscapes that work for biodiversity and people. <i>Science</i> , 362(6412), eaau6020. <a href="https://doi.org/10.1126/science.aau6020">https://doi.org/10.1126/science.aau6020</a>	This is treated in chapter 7 on agriculture, forestry and other land uses.	Rachel Bezner Kerr	Cornell University	United States of America
4661	61	35	62	6	When discussing about "Global accelerated action towards long term climate goals" (3.5.2), I suggest an evaluation of Sua, M., 2017: The Mitigation Alliance Target and Its Distribution and Stua, M., 2017: Approaches to the Exchange of Mitigation Outcomes, both of them in M. Stua (Ed.), From the Paris agreement to a low-carbon brettton woods: Rationale for the establishment of a mitigation alliance. Springer International Publishing.	To be taken into account. Reference will be evaluated.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
15507	61	35	66	19	This section could be strengthened by expanding its focus to include mention of other social and political approaches to accelerating action, not just technical and economic approaches. Changing norms around fossil fuels, and indeed increasing the risk to fossil fuel investment, could be catalytic approaches. See e.g. Green, F. Anti-fossil fuel norms. <i>Climatic Change</i> 150, 103–116 (2018). & Otto, I. M. et al. Social tipping dynamics for stabilizing Earth's climate by 2050. <i>PNAS</i> 117, 2354–2365 (2020).	Taken into account. Sec. 3.5.3 will be revised and we will check to what extent a discussion of socio-technical and socio-political factors tied to the global pathway assessment fits here. Main places for this discussion is Section 3.8 on feasibility, Chapter 5 on demand side changes and Chapters 13 and 14 on policies.	Peter Erickson	Stockholm Environment Institute	United States of America
10217	63	1	64	19	Description of the Figure 3.38 does not seem to align with the charts (rows of charts in the figure), one row seems to be missing. The years on the X-axis are inconsistent between the charts, some ending in 2050, some in 2055 and some in 2100.	Accepted. Figure will be revised.	Aglaia Obrekht	Environment and Climate Change Canada	Canada
44571	64	1	64	19	cumulated CDR deployment (lower right) is gross CDR, right? Better say so explicitly	Taken into account. Gross CDR is meant, but the bigger point is that these concepts need to be carefully introduced in earlier Sections or Chapters. CDR is always meant as "gross CDR", the other term is "net negative emissions" (which is only part of CDR as explained in SR1.5).	Oliver Geden	German Institute for International and Security Affairs	Germany
24179	64	3	64	19	Assign the explanations to the various figures seperately.	Editorial	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
9129	64	19	64	19	"[Example can be updated for SOD]" needs considerations.	Accepted. Will be considered in the SOD.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
24181	64	21	64	21	Pathways don't try to move. They are designed to do so. Replace "try" with "designed"	Accepted. Wording will be revised.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
2601	64	25	64	25	"marginal abatement costs" - this may be true for CO2 abatement but is not the case for other gases such as PFCs like CF4, C2F6 etc. In the case of PFCs (used in semiconductor "chip" manufacture), their high GWPs make abatement extremely cost-effective and there has been adoption across the industry, facilitating the WSC 2010 goal of reducing PFC emissions by >90%.	Noted.	Michael Czerniak	Atlas Copco - Edwards	United Kingdom (of Great Britain and Northern Ireland)
24919	64		64		None of the scenarios presented in Figure 3.38 are aligned with the SDG targets	Noted.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
47007	64	21	66	15	The treatment of different policy options in this section is necessarily cursory. It may be better to provide less detail here, and more detail in Ch13. In any case, future drafts will refer to Ch13 findings.	Accepted. Coordination with Chap. 13 will be sought.	Frank Jotzo	ANU	Australia
27673	65	3	45	8	But such announcements may be fundamentally not credible as they are usually time inconsistent: Once abatement has been chosen by the firms given on the announcement, it is no longer optimal for the government to stick to the announcement, D'Amato and Dijkstra (2015) among many others. D'Amato, A., Dijkstra, B.R., 2015. Technology choice and environmental regulation under asymmetric information. <i>Resource and Energy Economics</i> 41, 224 – 247.	Taken into account. References will be evaluated.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
24921	65	5	65	8	Delete "The credible announcement ..." (Bauer et al. 2018b)." as it contradicts with analysis presented later	Rejected. The sentence accurately describes the finding in the paper and is not in contradiction with the assessment in the subsection.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
27675	65	29	65	32	The fragment is insufficiently clear.	Editorial	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
9709	65	35	65	35	any example or reference?	Noted. The assessment of the historical development of climate policy coverage is not part of this section. It will be assessed in Chapter 13. (to be checked)	Nathalie Hilmi	Centre Scientifique de Monaco	France
4663	65	9	66	15	As in comment 14, I suggest considering Stua, M., 2017: Approaches to the Exchange of Mitigation Outcomes, Stua, M., 2017: A Hybrid Model to Govern the Mitigation Alliance and Stua, M., 2017 The Carbon Pricing and the Establishment of a Low Carbon Bretton Woods, all available in M. Stua (Ed.), From the Paris agreement to a low-carbon brettton woods: Rationale for the establishment of a mitigation alliance. Springer International Publishing. These may offer some new reflections, as for what concerns carbon markets, carbon pricing and the need for narrowing the gap between NDC and overall objectives of the Paris Agreement.	To be taken into account. Reference will be evaluated.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
36039	65	47	66	2	"successful implementation of 19 international climate initiatives": what type of initiative (without necessarily going into detail but here it is not very explicit while being precise on the number of initiatives..)	Accepted. Discussion of the literature reference will be improved.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
5155	65	9			Similar convergence of carbon prices is also assumed in the scenarios of in <a href="http://dx.doi.org/10.2760/438139">http://dx.doi.org/10.2760/438139</a> (these scenarios are included in <a href="https://doi.org/10.1038/s41558-019-0453-5">https://doi.org/10.1038/s41558-019-0453-5</a> ) and <a href="http://dx.doi.org/10.2760/350805">http://dx.doi.org/10.2760/350805</a>	To be taken into account. References will be evaluated.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
9131	66	16	66	19	"[An ongoing multi-model study on bridging /accelerated action pathways will provide more robust insights into the ability of accelerated action pathways to narrow the gap and improve target achievability. This study is expected to be available by the time of SOD, and if so will be assessed here.]" needs considerations.	Accepted. Considered in the SOD.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
1343	66	20	66	20	In section 3.6, many emissions trading related literature are missing. At least we have Fujimori et al.2015 and Fujimori et al. 2016 shows clear benefit of emissions trading which can reduce the total mitigation cost substantially.  Fujimori S, Kubota I, Dai H, Takahashi K, Hasegawa T, Liu J-Y, et al. Will international emissions trading help achieve the objectives of the Paris Agreement? <i>Environmental Research Letters</i> 2016, 11(10).  Fujimori S, Masui T, Matsuoka Y. Gains from emission trading under multiple stabilization targets and technological constraints. <i>Energy Economics</i> 2015, 48: 306-315.	Mitigation costs are reported at the global level and for IPCC regions. The issue of the equity and fairness in the transition is touched upon in the subsection on regional mitigation costs, but limited due to space constraints. Further elements on just transition, in particular implications for fossil fuel dependent communities, are synthesized in chapter 4. Sectoral aspects are addressed in respective sectoraal chapters.	Shinichiro Fujimori	Kyoto University	Japan
9133	66	29	66	29	In "[Below is a preliminary list of key points that emerge from the section...]", why did you mean preliminary? Is it OK?	Agreed. Closer integration attempted for Second Order Draft.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
9135	66	43	67	2	"[For all sub-sections, the scenarios in the database will be used to highlight how the result of interest (e.g. mitigation costs, investment needs...) changes with stringency of the mitigation goal and with the timing of net-zero carbon. The other main factors determining results will also be investigated (e.g. technologies assumptions, socioeconomic assumptions, energy 1 services demand, type of policy implementation...)]" needs considerations.	Due to space constraints this cannot be done in the chapter. Elements to understand modelling results are detailed in Annex C.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
1339	66	20	69	30	Liu et al. (2016) discusses about the temporal and spatial equity in terms of mitigation cost associated with NDC implementation.  Liu J-Y, Fujimori S, Masui T. Temporal and spatial distribution of global mitigation cost: INDCs and equity. Environmental Research Letters 2016, 11(11).	Due to limitations in the database of scenarios, this can only be done for some aspects of mitigation strategies. Further elements on how mitigation costs depend on mitigation strategies and in particular the design of policies are assessed and synthesized in chapter 13.	Shinichiro Fujimori	Kyoto University	Japan
27677	66	20	70	32	For completeness sake, it might be worth mentioning that some studies investigate the potential impact of transition on interpersonal distribution. Also, the impact on trade might be addressed. L. Taylor et al., 2015. "An Integrated Approach to Climate Change, Income Distribution, Employment, and Economic Growth," Ecological Economics Papers ieeep3, Institute of Ecological Economics. G. Claeys et al.(2018), The distributional effects of climate policies. OECD 2017, Understanding the distributional and household effects of the low-carbon transition in g20 countries, G Mclnnes.	Accepted. Thank you for the references.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
47031	66	1	98	10	Sections 6 and 8 of Chapter 3 need close integration with Chapter 13.	Accepted. Thank you for the references.	Frank Jotzo	ANU	Australia
2983	66	0			Section 3.6: 1- cost implication for fossil fuel dependent economies and the issue of "just transition" not reported or discussed? 2- Sectoral mitigation costs and implications are not reported or discussed? Will these be included in SOD?	Distributional questions are addressed further in the section. Thank you for the references. For the last one, it is not included because it is preferred to rely on peer-reviewed published articles when there is published literature, which is the case on this topic.	Mustafa Babiker	Aramco	Saudi Arabia
45683	66	1			In order to understand this chapter on costs, dataranges should be provided of costs of the different technologies in the models.	Preliminary because this was the first order draft and key points are subject to change in the course of the assessment.	Machteld van den Broek	Utrecht University	Netherlands
45685	66	1			As far as I saw, different costs are not related to different mitigation strategies. Is it possible to indicate whether costs differ for different strategies?	Due to limitations in the database of scenarios, this can only be done for some aspects of mitigation strategies, for example the timing of mitigation and elements on this topic have been added. Further elements on how mitigation costs depend on mitigation strategies and in particular the design of policies are assessed and synthesized in chapter 13.	Machteld van den Broek	Utrecht University	Netherlands
10811	67	4	67	4	It is of great surprize that there is no cost (to GDP or Consumption) figure throughout section 3.6.1. IPCC report without the information of economic cost of mitigation is less valuable and less policy relevant. Costs were shown in AR5/WG3 Chapter 6 (Figure 6.21), SPM (Table SPM.2) and even in SPM of the Synthesis Report (Figure SPM.13 and Table SPM.2). Also in AR4, costs are shown in Table SPM.4 (at that time in 2030). For the comparison purpose between AR5 and AR6, same kind of cost based on the same assumptions is imperative for policymakers and readers.	Mitigation costs information are reported in the second order draft.	Mitsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
41233	67	5	67	28	Box 3.1. contains very important information for the understanding of the material in this chapter. I suggest expanding this and highlighting more what is not included in the model studies (e.g. damages on human systems) and that benefits of limiting CC are not included. There is some confusion among readers about Cost Effectiveness and Cost Benefit approaches in the model studies assessed by IPCC	Thank you for the comment. Emphasis is added to avoid this common confusion indeed.	Jan Fuglestedt	CICERO	Norway
9711	67	6	67	28	Any reference for "most studies"?	The sentence has been rephrased, and details given to qualify what is meant by "most studies".	Nathalie Hilmi	Centre Scientifique de Monaco	France
10813	67	6	67	28	It is understandable that aggregate mitigation costs (on GDP or consumption) depend strongly on assumptions about the baseline against which policy costs are measured, in particular whether the baseline scenario is on or not on the efficiency frontier of the economy. In these cases mitigation cost can be shown based on the baselines such as SSP 1-5 or some such development pathways discussed in Chapter 4. Another way maybe to show mitigation costs based on the same assumption used in AR5 cost calculation (ex. Table SPM.2 of Synthesis report). What is important is that 1) policymakers need to know economic cost for their decision-makings and 2) they can compare costs with those in AR5 to know how scientific literatures progressed during past 6 years.	The assessment of costs relies on the scenarios that have been submitted to the scenarios database, and thus on the range of underlying assumptions. They cannot be the same assumptions as in AR5 where scenarios are older scenarios. However, the text clarifies how mitigation costs are computed and how they relate to baseline assumptions.	Mitsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
47009	67	6	67	28	Discussion of macroeconomic cost estimates: this discussion must reflect fundamental limitations about how economic models represent long-term change, and experience that models have typically underestimated technology progress in the past. This means that model-based macroeconomic cost estimates are highly uncertain, and are likely biased toward over-estimates. There is a literature on this, it must be reflected in this Box, and also in subsequent pages.	Agreed. Due to space limits however, the discussion about models structures and limitations cannot be discussed in depth in the chapter. Annex C allows to develop a little further this aspect.	Frank Jotzo	ANU	Australia
10821	67	7	67	10	Add after line 10 that "cost-effective mitigation pathways means to introduce uniform carbon pricing for all countries, including both developed and developing countries. In this sense, it may be rather optimistic this to be realized by 2030 or in decades, and this means actual cost is inevitably underestimated. One study shows, in relation to NDCs, that the global cost will be 6.5 times in comparison to that calculated by the least cost model if each country implement their NDC by their own carbon tax to achieve the same total reductions". Reference: Akimoto et al. (2018) Evaluations on emission reduction efforts of NDCs and their economic impacts by sector, A paper presented at The 6th World Congress of Environmental and Resource Economists (WCERE 2018).	Thank you for the reference. However, because this is not a peer-reviewed published article and because there exist some literature in the topic, it will not be included.	Mitsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
9713	67	13	67	13	why not considering other components of GDP such as government spending, investments, exports and imports?	Consumption is used following what has been done in previous assessment for continuity. It has been chosen because it is a proxy for impacts on welfare and well-being. Note that investments are also assessed further in the section.	Nathalie Hilmi	Centre Scientifique de Monaco	France
4665	67	18	67	18	Typo: "levelof" to be changed with "level of"	corrected.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
5157	67	27	67	28	Maybe provide an example to make it better understandable. A classic one is pre-existing taxes on labor (distrotro), or pre-existing subsidies on fossil fuels.	Thank you for the suggestion.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
19333	67	30	67	31	Marginal abatement cost of 1.5 degree scenario indicated in Figure 3-39 looks too low compared with "135-6050 USD" presented in Chapter 1 page 8	Coordination with chapter 1 done to ensure consistency.	Sumie Nakayama	Tokyo Institute of Technology	Japan
19261	67	30	67	32	Although I understand the figure is preliminary, marginal costs should be presented for 2050, not just 2030.	Accepted.	Masahiro Sugiyama	University of Tokyo	Japan
36041	67	31	67	31	In order to preserve the graphics representation of the different categories, indicate the corresponding C1, C2, etc.	Categories are harmonized across the chapter.	Sandrine Selosse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
41235	67	32	67	33	No reference is given in the text to Figure 3.39: Marginal abatement cost of carbon in 2030 for different mitigation pathways category.	corrected.	Jan Fuglestedt	CICERO	Norway
10815	67		67		Chaper 3 deals with long-term emission pathways and strategies toward reaching Paris goals. Figure 3.39 should be also shown in Chapter 4 that deals with near and mid-term strategies. In addition, in Chapter 3, Marginal Abatement Costs at the time of carbon neutrality and 2100 should definitely be shown what will be long-term impact to achieve Paris goals. In all cases, numerical MAC figures with ranges also should be shown in addition to graphs.	Agreed.	Mitsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
9137	67	33	68	3	"Preliminary data from the AR6 global scenarios database. Note that the 1.5°C with no or low OS category has currently too few scenarios that reported marginal abatement cost of carbon to 1 be reported in the figure. Note also that data has not been corrected for potential bias, such as different types of models over or under-represented in some temperature categories." needs considerations.	Due to space constraints, duplication is avoided, but cross-reference and coordination ensure the link and consistency.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
2985	67				Figure 3.39: Add to the caption that these marginal abatement costs were simulated under efficient uniform global carbon pricing regimes.	Accepted.	Mustafa Babiker	Aramco	Saudi Arabia
9139	68	4	68	10	"If data permits in further versions of the AR6 global scenarios database, the section will explore how marginal abatement cost of carbon in mitigation pathways varies with technologies assumptions, socioeconomic assumptions, discounting assumptions, energy services demand, type of policy implementation and/or the timing of net-zero carbon. The time profile of marginal abatement cost of carbon could also possibly be studied. In mitigation pathways with explicit carbon pricing, the quantification of how much carbon revenues (or subsidies for negative emissions) represent could also be assessed if data allows." needs considerations.	Agreed.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
17231	68	11	68	29	If the SSPs show different economic growth rates, does this also imply that the SSPs have different welfare levels in 2100 and if yes, how is this (as a proxy for reaching the SDGs) considered in the analyses? Please include - here or where appropriate in Chapter 3 - an explanation on this topic.	Scenarios that do not run until 2100, but only 2050 have been retained as well.	Joachim Rock	Thuener-Institute of Forest Ecosystems	Germany
9141	68	13	68	15	"Preliminary data from the AR6 database did not allow to analyse GDP results, therefore data is taken from the SSP database. In further elaboration of the chapter the analysis will be conducted on the AR6 global scenarios database, with temperature categories in place of the RCP categories" needs considerations.	Yes, different socioeconomic assumptions lead to different growth rates and different welfare levels. Accepted.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
9715	68	16	68	16	This is important for developing countries: compensation if they reduce their CO2 emissions	Agreed.	Nathalie Hilmi	Centre Scientifique de Monaco	France
24923	68	19	68	29	Delete "Studies have found that ... (Nieto et al. 2019)," as these studies do not consider sustainable development issues	Sorry I do not understand this comment.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
45565	68	25	68	25	Are climate damages included in the baseline here?	Sorry I do not understand this comment.	Daniel Crow	International Energy Agency	France
9143	68	30	68	36	"Placeholder for FOD. This assessment of mitigation costs will be refined based on further references. If space allows, the following questions could also be further explored: How do discounting assumption change results? What are the implications for transition costs during periods of largest transformation speed? What are the implications for intergenerational equity? How do development pathways (SSP, energy services demand assumptions, growth assumptions...) influence carbon values and global economic impacts of mitigation? How do policy designs influence carbon values and global economic impacts of mitigation?" needs considerations.	No damages on economic activities from climate change is not included. It is an important point, which has been further emphasized.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
5159	68	4			Some models that focus more on economics are often not running scenarios until 2100. Hence one might get a model selection bias if only filtering for 2100 representation. Maybe some costs for the shorter 2030/2050 horizon emerges also from chapter 4.	Agreed.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
24185	69	2	69	13	Carbon prices have been mentioned in this chapter. It is not clear if a mechanism for carbon pricing has been developed for application worldwide. If it is the cost of reduction of GHG that is being referred to, this must be stated because it differs from country to country and depends on the technology used.	What is meant by carbon pricing has been clarified.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
4667	69	2	69	30	When discussing the effort-sharing, I suggest you to reflect upon citing the effort-sharing formula included in Stua, M., 2017: The Mitigation Alliance Target and Its Distribution. In M. Stua (Ed.), From the Paris agreement to a low-carbon bretton woods: Rationale for the establishment of a mitigation alliance. Springer International Publishing. Whilst unexplored in literature, the formula proposes an innovative, flexible, dynamic effort-sharing system, resulting able to take into account the CBDR-RC principle, as well as equity, efficiency, transparency and effectiveness.	Thank you for the reference. However, due to space constraints, the section does not directly discuss formulas for effort-sharing and the reference has therefore not been retained.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
44573	69	2	69	30	This is a very important section that should probably be extended, focusing on equity in the context of very tight remaining global carbon budgets, which will emerge as a major political issue, but is not widely discussed yet (neither politically nor scientifically). The cited van den Berg et al. 2019 is very instructive but (in my view) leaves open how to bridge negative budget requirements for OECD countries with higher CDR potential in, say, Latin America. This is important because if we take the concept of net negative seriously than this needs a debate about "net negative obligations", giving the (maybe slightly disruptive) signal that national mitigation efforts don't end at net zero, at least not for OECD countries	Accepted. There is recent literature on the topic, which will be included in the assessment.	Oliver Geden	German Institute for International and Security Affairs	Germany
41237	69	8	69	8	is "in" missing before "developed"?	Thank you for the reference. However, we focus on new literature beyond AR5.	Jan Fuglestedt	CICERO	Norway
24183	69	8	69	9	The statement "with uniform carbon prices.....intensity of GDP" must be substantiated. Unless there is data to back this statement, it must be expunged. There are many developing countries in Africa, Asia, Latin America with much lower carbon intensities than developed countries.	corrected.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
9717	69	10	69	10	Why? Any reference?	Agreed. Sentence has been refined.	Nathalie Hilmi	Centre Scientifique de Monaco	France
47011	69	14	69	14	Figure 3.41: representing 'distribution of mitigation costs' geographically in scenarios of uniform carbon tax simulations is highly questionable. The results shown here are subject to very many caveats that cannot be conveyed in the Figure, and are not conveyed in accompanying text. Recommend not using such a simplistic representation.	The analysis is based on existing scenarios that do indeed exclude damages from climate change, which is a limitation. Further in the section, this is discussed and quantifications of economic benefits from avoided climate change impacts along mitigation pathways are assessed.	Frank Jotzo	ANU	Australia
9145	69	17	69	18	"[This figure will be updated to 10 regional aggregates and the most recent AR6 scenarios]" needs considerations.	Representation has been refined. There is strong evidence, from both ex post and ex ante studies, that uniform carbon pricing leads to larger economic losses in carbon intensive regions. In this sense, this is not 'highly questionable'. We plan to better substantiate this point with reference to the literature. However, we concur with the comment that uniform carbon pricing itself is questionable, though often employed in model based assessments. To this end, we plan to revise the figure by making a composite one including regional distribution costs for a broader range of allocation schemes.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
10219	69	19	69	19	what is meant by 'equitable burden sharing'? It could be defined in a number of different ways. Is it % reduction in GDP from baseline, i.e. when all the regions in Figure 3.41 would have the same shade?	Agreed.	Aglaiä Obrekht	Environment and Climate Change Canada	Canada
36045	69	19	69	19	with Paris Agreement	Accepted. This point has been clarified.	Sandrine Sellose	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
41239	69	19	69	20	Re "negative carbon budgets": Please explain better and check consistency with WGI	corrected.	Jan Fuglestedt	CICERO	Norway
5163	69	21	69	24	Another reference for how trading can reduce the cost of achieving the Paris Agreement is <a href="https://doi.org/10.1088/1748-9326/11/10/104001">https://doi.org/10.1088/1748-9326/11/10/104001</a> . EMF36 is currently ongoing, also with a focus on this topic. A first draft paper should be available over the summer and submitted in time to be considered in AR6. You may wish to contact Chris Boehringer (Univ. Oldenburg) or Sonja Peterson (IFW Kiel) to obtain a first draft	Accepted. Carbon budgets are here at the national/regional level, not at the global level. It has been explained better.	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
32339	69	23	69	24	It is not clear what kind of carbon prices the IPs and other pathways assume, Will it be possible to provide more details and a couple of graphs to show this information?	Accepted. Thank you for the reference. Contact was also taken with EMF36 coordinators, and results from the project will be included if submitted before the deadline.	Penny Apostolaki	Barclays	United Kingdom (of Great Britain and Northern Ireland)
36047	69	28	69	28	missing space	Carbon prices in scenarios are shown previously in the section.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
8811	69	31	69	31	It would be very helpful to provide a comparison of these investment estimates with the current levels. Upstream oil and gas investments are not shown. Are they covered elsewhere or is there a reason why they were excluded?	Accepted. However, due to space constraints and to avoid duplication, this has been taken up in chapter 15 on investment and finance.	Saygın Değer	SHURA Energy Transition Center	Turkey
24925	69		69		It should be stressed that the costs reported in Figure 3.41 are also not consistent with the provisions of the Convention and the Paris Agreement	Noted.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
36043	69	2	70	32	Additional reference on mitigation costs: Olivia Ricci, Sandrine Seloisse. A cost analysis of the Copenhagen emission reduction pledges. Economics Bulletin, Economics Bulletin, 2013, 33 (1), pp.764-771	Accepted. Oil and gas investment are included.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
47013	69	31	70	31	Investment: in the discussion of investment, it would be appropriate to mention macro-economic effects of increased investment due to mitigation policy - namely, this tends to increase GDP.	Accepted. However, this is a debated topic, and depends on mechanisms of crowding-out in particular.	Frank Jotzo	ANU	Australia
11717	69	32	70	7	What does this mean in terms of electricity prices? It is not clear if the world economy can afford it (and regional economies too). Is there a risk of a large-scale economic crisis from rising energy prices?	This is an important topic. However, due to space constraints, and to avoid duplication with chapter 6 on Energy, this is not treated here. It is in chapter 6.	Andrey Kolpakov	Institute of Economic Forecasting of the Russian Academy of Sciences	Russian Federation
9377	69				tables need to be briefly introduced and explained before being pasted at the beginning of the section.	Accepted.	ANNA LAURA PISELLO	DEPARTMENT OF ENGINEERING - UNIVERSITY OF PERUGIA, ITALY	Italy
721	70	1	70	2	would be helpful to show ratio between fossil/non-fossil investment under each scenario -- and perhaps more meaningful than specific investment numbers from the models?	Thank you for the suggestion. However, because this was possible only for a limited number of scenarios, it has not been done, also to respect space constraints. More elements on investments, and interpretation and implications of the numbers, are given in chapter 15.	Christa Clapp	CICERO	Norway
36051	70	1	70	3	Upper case for Fossil	corrected.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
36049	70	1	70	7	The font size of the information in these tables is really small and does not make it easy to read. It might be appropriate to transpose the columns/lines	Thank you for the suggestion. Accepted.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
9147	70	3	70	3	The right side of the table is open! Needs graphic considerations.	Fixed.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
10221	70	4	70	7	Would be good to have explanations of what countries are included under different codes: R5LAM, R5REF, etc.	The regions are harmonized at the report level. Countries aggregation in relation to the regions will be given for all chapters.	Aglia Obrekht	Environment and Climate Change Canada	Canada
9149	70	7	70	7	The right side of the table is open! Needs graphic considerations.	Fixed.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
24927	70	14	70	18	The regions reported are also those with the highest share of population being energy poor	Noted.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
36053	70	19	70	19	opening parenthesis to be deleted	corrected.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
24929	70	19	70	31	Are these studies consider implementation of the 2030 Agenda and achievement of SDG targets?	corrected.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
36055	70	20	70	20	"and" instead of ;"	Not all studies explicitly consider all SDGs, so it is not possible to answer this question.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
9151	70	32	70	32	"[Cross reference to chapter 15 for a discussion of the financing issue of investment needs]" needs considerations.	corrected.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
41241	70	32	70	32	In addition to referring to ch 15, ensuring consistency is of course also important	agreed.	Jan Fuglested	CICERO	Norway
9379	70	16			bracket is not needed	agreed.	ANNA LAURA PISELLO	DEPARTMENT OF ENGINEERING - UNIVERSITY OF PERUGIA, ITALY	Italy
46477	71	3	71	46	No mention of calculation of economic cost of loss of ecosystem services and biodiversity associated with climate change impacts on agriculture, forestry and other land use, and mitigation impacts on ecosystem services and biodiversity.	Agreed this is a complex topic. It is important it appears here because it is the direct benefit of mitigation action, therefore a complete picture has to be given. The approach taken is indeed to collaborate with WGII authors, and put here in the context of mitigation pathways the assessment and synthesis of economic impacts of climate change from WGII.	Rachel Bezner Kerr	Cornell University	United States of America
10817	71	14	71	16	The information of the estimate of GDP loss of impact of 4 degree increase is quite useful for decisionmakers, though we don't know the impacts of GDP loss in case of 2 degree and 1.5 degree temperature increase. It is pity for policymakers that they cannot compare mitigation cost against climate loss estimate. Up until AR5, experts in WG2 were so cautious to show in numerical terms while WG3 are very open to show economic cost. As WG2 has changed their attitude to a little bit, it is more valuable and relevant for WG3 to show economic cost.	Accepted. Clarity and precision has been improved.	Mitsutsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
24931	71	14	71	18	It is not only those already poor who are disproportionately affected, it is also those who are not responsible for the historical emissions that caused climate change impacts	You are right that GDP is a limited indicator, with several "biases". A full discussion of the issue that would do justice to it is beyond the possibilities of the chapter due to space constraints. Also, the chapter assesses and synthesises the existing literature, a large part of it using GDP as an indicator and very few using alternatives. Therefore, this will be kept, but a note on the limitation of GDP as an indicator of welfare added.	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
27083	71	19	71	30	Another study that looked at co-benefits of reducing air pollution in the EU is Schwanitz et al. (2015) that found that the co-benefit in 2020 of decarbonizing electricity tended to rival the total cost of the policy when coal is replaced by non-biomass renewables. <a href="https://doi.org/10.1016/j.techfore.2014.01.003">https://doi.org/10.1016/j.techfore.2014.01.003</a>	Agreed that co-benefits are an very important part of the picture, and may be decisive for action. This is addressed in the section, as well as in the section 3.7 on sustainable development dimension. The literature on analysis of CDM does not fit into this chapter on long term mitigation pathways, but is present in chapter 4 and chapter 13.	Thomas Longden	Australian National University	Australia
32429	71	19	71	30	In a warming world with a growing population and expanding middle-class, the demand for cooling is projected to rise substantially. Currently, there are 3.6 billion cooling appliances, which is projected to rise to 9.5 billion by 2050, though up to 14 billion would be required to provide adequate cooling for all. University of Birmingham (2018) A Cool World: Defining the Energy Conundrum of Cooling for All ("Considering per capita equipment penetrations at regional level, it becomes clear that 9.5 billion cooling appliances by 2050 will, on the current technology pathways, not be sufficient to deliver universal access to cooling, let alone meet the UN SDGs 2030 targets. Food and medicine loss in the supply chain will still be high; food poisoning from lack of cold chain and domestic temperature management will still be significant; farmers will lack market 'connectivity' or 'access'; hundreds of millions of people will not have safe, let alone comfortable, living or working environments; medical centres will not have temperature-controlled services for post-natal care, etc... By 2050, would require a total of 14 bn cooling appliances – an additional 4.5 bn appliances compared to the baseline forecast – or 4 times as many pieces of cooling equipment than are in use today."); Dreyfus G., et al. (2020) ASSESSMENT OF CLIMATE AND DEVELOPMENT BENEFITS OF EFFICIENT AND CLIMATE-FRIENDLY COOLING.	Exactly. Collaboration with WGII authors to develop a Box on economic benefits due to avoided climate change impacts is put in place.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32431	71	19	71	30	At the same time, increased demand for air conditioning will increase energy demand that will thus require additional energy production. Energy efficiency, including in equipment efficiency like air conditioners, can reduce this demand and help limit additional emissions that would further exacerbate climate change. Dreyfus G., et al. (2020) ASSESSMENT OF CLIMATE AND DEVELOPMENT BENEFITS OF EFFICIENT AND CLIMATE-FRIENDLY COOLING; Sachar et al. (2018) Solving the Global Cooling Challenge: How to Counter the Climate Threat from Room Air Conditioners. Rocky Mountain Institute; Shah, N., Wei, M., Letschert, V. and Phadke, A. (2019). Benefits of Energy Efficient and Low-Global Warming Potential Refrigerant Cooling Equipment. U.S.A: Lawrence Berkeley National Laboratory; Shah N., et al. (2015) Benefits Of Leapfrogging To Superefficiency And Low Global Warming Potential Refrigerants In Air Conditioning, Ernest Orlando Lawrence Berkeley National Laboratory; IEA (2018) Future of Cooling; Sustainable Energy for All (2018) Chilling Prospects: Providing Sustainable Cooling for All; and Birmingham Energy Institute, University of Birmingham (2018) A Cool World: Defining the Energy Conundrum of Cooling for All; Biardeau, L.T., Davis, L.W., Gertler, P., Wolfram, C., 2020. Heat exposure and global air conditioning. Nature Sustainability 3, 25–28 ("Air conditioning adoption is increasing dramatically worldwide as incomes rise and average temperatures go up. Using daily temperature data from 14,500 weather stations, we rank 219 countries and 1,692 cities based on a widely used measure of cooling demand called total cooling degree day exposure. India, China, Indonesia, Nigeria, Pakistan, Brazil, Bangladesh and the Philippines all have more total cooling degree day exposure than the United States—a country that uses 400 terawatt-hours of electricity annually for air conditioning.").	The cost of delayed action is addressed in the previous section 3.5.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32775	71	19	71	30	The demand for cooling is projected to rise substantially. Currently, there are 3.6 billion cooling appliances, which is projected to rise to 9.5 billion by 2050, though up to 14 billion would be required to provide adequate cooling for all. University of Birmingham (2018) A Cool World: Defining the Energy Conundrum of Cooling for All ("Considering per capita equipment penetrations at regional level, it becomes clear that 9.5 billion cooling appliances by 2050 will, on the current technology pathways, not be sufficient to deliver universal access to cooling, let alone meet the UN SDGs 2030 targets. Food and medicine loss in the supply chain will still be high; food poisoning from lack of cold chain and domestic temperature management will still be significant; farmers will lack market 'connectivity' or 'access'; hundreds of millions of people will not have safe, let alone comfortable, living or working environments; medical centres will not have temperature-controlled services for post-natal care, etc... By 2050, would require a total of 14 bn cooling appliances – an additional 4.5 bn appliances compared to the baseline forecast – or 4 times as many pieces of cooling equipment than are in use today."); UNEP and IEA (2019) COOLING SYNTHESIS REPORT (pre-publication draft) <a href="https://ccacoalition.org/en/resources/cooling-synthesis-report-final-draft">https://ccacoalition.org/en/resources/cooling-synthesis-report-final-draft</a> ; UNEP & IEA (2019) Cooling in a warming world – Opportunities for delivering efficient and climate friendly cooling for all ("Globally, an estimated 3.6 billion cooling appliances are in use today, and this is projected to increase to 9.5 billion appliances by 2050. If cooling is provided for all who need it in a warming world—and not just those who can currently afford it—this would require up to 14 billion cooling appliances by 2050.").	This will be added, in the section on sustainable development dimensions.	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
32777	71	19	71	30	At the same time, increased demand for air conditioning can increase energy demand that will thus require additional energy production. Energy efficiency, including in equipment efficiency like air conditioners, can reduce this demand and help limit additional emissions that would further exacerbate climate change. Sachar et al. (2018) Solving the Global Cooling Challenge: How to Counter the Climate Threat from Room Air Conditioners. Rocky Mountain Institute; UNEP and IEA (2019) COOLING SYNTHESIS REPORT (pre-publication draft) <a href="https://ccacoalition.org/en/resources/cooling-synthesis-report-final-draft">https://ccacoalition.org/en/resources/cooling-synthesis-report-final-draft</a> ; Shah, N., Wei, M., Letschert, V. and Phadke, A. (2019). Benefits of Energy Efficient and Low-Global Warming Potential Refrigerant Cooling Equipment. U.S.A: Lawrence Berkeley National Laboratory; Shah N., et al. (2015) Benefits Of Leapfrogging To Superefficiency And Low Global Warming Potential Refrigerants In Air Conditioning, Ernest Orlando Lawrence Berkeley National Laboratory; IEA (2018) Future of Cooling; Sustainable Energy for All (2018) Chilling Prospects: Providing Sustainable Cooling for All; and Birmingham Energy Institute, University of Birmingham (2018) A Cool World: Defining the Energy Conundrum of Cooling for All.	Thank you for the references. Some were already cited (further down in the section, where there was already sentence on tipping point). The others will be added, as well as further emphasis on the risks.	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
12407	71	40	71	46	Considering the range of results coming from different models(/model versions) for these results, the literature used to support these claims is a little scarce, and especially the last two sentences could use an extra study.	Noted.	Jarmo Kikstra	International Institute for Applied Systems Analysis	Austria
10819	71	41	71	43	The information here on economic gains are not consistent with figures shown in lines 14-16 in the same page.	Some elements about how estimates of damages from climate change can be used (and limitations in doing so) to reveal economic benefits of mitigation via avoided impacts will be developed.	Mitsutsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
27679	71	2	72	19	Section 3.6.2.1 is not always as precise as could be. E.g., the distinction between what is economic and what is not is unclear – the section includes a very exhaustive list of risks before stating that not all risks are economic. Which are the non-economic risks in the list, considering that many economists consider e.g. the loss of life as an economic loss? Why e.g. putting loss of health and loss of welfare in two separate categories – health is usually considered a component of welfare unless welfare is defined uniquely in terms of goods consumption ... The distinction between economic and non-economic appear therefore more confusing than enlightening. Perhaps it would be best not to mention "economics" at all. The perceived lack of precision is particularly fragrant in the lines 13-18 p. 71, which mix economic and non-economic risks, GDP and welfare, and an inconsistent manner. It would be useful to reorganize the whole section, and to make it more precise. Lines 8-13 are uselessly repetitive.	Agreed.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
27681	71	2	72	19	More generally, shouldn't the report include a sub-section or a box presenting the main arguments against the use of GDP as an indicator of welfare and a short overview of alternatives, possibly in relation to SDGs? In a nutshell, the main reason for reconsidering the use of GDP in the current context might be: By construction, GDP can only increase ("growth" is only possible) if material and energy use increases. Thus, the use of GDP as a metric for welfare and growth implies that an increase in welfare cannot be decoupled from a growth in material and energy use. While historically, i.e. in a world with practically infinite resources and negligible external effects, this may have been largely innocuous, it is no longer so in the current situation and conflicts with sustainability. It is also refuted by empirical data that show that increasing welfare can be compatible with a reduced use of resources. There is an abundant, growing, and well-recognized literature on all the above. Note that the concept of GDP emerged from efforts to measure the capability of a nation to sustain a war effort, i.e., to measure the quantity of material outputs that could be devoted to war, see e.g. Keynes (1940) seminal "How to pay for the war. The modern GDP concept and its use as a welfare proxy may hide his origins under a theoretical justification based on some of the most egregious and ad hoc methodological assumptions of neoclassical economic theory. Nonetheless, its original DNA is still very much present. The recent proposal to "seal off" the North Sea to protect from rising seas, if realized, would tremendously increase the GDP as it involves massive construction and use of resources, and leads to longer maritime routes. Being the simple sum of values (prices x quantities) the GDP does not consider distributional aspects despite their crucial major on welfare. Etc., etc.	Thank you for the reference.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
47015	71	1	73	10	The discussion of economic benefits from avoided climate change is a very complex matter, subject to far greater uncertainties than the (already large) uncertainties in mitigation costs. It's very hard to do it justice in two pages. Recommend sticking much closer to WGII work; sticking to principles rather than the many numbers cited in the text; and providing simply some broad ranges of aggregate economic estimates as they may have been compiled by WGII.	Due to space constraints, this topic is not treated in the section on economic implications, but touched upon in the section on emissions pathways and how climate change itself feedbacks on emissions (cooling demand being one channel). The chapter on energy, chapter 6, addresses the topic.	Frank Jotzo	ANU	Australia
4669	71	2	73	10	By limiting the cost-benefit analysis to an understanding fo the risks/damages produced by climate change against the cost of mitigation actions, section 3.6.2 fails in offering a full framework on the subject. The proposed analysis neglects the economic co-benefits that mitigation may bring, giving them partial recognition in section 3.6.3. Bold mitigation actions imply triggering new economic processes whose potential may be better understood by analysing data collected during 20 years of mitigation experience. Studies focused on past mitigation experiments and their economic co-benefits (i.e.: analyses of the socio-economic impacts of the Clean Development Mechanism on hosting countries) may contribute opening the debate. Suggested references: Mathur, V. N., Afionis, S., Paavola, J., Dougill, A. J., Stringer, L. C., 2014: Experiences of host communities with carbon market projects: Towards multi-level climate justice. Climate Policy, 14(1), 42–62. Phillips, J., Newell, P., 2013: The governance of clean energy in India: The clean development mechanism (CDM) and domestic energy politics. Energy Policy, 59, 654–662. Potdar, A., Singh, A., Unnikrishnan, S., Naik, N., Naik, M., Nimkar, J., 2016: Innovation in solid waste management through clean development mechanism in India and other countries. Process Safety and Environmental Protection, 101, 160–169. Wang, C., Zhang, W., Cai, W., Xie, X., 2013: Employment impacts of CDM projects in China's power sector. Energy Policy, 59, 481–491. Wara, M., 2008: Measuring the Clean Development Mechanism's performance and potential. UCLA Law Review, 55, 1759–1803. Stua, M., 2013: Evidence of the clean development mechanism impact on the Chinese electric power system's low-carbon transition. Energy Policy, 62, 1309–1319. Tatrallyay, N., Stadelmann, M., 2013: Climate change mitigation and international finance: The effectiveness of the clean development mechanism and the global environment facility in India and Brazil. Mitigation and Adaptation Strategies for Global Change, 18(7), 903–919. Michaelowa, A., Hoch, S., 2016: How to transition from the CDM to the sustainable development mechanism under the Paris agreement. Carbon Mechanisms Review, 1, 28–31. Lim, X.-L., Lam, W.-H., 2014: Review on clean development mechanism (CDM) implementation in Malaysia. Renewable and Sustainable Energy Reviews, 29, 276–285.	Due to space constraints, this topic is not treated in the section on economic implications, but touched upon in the section on emissions pathways and how climate change itself feedbacks on emissions (cooling demand being one channel). The chapter on energy, chapter 6, addresses the topic.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
41243	71	2	73	10	This section is important and some mechanisms for collaboration with WGII could be useful; such as involving WGII authors as Contribution Authors here	Due to space constraints, this topic is not treated in the section on economic implications, but touched upon in the section on emissions pathways and how climate change itself feedbacks on emissions (cooling demand being one channel). The chapter on energy, chapter 6, addresses the topic.	Jan Fuglestedt	CICERO	Norway
14195	71	3	73	10	This section 3.6.2 misses that there is an increasing possibility of tipping points which may drive the system far from current conditions which may make unlivable many currently densely areas in the world. In these conditions, the costs of inaction would be closer to infinity rather than the small numbers given here (4-25% of GDP). This is crucial since it gives a false impression of control. Follow some references which support the above:  Lenton, T.M., 2011. Beyond 2°C: redefining dangerous climate change for physical systems. Wiley Interdisciplinary Reviews: Climate Change 2, 451–461. <a href="https://doi.org/10.1002/wcc.107">https://doi.org/10.1002/wcc.107</a> Lenton, T.M., Ciscar, J.-C., 2013. Integrating tipping points into climate impact assessments. Climatic Change 117, 585–597. <a href="https://doi.org/10.1007/s10584-012-0572-8">https://doi.org/10.1007/s10584-012-0572-8</a> Cai, Y., Lenton, T.M., Lontzek, T.S., 2016. Risk of multiple interacting tipping points should encourage rapid CO2 emission reduction. Nature Climate Change 6, 520–525. <a href="https://doi.org/10.1038/nclimate2964">https://doi.org/10.1038/nclimate2964</a> Lontzek, T.S., Cai, Y., Judd, K.L., Lenton, T.M., 2015. Stochastic integrated assessment of climate tipping points indicates the need for strict climate policy. Nature Climate Change 5, 441–444. <a href="https://doi.org/10.1038/nclimate2570">https://doi.org/10.1038/nclimate2570</a> Steffen, W., Rockström, J., Richardson, K., Lenton, T.M., Folke, C., Liverman, D., Summerhayes, C.P., Barnosky, A.D., Cornell, S.E., Crucifix, M., Donges, J.F., Fetzer, I., Lade, S.J., Scheffer, M., Winkelmann, R., Schellnhuber, H.J., 2018. Trajectories of the Earth System in the Anthropocene. PNAS 115, 8252–8259. <a href="https://doi.org/10.1073/pnas.1810141115">https://doi.org/10.1073/pnas.1810141115</a>	Due to space constraints, this topic is not treated in the section on economic implications, but touched upon in the section on emissions pathways and how climate change itself feedbacks on emissions (cooling demand being one channel). The chapter on energy, chapter 6, addresses the topic.	Iñigo Capellán-Pérez	University of Valladolid	Spain
14197	71	3	73	10	IAMs neglect or strongly underestimate the impacts of climate change, so the range of 4-25% losses is biased downwards. This should be state up-front and not let for one page later in p72129-32. "Cost-benefit approaches that represent both mitigation costs and benefits in a unified framework have many limits and raised numerous critics, in particular for underestimating damages from climate change, their uncertain nature and the risk of high damages (Revesz et al. 2014; Stern 2016; Diaz and Moore 2017; Pindyck 2017)."	Accepted.	Iñigo Capellán-Pérez	University of Valladolid	Spain
18795	71		73		When discussing the benefits of abatement i think you should cite the most recent and complete meta-analysis of climate damages which shows higher values than previous work by Nordhaus, leading also to higher estimates of SCC. See Howard, P. and Sterner, T. (2017). "Few and Not So Far Between: A Meta-analysis of Climate Damage Estimates". Environmental and Resource Economics, 68, 197-225.	Agreed this is confusing. Will be clarified and made consistent.	thomas Sterner	Univ of Gothenburg	Sweden
5161	71	2			The section is relatively silent on cost of delayed action, cost of carbon lock-in etc, despite the fact that this is mentioned in the exec. summary of this chapter	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
700	72	1	72	11	This paragraph accurately summarizes the relevant literature, but should clarify the difference between climate damage in absolute terms (e.g. in USD terms) and relative damage (e.g. as % of GDP). The paragraph correctly mentions disproportionate damage in hotter and poorer countries estimated by Diffenbaugh and Burke (2019). But it should clarify that this is an insight concerning relative damages (% of GDP). In absolute terms (e.g. USD), climate damage is likely largest in richer and more populous countries (as found also in the cited work by Ricke et al. 2018). This clarification does not change the broader implications of the paragraph, but it should be included nonetheless.	Accepted.	Lutz Sager	Georgetown University	United States of America
9719	72	1	72	11	It would be nice to have some specific examples to illustrate or localise those impacts	The impacts of climate change are extensively treated in WGII report, including their location. Here space does not allow to go into details, but reference will be made to WGII.	Nathalie Hilmi	Centre Scientifique de Monaco	France
46465	72	1	72	11	We should be concerned about the impact of climate change on vulnerable populations, without question. There is nothing automatic about adaptation. And it's true that the poor are more vulnerable to climate change, but they are also more vulnerable to the weather and natural disasters today. As such, it's misleading for IPCC authors to invoke the poor, and the risks they face from climate change, without acknowledging that economic development is overwhelmingly what will determine their standard of living, and the future of their children and grandchildren, not how much the climate changes. What will determine whether their homes are flooded is primarily whether their governments build hydroelectric, irrigation, and rainwater system, not the specific change in precipitation patterns. What will determine whether their homes are secure or insecure is whether they have the money to make it secure. And the only way they'll have money to make it secure is through economic growth and a higher income. The authors should make this clearer in the introduction and in the text.	We agree that future damage from climate change depend both on the extent of climate change itself and on socioeconomic evolutions that will determine the exposure and vulnerability of people to climate change impacts. This is documented in the literature and will be assessed and synthesized in WGII report. Here the point is that along mitigation pathways, including assumptions on socioeconomic evolutions, literature shows climate change remains an important determinant of inequalities. Literature also showed that the unequal distribution of impacts gives higher value to mitigation actions, as measured through the social cost of carbon for instance.	Michael Shellenberger	Environmental Progress	United States of America
41247	72	12	72	19	This para could be expanded since it discusses some very important aspects	Noted.	Jan Fuglestedt	CICERO	Norway
698	72	13	72	13	Typo: "concentrated is" should read "concentrated in"	corrected.	Lutz Sager	Georgetown University	United States of America
12409	72	13	72	17	This sentence could perhaps be made a bit clearer by improved signposting or splitting up the sentence.	Accepted.	Jarmo Kikstra	International Institute for Applied Systems Analysis	Austria
41245	72	17	72	19	This last sentence contains a very important point that in my view deserves more attention and space	Noted.	Jan Fuglestedt	CICERO	Norway
41249	72	22	72	27	The first sentence lists challenges related to comparing costs and benefits, but I miss the issues related to different (and long) timescales.	This subsection is given more emphasis by developing a cross-WG box, in collaboration with WGII authors, on the topic.	Jan Fuglestedt	CICERO	Norway
12411	72	25	72	30	It might be worthwhile to point out here that part of the underestimation of damages comes from the lack of a proper incorporation of human-climate feedbacks (persistence of growth, arctic feedbacks, etc.), stochasticity (uncertain nature -> e.g. climate variability), and extremes (risk of high damages -> warm and cold periods or years, and extreme events, rather than just mean temperature levels)	Accepted.	Jarmo Kikstra	International Institute for Applied Systems Analysis	Austria
27685	72	33	72	46	More generally, the whole paragraph is rather confused and confusing, and might benefit from being entirely reworked. The main points here (they are not clearly expressed in the current formulation) are that many economic analyses find that certain policies are not economically justified in the sense that the expected costs are higher than the expected benefits. These results are very much dependant on largely arbitrary assumptions about the objective function (including time preference), the process model, and so on. "Uneconomical" policies will typically become economically justified if the size and range of damages is increased. Importantly, some classical analyses find higher benefits to 1.5 than to 2.0 policies. Drouet et al. (2015) has interesting quantitative results on the relative importance of preferences, model, and state uncertainties worth mentioning. Etc.	Noted. Caution to reflect mainstream literature will be taken. And collaboration with authors from WGII on impacts has been established.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
46127	72	33	72	46	72 33-46 More generally, the whole paragraph is rather confused and confusing, and might benefit from being entirely reworked. The main points here (they are not clearly expressed in the current formulation) are that many economic analyses find that certain policies are not economically justified in the sense that the expected costs are higher than the expected benefits. These results are very much dependant on largely arbitrary assumptions about the objective function (including time preference), the process model, and so on. "Uneconomical" policies will typically become economically justified if the size and range of damages is increased. Importantly, some classical analyses find higher benefits to 1.5 than to 2.0 policies. Drouet et al. (2015) has interesting quantitative results on the relative importance of preferences, model, and state uncertainties worth mentioning. Etc.	There are indeed limitations and consistency issues in crude comparison of damage estimates and mitigation costs, this will be explained clearly. However there is a growing literature that analyses costs and benefits in a common framework, and this literature will be assessed and synthesized.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
27683	72	34	72	37	Although the core of the sentence is taken almost verbatim from the mentioned Drouet et al. (2015) it is both non-informative and substantively questionable. Please consider using the more instructive formulation, also to be found in Drouet et al.: "Based on knowledge from the Fifth Assessment Report, it was shown that the quadratic damage model, typically employed in most cost-benefit analysis of climate policy, fails entirely to capture significant fat-tailed impact events, even when considering the uncertainty in climate response."	Thank you for the reference.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
27079	72	37	72	40	Its great that you mention damage estimates using econometric methods. You should extend this discussion further with reference to this study. Huber V et al (2017) Cold-and heat-related mortality: a cautionary note on current damage functions with netbenefits from climate change. Clim Chang 142:407–418. <a href="https://doi.org/10.1007/s10584-017-1956-6">https://doi.org/10.1007/s10584-017-1956-6</a> This is an important study that finds that commonly used/cited damage functions are cold-biased. And inflate the impact of cold with respect to the heat. This major issue with the V-shaped relationship developed in Martens (1998) and utilised in Tol (2002) is that it has been found to be biased towards cold-related mortality and that this is likely to have led to bias towards finding a net reduction in mortality associated with climate change. Note that the damage function on Tol (2002) has been used widely.	Accepted.	Thomas Longden	Australian National University	Australia
27081	72	37	72	46	Also related to damage functions and the estimation of damages from increased heat-related mortality are recent findings that a well-cited publication in The Lancet (Gasparri et al. 2015) has been found to be biased towards cold-mortality. Also, some related assessments (using a U-shape) have found a net benefit from climate change due to reduced cold temperature deaths (these include Gasparri et al. 2017; Gosling et al. 2009a; Guo et al. 2016; Vicedo-Cabrera et al. 2018). Examples of locations where a net benefit from climate change coincided with cities and countries that are in temperate areas with warm summers include Melbourne (Guo et al. 2016) and Australia (Gasparri et al. 2017; Vicedo-Cabrera et al. 2018). But a recent study in Climatic Change finds that the majority of deaths related to temperature in Australia are caused by heat. It uses the same method, but national data and breaks it down into climate zones. This has significant consequences for damage functions that have been developed using U-shaped relationships that may be appropriate for temperate zones, but are not valid in warm climate zones. In these cases, a J-shape is probably appropriate. I encourage you to read: Longden, T. The impact of temperature on mortality across different climate zones. Climatic Change 157, 221–242 (2019). <a href="https://doi.org/10.1007/s10584-019-02519-1">https://doi.org/10.1007/s10584-019-02519-1</a>	Thank you for the reference. This topic is more directly a topic that will be assessed and synthesized in WGII. Here, a collaboration with WGII authors has been established to develop text on how damage estimates can be interpreted in the context of mitigation pathways.	Thomas Longden	Australian National University	Australia
10823	72	41	72	45	Please delete this part because the calculation is based on SSP 1 that never reflects current situation. Or if this part is to remain here, please cite other calculations of the same model (PAGE-ICE) that are based on other SSP scenarios.	Accepted. The paragraph has been rephrased to avoid confusion.	Mitsutune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
41251	72	43	72	46	What about discount rate here?	Accepted. The paragraph has been rephrased to avoid confusion.	Jan Fuglestedt	CICERO	Norway

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
17737	72	21	73	10	This subsection is important and should be placed in just after the title of section 3.6 (page 66), because section 3.6 should discuss Cost-Benefit Analysis (CBA) originally. Especially, what is written in line 22-26 in page 72 could affect all the contents in section 3.6.	Accepted.	Morimoto Soichi	The Institute of Energy Economics, Japan	Japan
47017	72	21	73	10	Comparing mitigation costs and benefits: the complexities in the CBA of climate action go far beyond what is captured in this short section. They are treated extensively in AR5 Ch3. Please refer to this, and summarize main elements as laid out there. These are in-principle issues that should not require reference to specific IAM models.	Thank you for the reference.	Frank Jotzo	ANU	Australia
18563	72	21	73	11	Whilst I sympathise with the thrust of this section on cost-benefit, I am not sure that many mainstream economists would recognise it as a balanced assessment of the economics literature. It does after all not even cite the Nobel Laureate in this area, Bill Nordhaus (including his book, Rolling the Dice). On assessing impacts, presumably one would want to check with WG2. However, I found the critique by Pezzey (2018). Why the social cost of carbon will always be disputed, WIRES climate change, <a href="https://doi.org/10.1002/wcc.558">https://doi.org/10.1002/wcc.558</a> , to be a good overview. However almost all this literature – and this section – focuses upon the damage assumptions. The central point of my own contribution to this debate is that assumptions around the structure and processes of mitigation costs are just as important, because with induced innovation, inertia and path dependence, early mitigation actions reduce the cost of future emission reductions (relative to ex-ante reference): this shows that even with the standard DICE damage assumptions, far stronger abatement is justified and c. 2 deg.C may be optimal: forthcoming (revised) for WIRES Climate Change, but available in working paper form as: Grubb M, and C.Wieners (2020), Modeling Myths: On the Need for Dynamic Realism in DICE and other Equilibrium Models of Global Climate Mitigation, Institute for New Economic Thinking, Working Paper No. 112. <a href="https://www.ineteconomics.org/research/research-papers/modeling-myths-on-the-need-for-dynamic-realism-in-dice-and-other-equilibrium-models-of-global-climate-mitigation">https://www.ineteconomics.org/research/research-papers/modeling-myths-on-the-need-for-dynamic-realism-in-dice-and-other-equilibrium-models-of-global-climate-mitigation</a> . Finally, the central point covered in many literatures, including the mainstream economics literature, emphasises that this is a problem of sequential decision-making under uncertainty. There is no single sensible long-run optimal trajectory – there are only sensible efforts now in the light of deep uncertainty and risk aversion, combined with inertia, induced innovation, path dependence.	Thank you for the reference. This topic is more directly a topic that will be assessed and synthesized in WGII. Here, a collaboration with WGII authors has been established to develop text on how damage estimates can be interpreted in the context of mitigation pathways.	Michael Grubb	UCL - Institute of Sustainable Resources	United Kingdom (of Great Britain and Northern Ireland)
35621	72	21			In AR5 Synthesis report it is clearly stated that "mitigation cost and climate damage estimates at any given temperature level cannot be compared to evaluate the costs and benefits of mitigation" and also "it is outside the scope of science to identify a single best climate change target and climate policy" (p.79). I think these are important statements and that they somehow are reflected here as well. Are they still valid (which I think), and how should that be reflected in the text in this chapter? If they are not valid, what are the new arguments?	Accepted. The paragraph is rephrased to avoid singling out one study, so does not apply.	Göran Finnveden	KTH Royal Institute of Technology	Sweden
35643	72	21			There are of course a lot of literature on this topic. There are for example some reviews that also draw some important conclusions that could be used here: Van den Bergh, J.C.J.M. and Botzen,W.J.W. (2015): Monetary valuation of the social cost of CO2 emissions: A critical survey. Ecological Economics, 114, 33-46; Isacs, L., Finnveden, G., Dahlöf, L., Håkansson, C., Petersson, L., Steen, B., Swanström, L. and Wikström, A. (2016): Choosing a monetary value of greenhouse gases in assessment tools. Journal of Cleaner Production, 127, 37-48; Bergh, J.C.J.M. and Botzen,W.J.W (2014): A lower bound to the social cost of CO2 emissions, Nature Climate Change, 4, 253-258; Howard and Sterner (2017): Few and not so far between: A meta-analysis of Climate Change estimates, Environmental and Resource Economics, 68, 197-225; Karlsson, Alfredsson, Westling (2020): Climate policy co-benefits: a review, Climate Policy, In press.	The paragraph is rephrased to avoid singling out one study, so does not apply. But you are right, the assumption on discount rate is important for results on optimal mitigation pathways.	Göran Finnveden	KTH Royal Institute of Technology	Sweden
18797	73	5	73	10	Estimates of the Social cost of Carbon are also substantially higher in models that allow for relative price change between sectors or differences in discount rate between sectors. See Sterner, T and Persson, M. (2008). "An Even Sterner Review": Introducing Relative Prices into the Discounting Debate, Review of Environmental Economics and Policy, 2(1).	Thank you for the reference. However, we focus on recent literature, since previous assessment so will not retain it. But we are using the related meta-analysis by Howard and Sterner.	thomas Sterner	Univ of Gothenburg	Sweden
10223	73	7	73	7	"...damage from climate change on growth" seems to be missing something, unclear.	corrected	Aglaia Obrekht	Environment and Climate Change Canada	Canada
35623	73	9	73	9	Tipping points are mentioned here. Maybe it could be expanded to also discuss what the implications of tipping points could be.	Noted. However space constraints do not allow to develop with great depth the topic. Tipping points are further addressed on WGI and WGII in terms of there likelihood and implications. Here, only the implication for mitigation is treated.	Göran Finnveden	KTH Royal Institute of Technology	Sweden
36057	73	13	73	13	long-term	Accepted	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
36555	73	13	73	29	Transformation of energy sector means economic and industrial restructuring, so it will have both winner and losers. Without the care of losers, restructuring will not go forward. This part is very important. As the reference, it is suggested to refer the analysis of "EU coal regions; opportunities and challenges ahead" too.	Accepted. Thank you for the additional reference, it is passed on to chapter 4 that has a dedicated section to the topic of just transition.	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
46467	73	13	73	29	The claims here about jobs is confusing. If it takes more jobs per energy then economic growth and welfare are harmed. The idea that job loss is "mitigated" by more labor-intensive energy is just wrong. The declining number of workers required for food and energy production, over time, thanks to the use of modern energy and machinery, increases productivity, grows the economy, and diversifies the workforce. Indeed, it is labor-efficiency, "job loss," that is responsible for much of our prosperity. This should be stated clearly. The authors appear to be advocating reductions in labor-productivity, and thus lower growth and welfare, and in a stealth way.	Thank you for your comment. It has been included in a discussion of macroeconomic assessment of mitigation pathways.	Michael Shellenberger	Environmental Progress	United States of America
46479	73	13	73	29	What about employment implications of transitions to a more labour intensive, lower fossil fuel agricultural system such as diverse farming systems, agroecology, organic agriculture, promotion of regional food systems? Recent review found that increased crop diversity is associated with higher levels of employment, see: Garibaldi, L. A., & Pérez-Méndez, N. (2019). Positive outcomes between crop diversity and agricultural employment worldwide. Ecological Economics, 164, 106358. <a href="https://doi.org/10.1016/j.ecolecon.2019.106358">https://doi.org/10.1016/j.ecolecon.2019.106358</a>	Thank you for the additional reference. It is not directly treated in this chapter. But chapter 7 on agriculture, forestry and other land uses.	Rachel Bezner Kerr	Cornell University	United States of America
5165	73	17	73	17	<a href="https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf">https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf</a> The European Commission analysis has some sections on just transition and contains an analysis of jobs at risk. This is contrasted with natural turnover due to retirements. After accounting for this, only the energy sector might be in need to actively reduce jobs beyond retirements. (Tables 17 and 18 of the link provided, however, this is not peer-reviewed literature)	Thank you for the reference.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
45417	73	30	73	35	The text points out that "limited evidence about quantifications of the net effect of mitigation on total employment at the global scale", but the section only includes results of one model and overlooks some of the evidence. For instance, Vandyck et al. (2016) (already referenced elsewhere in the same chapter) includes employment estimates by sector (and totals in the text).	Thank you for the reference.	Toon Vandyck	European Commission, Joint Research Centre	Spain
723	73	43	73	43	what are investment-related sectors?	This phrasing was unclear and has been removed.	Christa Clapp	CICERO	Norway
6149	73	12	74	10	The discussion about employment should be framed in the wider discussion about future jobs. References to the work of e.g. Aghion or Brynjolfsson should be included here. The ILO has interesting documents in this regard that should also be mentioned. Finally, there are very good reports on the just transition from IDDRI and IISD.	Thank you for the references. A broader context is now given to the discussion. The topic of just transition is treated in chapter 4, now referenced.	Linares Pedro	Universidad Pontificia Comillas	Spain
47019	73	13	74	10	The emphasis on employment effects is too strong. Employment is primarily a function of macroeconomics, not the microeconomic changes that arise from mitigation policy; and of overarching trends in technology (ie automation) that drown out any changes from mitigation policies. This notion should be prominently reflected in the employment discussion.	Accepted.	Frank Jotzo	ANU	Australia
27687	73	47	74	2	This sentence is unclear. The following sentence (p. 74 lines 2-5) would benefit from being reformulated.	Accepted.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
5167	73	30			Vandyck et al. 2016 (already referenced in this chapter) provides global employment numbers, however, only for 2030	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
1341	74	3	74	4	Fujimori et al.(under review) confirms same conclusion that employment is dependent on the carbon tax revenue recycle.		Shinichiro Fujimori	Kyoto University	Japan
					Shinichiro Fujimori, Tomoko Hasegawa, Kiyoshi Takahashi, Hancheng Dai, Jing-Yu Liu, Haruka Ohashi, Yang Xie, Yanxu Zhang, Tetsuya Matsui, Yasuaki Hijoka, Environmental Research Letters, under review.	Thank you for the reference.			
9153	74	5	74	6	"[In further elaboration of the chapter, the assessment of the literature on the change in the quality of jobs and skills would be pursued. References to be found]" needs considerations.	Accepted.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
9155	74	10	74	10	"[cross reference to be added to appropriate WGII chapter]" needs considerations.	Accepted.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
27689	74	14	74	18	"In the context of climate change mitigation, stranded assets are linked to unburnable fossil fuel reserves (McGlade and Ekins 2015; Jakob and Hilaire 2015; van der Ploeg and Rezaei 2018). They concern the fossil fuel reserves themselves, assets used to extract, transport, transform or distribute fossil fuel, as well as assets that use fossil fuels as inputs for production, or are otherwise energy- or carbon-intensive." è "In the context of climate change mitigation, assets at risk of being stranded are the fossil fuel reserves that may need to be left unexploited (McGlade and Ekins 2015; Jakob and Hilaire 2015; van der Ploeg and Rezaei 2018), the assets used to extract, transport, transform or distribute fossil fuel, and the assets that use fossil fuels as inputs for production or are otherwise energy- or carbon-intensive."	Accepted. Thank you.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
27691	74	18	74	21	"There is also some evidence that owners of financial assets could also be exposed to stranding risk because the valuations of coal, oil and gas companies could be overstated, particularly for undiversified companies with high capital exposure to carbon-intensive resources." è " There is evidence that the stranding of above assets may have important financial implications as it will severely affect the valuation (among others) of coal, oil and gas companies and of undiversified companies with high capital exposure to carbon-intensive resources."	The sentence has been cut from the second order draft.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
16561	74	41	74	42	You can't claim to know what "well below 2°C" means. See for details my previous comment on "well below 2°C".	Agreed. Reference to "well below 2°C" has been removed.	Andreas Fischlin	IPCC Vice-Chair WGII and ETH Zurich	Switzerland
725	74	12	75	28	this sub-section should be just a summary with a clear reference to Ch. 15 (see pgs. 66-72)which discusses stranded assets in more detail. Most of this material fits better and is covered already in Chapter 15 (such as financial instability) and Ch. 3 should just provide a short summary/referral here. The relevant parts to keep in Ch. 3 include the para on quantitative estimates in mitigation pathways which could also include a brief description of stranded assets, while the discussion on drivers, impacts e.g. potential financial instability, and information gaps related to stranded assets is elaborated in Ch. 15).	Accepted. Section reduced (and moved and merged within section 3.5). Reference added to chapter 15.	Christa Clapp	CICERO	Norway
47021	74	12	76	29	Transition and distribution: these topics are extensively covered in Ch13. The discussion will need to be closely integrated in future drafts. An important aspect that needs to be covered is the impact on regions and local communities, which is an important factor in the political economy of structural change.	Accepted. Reference to chapter 13 added.	Frank Jotzo	ANU	Australia
9721	75	6	75	11	What about GCC countries? What will be the impact of climate change policies on their economies?	The available analyses do not give results for this regional agregation.	Nathalie Hilmi	Centre Scientifique de Monaco	France
24933	75	8	75	9	Delete "(Bauer et al. 2016) ... carbon pricing," as this conclusion is not aligned with sustainable development in developing countries	In the revised section, this reference is not used.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
24935	75	13	75	15	Delete "The risk to transition ... (Kalkuhl et al. 2019)."	Accepted, because this topic relates more to chapter 15.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
16217	75	21	75	23	Consider changing "On the other hand, mitigation, by limiting climate change, reduces the risk of destroyed assets from the physical impacts of climate change from more frequent, intense or extended extreme events and from sea level rise." to "On the other hand, mitigation, by limiting climate change, reduces the risk of destroyed assets from the physical impacts of climate change from more frequent, intense or extended extreme events and from sea level rise or warfare driven by climate change." for clarity. Including the destruction of assets due to wars that are driven by climate change gives a more complete picture of foreseeable economic outcomes.	This is a topic for WGII. A reference to WGII chapter is given.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
27693	75	25	75	29	The sentence needs editing – in particular, model uncertainties cannot be the main driver of real phenomena.	Sentence was rephrased to avoid misunderstanding.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
702	75	31	75	45	This paragraph does well in discussing the impact of reducing global poverty on GHG emissions by raising incomes of the poor in developing countries (e.g. the cited work by Rao and Min, 2018b). In addition to poverty reduction, there should also be a reference to recent findings on the effect of inequality reduction in rich countries on emission levels. Key references in that area are the survey by Berthe & Elie (Ecological Economics, Vol. 116, 2016) and the quantification of the so-called "equity-pollution dilemma" by Sager (Energy Economics, Vol. 84, 2019). Sager (Energy Economics, Vol. 84, 2019) estimates that reducing income inequality in the United States would only raise consumption-based CO2 emissions slightly (+2.3% in CO2 emissions when moving to full income equality). This confirms the findings cited in the text for developing countries, but in a developed country context.	Accepted. Thank you for the additional references.	Lutz Sager	Georgetown University	United States of America
37933	75	38	76	3	Please clarify the distinctions between inequality and inequity, and the kind of policies needed to avoid higher emissions while supplying the conditions for equitable energy access and reducing incentives for high-emission energy consumption especially by the rich. Equality relates to distribution of income or wealth; equity relates to distribution of impacts, effects and opportunities.	Accepted. Reference to definitions in Glossary and in chapter 5 box 5.1 added.	Patricia Perkins	York University	Canada
5169	75	30			EMF36 is currently ongoing, also with a focus on this topic. A first draft paper should be available over the summer and submitted in time to be considered in AR6. You may wish to contact Chris Boehringer (Univ. Oldenburg) or Sonja Peterson (IFW Kiel)	Accepted. Contact has been taken with the EMF36 leaders.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
9157	76	3	76	3	"[cross reference to Chapter 13]" seems need to be reconsidered.	Accepted	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
24937	76	4	76	16	Analysis does not take into account other sustainable development issues, as for example reliability and affordability of different energy sources	The space available for this section does not allow to develop. But other sustainable development issues are treated in section 3.7 of this chapter, as well a in chapter 4 and chapter 17 in particular.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
37935	76	17	76	22	Chapter 5 also addresses the relationship between inequity and mitigation.	Accepted. Reference to chapter 5 added.	Patricia Perkins	York University	Canada
9159	76	21	76	22	"[Placeholder for FOD. To be developed with reference to WGII chapters assessments]" needs considerations.	Accepted.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
9161	76	28	76	29	"[To be developed with further references]" needs considerations.	Accepted.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
13465	76	41	76	43	The cited paper considers the health co-benefits and aerosol-induced climate co-harms.	Thank you for pointing to this. It is now explicitly said in the text.	Sophie Szopa	Commissariat à l'Energie Atomique et aux Energies Alternatives	France
13467	76	41	76	43	The assertion "may be consistent with a target of 2 °C or lower" is a little bit confusing as it's not for the optimized case shown in figure 1. It's only the case when changing the hypothesis (such as the life-year monetization).	This assertion has been removed.	Sophie Szopa	Commissariat à l'Energie Atomique et aux Energies Alternatives	France
13469	76	41	76	43	Could you make clear that this scenario is not an SSP scenario? One difficulty is to navigate in the "zoo" of scenarios and thus each mention to a scenario from the literature should be contextualized compared with the SSP (at least in term of hypothesis).	Agreed it is difficult to navigate the large number of scenarios and assumptions. This specific article is not using the SSP framework, and it is beyond the possibilities of the chapter to contextualize all articles mentioned in the SSP framework.	Sophie Szopa	Commissariat à l'Energie Atomique et aux Energies Alternatives	France

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46721	76	30	77	13	Section 3.6.4 is very thin and far from an "assessment" of the "literature" as promised in 3.6. (page 66, line 26-28). A recent reference is Karlsson et al. (2020), which can be inserted as a reference on p 76 line 34, and which can be summarised (e.g. the substance in the key policy insights) in the end of 3.6.4. Furthermore, the Figure 1 in Karlsson et al. (2020) can be included in the chapter in order to provide an overview of potential co-benefits.	Thank you for pointing to the systematic review reference, which is very useful. The section has been revised to provide an assessment.	Mikael Karlsson	KTH Royal Institute of Technology	Sweden
13471	76	45	77	2	Number cited in the sentence not found in the reference McColllum et al. 2018a	In revised text, the numbers of this specific publication are not given, but the main message in terms of order of magnitude in increased costs/investments is kept.	Sophie Szopa	Commissariat à l'Energie Atomique et aux Energies Alternatives	France
5171	76	4			There is more literature on this, however, often not on a global scale. E.g. <a href="https://doi.org/10.1016/j.eneco.2011.07.023">https://doi.org/10.1016/j.eneco.2011.07.023</a> for the USA	Thank you for pointing to this reference. The literature on co-benefits at the national scale is treated in chapter 4.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
9381	76	40			too general sentence needs to be better motivated or referenced. "Global health benefits from climate policy could reach trillions of dollars annually, but will importantly depend on the air quality policies that nations adopt independently of climate change"	Sentence deleted.	ANNA LAURA PISELLO	DEPARTMENT OF ENGINEERING - UNIVERSITY OF PERUGIA, ITALY	Italy
39699	77	3	77	5	The statement that "Food security support through [...] bioenergy tax [...] can shield..." is not substantiated by any reference. There is much literature actually giving evidence of the opposite effects: Sustainable bioenergy could improve food security, see e.g. Muscat, Abigail et al. (2019) The battle for biomass: A systematic review of food-feed-fuel competition. Global Food Security (in press) <a href="https://doi.org/10.1016/j.gfs.2019.100330">https://doi.org/10.1016/j.gfs.2019.100330</a> ; Henry, Roslyn et al. (2018) Food supply and bioenergy production within the global cropland planetary boundary. PLoS ONE 13 (3):e0194695 <a href="https://doi.org/10.1371/journal.pone.0194695">https://doi.org/10.1371/journal.pone.0194695</a> ; FAO (2017) Sustainable woodfuel for food security - A smart choice: green, renewable and affordable. Food and Agriculture Organization of the United Nations Working Paper. Rome <a href="http://www.fao.org/3/a-i7917e.pdf">http://www.fao.org/3/a-i7917e.pdf</a> ; FAO & EBRD (2017) BEFS Assessment for Turkey - Sustainable bioenergy options from crop and livestock residues. Food and Agriculture Organization of the United Nations & European Bank for Reconstruction and Development. Rome <a href="http://www.fao.org/3/a-i6480e.pdf">http://www.fao.org/3/a-i6480e.pdf</a> ; Kline, Keith et al. (2017) Reconciling food security and bioenergy: priorities for action. GCB Bioenergy 9: 557-576; IFPRI (2015) Workshop on Biofuels and Food Security Interactions - Report of the Scientific Committee 19-20 November 2014. International Food Policy Research Institute. Washington, DC <a href="http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/129175/filename/129386.pdf">http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/129175/filename/129386.pdf</a> ; Maltoglou, Irini et al. (2015) Combining bioenergy and food security: An approach and rapid appraisal to guide bioenergy policy formulation. Biomass and Bioenergy 79: 80-95; Osseweijer, Patricia et al. (2015) Bioenergy and Food Security. In: Souza, Gláucia Mendes et al. (eds.) Bioenergy & Sustainability: Bridging the Gaps. SCOPE report. Sao Paulo: 90-136 <a href="http://bioenfapesp.org/scopebioenergy/images/chapters/bioenergy_sustainability_scope.pdf">http://bioenfapesp.org/scopebioenergy/images/chapters/bioenergy_sustainability_scope.pdf</a>	Thank you for pointing to this topic, and for suggesting references. The statement you mention has been removed from the section, as it referred to a single article. The topic of bioenergy itself is treated in detail in other parts of the chapter (section 3.4 on sectoral aspects of pathways and section 3.7 on sustainable development), as well as in chapter 7.	Uwe Fritsche	IINAS	Germany
27695	77	7	77	8	Does "additional" mean here "increase in"? How is welfare measured? In terms of GDP?	Yes, this means increase in: it has been clarified in revised version of the text. The mention to welfare in this part has been deleted.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
11419	77	32	77	35	Check whether these studies contribute evidence: Pedercini, M., Arquitt, S., Collste, D. and Herren, H. (2019) Harvesting synergy from sustainable development goal interactions. Proceedings of the National Academy of Sciences, 116(46), 23021-23028. <a href="https://doi.org/10.1073/pnas.1817276116">https://doi.org/10.1073/pnas.1817276116</a> Allen, C., Metternicht, G., Wiedmann, T. and Pedercini, M. (2019) Greater gains for Australia by tackling all SDGs but the last steps will be the most challenging. Nature Sustainability, 2(11), 1041-1050. <a href="https://www.nature.com/articles/s41893-019-0409-9">https://www.nature.com/articles/s41893-019-0409-9</a>	Noted. We are selecting references based not only on topic but on timespan, with a priority for timespans beyond 2050. We will take into account this literature on modelling synergies.	Thomas Wiedmann	UNSW	Australia
35625	77	32	77	35	The paper by Fuso-Nerini et al (2019): Connecting climate action with other sustainable development goals, Nature Sustainability,2, 674-680 could be usefull here.	Accepted. Fuso-Nerini is already cited in our chapter, but should be mentioned at the start.	Göran Finnveden	KTH Royal Institute of Technology	Sweden
19335	78	1	78	1	These figures are very much biased towards mitigation scenario suggesting that mitigation provides better solution in every aspect, which is not at all consistent with the executive summary (page 7) touching on trade-off and co-benefit. For example, population of poverty (SDG1, the most important goal) and energy cost (SDG7) for mitigation and reference scenario should also be presented, if they are not intentionally hidden. It is not convincing at all that unemployment rate is lower and there is no impact on GDP under mitigation scenarios. It is inconsistent with Figure 4.6 that shows many studies suggest negative impact of mitigation policies on GDP.	Noted. The reviewer misunderstood. This figure does not say that mitigation is good for all aspects. For example, price of agricultural commodities rise in mitigation. Poverty are not available for now but will be added when it becomes available. Energy costs are not included because it is not in SDG targets.	Sumie Nakayama	Tokyo Institute of Technology	Japan
19337	78	1	78	1	The source of figures and conditions of mitigation and reference scenario should be annotated, to show how these comparisons have made and what mitigation scenario is (1.5 degree scenario or 2.0 degree scenario?).	Accepted. Source of figure and conditions of mitigation have been added. Figure is updated with more mitigation scenarios. We added to figure caption "Purple line represents the baseline and red, blue, green and orange do mitigation scenarios (2.5C, 2C, wel-below 2 degree C (WB2C) and 1.5C), respectively."	Sumie Nakayama	Tokyo Institute of Technology	Japan
39823	78	1	78	3	Figure 3.42 is a nice graph showing the effects of mitigation policy in different sectors, but almost no explanations are given in the caption or in the text, which debases the value of this figure. Please provide sufficient details for readers to understand what is presented here and in the text.	Accepted. We added to the figure caption "Purple line represents the baseline and red, blue, green and orange do mitigation scenarios (2.5C, 2C, wel-below 2 degree C (WB2C) and 1.5C), respectively. In all climate change mitigation scenarios, carbon pricing starts from the year 2020 with a global universal carbon price. Carbon price on the agricultural sector was capped at \$100/tCO2 to avoid excessive negative side effects. The global mean temperature increases in 2100 compared with the pre-industrial level of around 1.5, 1.7, 2.0 and 2.5 °C at the end of the century, while the baseline scenario increases by over 3.5°C. SSP2 (Shared Socioeconomic Pathways) was utilised for the background socioeconomic assumptions. For the near-term, we utilised the most recent energy information available and, consequently, the model results mostly follow the IEA Energy Balance Table until 2015. "	Hasegawa Toshihiro	National Agricultural and Food Research Organization	Japan

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47741	78	13	78	23	Three comments on this section describing climate impacts on agriculture. - WGI CH12 has a section focused on establishing a connection of ~30 climatic impact drivers on crop yields, livestock, and fisheries. Some connections are stronger than others, but this framework would expand the discussion beyond the temperature, precipitation, and CO2 listed here. WGI also has an increased emphasis on climate information for regional impact and risk analysis; it may be useful to include this more local perspective in terms of understanding the benefits of mitigation (not just global systems) - There is a large amount of literature cited in WGII CH5 on climate change impacts on different aspects of the food system, as well as the Special Report on Climate Change and Land (SRCLL) Food Chapter. - ISIMIP and AgMIP are working together to make new projections of crop yield impacts for AR6 (papers expected to be submitted before WGIII deadline)	Partially accepted. For the first, point, this chapter is about global perspective. Local stories on agriculture should be in Chapter 7. For second, we refer it. For the third, if it is available, then it will be included.	Alex Ruane	NASA Goddard Institute for Space Studies	United States of America
39819	78	16	78	19	I do not understand what this sentence means. Please specify what "these effects" and why yields are projected to increase in the absence of climate change.	Accepted: 'These effects' were revised as 'the decrease in nutrition'.	Hasegawa Toshihiro	National Agricultural and Food Research Organization	Japan
27697	78	17	78	17	Using minus signs, e.g. (- 6+/-2.9%) instead of (6+/-2.9%) may be clearer.	Accepted. We removed this part.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
39825	78	18	78	19	"Due to unequal geographic distribution" of what? Please specify.	Accepted We removed this part.	Hasegawa Toshihiro	National Agricultural and Food Research Organization	Japan
41255	78	9	79	8	Clearer references to SRCLL would be useful - both for similar findings and if contrasting findings. And more assessment, not only description.	Accepted. SRCLL has been referred.	Jan Fuglestedt	CICERO	Norway
46635	78	10	79	8	The whole section needs to be harmonized the next section (3.7.1.2), as all benefits seems to rely on the impact of mitigation measure as well, and the capability to "limit the impact of mitigation measure" which requires large land surfaces (beccs and afforestation).	Accepted. We rewrite the part in more harmonization with next section.	Florian Leblanc	Centre International de Recherche sur l'Environnement et le Développement	France
39821	78	9	80	3	Conflicts between land use for mitigation and biofuel are desirably discussed here.	Accepted. We added discussion on competition for land between food and bioenergy here as "Less competition for land and meeting bioenergy demands with reconciling food and biodiversity would require major change in the supply- and demand-side of the food system or advancing biotechnologies such as agricultural intensification, open trade, less meat consumption and reduced food loss (Henry et al. 2018 Pros One, Wu et al., 2018 GCBB) . Careful selection of bioenergy feedstocks and resources is also expected to reduce such effect. E.g. wood-based bioenergy is less competitive with food supply (FAO, 2017)."	Hasegawa Toshihiro	National Agricultural and Food Research Organization	Japan
27699	79	1	79	2	I cannot understand the sentence	Accepted: This sentence was revised as 'Reducing climate change from RCP8.5 levels to RCP2.6 levels can reduce the impacts of climate change including extreme climates on food consumption and risk of hunger and adaptation measures are expected to significantly lower the risk of hunger resulting from climate change (Hasegawa et al. 2014).'	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
41253	79	6	79	7	I think this conclusion could be elaborated a bit	Accepted: The conclusion was elaborated by adding 'However, reducing climate change, if the measures are not properly implemented, may increase risk of food insecurity (see 3.2.1.2).'	Jan Fuglestedt	CICERO	Norway
12413	79	8	79	8	How is "business as usual" defined here?	Accepted: We delete it.	Jarmo Kikstra	International Institute for Applied Systems Analysis	Austria
46481	79	14	79	22	What about impacts for smallholder farmers if they lose access to land through mitigation policies? Smallholder producers are already disadvantaged in many global and national policies, and make up a considerable proportion of the global food insecure population. Investment in smallholders has multiple benefits see for example HLPE, 2013: Investing in smallholder agriculture for food security. In: Fao, Rome, Italy, while contributing substantially to food production, particularly more diverse nutritional food sources. Ricciardi, V. et al., 2018: How much of the world's food do smallholders produce? Global Food Security, 17, 64-72, doi:10.1016/j.gfs.2018.05.002. Smallholders are a vulnerable group that is at higher risk from mitigation policies because politically they often have less power than large landholders or other groups. Indigenous people are also at risk, (and sometimes these categories overlap) as those who are more likely to live in tropical forest regions, and are at risk of land loss for which they rely on for food and livelihoods. See: Corbera, E., Costedoat, S., Ezzine-de-Blas, D. and Van Hecken, G. (2020), Troubled Encounters: Payments for Ecosystem Services in Chiapas, Mexico. Development and Change, 51: 167-195. doi:10.1111/dech.12540	Rejected: This topic should be more suitable for Chapter 7.	Rachel Bezner Kerr	Cornell University	United States of America
46633	79	19	79	19	Not only biofuels (all type of bioenergy and afforestation).	Accepted: Bioenergy and afforestation has been added.	Florian Leblanc	Centre International de Recherche sur l'Environnement et le Développement	France
27701	79	25	79	27	Please check the formulation	Accepted: The sentence was revised as 'Recent studies (Hasegawa et al. 2015a; Fujimori et al. 2019; Hasegawa et al. 2018a) show that climate change mitigation aimed at achieving stringent climate goals, if not managed properly, could negatively affect food security.'	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
36061	79	30	79	30	long-term	Accepted: Revised as suggested.	Sandrine Selosse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France



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15763	79	32	79	35	Fanzo, J., Davis, C. Can Diets Be Healthy, Sustainable, and Equitable?. <i>Curr Obes Rep</i> 8, 495–503 (2019). <a href="https://doi.org/10.1007/s13679-019-00362-0">https://doi.org/10.1007/s13679-019-00362-0</a> conclude that "There is not one simple solution that will automatically shift diets towards those that are healthier, more environmentally sustainable, and more equitable at the national or global scale. Rather, a range of different strategies and interventions will be necessary." And "Environmental outcomes and nutritional needs are highly context specific; replacing animal-source foods with plant-based alternatives may be more feasible in high- and middle-income countries" So a one size fits all diet recommendation might not be good for all people. Furthermore, there are some doubts about the EAT Lancet paper expressed here: Francisco J Zagmutt, Jane G Poulou, Solenne Costard, The EAT-Lancet Commission's Dietary Composition May Not Prevent Noncommunicable Disease Mortality, <i>The Journal of Nutrition</i> , , nxa020, <a href="https://doi.org/10.1093/jn/nxaa020">https://doi.org/10.1093/jn/nxaa020</a> which states: "The report did not meet standards for transparency and replicability, nor did it fully account for statistical uncertainty. Our attempt to replicate the mortality calculations for the United States revealed flaws in the assumptions and methods used to estimate the avoided mortalities. After correcting some calculation errors and fully accounting for uncertainty in the avoided mortalities, the mortality reduction effect of the EAT-Lancet proposed diet in the USA is no greater than the impact of energy consumption changes that would prevent under-weight, over-weight, and obesity alone. As our findings call into question the global conclusions of the EAT-Lancet report, further independent validation is needed before it can be used to inform dietary guidelines." I think that these critics to the EAT Lancet diet with almost no protein should be taken into account by IPCC	Noted. EAT-Lancet paper is not referred in this part. We did not say dietary shift is a simple and single solution. We added other strategies to reduce trade-offs, e.g. agricultural intensification, and added "There is not one single solution that will meet climate mitigation and food security. Rather, a range of different strategies and interventions will be necessary. They are supposed to be implemented jointly in order to deliver a more sustainable food and land future."	EDUARDO PEDRO FRACASSI	ITBA Instituto Tecnológico de Buenos Aires	Argentina
17233	80	1	80	3	In the third panel, no 1.5° pathways are shown. Does this mean that there is no population at risk of hunger in these pathways, or has this not been assessed? Please revise the figure and add an explanation.	Accepted. There is numbers in 1.5C. We revised the fig to include 1.5C.	Joachim Rock	Thuenen-Institute of Forest Ecosystems	Germany
39827	80	1	80	3	Figure 3.34 needs more explanations for readers to understand what is presented. I could not find any texts referring to this figure.	Accepted: The following explanation has been added. "Panels show (a) food demand, (b) food price, (c) population at risk of hunger. All the scenarios are from AR6 scenario database. Socioeconomic assumptions are different on the scenario study. Please see section 3.2. for scenario categorization."	Hasegawa Toshihiro	National Agricultural and Food Research Organization	Japan
10127	80	2	80	3	Figure 3.43 shows that there is more hunger in mitigation scenarios vs. baseline cases - this is confusion because isn't it at odds with the previous section on impacts on food security from warmer temperatures?	Accepted: To avoid such confusion, we harmonized these two sections and added "However, reducing climate change, if the measures are not properly implemented, may increase risk of food insecurity (see 3.2.1.2)." at last of the previous section.	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
1437	80	18	80	21	In a review paper on water scarcity (Liu et al., 2017), we also pointed out that water scarcity results are very uncertain due to selection of climate models, hydrological models, different scenarios, different study periods. In mean while, this review also pointed out that many studies focus on water quantity-induced water scarcity, but still very few are working on water-quality induced water scarcity. Given that the impacts of climate change on water quality is not clear, the impacts on quality-induced water scarcity are also not yet clear. I recommend the quantity- and quality-induced water scarcity is mentioned here. Liu J., Yang H., Gosling, S. N., Kumm, M., Flörke, M., Pfister, M., Hanasaki, N., Wada, Y., Zhang, X., Zheng, Y., Alcamo, J., Oki, T., 2017. Water scarcity assessments in the past, present, and future. <i>Earth's Future</i> 5: 545-559.	Accepted. We have added this citation and included a brief discussion of water quality.	JUNGUO LIU	Southern University of Science and Technology	China
27885	80		81		This section focuses on water scarcity. Could it be balanced with some discussion of flooding?	Accepted. We have added a brief discussion on flooding.	Jenkins Rhosanna	University of East Anglia	United Kingdom (of Great Britain and Northern Ireland)
41957	80	5			The consequences on human health, because of the increase of waterborne diseases are of paramount importance and should be indicated here together with clean water and sanitation	Noted. We agree that these are important issues, but have opted to keep this discussion in the health subsection.	Francisco Javier Hurtado Albir	European Patent Office	Germany
36063	81	2	81	4	Additional reference on water/energy issues: Nadia Maïzi, Stéphanie Bouckaert, Edj Assoumou. Long-Term Water and Energy Issues in European Power Systems. <i>Jadwiga Ziolkowska &amp; Jeffrey Peterson. Competition for Water Resources: Experiences and Management Approaches in the US and Europe, Elsevier, 233-251 - Chapter 2.2.7, 2016, 978-0-12-803237-4.</i>	Accepted	Sandrine Sellose	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
30891	81	9	81	24	It would be helpful to explain a bit more what the differences and trade-offs between consumption and withdrawal are. In addition, CCS systems do not necessarily have to increase water usage, see IEAGHG report 2010/05 "Evaluation and Analysis of Water Usage of Power Plants with CO2 Capture" and Magneschi et al. "The Impact of CO2 Capture on Water Requirements of Power Plants", <i>GHGT-13, Energy Procedia</i> 114 (2017) 6333-6347.	Accepted	Jasmin Kemper	IEA Greenhouse Gas R&D Programme (IEAGHG)	United Kingdom (of Great Britain and Northern Ireland)
15765	81	16	81	18	Dietary changes should be towards healthy diets. Recently WHO retired their support to the EAT Lancet diet, low in proteins, based on health issues and other reasons. For example: British Medical Journal BMJ reports WHO withdraw support for the "Planetary Diet" <a href="https://www.bmj.com/content/365/bmj.11700">https://www.bmj.com/content/365/bmj.11700</a> , so there seems to be some discussion on whether such a diet would be applicable to all the world's population and whether it is indeed healthy. I checked the WHO recommended diet at <a href="https://www.who.int/en/news-room/factsheets/detail/healthy-diet">https://www.who.int/en/news-room/factsheets/detail/healthy-diet</a> and there is no reference on recommended protein or carbohydrate intake. There are other critics who state that the "EAT Lancet report not backed by rigorous science: <a href="https://www.nutritioncoalition.us/news/eatlancet-report-one-sided">https://www.nutritioncoalition.us/news/eatlancet-report-one-sided</a> The US Dietary Guidelines, one key pillar of the EAT Lancet report, is also questioned: <a href="https://www.nutritioncoalition.us/there-is-concern-about-the-dietary-guidelines">https://www.nutritioncoalition.us/there-is-concern-about-the-dietary-guidelines</a> Moreover the EAT Lancet Planetary diet might not be affordable to an important part of poor people in sub-Saharan Africa, parts of Asia and South America <a href="https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(19)30447-4/fulltext">https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(19)30447-4/fulltext</a>	Rejected. This sentence is describing links between diet and water use. Discussions of what diet is recommended is outside the scope of this subsection.	EDUARDO PEDRO FRACASSI	ITBA Instituto Tecnológico de Buenos Aires	Argentina
6539	81	31			Increase figure size, or font size of legend	Accepted. Will be done.	Maria E. Mondejar	Technical University of Denmark	Sweden
4671	82	3	82	14	Whilst detailing the energy risks related to temperature, precipitation and cloudiness, you don't provide similar details for windness (which nevertheless you cite as a risk in line 6). Is it due to lack of literature? If not, I strongly suggest you to give additional details to the issue as it has been already registering some significant impacts (i.e.: the reduced efficiency from UK offshore wind energy capacity compared to expectations and forecasts made before the installation of the most recent offshore wind power plants in the country).	Noted. It is already addressed.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
39207	82	3	82	42	The title is not consistent with the contents. While the title is about benefits, the contents are about the impacts of climate change.	Noted. The title intends to highlight the benefits of avoided impacts across the subsections.	Diego Silva Herran	National Institute for Environmental Studies	Japan
34067	82	4	82	9	It could be added that climate change also alters the production of energy through potential threat to coastal facilities (Brown, 2020 <a href="https://climatenewsnetwork.net/speeding-sea-level-rise-threatens-nuclear-plants/">https://climatenewsnetwork.net/speeding-sea-level-rise-threatens-nuclear-plants/</a> ) or the IAEA report on this topic	Accepted but referencing peer-reviewed article Brown, S., Hanson, S., & Nicholls, R. J. (2014). Implications of sea-level rise and extreme events around Europe: a review of coastal energy infrastructure. <i>Climatic change</i> , 122(1-2), 81-95.	Antoine BONDUELLE	Climate Action Network France	France
35365	82	4	82	9	It could be added that climate change also alters the production of energy through potential threat to coastal facilities (Brown, 2020 <a href="https://climatenewsnetwork.net/speeding-sea-level-rise-threatens-nuclear-plants/">https://climatenewsnetwork.net/speeding-sea-level-rise-threatens-nuclear-plants/</a> )	Accepted. Thanks a lot for pointing this out and providing the reference.	Charlotte MIJEON	Réseau "Sortir du nucléaire" - member of the French Réseau Action Climat	France
45141	82	32	82	32	The references for the statement "a number of studies have focused on the water-energy-food nexus at global and regional scales" can be expanded to include the "Nexus City: Operationalizing the urban Water-Energy-Food Nexus for climate change adaptation in Munich, Germany" from 2017 < <a href="https://doi.org/10.1016/j.uclim.2016.11.004">https://doi.org/10.1016/j.uclim.2016.11.004</a> > and others.	Noted. We are limited in the specific references we can consider. This very interesting paper would fit better under chapter 8.	Siir Kilikis	The Scientific and Technological Research Council of Turkey	Turkey
12415	82	44	82	44	Is the word "abundance" here required - according to the literature?	If there is access to reliable, affordable and clean energy - which is not adequate, it won't help. So the "abundance or adequacy" is an underlying assumption..	Jarmo Kikstra	International Institute for Applied Systems Analysis	Austria
19339	82	1	83	16	Description of 3.7.3 is not balanced strongly focusing on "benefits of avoided climate impacts along mitigation pathways" on one hand while presenting limited reference to trade-off. The last paragraph of 3.7.3 should further be elaborated.	Noted. That paragraph has been modified.	Sumie Nakayama	Tokyo Institute of Technology	Japan

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
20603	82	1	83	16	Please note the forthcoming paper by Gernaat et al. which investigates the climate impacts on renewable energy supply and how this may affect mitigation strategies of different regions. The analysis uses harmonised maps of climate impacts from the ISIMIP project, as well as statially explicit and biophysical representation of renewable energy supply.  Reference: Gernaat et al. "Climate impacts on renewable energy supply" (under review for publication in Nature Climate Change)	Noted. When the paper is published, we will consider it.	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
39209	82	3	83	16	This section should mention studies on the implications of mitigation pathways on energy access in terms of substitution of traditional biomass in addition to electrification.	Accepted. We have made more mention of clean cooking fuel studies.	Diego Silva Herran	National Institute for Environmental Studies	Japan
24939	82		83		Section 3.7.3 should also consider reliability issues related to energy access	Accepted. The literature on system suitability of energy will be considered.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
16219	82	1			In Section 3.7.3 Energy, consider adding a description of the risk of nuclear arms proliferation arising from new countries acquiring nuclear power technology, and perhaps using this for developing arms. For example, Saudi Arabia has just made an agreement with South Korea to develop nuclear power in the kingdom, and a nuclear fuel enrichment facility is being built there. The Non-Proliferation Treaty was not designed with climate change in mind, and some 30 new countries are aiming for nuclear power. Risk comes from access to knowledge and technology, as well as from increases in mining, refining and transportation of nuclear materials. Likewise, the rare-earth elements (REEs) used in, e.g. wind power generation magnets, increases the production of uranium(which is a REE) and other fissile materials as these are all found together in nature. A new international framework is warranted that addresses the risk of nuclear arms from nuclear power increases to address climate change. Nuclear holocaust poses an existential threat equal to that posed by climate change.	Noted. We agree that these are important issues, but will need references supporting such speculations.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
6541	82	7			Increases in temperature reduce efficiencies of thermal power plants (e.g., fossil fuel and nuclear plants, concentrated solar plants, geothermal plants)	Accepted, however it is already mentioned.	Maria E. Mondejar	Technical University of Denmark	Sweden
6543	82	28			It is anticipated that climate change will alter water supply and water temperature, which may reduce conversion efficiencies and increase the (vulnerability to water shortage may be caused by lack of water supply, but cannot see direct link with water temperature)thermoelectric plants' vulnerability to water shortage	Accepted, however it is already mentioned.	Maria E. Mondejar	Technical University of Denmark	Sweden
10071	82	42			Also needs to be mentioned that climate change may affect production of food by crops, thus affecting as well the production of biofuels. <a href="https://doi.org/10.1088/1748-9326/2/1/011002">https://doi.org/10.1088/1748-9326/2/1/011002</a>	Noted. We are focusing on literature since AR5, and this study is from 2007, so more than 10 years old. We reference many studies considering crop yields being affected by climate.	Maria E. Mondejar	Technical University of Denmark	Sweden
12417	83	6	83	8	The LED scenario is a good addition to this section, but I think the section could be improved if the role of the LED scenario/the relation to the rest of this section is explained.	Accepted. The link to demand considerations has been rephrased.	Jarmo Kikstra	International Institute for Applied Systems Analysis	Austria
24941	83	12	83	12	Replace "cannot" with "can"	Accepted. Thanks a lot for pointing out this gross error.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
24943	83	13	83	14	Delete ", minimizing potential ... renewables." as transition pathways should consider all options including energy efficiency improvement	Partially accepted. We have added mention of efficiency improvements.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
13473	83	45	83	47	Orru et al. 2017 is not "a systematic review of air pollution studies relevant to climate change", it's a review of studies having also include a quantification of health impacts. WG1 chapter 6 concludes that climate change has a weak effect on PM and that the effect on ozone depends on the region. A discussion of the benefits on SLCF emissions induced by climate mitigation versus air pollution control in SSP scenario would be more helpful here and the impact on health can be discussed based on Rao et al. Global Environmental change 2017 (by comparing results from the same scenario but different climate mitigation only).	Accepted. We will take into closer account the findings of WG1 chapter 6 and also Rao et al 2017.	Sophie Szopa	Commissariat à l'Energie Atomique et aux Energies Alternatives	France
13503	83	45	84	2	Elements about the climate impact on air pollution will be discussed in WG1 chapter 6 and 12 and WG2. Anyway the driver of air pollution is the emission trajectory rather than climate and, in the emission trajectories the level of air pollution control is often the more important than the climate mitigation level. It should be explained (see Rao et al. 2017)	Noted. Since WG3 focuses on mitigation, which is most relevant to emission trajectories, it is relevant to discuss air pollution implications of these emission trajectories.	Sophie Szopa	Commissariat à l'Energie Atomique et aux Energies Alternatives	France
25833	83	45	84	2	There's a lot more that can go in here. Listing the health effects associated with air pollution can be a good start, and there was a recent review article that might be a good place to start. Manisalidis, Ioannis, Elisavet Stavropoulou, Agathangelos Stavropoulos, and Eugenia Bezirtzoglou. "Environmental and Health Impacts of Air Pollution: A Review." <i>Frontiers in Public Health</i> 8 (February 20, 2020): 14. <a href="https://doi.org/10.3389/fpubh.2020.00014">https://doi.org/10.3389/fpubh.2020.00014</a> .	Rejected. We have to keep the focus on the chapter's time frame, which is long term. This article is a review of current evidence.	Jonathan Buonocore	Harvard University	United States of America
46723	83	45	84	2	The paragraph on air pollutants is very short and besides adding conclusions from Karlsson et al. (2020), for example the summarising Table 4 ("Monetary estimates of air quality co-benefits in a single, comparable, metric."), conclusions from the following study are key to highlight: Markandya, A., Sampedro, J., Smith, S. J., Van Dingenen, R., Pizarro-Irizar, C., Arto, I., & González-Eguino, M. (2018). Health co-benefits from air pollution and mitigation costs of the Paris agreement: A modelling study. <i>The Lancet Planetary Health</i> , 2(3), e126–e133. doi:10.1016/S2542-5196(18)30029-9	Accepted. We will take into account Karlsson <a href="https://www.tandfonline.com/doi/full/10.1080/14693062.2020.1724070">https://www.tandfonline.com/doi/full/10.1080/14693062.2020.1724070</a> and Markandya et al. 2018	Mikael Karlsson	KTH Royal Institute of Technology	Sweden
41961	83	23			Add reference landslide or mudflow after "floods"	Accepted.	Francisco Javier Hurtado Albir	European Patent Office	Germany
4673	84	2	84	2	Typo: "is thus has significant" to be changed with "thus has significan".	Accepted.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
4675	84	12	84	13	Typo: "The ever in increasing droughts" to be changed with "The ever increasing droughts".	Accepted.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
4677	84	22	84	40	These paragraphs of section 3.7.4.1 appear badly written and require editorial review.	Accepted. Writing will be revised.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
36065	84	23	84	23	"affect" instead of "effect"	Accepted.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
9163	84	42	84	44	"[Missing, to be included in SOD: summary of projections in recent literature regarding time implications of mitigation efforts for each of the categories of health effects in section 3.7.4.1, as well as a summary paragraph]" needs considerations.	Taken into consideration.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
41959	84	21			Add "Climate change eases the penetration of invasive species or the alteration of local ecosystems what can compromise food security by negatively affecting crops or livestock. Also a raise in temperatures can, apart of altering the yield of crops, and affect fisheries or livestock, can jeopardize the storage and conservation of food".	Taken into consideration. We cannot just add text without references to evidence the points being made, but we will make an effort to look for such references.	Francisco Javier Hurtado Albir	European Patent Office	Germany
36067	85	3	85	3	"Air pollution": underline, as in the previous section?	Accepted.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
13475	85	3	85	14	It's important to specify that air pollution mitigation is driven independently. The benefit of climate mitigation vs air pollution control is discussed in Rao et al. 2017 and should be reminded here.	Partially accepted. We will reference Rao et al 2017, but we must reflect other literature as well.	Sophie Szopa	Commissariat à l'Energie Atomique et aux Energies Alternatives	France
36069	85	7	85	8	near- and long-term	Accepted.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
36071	85	15	85	16	reduce the font size of the text underneath graphics and remove the reference to the footnote (25)	Accepted: figure will be removed.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
9165	85	16	85	16	The figure needs a better quality.	Accepted: figure will be removed.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
9167	85	16	85	16	The caption of the figure needs to be written under it not the picture as it is now. And the font is very large!	Accepted: figure will be removed.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
4679	85	20	85	20	Typo: "estimate that" to be changed with "estimate".	Accepted	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
9169	86	5	86	5	"[Section in progress: will be focused on studies of projections of biodiversity along pathways in SOD]" needs considerations.	Noted. We will take this points into consideration for the SOD	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
17235	86	6	86	10	Here, the impact of mitigation strategies that employ CDR which leads to land use change and / or increases in the demand for biomass for energy can negatively impact biodiversity. This has been broadly studied and should be reflected in the introduction, too,	Noted with thanks. As indicated, this section is currently in progress: will be focused on studies of projections of biodiversity along pathways in SOD	Joachim Rock	Thuener-Institute of Forest Ecosystems	Germany
36073	86	17	86	20	"A significant body of evidence from studies of...(Parmesan and Yohe 2003; Root et al. 2003).": References should be added, including more recent ones.	Accepted, thanks. Additional citations have been included (Urban et al. 2015; Powers & Jetz 2019 Warren et al. 2018)	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
6071	86	29	86	30	This estimate of area thawed is likely based on an equilibrium model so the actual thaw will occur sometime after air temperature reaches 1.5°C above pre-industrial level (lags between warming at surface and warming of permafrost at depth).	Accepted. This sentence is now included in brackets (the actual thaw will occur sometime after air temperature reaches 1.5°C above pre-industrial level )	Sharon Smith	Geological Survey of Canada, Natural Resources Canada	Canada
10225	86	41	86	42	"Coral reefs are at very high risk" of what? Of disappearing? 70-90% of coral reefs would disappear under 1.5 degree scenario?	Accepted. Sentence modified including "of disappearing"	Aglaia Obrekht	Environment and Climate Change Canada	Canada
27887	86		87		The papers produced that discuss findings from the Wallace Initiative work could be useful here. These include: Warren et al. (2013) Quantifying the benefit of early climate change mitigation in avoiding biodiversity loss. <a href="https://doi.org/10.1038/nclimate1887">https://doi.org/10.1038/nclimate1887</a> Warren et al. (2018) The implications of the United Nations Paris Agreement on climate change for globally significant biodiversity areas. <a href="https://doi.org/10.1007/s10584-018-2158-6">https://doi.org/10.1007/s10584-018-2158-6</a> Warren et al. (2018) The projected effect on insects, vertebrates, and plants of limiting global warming to 1.5°C rather than 2°C <a href="https://doi.org/10.1126/science.aar3646">https://doi.org/10.1126/science.aar3646</a>	Accepted. Some of the studies have been cited in the text	Jenkins Rhosanna	University of East Anglia	United Kingdom (of Great Britain and Northern Ireland)
36557	86	4	88	12	What is the impacts on biodiversity using more bioenergy? Is the use of biodiversity biodiversity-neutral?	Noted. We will keep this reference in mind for the SOD. Additionally we have added a brief discussion on flooding on page 81 as well.	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
44921	86	5	88	12	3.7.5 Biodiversity (land and Water). It is important to recognise that Life on Earth faces two interlinked existential crises of biodiversity loss and climate change and that unchecked each crisis will amplify the other. Given that ecosystem carbon stocks exceed known reserves of fossil fuels we need to pay far greater attention to the implications for carbon storage and sequestration of the health of the Biosphere. Past conversion, all forms of exploitation, degradation, pollution and over use have contributed to the parlous state of Earth's life support systems and the build up of GHG in the atmosphere. Minimising premature release of ecosystem carbon stocks to the atmosphere and maximising the ability of ecosystems to adapt to a changing climate depend on maintaining and restoring natural patterns of biodiversity distribution and abundance (or as close as possible thereto) at all levels from genetic diversity up. Maintaining bottom up and top down trophic interactions -from micro organisms to top order predators- is important, as is understanding the ecological processes that operate across landscapes at all scales - from local and regional to continental. Given that Earth system models do not as yet capture the risks to the health of the biosphere from the loss of biodiversity and ecological function that are highly complex and operate across many scales , it is critical to adopt a precautionary approach and ensure climate action in land forests and other ecosystems does not directly contribute to further damage and loss and instead contributes to protection and restoration of ecosystem integrity and stability. Preventing further loss or damage to carbon dense natural ecosystems and in particular of primary forests would deliver immediate benefits for both both crises. Focussing restoration on actions that build ecosystem resilience and stability must also be a high priority. Protecting and restoring biodiversity will be essential for minimising risk associated with land and forest climate action (Ref: IUCN Policy on Primary Forests Including Intact Forest Landscapes; Millenium Ecosystem Assessment 2005). Notably the review of SDG15 'Life on Land' recognised that the 'quality' of ecosystems is important (and not just area), that biodiversity plays a role in ecosystem quality and that new metrics need to be developed to take the relationship between biodiversity and ecosystem quality into account. Ecosystem condition (quality or integrity) is a continuum. A blunt but nevertheless useful surrogate for condition (and risk of loss or damage) is to distinguish between primary, natural production and monoculture systems - particularly for forests (Mackey et al 2020). There is consistent evidence (including from fire patterns and severity in the Amazon in 2019 and Australia (2019/2020) that primary forests are still resistant to drought and fire.	Noted with thanks. We appreciate your comments and will consider the citations and rational provided in our SOD.	Virginia Young	Australian Rainforest Conservation Society, Griffith University, CAN Ecosystems	Australia
41963	86	32			After "attributable to climate change" I propose to add "having an impact also on food security and vector-borne diseases"	Accepted. We have included the addition suggested	Francisco Javier Hurtado Albir	European Patent Office	Germany
43841	86	35			Similar to the section above for terrestrial species there are a number of studies attributing distribution and other shifts to climate change eg AR5 WGII Chp 30 and cross chapter box MB, Burrows et al 2019 nature climate change.	Noted with thanks. We appreciate your comments and will consider the citations provided and the ARS content in our SOD.	Hans Poertner and Elvira Poloczanska	Alfred-Wegener-Institut	Germany
28433	87	7	87	10	A review of estuaries effect to climate change suggests more than flood risks, but water quality and habitat loss: Robins, P.E., Skov, M.W., Lewis, M.J., Giménez, L., Davies, A.G., Malham, S.K., Neill, S.P., McDonald, J.E., Whitton, T.A., Jackson, S.E. and Jago, C.F., 2016. Impact of climate change on UK estuaries: A review of past trends and potential projections. Estuarine, Coastal and Shelf Science, 169, pp.119-135.	Noted. We will keep this reference in mind for the SOD. Additionally we have added a brief discussion on flooding on page 81 as well.	Matt Lewis	Bangor University	United Kingdom (of Great Britain and Northern Ireland)
4681	87	11	87	14	In order to be clearer and consistent with the formatting adopted in other parts of the chapter, I suggest you to change the use of "(Bindoff et al. 2019)" with "Bindoff et al. (2019)" in line 11 and to cut "(Bindoff et al. 2019)" from line 14.	Accepted. Thanks	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
28435	87	21	87	29	Lewis, M.J., Palmer, T., Hashemi, R., Robins, P., Saulter, A., Brown, J., Lewis, H. and Neill, S., 2019. Wave-tide interaction modulates nearshore wave height. Ocean Dynamics, 69(3), pp.367-384. indicates an increase to resource of some marine renewables with climate change projections (sea-level rise); might be worth mentioning here.	Noted with thanks. We will keep this reference in mind for the SOD	Matt Lewis	Bangor University	United Kingdom (of Great Britain and Northern Ireland)
36075	88	2	88	2	Harmonize in the chapter 1.5°C or 1.5 °C (as here, with * underlined), idem for 2°C	Accepted. This has been harmonized.	Sandrine Seloisse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
28437	88	13	88	44	recently published MCCIP indicates potential benefits are sustainable growth in Blue Economy sectors - such as governmental desires to substantial increase aquaculture: n: Collins, C., Bresnan, E., Brown, L., Falconer, L., Guilder, J., Jones, L., Kennerley, A., Malham, S., Murray A. and Stanley, M. (2020) Impacts of climate change on aquaculture. MCCIP Science Review 2020, 482–520. doi: 10.14465/2020.arc21.aqu	Noted. We opted out of citing this reference because aquaculture is beyond the scope of this chapter.	Matt Lewis	Bangor University	United Kingdom (of Great Britain and Northern Ireland)
9171	88	14	88	15	"[Section in progress – considering consolidating all elements into Section 3.6 due to considerable overlaps]" needs considerations.	Noted. Consolidation with 3.6 has been considered to remove overlap.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
9173	88	22	88	23	"[Missing, to be included in SOD: more comprehensive summary of the projected benefits of avoided impacts on economic aspects of SD (livelihoods, equity, work), based on recent literature]" needs considerations.	Noted. This has been considered.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
39211	88	40	88	44	Estimates of job creation benefits of shifting to renewables in some national contexts exist in the literature (e.g. Fragkos et al., Applied Energy, 2018).	Noted. Thank you for the reference.	Diego Silva Herran	National Institute for Environmental Studies	Japan
2263	88	5			This sentence gives the impression that all CDR techniques have a negative impact on biodiversity. That is not true and some may even have a positive impact. It would be worth mentioning that some nature-based CDR techniques (e.g. soil carbon sequestration, enhanced weathering, biochar) can come with several co-benefits (often depending on how they are implemented). See overview in <a href="https://www.annualreviews.org/doi/full/10.1146/annurev-environ-101718-033129">https://www.annualreviews.org/doi/full/10.1146/annurev-environ-101718-033129</a> . This sentence thus requires reformulation to take this into account	Accepted. Reformulation has been done.	Sara Vicca	University of Antwerp	Belgium
5173	88	35			Figure 8 in Vanduyck et al 2016 (already referenced in this chapter) has a figure that shows how the job transition is concentrated in certain sectors (for 2030), a similar figure for 2050 is figure 122 in doi:10.2760/67475	Noted. Thank you for the reference.	Matthias Weitzel	European Commission, Joint Research Centre	Spain
4683	89	1	89	45	When discussing cities you give no space to their impact on water resources. Big cities require significant amount of water, often leading to the edge of water crises for the areas surrounding the same cities. A good example is given by the British East Sussex, whose proximity to London is considered one of the drivers for its current status of semi-arid region, with strong implications for its agricultural system and beyond.	Partially accepted. This is an interesting point, but we need to find literature relevant to this point and climate mitigation for its inclusion.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
9175	89	2	89	4	"[Section in progress. In the SOD, it will be structured according to "benefits of avoided impacts" and "implications of mitigation efforts", as the previous sections, with a focus on studies including long term projections]" needs considerations.	Accepted. This will be done.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
24187	89	5	89	5	"Between now and ...." When is "now"? 2020 or 2017? The ord is relative. A more definitive reference point must be used.	Partially accepted. Since the time span under consideration is many decades, the difference between 2017 and 2020 is not great.	Alfred Oforu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
4685	89	15	89	18	How could "increased electricity demand and reduced natural gas demand" lead to small effects?	Accepted. Text will be changed to reflect literature.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
9177	89	16	89	17	"[Reference to be included in SOD]" needs to be addressed.	Accepted. This will be done.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
9179	89	18	89	18	"[Reference to be included in SOD]" needs to be addressed.	Accepted. This will be done.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
2603	89	20	89	20	... "potential for reduce CO2 emission by 8 to 10%," should read "potential to reduce CO2 emissions by 8 to 10%,"	Accepted.	Michael Czerniak	Atlas Copco - Edwards	United Kingdom (of Great Britain and Northern Ireland)
9181	89	21	89	22	"[Reference to be included in SOD]" needs to be addressed.	Accepted. This will be done.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
4687	89	27	89	28	The meaning of the phrase "A key trade-off is meeting material needs of cities; we may blow our carbon budget on concrete and steel production" is unclear and requires further details.	Accepted. Will be rephrased & referenced.	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
20605	89	27	89	28	A recent publication highlights material demand across SSP scenarios based on projected demand for housing. The volume of material demand as well as regional and temporal implications are relevant for the argumentation here.  Marinova, S., S. Deetman, E. van der Voet, & V. Daioglou (2019), Global construction materials database and stock analysis of residential buildings between 1970-2050. <i>Journal of Cleaner Production</i> . Accepted	Accepted. This article will be referenced.	Vassilis Daioglou	Copernicus Institute of Sustainable Development	Netherlands
38797	89	35	89	37	This entire section is incomplete, inappropriate, and insensitive as written. How are "slums" defined? The sentence as phrased needs to be explicitly cited and/or connected to its specific relevance to the text. As written, it is very insensitive to the socio-economic status of some populations who are particularly vulnerable to pre-existing socio-political conditions that cause such "slums" and conditions. The current status of these "slums" are not entirely climate-driven so it is unclear the motivation of this sentence. Moreover, "solving slums" with more urban areas could be argued against given the large socio-economic disparities that already exist and carbon intense infrastructure. If this argument is kept, this paragraph needs to be expanded with policy-neutral language that is also more connected to the actual chapter.	Accepted. This paragraph is indeed problematic as written. We will seek relevant references or delete it (prefer term "informal settlement" to slum in any case).	Julian Reyes	Personal Capacity	United States of America
9183	89	36	89	36	"[Reference to be included in SOD]" needs to be addressed.	Accepted. This will be done.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
24189	89	36	89	37	Replace "solving slums needs" with "Resolving the issue of slums will require"	Accepted. See comment 38797.	Alfred Oforu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
9185	89	37	89	37	"[Reference to be included in SOD]" needs to be addressed.	Accepted. This will be done.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
9187	89	41	89	41	"[Reference to be included in SOD]" needs to be addressed.	Accepted. This will be done.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
9189	90	3	90	4	"[Section in progress, to be completed on the basis of the finalized previous subsections, more comprehensive studies and results of projects such as CD-LINKS]" needs considerations.	Accepted. This will be done.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
4689	90	9	90	9	Typo: "may more or less" to be changed with "may be more or less".	Accepted.	michele stua	APE-FVG	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
2265	90	17	90	20	Similar comment: some CDR techniques come with co-benefits. This paragraph needs more nuance in this regard. Deployment of CDR will need to consider which options are optimal under which conditions; how can the co-benefits be maximized while minimizing negative impacts. See also chapter 7.	Accepted. Chapter 7 will be consulted.	Sara Vicca	University of Antwerp	Belgium
30893	90	17	90	20	Needs a bit more differentiation, as not all CDR options impact food availability and biodiversity, e.g. DAC. There are also options for BECCS based on waste and residues, although the amount of those won't be enough to achieve 1.5C.	Noted.	Jasmin Kemper	IEA Greenhouse Gas R&D Programme (IEAGHG)	United Kingdom (of Great Britain and Northern Ireland)
9191	90	24	90	24	The quality of the figure needs to be improved.	Noted. Unclear what improvement would have to be though.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
19341	90	24	90	24	"Change in indicator relative to national policy" in Figure 3.46 is not at all clear. Who has made such judgement? The source should be presented.	Accepted. Context and basis of figure 3.46 needs to be better described.	Sumie Nakayama	Tokyo Institute of Technology	Japan
19343	90	24	90	24	No indicator on poverty is not presented as SDG1 is the first priority among 17 goals. While energy access, energy efficiency and RE is presented in SDG7, affordability is not presented, which is one of the most important policy goal of SDG7. This figure is very misleading without any reference to the impact on affordability, Add poverty indicator and affordability indicator.	Noted.	Sumie Nakayama	Tokyo Institute of Technology	Japan
9193	90	26	90	26	"[will be updated]" needs considerations.	Accepted. This will be done.	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
24945	90	14	91	5	Arguments presented in Section 3.7.8.1 are not based on robust analysis. Delete this section	Rejected. Without any argument given, whereas our section is based on existing literature, this point is not receivable.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
4691	91	3	91	3	In order to be clearer and consistent with the formatting adopted in other parts of the chapter, I suggest you to change the use of "(Bertram et al. 2018)" with "Bertram et al. (2018)".	Accepted. Thanks	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
15767	91	7	91	10	The issue about the carbon content of meat production pehaps needs to be revised within the light coming from red meat producing countries like Australia, Argentina, Brazil, UK and US, many of them have implemented Silvopastoral systems or SPS. For example, the Australian Beef Sustainability states that "In 2017 the Australian red meat industry set an ambitious target to be carbon neutral by 2030." and that "A new indicator has been added to the 2019 Annual Update to publicly track the industry's CN30 (Carbon Neutral by 2030) initiative. Since the baseline year of 2005, the industry has reduced absolute emissions by 55.7% (for the most recent reporting period of 2016) largely through a focus on improving productivity and vegetation management practices." Sources: <a href="https://www.sustainableaustralianbeef.com.au/managing-climate-change-risk-and-also-ABS2019-Australian-Beef-Sustainability-Annual-Update-web.pdf">https://www.sustainableaustralianbeef.com.au/managing-climate-change-risk-and-also-ABS2019-Australian-Beef-Sustainability-Annual-Update-web.pdf</a> In the UK, the NFU states "The NFU has reiterated that improvements in productivity, carbon capture and renewable energy production are the most effective ways to reach agricultural net zero targets, as part of its ambition to reach net zero by 2040." reference: <a href="https://www.nfonline.com/news/latest-news/nfu-reiterates-its-net-zero-aims-for-agriculture/">https://www.nfonline.com/news/latest-news/nfu-reiterates-its-net-zero-aims-for-agriculture/</a> In Brazil, EMBRAPA has published studies which support the viability of carbon neutral beef: "http://www.alice.cnptia.embrapa.br/alice/handle/doc/1118359" and also this article <a href="https://www.alice.cnptia.embrapa.br/bitstream/doc/1118439/1/Economicanalysisof.pdf">https://www.alice.cnptia.embrapa.br/bitstream/doc/1118439/1/Economicanalysisof.pdf</a> and this third article <a href="https://link.springer.com/article/10.1007/s10457-019-00460-x">https://link.springer.com/article/10.1007/s10457-019-00460-x</a> In USA, studies are being done in this sense, for example by Yale "Silvopastoral systems and climate change mitigation in Latin America" by Montagnini, F, Ibrahim, M, Murguetaio, E. Restrepo at <a href="https://pdfs.semanticscholar.org/018b/34c7da1176d1e9134edd1aabef2a0ab98a7f.pdf">https://pdfs.semanticscholar.org/018b/34c7da1176d1e9134edd1aabef2a0ab98a7f.pdf</a> In Colombia: Charry, A., Narjes, M., Enciso, K. et al. Sustainable intensification of beef production in Colombia—Chances for product differentiation and price premiums. <i>Agric Econ</i> 7, 22 (2019). <a href="https://doi.org/10.1186/s40100-019-0143-7">https://doi.org/10.1186/s40100-019-0143-7</a>	Partially accepted. We will consider this literature in the context of the overview of the field, with focus on long term trends. More detailed discussion is relevant to chapter 7.	EDUARDO PEDRO FRACASSI	ITBA Instituto Tecnologico de Buenos Aires	Argentina
24191	91	27	91	31	Break the sentence into simpler sentences. The link between mitigation and water scarcity must be established.	Noted. Clarity will be improved	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
24947	91	41	91	44	Delete "Political action ... (Healy and Barry 2017)," as these statements are contradicting the results obtained by the scenario analysis presented earlier in the Chapter	Rejected. The scenario analysis does not contradict the points made in this section.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
24193	92	3	92	9	This sentence needs rephrasing. Which planetary bundries are being referred to?	Accepted. The planetary boundaries literature will be more specifically referred to.	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
24949	92	3	92	9	indicate that conclusions for specific countries cannot necessarily be valid for all developing countries owing to national circumstances	Rejected. These references are international and already pay specific attention to national circumstances.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
24195	92	12	92	14	Sentence needs rephrasing. Difficult to comprehend	The sentence will be clarified	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
15769	92	18	92	21	This paragraph needs quotes and refernces supporting it.	References will be added	EDUARDO PEDRO FRACASSI	ITBA Instituto Tecnologico de Buenos Aires	Argentina
24951	92	34	92	35	Delete ", and yet political ... fossil fuel based ones."	The sentence is based on the cited article. No reason is provided by the reviewer on why this sentence should be deleted. Thus, the sentence will remain	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
4693	92	39	92	39	When citing "the 'whom' question", I suggest you o reflect upon citing the effort-sharing formula included in Stua, M., 2017: The Mitigation Alliance Target and Its Distribution. In: M. Stua (Ed.), From the Paris agreement to a low-carbon brettton woods: Rationale for the establishment of a mitigation alliance. Springer International Publishing. Whilst unexplored in literature, the formula proposes an innovative, flexible, dynamic effort-sharing system, resulting able to take into account the CBDR-RC principle, as well as equity, efficiency, transparency and effectiveness.	Thanks for referring to your article. Will review it and incorporate it if relevant	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
24197	92	46	92	46	Replace "Solving" with "Mitigating"	I could not find the indicated line (46). Page has only 45 lines	Alfred Ofosu Ahenkorah	Ahenkorah and Partners Energy and Engineering Services Ltd	Ghana
47023	92	15	93	18	Feasibility: this discussions should make prominent mention of feasibility in terms of economic and social change and how this relates to policies and politics. Integration with Ch13 required.	Look forward to integrate more with Chpt 13, very much needed	Frank Jotzo	ANU	Australia
27709	92	18	94	28	have issue with the use of "solve" in "models cannot solve specific scenarios." and similar sentences. Models are used to generate or to analyse scenarios, not to solve them. A more standard and easier to understand formulation might e.g. be. "satisfactory scenarios cannot be generated by the models. I.e., these scenarios are model-infeasible". Etc. The last very unclear two sentences lines 3-7 presumably refer to the fact that the sample of results in the literature is statistically biased because authors do not explore all possibilities on all models but "preselect" the models according to the questions they address (model selection bias). In addition, there is a data bias and a questions bias .... These points are important and should preferably be stated in an accurate and commonly understandable way.	Well taken points. The paragraph will be re-written and be accurate	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
5047	92	15	97	47	This chapter is titled "Feasibility of socio/techno/economic transitions", which is about the transition. Concepts of feasibility, scenarios are examined. But if the term "transition" means the same as the word in the chapter, the transition is not discussed proper way as did in Chapter 1. I think there are some misunderstandings in whole chapters around the several concepts such as "transition", or "public". As for the transition, the concept which Geels and his colleagues discussed (2002,2005,2016,2018, etc.), was exactly and nicely written in Chapter 1: that reads: Explicit frameworks of transition analysis identify interacting processes at three broad levels, which also align with different levels of economic behavior and associated theories: a common component is that major transitions usually need to overcome political resistance in the middle ("meso") level of economic rules and regulations (the socio-technical regimes governing specific sectoral markets), as well as macro-level infrastructure and innovation systems. These in turn interact with social transformations, so as to ensure 'just transitions'. (Chap1-p5-L7). None of the authors in other chapters followed this definition. They wrote their own definition or impression. Every author has to review in this regard. If some specific fields have their own definition of "transition", authors have to write clearly the differences between the two. The same can be pointed out about the concept of the "public", which means "the collective body of individuals". In chapter 1, the authors here clearly distinguished the public which means the collective body of individuals, and individuals (or consumers). But in other chapters (exclude chapter 5), the authors could not recognize the concept of the public, they only could recognize the consumer, or individuals who could take actions in the context of "behavioural change" or "changing lifestyles".	The comment seems to apply more generally to the chapter than to the section, where no definition of transition is provided. Naturally, as the chapter deals with long term assessments, the transition is seen through the lens of the model used to evaluate long term policies. We plan to collaborate with Chpt 1 in order to streamline language	Midori Aoyagi	National Institute for Environmental Studies	Japan
27713	92	11	98	6	The whole section reads poorly. It is hard to understand and often insufficiently argued.	We plan to improve the clarity of the section	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
41257	92	11	98	6	This is a much needed section and has the potential to become an extremely useful section for AR6. At this stage it is, for good reasons, quite general, and I look forward to its development into more concrete assessment. It can add much needed nuances and aspects to the discussions going on about feasibility of the high and low emission scenarios. It can develop further the reflections on RCP 8.5 that is given in Annex C. As it is now, it is a bit strange to have this statement in an Annex and these considerations need to be placed in the chapter. This section can also help building a basis for integration of scenario results across WGs for presentation and use in SYR.	Well taken points. We plan to elaborate the section and connect to other WGs	Jan Fuglestedt	CICERO	Norway
44575	92	11	98	6	This is already a very good section, particularly the new differentiations (what/when/where/whom plus model/option level/system level). Since it puts the recent Jewell/Cherp article center stage I'd like to add some 'political'/institutional' factors that aren't captured well in said article, since it is overly concerned with (monetary) transitions costs and how politicians deal with these. The other important political/institutional factor discussed in the literature (but only named by Jewell/Cherp) deals with the ways policymaking is organized, like the "institutional (in)capacity" to steer transitions at the speed necessary to reach global/national climate targets, e.g. the electoral market orientation of politicians (see <a href="https://journals.sagepub.com/doi/10.1177/0038026117731658">https://journals.sagepub.com/doi/10.1177/0038026117731658</a> ), the status quo orientation of senior public officials (see <a href="https://onlinelibrary.wiley.com/doi/abs/10.1002/wcc.305">https://onlinelibrary.wiley.com/doi/abs/10.1002/wcc.305</a> ), path dependencies created by 'instrument constituencies' (see <a href="https://onlinelibrary.wiley.com/doi/abs/10.1111/gove.12179">https://onlinelibrary.wiley.com/doi/abs/10.1111/gove.12179</a> ), or the benefits (for politicians) of deliberate inconsistencies between talk, decisions and actions in climate policy (see <a href="https://onlinelibrary.wiley.com/doi/abs/10.1002/wcc.305">https://onlinelibrary.wiley.com/doi/abs/10.1002/wcc.305</a> )	Well taken points and thanks for providing references. We plan to integrate them in the SOD	Oliver Geden	German Institute for International and Security Affairs	Germany
10535	92	11			Section 3.8 clearly has a lot more work to do. At present, it's not clear whether this is the beginning of a framework that will be fleshed out with more criteria/dimensions, and to what extent this framework will actually be applied within this assessment (i.e. will the authors of chapter 3 offer their assessment of how the different scenarios perform against the various feasibility dimensions)? For what it's worth, the broad 'socio-cultural' (including political) dimension needs to be clarified so that it can be used in this report in a way that is not entirely subjective.	Indeed, the plan is to offer a scenario based assessment of feasibility risks and put it in the context of the broader literature. We plan to do it for SOD	Andy Reisinger	NZAGRC	New Zealand
15771	93	2	93	5	The y axis needs a little more explanation. What is being measured? At least it should be divided into different categories, otherwise an horizontal line should be sufficient!	the figure is rather conceptual, but will clarify it better in the caption.	EDUARDO PEDRO FRACASSI	ITBA Instituto Tecnológico de Buenos Aires	Argentina
27703	93	4	93	4	Figure 3.47 is very difficult (impossible?) to understand without additional information	the figure is rather conceptual, but will clarify it better in the caption.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
27707	93	5	93	18	The paragraph mixes a few simple statements with many obscure ones. What do e.g. lines 9-11 mean? What are the trajectories mentioned on line 15? I assume that the derivative mentioned are time derivatives. It is not clear why the second time derivative characterizes trend breaks. Anyway, why speak of derivatives if it is not necessary for the understanding? "Hard coded" has a very specific meaning: the embedding of data in the source code itself. Is that really what is meant here? And so on.	We plan to improve the clarity of the section. Current terminology is tied to scenario based assessment, and will be put in that context.	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
10129	93	20	93	30	The discussion of low carbon pathway feasibility is welcome here, but is also necessary in the context of all long-run scenarios that extend beyond 2050, hence the more important question is how to gauge feasibility of scenario beyond 2050 in general, including non-climate policy scenarios as raised by Hausfather and Peters in this recent article: <a href="https://www.nature.com/articles/d41586-020-00177-3">https://www.nature.com/articles/d41586-020-00177-3</a>	Well taken point. We plan to discuss the feasibility of no climate policy scenarios too in the SOD	Justin Ritchie	University of British Columbia - Institute for Resources, Environment and Sustainability	Canada
27705	93	23	93	25	Please check the sentence	will do	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
46637	93	29	94	3	Talking about "hard coded constraints" seems to be too simplistic, as hard constraint can always be replaced by asymptomatic behaviors but still leading the scenario to be infeasible. Also infeasibility could result from the sum of asymptomatic behaviors due to the complexity of the model. Here is a suggestion: "Specific assumptions in models leads to asymptomatic behaviors. For example, resource scarcity can be represented by a hard limit on cumulative production, as well as a scarcity rent strongly increasing as approaching the limit. In both cases the model will try to overcome the constraint towards other part of the system. When substitution possibilities are limited or when all part of the system reach their asymptote, the scenario might be infeasible." I would also expect that most IAM scenarios to exhibit a technical feasibility, which can still be challenged in reality in terms of capacity ramp-up, investment needs, social acceptance, etc. This could be more discussed.	Thanks for your suggestion on how to rephrase the sentence, will take that into account	Florian Leblanc	Centre International de Recherche sur l'Environnement et le Développement	France
10825	93	19	97	11	Here several feasibility criteria are discussed which are informative. On the other hand in page 5 of this Chapter (lines 36-38), there are following sentences, i.e. "If NDCs are followed until 2030, leading to estimated emissions of 49-62 GtCO <sub>2</sub> -eq in 2030 (cf. 37 Chapter 4, Section 4.2.2), it is no longer possible to stay below 1.5°C warming with no or low 38 (<0.1°C) overshoot. It would also strongly increase challenges to stay below 2°C warming". Please make it clear on what criteria this comes from.	This comment seems to refer to another section and I cannot understand it	Mitsune Yamaguchi	Research Institute of Innovative Technology for the Earth	Japan
4695	94	1	94	1	Typo: "physically" to be changed with "physical".	will do	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
4697	94	10	94	10	In order to be clearer and consistent with the formatting adopted in other parts of the chapter, I suggest you to change the use of "(Riahi et al. 2015)" with "Riahi et al. (2015)".	will do	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
44201	94	16	94	33	The two references to Gambhir et al. (2017) should actually be to Napp et al. (2017) which is also on the same page. Napp et al. (2017) is the study in which the IAM was constrained to historical transition rates.	Will correct, thanks	Ajay Gambhir	Imperial College London	United Kingdom (of Great Britain and Northern Ireland)
9195	95	1	95	1	At the bottom right of the figure it seems that some thing has been missed! Notice to the "B" there.	indeed, this is part of a more complex figure. We plan to redo this chart using AR6 data	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
27715	95	4	95	20	It might be appropriate to address synthetic indicators at the same time than GDP.	Good suggestion thanks	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
45143	95	10	95	11	The statement "the literature on composite indicators is vast and highlights weighting and aggregation as critical issues" can be supported with references for composite indicators on cities.	Will add relevant citations	Siir Kilkis	The Scientific and Technological Research Council of Turkey	Turkey
4699	95	15	95	15	The line misses an explanation for the acronym "DEA".	Will add it	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
27711	96	0	96	0	In their current form, Fig. 3.49 and its caption are not particularly enlightening.	Indeed, this was a proof of concept and will be replaced by a new one based on AR6 scenarios	Christophe Deissenberg	Institute for non-linear dynamic inference	Luxembourg
9197	96	9	96	9	"here" is not linked to the right hyperlink.	Will correct, thanks	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
9199	96	9	96	10	"[A figure with AR6 scenarios and ranges of feasibility risks elicited by the literature or from experts is planned for SOD]" needs considerations.	The plan is indeed to add such a figure	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran
30153	96	11	96	35	unclear. Needs to be better structured and clarified	Will improve clarity	Bert Metz	European Climate Foundation	Netherlands
15509	96	33	96	35	It isn't just the acceptance and legitimacy of low-carbon options that needs to be considered here, but also how IAM pathways can better represent a destabilized fossil fuel industry and fossil fuel energy system. For a couple concrete suggestions for IAMs - better representing investment decisions for fossil fuel supply and better representing fossil fuel investor risk, see Erickson, P. et al. Why fossil fuel producer subsidies matter. Nature 578, E1–E4 (2020).	Will consider the referee's publication thanks for point it out	Peter Erickson	Stockholm Environment Institute	United States of America
30497	97	1	97	11	Research on the effectiveness of rights-based climate policy, as relating to 'social justice', to legitimate, coherent and sustainable climate policy that I am shocked it is given only a paragraph here. Research evolving from the Special Rapporteur on Human Rights and the Environment has collated examples over the years, the the 'legitimate' quote is from the Human Rights Council. Please give this area more coverage, to ensure policy makers have policy relevant information concerning effective ways to engage societies on the transformation needed. For background: <a href="https://quono.org/sites/default/files/resources/Climate%20Justice_August_2016.pdf">https://quono.org/sites/default/files/resources/Climate%20Justice_August_2016.pdf</a>	We'll try to increase coverage but please consider the strict page limitations	Lindsey Cook	Quaker United Nations Office / Friends World Committee for Consultation (IPCC Observer)	Germany
4701	97	5	97	5	When stating "Reviewing the literature, (2018) find that" it seems that author(s) reference before the date is missing.	Will correct, thanks	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
6151	97	5	97	5	The authors are missing in the reference.	Will correct, thanks	Linares Pedro	Universidad Pontificia Comillas	Spain
36077	97	5	97	5	incomplete reference	Will correct, thanks	Sandrine Selse	PSL Research University, MINES ParisTech, Centre for Applied Mathematics	France
4703	97	14	97	15	Typo: "This can be done both at the level of option and system level feasibility" to be changed with "This can be done both at option and system level feasibility".	Will correct, thanks	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
15511	97	16	97	27	The institutional framework dimensions mentioned here are important, but they don't only apply to "climate policy" per se; they also apply to that which competes with climate policy: fossil fuels. This section would be strengthened by mentioning how important the institutional framework and investor framework for fossil fuels are, and perhaps how divestment movements, financial regulation, or other related efforts could diminish the investment climate for fossil fuels. For some quantitative assessment of how these efforts can matter, see e.g. Fattouh, B., Poudineh, R. & West, R. Energy Transition, Uncertainty, and the Implications of Change in the Risk Preferences of Fossil Fuels Investors. <a href="https://www.oxfordenergy.org/publications/energy-transition-uncertainty-implications-change-risk-preferences-fossil-fuels-investors/?v=7516fd43adaa">https://www.oxfordenergy.org/publications/energy-transition-uncertainty-implications-change-risk-preferences-fossil-fuels-investors/?v=7516fd43adaa</a> (2019).	Well taken suggestions and citations, will consider them	Peter Erickson	Stockholm Environment Institute	United States of America
10227	97	39	97	40	Not clear how can a median value of 180 USD 2010 translate to 2-8 USD 2010 tCO2?	Will clarify	Aglaia Obrekht	Environment and Climate Change Canada	Canada
4705	97	12	98	6	When discussing about Carbon Pricing, you should refer also to alternatives like Positive Carbon Pricing. Here follows some literature I suggest for you to refer at: Stua, M., 2017: The Carbon Pricing and the Establishment of a Low Carbon Bretton Woods. In: M. Stua (Ed.), From the Paris agreement to a low-carbon bretton woods: Rationale for the establishment of a mitigation alliance. Springer International Publishing. Aglietta, M., Hourcade, J.-C., Jaeger, C., Peressin Fabert, B., 2015: Financing transition in an adverse context: Climate finance beyond carbon finance. International Environmental Agreements, 15, 403–420. Campiglio, E., 2016: Beyond carbon pricing: The role of banking and monetary policy in financing the transition to a low-carbon economy. Ecological Economics, 121, 220–230. Dasgupta, D., 2016: 'De-carbonizing the world': Reviewing recent proposals on positive pricing of carbon and large-scale climate finance. In A. Sirkis (Ed.), Moving the trillions: A debate on positive pricing of mitigation actions, 36–68. Rio de Janeiro: Brasil No Clima. Fell, H., MacKenzie, I. A., Pizer, W. A., 2012: Prices versus quantities versus bankable quantities. Resource and Energy Economics, 34, 607–623. Stua, M., Coulon, M., Nolden, C., Sabljic, V., 2016: COP21 and beyond: Challenges for a fair agreement and the significance of the social and economic value of carbon mitigation actions and related positive carbon pricing. In A. Sirkis (Ed.), Moving the trillions: A debate on positive pricing of mitigation actions, 113–143. Rio de Janeiro: Brasil No Clima. Zaman, P., Rock, N., Hedley, A., Smokelin, J., 2016: The Paris Agreement: Leading the pathway to a low carbon economy. 16 Platt's Energy Law Report 4, 31–149. LexisNexis A.S. Pratt.	Thanks for the suggestions, will consider them for SOD	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
47025	97	12	98	6	Enabling factors: this discussions should make prominent mention of enabling conditions wrt policies and politics. Integration with Ch13 required.	As noted above, we look forward to integrate more with Chpt 13	Frank Jotzo	ANU	Australia
47027	97	12	98	6	Here and/or in CDR sections, worth referring to non-technical enabling factors for negative emissions technologies, eg as per Colvin, R.M., Kemp, L., Talberg, A., De Castilla, C., Downie, C., Friel, S., Grant, W.J., Howden, M., Jotzo, F., Markham, F. and Platow, M.J., 2020. Learning from the Climate Change Debate to Avoid Polarisation on Negative Emissions. Environmental Communication, 14(1), pp.23-35.	Thanks for the suggestions, will consider them for SOD	Frank Jotzo	ANU	Australia
46725	97	46	98	1	The claim in Bernauer and McGrath (2016) needs to be considered alongside the nearly opposing conclusion in "Bain, P. G., Milfont, T. L., Kashima, Y., Bilewicz, M., Doron, G., Gardarsdóttir, R. B.,...Pasquali, C. (2016). Co-benefits of addressing climate change can motivate action around the world. Nature Climate Change, 6(2), 154–157."	Thanks for the suggestions, will consider them for SOD	Mikael Karlsson	KTH Royal Institute of Technology	Sweden
4707	98	2	98	2	When speaking of "near (2020) to medium term (2030)", you should rephrase and delete the near term year reference, as, being 2020 our present, it does not represent a 'near term' perspective.	Will do	michele stua	APE-FVG	United Kingdom (of Great Britain and Northern Ireland)
28355	98	7			may include the section of "research gap" or "knowledge gap". E.g. Some countries, the NDCs are not absolute or BAU emission reduction but in the form of policy and measures. Most of the developing countries are lack of knowledge how to estimate the policy impacts in terms of emission reduction. so the results from NDCs in fact ia a challenge in estimating the real emission reduction. this is related to chapter 4	Thanks for the suggestions, will consider them for SOD	Hoy Yen Chan	ASEAN Centre for Energy	Malaysia
36781	99	126			Some references need attention, no names for first authors and at times second and 3rd authors.	Noted. References will be detailed	Lazarus Chapungu	Great Zimbabwe University	Zimbabwe
9201	99	2	127	20	In reference section it is proposed that all "doi"s be hyperlinked so that when someone clicks on them, they can refer directly to the reference. I suggest to make them hyperlinked.	This is beyond the scope of the chapter, given that it follows standard IPCC procedure for publications	Hosseini Hossein Abadi Farzad	Sharif University of Technology	Iran

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
32667	100	8	100	9	Two missing references must be added between lines 8 and 9 : Berger, A. et al., 2017a: Nuclear energy and bio energy carbon capture and storage, keys for obtaining 1.5°C mean surface temperature limit. International Journal of Global Energy Issues, 40(3/4), 240, doi:10.1504/IJGEI.2017.086622. Berger, A. et al., 2017b: How much can nuclear energy do about global warming? International Journal of Global Energy Issues, 40(1/2), 43, doi:10.1504/IJGEI.2017.080766.	Noted, thank you.	Jean-Luc SALANAVE	Ecole Centrale-Supelec, Paris, France (professor, energy systems)	France
1293					Pathways, baselines scenarios, please also agree with chapter 2 on a unique definition.	Taken into account. Text will be revised.	VALENTINA BOSETTI	BOCCONI -eiee	Italy
1295					Please move figure 3.4 where baseline scenarios are defined.	Editorial	VALENTINA BOSETTI	BOCCONI -eiee	Italy
1297					Chapter is too long.	Taken into account. Text will be revised.	VALENTINA BOSETTI	BOCCONI -eiee	Italy
1299					aren't there scenario-model combinations for the illustrative pathways WHICH ARE NOT FROM THE AUTHORS OF THIS CHAPTER? And 3 from the CLA?? You are really calling for lots of critiques, aren't you?	Taken into account - IP process	VALENTINA BOSETTI	BOCCONI -eiee	Italy
1301					Chapter 3.3.2 going back to baselines after you introduced mitigation scenarios is confusing. Maybe baseline could sit in chapter 2??	Taken into account. Text will be revised.	VALENTINA BOSETTI	BOCCONI -eiee	Italy
1303					After baseline scenarios and Ips, the new set of scenarios C1-C7 have to be explained some more. This becomes really cryptic and involuted.	We will explain the C1-C7 set better	VALENTINA BOSETTI	BOCCONI -eiee	Italy
1305					Figure 3.27 Now new scenarios??? Are these C1-C7???	Taken into account. Text will be revised.	VALENTINA BOSETTI	BOCCONI -eiee	Italy
1307					Figure 3-31 Cannot read	Accepted.	VALENTINA BOSETTI	BOCCONI -eiee	Italy
6017					There are two additional studies that the authors might consider, which are relevant to this chapter. The first is this 2019 article demonstrating the empirical contradictions within the Sustainable Development Goals, between Goal 8 (the call for global economic growth) and the sustainability objectives: <a href="https://onlinelibrary.wiley.com/doi/abs/10.1002/sd.1947">https://onlinelibrary.wiley.com/doi/abs/10.1002/sd.1947</a> The second is this 2019 article on whether it is possible to achieve a good life for all within planetary boundaries. The article re-interprets the O'Neill et al (2018) data to show that a number of countries demonstrate that it is theoretically possible to meet all social thresholds while remaining at or near planetary boundaries. <a href="https://www.tandfonline.com/doi/abs/10.1080/01436597.2018.1535895?journalCode=ctwq20">https://www.tandfonline.com/doi/abs/10.1080/01436597.2018.1535895?journalCode=ctwq20</a>	Taken into account. Text will be revised.	Jason Hicke	Goldsmiths, University of London	United Kingdom (of Great Britain and Northern Ireland)
9383					fig 3.23 and 3.24 are not really readable due to small signs and also quantities which are difficult to be correlated to the lines	Accepted.	ANNA LAURA PISELLO	DEPARTMENT OF ENGINEERING - UNIVERSITY OF PERUGIA, ITALY	Italy
9385					fig 3.31 is too low quality	Accepted.	ANNA LAURA PISELLO	DEPARTMENT OF ENGINEERING - UNIVERSITY OF PERUGIA, ITALY	Italy
9387					tables 3.5 and 3.6 are too small to be understood	Editorial. Will be improved	ANNA LAURA PISELLO	DEPARTMENT OF ENGINEERING - UNIVERSITY OF PERUGIA, ITALY	Italy
13477					The hypothesis underlying SLCF in SSPs should be explained. It's all the more important than future evolution of SLCF does not systematically follow the LLGHG trends due to hypothesis on air pollution control. A discussion of that would help for a tradeoffs/benefits discussion of SLCF regulation for climate and air quality which could take place at the end in the synthesis report.	Need more attention to SLCF in SSPs	Sophie Szopa	Commissariat à l'Energie Atomique et aux Energies Alternatives	France
24871					Introduce a section on "Knowledge gaps"	Taken into account. Text will be revised.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
24917					A clear definition of "cost-efficient mitigation pathways consistent with the Paris climate targets" is required	Taken into account. Text will be revised.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
24953					Sections 3.9 and 3.10 on methods of assessment, knowledge gaps, and frequently asked questions to be added	Taken into account. Text will be revised.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
24955					Analysis on the links to adaptation needs to be expanded	Taken into account. Text will be revised.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
25517					Please take care not to use value-judgement terms such as 'important', 'significant' and also prescriptive terms such as 'need' and 'must'. Some readers will interpret these statements as policy prescriptive.	Taken into account. Text will be revised.	Sarah Connors	IPCC WGI TSU	France
25551					As a reader who isnt familiar with all the topics being discussed in your chapter, it might help many Exeutive Summaries to include subheadings to cluster the statements by topic or overarching chapter themes.	Taken into account. Text will be revised.	Sarah Connors	IPCC WGI TSU	France
26115					overall comment: The chapter misses all the opportunities for greenhouse gas emissions related to gas flaring abatement.gas flaring constitutes a large part of emissions and therefore has to be include. Considering that oil and gas will persist in the decades ahead, we must find a way to make hydrocarbons in line with the climate mitigation goals. Moreover, IPCC could issue recommendations for oil industries who recently announced their objectives of climate neutrality. Where exactly cn they invest? etc	Taken into account. Text will be revised.	Belyi Andrei	University of Eastern Finland, Centre for Climate Change, Energy and Environmental Law	Estonia
27577					p.25, in the scenarios, you should mention "Very High nuclear (electricity)", (>30%) References to a typical scenario:  Berger, A. et al., 2017a: Nuclear energy and bio energy carbon capture and storage, keys for obtaining 1.5°C mean surface temperature limit. International Journal of Global Energy Issues, 40(3/4), 240–254, doi:10.1504/ijgei.2017.086622. Berger, A. et al., 2017b: How much can nuclear energy do about global warming? International Journal of Global Energy Issues, 40(1/2), 43–78, doi:10.1504/ijgei.2017.080766.  This scenario was mentioned in the previous reports: "Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development"	Need to mention scenarios with nuclear outliers?	Frédéric Livet	CNRS-France	France
27579					p. 33 Fig 3-17: the "regions" are not explicitly defined, and I do not understand why emissions in 2010(??) can vary so much.	Editorial. Accepted	Frédéric Livet	CNRS-France	France
27581					p. 36 Fig 3-18 there are high nuclear contribution (~500EJ, black points), but you never mention the papers of Berger et al. This scenario uses breeders, which has to be mentioned explicitly. (In Berger et al, 500EJ of electricity, not primary energy.	Need to mention scenarios with nuclear outliers?	Frédéric Livet	CNRS-France	France
27583					p. 47 I suggest to mention biotechnologies: line 5: "decrease with high land productivity and the developement of biotechnoloies" Future technical progress should not be forgotten. I have two references on this subject to add:  Graham Brookes & Peter Barfoot (2018) Environmental impacts of genetically modified (GM) crop use 1996-2016: Impacts on pesticide use and carbon emissions, GM Crops & Food, 9:3, 109-139, DOI: 10.1080/21645698.2018.1476792  Brookes G. (2019): Twenty-one years of using insect resistant (GM) maize in Spain and Portugal: farm-level economic and environmental contributions. GM Crops & Food	We have included "biotechnologies" but not cite the papers because their focus on GM's impacts on pesticide, not about land productivity.	Frédéric Livet	CNRS-France	France
27585					p. 49 Figure 3-31 is impossible to read: too poor a quality.	Accepted.	Frédéric Livet	CNRS-France	France
27587					p. 63 The figures of the contribution of nuclear power to primary energy seem false. For a 2700TWhel production, with a 33% efficiency, it gives 8100TWh of nuclear primary energy, i.e. 29EJ. The figures at the left suggest <10EJ (yellow band). It seems that one compares a final energy to primary energies, which is an error.	Rejected. We are using direct equivalent PE accounting. It is not an error, just a convention.	Frédéric Livet	CNRS-France	France



Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
27589					p. 70 Table 3-5. there is no estimate of nuclear investments for electricity, though numerous scenarios have important nuclear contributions. You may not appreciate nuclear power, but many experts think that it will be an essential part of non-CO2 mitigation (and this was present in previous report: p.132, table 2-6 of "Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development"). Table 3-6. There is a problem: ou distinguish "fossils" and "Renewables". Where should you put nuclear? I maintain that best should be to distinguish "non emitting" and "emitting". It is a fundamental problem. Sectarism is not Science!	Taken into account. Text will be revised.	Frédéric Livet	CNRS-France	France
27591					p. 90, Fig 3-6 I am surprised that you mention the idea of a large benefit of "Renewable energy": in a country like Germany are spent 25-30b€ a year to subsidise renewables which are essentially devoted in replacing a non-emitting nuclear power, i.e. few direct benefits to CO2 mitigation....	Thank you for your comment. We are relying on the literature.	Frédéric Livet	CNRS-France	France
27593					p. 93, The figure 3.47 is beautiful, but its interest seems limited.	Taken into account. Text will be revised	Frédéric Livet	CNRS-France	France
28807					Section 3.4.6 The linkage of DACCS to target ppm levels misunderstands current literature about DACCS which suggests it is more likely to be used by countries to deliver on their own national targets. The orientation toward a global ppm target implies DACCS will be a globally governed and coordinated endeavour. However, literature indicates that DACCS will be deployed within state boundaries by individual countries with no international governance debate prior to deployment. Further, there is a gap regarding MRV governance for DACCS, which would require new governance tools within the processes.	Partially accepted. We have noted the link between the results here and how scenarios are designed. However, the role of MRV and national targets is outside the scope of this chapter.	Paul Rouse	Carnegie Climate Governance Initiative	United Kingdom (of Great Britain and Northern Ireland)
29077					Could explore IPs based on SSP1, especially aligning with Chapter 5 in SR1.5. Deep decarbonisation difficult without strong sustainability	Taken into account - IP process	Priyadarshi Shukla	Ahmedabad University	India
29507					One needs to read both Ch3 and Annex C to collect all relevant information on illustrative Pathways. Perhaps combining all information in Ch.3.	Taken into account. Text will be revised.	Alaa Al Khourdajie	IPCC WGIII TSU	United Kingdom (of Great Britain and Northern Ireland)
33117					It should develop an international support framework how energy efficiency can be achieved in developing countries which are currently making rapid development changes resulting in greater emission in the near future	Noted.	Edris Alam	Rabdan Academy	United Arab Emirates
40311					On p. 3-29 you note the criticism articulated with regards to reliance on CDR due to their uncertain mitigation potentials and the risks of possible temperature overshoot. From my perspective, these concerns (that are very substantial, even fundamental) are not sufficiently addressed by simply noting them in the text. A consistent approach to the scenario literature that factors in the various scientific uncertainties around CDR and the risks of temperature overshoot would be to also treat the scenarios found in the scenario database differently; highlighting those that minimise risks and an uncertainty, and those that generate most synergies with other internationally agreed goals, such as the SDGs, as well as articulating much more concern around those scenarios that rely on large amounts of CDR and temperature overshoot.	Critique on CDR; will partly be handled via the new categorisation. Maybe also more discussion needed.	Linda Schneider	Heinrich Boell Foundation	Germany
40313					It would be helpful to include consistent storylines for each Illustrative Pathway, in particular those that are in line with other internationally agreed goals, such as the SDGs. Right now the storyline a somewhat atomized in that mitigation potentials for each Illustrative Pathway appear in the sectoral/thematic sections. It would be particularly important for IP5 and other scenarios that achieve ambitious mitigation goals, minimize the reliance on CDR and avoid or limit temperature overshoot.	Taken into account - IP process	Linda Schneider	Heinrich Boell Foundation	Germany
40315					The overall thrust of Chapter 3 is helpful and goes in the right direction from my point of view: It focuses on the need for mitigation and the additional mitigation potential that come with demand-side measures rather than a strong focus on the need for CDR.	Thank you.	Linda Schneider	Heinrich Boell Foundation	Germany
40319					The findings of WGI on the uncertainties of geophysical and biogeochemical implications of CDR and SRM don't seem to be fully incorporated in Chapter 3 of WGIII. What are the implications of WGI findings? If, for instance, high levels of temperature overshoot, and very high levels of necessary CDR to return to lower temperatures towards the end of the century – turn out not to be feasible from a climate system perspective, in particular when factoring in the risks of reaching tipping points during a period of temperature overshoot --- what does that mean for WGIII and the scenario literature it relies on? It is not clear to me if all scenarios assessed in WGIII are actually feasible from the perspective of WGI in this respect, and I think the IPCC needs to ensure coherence between WGI and WGIII findings and storylines.	Taken into account. Text will be revised.	Linda Schneider	Heinrich Boell Foundation	Germany
45663					I recommend a good definition of the following terms at the beginning of the chapter (including a clear description with respect to the differences and relations): emission pathways/mitigation pathways/emission scenarios/emission trajectories/alternative pathways/illustrative pathways/scenarios/SSPs/RCPs/Integrated Assessment Models (IAMs) pathways/categories/low emission scenarios/higher warming scenarios. And next a consistent use of the terms in text, figures and tables. I get the impression that sometimes different terms are used for the same. Also are 'low warming scenarios' the same as 'stringent mitigation scenarios' and the same as 'low-emission scenarios'? Because the definitions and relations are not clear, the whole chapter is difficult to follow.	Taken into account. Text will be revised.	Machteld van den Broek	Utrecht University	Netherlands
46131					As I write before in chapter 1, although everything is rigorously scientific and well described, I think that too many acronyms do not allow us to read fluently and one must continually go back in the sentence to retake the meaning.	Taken into account. Text will be revised.	Sharl Noboa	INOCAR	Ecuador
47977					The chapter executive summary lacks the use of the IPCC calibrated confidence language.	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
47979					Please treat CO2 separately from other GHG in the chapter (as done in SR15). Currently the CO2-eq approach is ambiguous and could be challenged depending on the approaches (GWP as in AR5 vs GWP* for instance).	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
47981					ES : "goals" (temperature levels) or PA goal (well below 2°C)?	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
47983					ES: is it possible to explicitly related illustrative pathways to SSPs-RCPs? (needed for integration with information from WGI)	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
47985					ES : please report increase in emissions for each GHG separately (not just in CO2-e)	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
47987					ES : I am surprised by the reported numbers for well below 2°C (by 2100, following or without an overshoot?). What are reference years for reductions in emissions? (compared to 2010? 2019 levels?). What is the likelihood choice here (50%? 66% chance)? Please again report CO2 separately from non CO2 as done in SR15 to facilitate integration and comparison.	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
47989					ES : please describe emissions of CH4, N2O and other gases too (not just CO2) in pathways compatible with <2°C.	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
47991					ES = please be explicit on carbon neutrality in this report (emissions minus removal by human activities?)	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
47993					ES : the classification of pathways / levels of warming needs to be coherent with the assessment of climate metrics (ECS, TCRE) of WGI, coordination is needed.	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
47995					ES : please highlight what is novel / different from SR15, SRCLL and why	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
47997					ES : please clarify the difference between NET and CDR (which includes nature based solutions not just technologies).	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France

IPCC AR6 WGIII - First Order Draft Review Comments and Responses - Chapter 3

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
48001					ES : I am surprised that pressure on food and biodiversity is only related to BECCS while some other aspects do also increase pressure on land (afforestation). In this paragraph, one problematic issue is the lack of an SDG focused on air quality (human health and ecosystem health aspects). This is problematic for instance for the assessment of increased reliance on methane in case of methane leakages (production, transport, at final consumption sites) due to the role of methane for air quality and ozone.	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
48003					ES : "when previously thought" => is this a reference to previous IPCC assessments? Which ones? (AR5? SR15? SRCL?). Please harmonize framing with chapter 1 (well being / decent living standards).	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
48005					ES : The last paragraph on carbon pricing could be placed in the recent social context related to energy prices... (both strong social troubles following attempts of increased carbon taxes or higher energy prices and current low prices of oil and gas).	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
48009					The chapter refers to economic benefits. How are non economic aspects addressed (heritage, culture, ecosystem functions and non economic services)?	Taken into account. Text will be revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France