

IPCC AR6 WGIII Second Order Draft Government and Expert Review Comments Responses (Technical Summary)								
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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66357	0	0			The TS could in principle be a vehicle for helping valuable cross-chapter intellectual integration, and summarizing the core and cross-cutting intellectual content, but as yet hasn't done so. The Co-Chairs/TSU could consider whether and how to convene discussion across the Tech Summary to address some obvious inconsistencies, narrative (as already suggested by Ambuj), and as a process to increase coherence, in ways that could feed back into relevant chapters.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted
66359	0	0			The TS could consider / encourage more consistent use of the Chapter 1 "Dimensions of Evaluation" (Feasibility, and relationships to Enabling Conditions and policy evaluations – see Ch.1 Figure 1.4), as well as the Chapter 1 "Four Frameworks" which also point to importance of Just Transitions.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - TS follows Chapt 1 executive summary
66361	0	0			AR6 should seek to update to 2019 data in general, and the description of base years in the global projection scenarios could be written as 2019(20) to clarify the assumed (ie. non-Covid). In presenting data on trends and changes since AR5, a an almost decadal average really is too long, it would be far more insightful to consistently report for 2010-2014, and 2015-19. [See Whole Report comments MG 6 & 7]	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - Addressed by chapters
66363	0	0			The TS is the place to clearly resolve the dilemmas around how we understand and present net-zero dates, and their relationship to least-global-cost and feasible pathways. See my Whole Report comments on Chapter 1 – 4 consistency MG 9 - 12. It is vital to get this clear and consistent; it might be eased by swapping order of TS4.1 and TS4.2 which would also seem a more natural progression. See also my final remark on overall TS structure.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted - this section has been revised
66365	0	0			The social science assessment suggest we are now in a world of disaggregated, quasi-voluntary approach to implementation, particularly in the context of the Paris Agreement. Delivering the global goals can only come as a disaggregated and evolutionary process, with a complex and diverse set of motivations, actors and institutions. This may imply a significant focus on lessons from successful cases, positive examples and their potential for growth, in the context of systems dynamics – [See Whole Report comments 13-20]. Coverage of these remains weak in the TS.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted - this section has been revised
66367	0	0			Both the SPM, and Tech Sum somewhat, downplay distributional data beyond the highest level of regional aggregation. The TS would be the obvious place to note more clearly key big difference at least at "level 2" disaggregation (eg. per capita emissions between East Asia and South Asia; and between US/Canada vs Europe or Japan), possibly level 3.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - additional Chapt 2 material included
66369	0	0			The AR6 could – and needs – to better illuminate the sheer diversity of regional experiences and trends. See my cross cutting Whole Report comment MG 18 for more detail but the statement that "Developing countries have lower per-capita emissions" is true only at the highest level (1) of aggregation, and not in specifics – there are numerous counter-examples.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - additional Chapt 2 material included
66371	0	0			The Tech Summary seems to indicate a strong evidence base for co-benefits across sectoral chapters: Almost every sectoral chapter identifies significant positive co-benefits to mitigation which seem to outweigh the negatives. Chapter 17 (final section of Tech Summary) does a powerful job of bringing these together, but it is not a consistent part of narrative.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - synthesising table introduced
66373	0	0			Strengthening attention to co-benefits is not to negate the potential negatives (some very important). However review the present 'positives and negatives' tone from most cross-cutting chapters – the natural default for academic balance – needs to be scrutinised in light of above, and the logic developed in Chapter 1 (p.56, lines 37-40) which we could strengthen.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	noted

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66375	0	0			A more consistent analysis of this might also benefit from the attempt to structure in Chapter 1 the concepts of synergies and tradeoffs (ie. when these are reasonably known), risks and opportunities (when uncertainties are deeper), and the logic that co-benefits arise from strategies that maximise the positives and minimise the negatives in these, particularly as may arise from innovation and transformations, including potential for positive sum cooperation (Chapter 1, sections 6.4 and 6.6 conclusions).	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	noted
66377	0	0			The co-benefits are largely cast in terms of SDGs, which I think is fine. But the huge overlap – and some inconsistencies – between “Figure TS.30” [why Figure?] and Table TS.10 is just confusing. This data really should form the core of evidence for net co-benefits in low carbon transitions and we don’t want confusion. Somehow they need to be synthesised into one, or one dropped from TS with a chapter cross-reference instead, or otherwise radically changed to relate to the other more sensibly.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted - this section has been revised
66379	0	0			The criteria for selection / summary of case studies in TS.9 should be reviewed, and spelled out. Viewed from the question of what case studies would be most important for assessing key examples of progress and lessons, the selection of “Case studies in sectoral chapters on integrated policymaking for sector transitions” (Table TS.9) seems bizarre for reasons flagged in next comment.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted
66381	0	0			The case studies presented in TS.9 appears as (i) a random mix which includes several which are just plans and not even implemented, (ii) mostly not at national scale, (iii) mainly focused on developing countries (why?) and (iv) are not assessed, the “findings” – the title of the table – do not include any evaluation of actual outcomes or effectiveness. A cynical reader might conclude this looks more like promoting a set of projects supported by foreign aid. My Whole Report comments MG 21 & 22 elaborate further and suggest some others to consider (Chapter 2 already touches on UK example Chapter 13 has good examples, and I volunteered to synthesise a UK electricity case study for Chapter 6).	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted - this section has been revised
66383	0	0			The TS – hopefully accompanied by chapter developments – could do much more to assess the evidence of impacts from past mitigation efforts. Most specifically, AR6 is a key opportunity to assess the effectiveness of international climate agreements to date of which by far the biggest is the Kyoto Protocol, which was NOT significantly assessed in AR5. Consistent with majority of other assessments, the most recent comprehensive econometric analysis concludes it reduced emissions in ratifying countries by about 7%, probably unequally distributed to extent that EITs did not need to implement policies to comply (this doesn’t take account of any savings secured by financial flows through the CDM) (Maamoun, N., 2019: The Kyoto protocol: Empirical evidence of a hidden success. J. Environ. Econ. Manage., https://doi.org/10.1016/j.jeem.2019.04.001).	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - new policy attribution box included
66385	0	0			Ideally, the TS could seek to foster & draw on evidence across Chapters 2 (correlation / causation with countries reducing emissions), 13 (the growth of climate legislation and instruments), 14 (which really has to cover the literature assessing Kyoto and its impact, but does not yet), 15 (growth of international finance including CDM) and 16 (indices of innovation linked to Kyoto’s adoption or entry into force). Perhaps one way of implementing a more comprehensive assessment of lessons, strengths and weaknesses would be a TS Box with authors from across these chapters?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - new policy attribution box included
66387	0	0			Improved intellectual integration across the report could include the dimensions, metrics and frameworks used. My cross cutting Whole Report comment MG 26 details how Chapter 1 have framed this, could the TS use these dimensions and the Four Analytic Frameworks to help inject more coherence into narrative?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - TS structure revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66389	0	0			Following the emphasis of SR1.5 on transformations, there seems a curious lack of analytic focus on this in AR6. There are some scattered indications in a couple of chapters. It forms one of the Four Frameworks. Could Chapters 1, 4, 5, 16 collaborate on material to inject on transition and transformation early in the TS (see also Whole Report comment MG 28).	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - Addressed by chapters
66391	0	0			Somehow evidence of the path-dependent, evolutionary nature of global socio-technical systems – and its obvious implications – does not seem to come through consistently in AR6. Could the TS work this conception in a bit more systematically? The Tech Sum could and should also stitch together the evidence from the sectoral chapters better with the concluding cross-cutting chapters.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - Addressed by chapters
66393	0	0			At 130 pages, the Technical Summary is far too long for most people to read, and contains substantial duplication. It would be better to cut to below 100 pages first by deciding on a more <u>integrating narrative</u> .	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - TS shortened
66395	0	0			The Technical Summary would be the natural place to evaluate / consider the following. A closer look at global emission trends suggests that emissions growth slowed, and per-capita global emissions almost stabilized in the past five years (2015-19) along with the rapid development and expansion of low carbon technologies. The TS could bring together evidence on the extent to which policies (chs 13-16), albeit focused mainly on a limited number of countries, helped (a) to achieve the observed slowdown in emissions (mainly, Chs.2, 5 and 6?) and (b) secured the expansion and radical cost reductions secured in key low carbon technologies (Sectoral chapters, Ch.16). Ideally some of this should be able to draw on case studies if relevant ones are included.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - new policy attribution box included
66397	0	0			From such empirical foundations that seek to integrate social/policy analysis and technical data, the TS would be better placed to 'link bottom-up and top-down' literatures, to assess how a rapid broadening and deepening of policies has potential to accelerate absolute emission reductions globally, initially from the bigger emitters, and more broadly and globally shift development pathways towards sustainability (eg. Chs.4, 5, 17).	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - addressed in chapters
66399	0	0			Consequently the authors could consider a significant change in TS structure. Following the TS1 and TS2 sections, a section on topic "Where we are and how we got here" could observe that it is 30 years since origins of IPCC and UNFCCC, that policies began to accumulate substantially around 2000, and look at the subsequent trends and evidence on linkages. From this, a section on "What are the options and where could current plans take us?" could cover both the sectoral material, and the Chapter 4 materials on national goals (NDCs, and net zero plans and trajectories). This would provide a much stronger foundation for the subsequent section to then look at the global model-based analyses of implications, and the Feasibility assessment structures and findings. From this, the TS could better conclude with its material on pathways, lock-in, applied implications of the earlier climate-SD conceptual material, and co-benefits, and re-introduce the central importance of integrating climate impacts in evaluating the economic and SD implications of Paris-compliant pathways.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted - TS structure revised
46725	0	0			The TS contains policy prescriptive formulations, that need revision please. These include all statements with the words "need", "require", "must", "should" etc, for example "Mitigation needs to be addressed in the context..." (10-11).	Government of Germany	Germany	accepted - chapter executive summaries revised
29449	0	0	0	0	To TS: Please use colours consistent between figures throughout the document. In some figures fossil fuels are green and FOLU pink. Other places AFOLU is green. We suggest that (A)FOLU is green through the document and fossil fuels grey or black. And for reading by colour blinde people - don't place green and red colours next to each other.	Government of Norway	Norway	accepted - will be addressed in production

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
7199	0	0	0	0	This WGIII TS and SPM will be one of the most important documents in the AR6 cycle. Everyone must be able to read it, not just the specialists. The TS will be read by a wide audience, not so much the chapters. Authors are encouraged to go to great lengths to make it as easy to read as possible. The TS contains many (even mostly) long, complicated sentences, many of 5-6 lines or even more. This makes it difficult to read. Also avoid jargon and keep acronyms to an absolute minimum. Avoid phrases that are not generally understood such as "raises the spectre" – keep in mind that to the vast majority of readers English is not their first language. Keep the language straightforward.	Debra Roberts	South Africa	accepted - text thoroughly revised
7201	0	0	0	0	Re: the term "climate target" – would it be possible to refer to this as "limit" whenever it refers to temperature, to emphasise the fact that we are not aiming to hit 1.5, we are trying to avoid going higher. Even at 1.5 the impacts will be severe. In some parts of the world they are already, at 1°. The Paris Agreement itself uses the words 'limiting' warming, and 'emissions targets' (the actions to achieve that) and general 'long term goals' (which incorporate mitigation, adaptation and finance aspects). In fact, this is something for all three Working Groups to consider i.e. careful wording around Paris aspirations.	Debra Roberts	South Africa	accepted - revised in TS and chapters
7203	0	0	0	0	Re: structure, currently there is some repetition as the TS moves from long-term to mid- and near-term, so that the same topic comes up again, causing redundancy. (One example: stranded assets or cost of renewables.) Would it make sense to avoid this by merging the different time horizons under each topic? Some topics have more content than others.	Debra Roberts	South Africa	Accepted - TS structure revised
7205	0	0	0	0	Please avoid acronyms.	Debra Roberts	South Africa	Accepted
30269	0	0	0	0	Throughout the Technical summary there are several Boxes that are of high interest for readers on many relevant areas. Please consider making an additional box that deals explicitly with circular economy. This theme is currently highly policy-relevant and also cross-sectoral by nature. So a box in the TS that gathers information from several of the underlying chapters would be very useful. You should also consider if the most policy relevant findings in such a box could be included in the SPM. At least relevant findings from Chapter 5.3, 3.7, 8.6 and 11.3 could form a good basis for such a cross-chapter box, but there are also probably even more information on circular economy in chapter 12 and 17.	Government of Norway	Norway	Accepted - circular economy box included
46723	0	0	0	0	Para with open questions of CCS is missing. We kindly urge the authors to add this important information. For instance, information on knowledge gaps is included in the TS of the Special Report on CCS (SRCCS, Rubin et al., 2005) and it is of great help to guide the assessment/judgement especially for non-specialists. It might be important to include this kind information in the current TS because it is addressing a larger audience that might not be able to correctly assess/judge the validity constraints of the statements given. Those readers probably won't consult the chapters and, thus, the information on knowledge gaps might be read only by specialists who are more familiar with them anyway. Rubin, E., Meyer, L., de Coninck, H. et al., Carbon Dioxide Capture and Storage – Technical summary, IPCC Special Report, 2005	Government of Germany	Germany	accepted - text thoroughly revised
20503	0				It appears that neither the TS nor SPM make mention of SRM while it is being extensively discussed in chapter 14.	Government of France	France	accepted, now included

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
24881	0				<p>A relevant recent development compared to AR5 regards the understanding and possible reconciliation of the differences on land-use CO2 fluxes between global models and national GHG inventories (GHGI). While this looks very specific for the AFOLU sector (ch. 7), with clear implications for Ch. 3 and 4, it is worth to be mentioned also in the Technical Summary. The reasoning is the following:</p> <p>(1) since NGHGI provide the basic information for climate policy and for assessing compliance toward the Paris Agreement (PA), and since the AR6 is expected to provide a key input for assessing collective countries' progress under the Global Stocktake (GST), any major discrepancy between NGHGI and the global models used in AR6 is relevant and as such worth to be discussed. In particular, the IAMS' emission pathways and the associated remaining global carbon budgets have an enormous conceptual importance for climate policy. To be fully useful as a benchmark, however, these pathways/ budgets should be conceptually comparable with national GHG inventories / climate targets.</p> <p>(2) The discrepancy is big enough (5 GtCO₂/y) to have a global relevance - this is not a criticism to global carbon budget models/IAMS or to GHGIs, but just a factual and policy-relevant observation. This discrepancy is due to different approaches to estimate the 'anthropogenic' CO₂ sink. It is already acknowledged elsewhere in the AR6 (Ch 7 and in the Glossary), in other high-level IPCC reports (SPM of SR CCL and in the SPM of SR 1.5C), and is an issue of concern under UNFCCC (in light of the GST starting in 2022).</p> <p>(3) recent literature (see Ch. 7.2.2.5 and box 5 in Ch. 7) indicate possible pragmatic ways forward to reconcile the discrepancy between global models/IAMS and GHGI.</p> <p>Given the above, I think this Technical Summary should mention the issue, similarly to how it was done in the SPM of SR CCL. A possible text, under section 5.6, could be (it is a slightly longer version of the text suggested in the SPM): "A large ~5 GtCO₂/yr gap exists on land fluxes between global models and national GHG inventories, mostly caused by differences in how the anthropogenic forest sink is estimated: countries consider a much larger area of managed forest than global models, and on this area consider the fluxes due to human-induced environmental change to be anthropogenic while global models consider them to be natural {7.2}. Adjusting global models' results to make them more comparable with national GHG inventories is possible {Cross-Chapter Box 5 in Chapter 7} and would enable a more accurate assessment of collective progress towards the Paris Agreement's climate goals."</p>	Giacomo Grassi	Italy	accept, issue is taken up in executive summary
66871	0				Independent Review Comments submitted by J Hopwood (President, UNENE, University Network of Excellence in Nuclear Engineering, c/o 1280 Main St. W., Hamilton, Ontario, Canada)	Jerry Hopwood	Canada	no action required
66873	0				I have reviewed sections of the report, including the executive summary and introduction, and in particular Chapters 3 and 4 which address mitigation matters. Based on this review I would like to submit the following comments:	Jerry Hopwood	Canada	no action required
15181	0				TS uses the expression "emerging economy" in several places (e.g., line 18 on p. 7, lines 16-20 on p. 22, line 33 on p. 37, line 6 on p. 78, Figure TS.35 on p. 125, line 25 on p. 128, etc.), with Figure TS.35 on p. 125 referring the emerging economy to the BRICS countries (Brazil, Russia, India, China, South Africa), making them independent of developed and developing countries. It is suggested that the TS adopt the criteria on the classification of countries in the previous IPCC assessment reports or in the United Nations Framework Convention on Climate Change (UNFCCC) by adopting the dichotomy between developed and developing countries, deleting the category of emerging economies, and including BRICS countries among developing ones.	Government of China	China	Accepted

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66897	0				The main messages from the mitigation portions of the IPCC report are clearly noted: An appropriate global target to manage climate change, "net-zero" by mid-century, required accelerated and broadened mitigation measures. As a nuclear practitioner who has continually scrutinized my own understanding of this technology, I believe that nuclear technology can and must play a vital role in this. I believe the principal obstacle to this is the gaps in objective assessment of nuclear technology capabilities and limitations, and the resulting level of mis-information that impacts policy-making to under-use nuclear technology. I believe that the IPCC can address this by encouraging a much greater engagement of the scientific community and policy-makers with the capabilities of nuclear. I urge the IPCC to highlight this in the current report.	Jerry Hopwood	Canada	Noted
31069	0				Military contributions to greenhouse gas emissions are missing from the Technical Summary.	Daniel Helman	Micronesia, Federated States of	Noted - The TS follows IPCC inventory sectors
66667	0				Having read the TS in full, a restructuring I suggest for consideration would imply bringing key empirical material from section TS.6 forward to the suggested section "Where we are and how we got here". I believe this would give the TS a much more solid and integrated grounding, much more useful for policymakers. Policymakers really want evidence, and some indication of what efforts over the past of decades have delivered, and taught us. The TS is the place to bring that together. At present, much of core evidence from experience, some of the richest and most convincing material for policymakers, appears intermittently from about page p.110 onwards – in the summary document! This risks being overlooked, and precludes any chance of an integrated, multi-disciplinary narrative that combines the earlier highly technical and modelling analysis with any sense of what we have learned about implementation and impacts.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	TS structure has been revised
66669	0				If that were done, then in my view this would free up section 6, after the technical, modelling and sectoral analyses, to be recast quite differently. Having established that we are just in the foothills of a huge journey of transformation including shifting development pathways towards sustainability, the section could start with these cornerstones: what we know about the processes of innovation and transition that lead to transformation, and the reminder of key elements of SDPS, including SD-climate relationships. Figure TS.33 would be a good backdrop for this, referring back also to the opening Figures in the Technical Summary, and the international interrelationships that could support such a shift including accelerated global diffusion of low carbon technologies and the financial needs. To deliver the above it would help if Chapter 16 could be expanded to cover transition dynamics more fully, but failing that I think there is enough material in relevant sections of Chapter 1 to draw on.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	TS structure has been revised
66671	0				The TS could thereby help address the paradox observed that whilst SR1.5 emphasised transition and transformation, there seems to be no focal point in AR6 for the associated literatures, and the components are scattered across chapters. These literatures emphasise intimate connections between behaviour, market policies & structures, technology-push, and wider socio-technological transition processes. They ALSO point to the role of finance, and strategic expectations such as may be formulated through international agreements.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted - this section has been revised
66673	0				This might also help to indirectly address a weakness in much of the academic transition literatures, that they are often quite abstract and conceptual. Our real content lies in Chapters 13-16, but at present this content has no coherence and its impossible for most readers to draw any integrated insights about how the bits might fit together.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
31089	0				The Technical Summary is weak in presenting a coherent solution or family of solutions to the climate crisis. There ought to be a special section that presents a viable two year transition plan to zero anthropogenic carbon release, with several alternatives. It is unreasonable for the authors to assume that governments will be able to put this together themselves without a roadmap.	Daniel Helman	Micronesia, Federated States of	TS structure has been revised - TS follows chapter content
66675	0				So restructuring TS.6 could help a more consistent and policy-relevant exposition of the materials there – (with particularly the Ch.13 empirical policy analysis moved earlier in the report as flagged): charting what kind of actions, institutions, and social and financial processes across the multiple dimensions would actually have any chance of starting the global trajectory downwards consistent with the Paris targets. At present TS.6 appears as a set of disjointed chapter summaries, on different topics, disciplines, and languages. It could and should be restructured to provide the analytic depth and connections across the chapters (including relevant aspects of Chapter 5), to support the final sections of the SPM in a far more coherent way.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	TS structure has been revised
31109	0				The technical summary does a poor job in presenting the pressing case for a new climate treaty. Under the Paris Agreement, the energy transition is too slow to prevent catastrophic results from <u>climate change</u> .	Daniel Helman	Micronesia, Federated States of	Noted
67359	0		0		General comment on sectoral models vs IAMs - Several chapters of the report contrast mitigation potential from sectoral models with that of IAMs. This is a welcome development. The finding that mitigation potentials from sectoral models tend to be larger is useful, but it is not obvious how policymakers are supposed to make use of this information. Perhaps a short box could be added to the TS and a statement added to the SPM. In particular, why does this difference occur? If sectoral models are closer to the ground, why do we still need IAMs? What implications does this difference have for how we interpret IAM evidence? e.g. presumably the mitigation pathways in Table SPM.1 / TS.1 are still robust, and the additional evidence from sectoral models means there may be more/ cheaper options for achieving these reductions than IAM evidence alone would suggest.	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.
18609	1	1	135	27	Policymakers will be particularly interested in information regarding peak emissions years and timing of global net zero for both CO2 and GHGs. However, in the current draft, the information presented in the report does not accurately reflect the analysis or give a clear picture of these key characteristics of pathways for 1.5 and 2C. The text over-simplifies some of the key results of the report and could lead to misinterpretation of the scale of action required. Please ensure that all instances where these complex results have been simplified are checked for the extent that they reflect the actual results, including their nuances, limitations and ultimate utility for policy makers.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	accepted - text thoroughly revised

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18611	1	1	135	27	Given that the most likely publication date for WGIII will be 2022, there is an issue throughout the report regarding the appearance of using out of date data i.e. the most recent emissions data used in the report will be from 2018 and none of the policies described as "current policies" will include anything from COP26 or, most likely, after 2020. As a result, we request that: 1) authors ensure that it is very clear which data are being used in any analysis or discussion. In particular, we propose that "current policies" is not used at all and that it is replaced with "2018 policies" or similar so that there is no confusion regarding the basis of WGIII analyses. 2) authors clarify the nature of data where it could be confusing to readers e.g. observations or model results? 3) authors should make every effort to update data, analyses and discussions where possible. Whilst we accept that there is a cut-off date for literature that can be cited in the report, it is also possible for authors to conduct their own analyses to feed into the report. This could, for example, have a large positive impact by attempting to incorporating NDC pledges up to COP26. For example, Figure SPM.6 specifies that it does not include updates submitted since November 2020, however there have been notable updates since this – the UNFCCC has recently produced an NDC synthesis report, which could be examined in line with the guidelines on grey literature - and there will likely be more before the end of 2021, potentially significantly affecting these scenarios. We would urge the authors to constantly revisit this and other findings related to NDCs, such that it is as up-to-date and policy-relevant as possible at the point of publication.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	accepted - date of "current policies" specified. Material as up to date as possible
18613	1	1	135	27	We are concerned that the groupings of countries used throughout the report, be that regionally or along developed/developing-type lines, is not logical, consistent or transparent. It needs to be clear why specific groupings have been used (ideally showing that the groupings are representative of their members), that they can be compared with other analyses (particularly within the WGIII report but also across all the WG reports and aligned with the UNFCCC) and it must be obvious which countries are in groups when they are used.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Accepted - addressed in Annex II
81757	1	1	39	6	Page numbering changes from "TS-<section>-<page>" to "TS-<page>" conventions (from page 40 onwards). This should be addressed.	Government of New Zealand	New Zealand	accepted - revised in TS and chapters
17763	1	6	1	9	(b TS.1) very useful, including excellent figure TS.1, and likely to attract a lot of interest. ...	Jonathan Lynn	Switzerland	Noted
17765	1	6	1	9	...Should be highlighted in the communications materials. Consider bringing into the embargo package along with the SPM	Jonathan Lynn	Switzerland	noted
3977	1		135		The text is very clear, complete and objective. It brings, in my understanding, fundamentally all the information pertinent to the treated subject. The section is very well written and the authors were very responsible and assertive in dealing with the subject in question. For these reasons I have nothing significant to add as I understand that the topic is being treated very clearly and completely. The authors are to be congratulated for the excellent work.	FABIO RUBENS SOARES	Brazil	Noted
30271	2	1	3	7	Throughout the Technical Summary there are several Boxes that are of high interest for readers on many relevant areas. Please consider to expand the table of content by including these boxes, to increase accessibility and visibility of these boxes. This would look similar to the established practise of including the Cross-Chapter Boxes in the Table of content to the underlying chapters.	Government of Norway	Norway	Noted - TS TOC has followed past convention
53079	2	1	3	7	The order of the sections in the Technical Summary should be consistent with the chapters order in the WG3 report.	Government of Saudi Arabia	Saudi Arabia	accepted - text thoroughly revised
24295	2	3	2	7	the numbering of the pages must be homogeneous	Government of France	France	accepted - text thoroughly revised
24297	2	31	2	32	the numbering of the pages must be homogeneous	Government of France	France	accepted - text thoroughly revised
77081	4	1	135	27	All of Comments #1 to #15 apply to the TS.	Jim O'Brien	Ireland	Noted
65579	4	1	135	27	"TS. 1 The changed global context since AR5" feels like the change in global context ON LAND since AR5, ignoring SROCC and IPBES Global Assessment	Mônica M. C. Muelbert	Brazil	accepted - text thoroughly revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
65581	4	1	135	27	It would be useful to know that {N.n.n} refers to other chapters in this Redport Draft. Better yet, exactly what section is referred to in the corresponding chapter. 11.1 should be Chapter 11 (Industry - Introduction and new developments)	Mônica M. C. Muelbert	Brazil	accepted - text thoroughly revised
53083	4	1	4	1	Ch1: There are multiple terms used when talking about net zero and it is not always clear what is being referred to specifically (e.g., net zero CO2 emission, net zero GHG emissions, net zero emissions, carbon neutrality, net zero carbon, etc...)	Government of Saudi Arabia	Saudi Arabia	accepted - text thoroughly revised terminology harmonised
30329	4	1	4	1	Suggest not using the acronym AR5 but using the full report title here with or without the acronym	Vanessa Lamers	United States of America	accepted - spelt out in first use
14343	4	7	4	7	"initial self-determined national contributions" should read "initial nationally-determined contributions". It is important to use the correct terminology.	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	accepted
83259	4	7	4	7	In the Paris Agreement language it is one "long-term temperature goal" (not limit) - should be used throughout the whole TS	Geden Oliver	Germany	accepted
30331	4	9	4	9	Confused here. Potential to do what? Confusing sentence.	Vanessa Lamers	United States of America	accepted
28201	4	14	4	16	Delete "- to be accomplished through facilitative means and global pressure, including by attracting and engaging various non-state actors, at multiple levels of governance to the global effort".	Eleni Kaditi	Austria	accepted - text revised
30333	4	16	4	16	Add comma - "The literature underlines, for many countries, an intimate . . ."	Vanessa Lamers	United States of America	accepted
46727	4	16	4	17	Please mention that the Paris Agreement also includes several references to sustainable development.	Government of Germany	Germany	Noted - text on paris revised
79671	4	17	4	19	The sentence on SD and Agenda 2030 is not fully pertinent. Clearly, climate change strategy should be taken in the framework of SD in order to respect other environmental constraints, take into account social development and equity. All negotiations and ARs have been going deeper into this direction over time while detecting the connections between these various aspects. However, the position of Agenda 2030 is a bit different. In 2012, at Rio, a global review of the SD situation has been done. And in order to respond to the environmental, social and economic challenge a series of concrete actions to be accomplished by 2030 were needed. In 2015, the 169 actions/targets were adopted as the urgent actions to take in the short term. They are interlinked and interdependent. They have been grouped in thematic domains for ease of reference, the SDGs. These thematic domains cover domains of SD. Then the question is how to use them. For the benefit of the report I see 2 levels because the perspective here is clearly over the 2030 deadline of SDGs. Level 1: use the domains SDGs as the structure of SD, taking into account interdependence for gross evaluation of SD trajectory, notably by analysing impact of evaluated measures on the various issues. This first level is not directly related to the concrete Agenda 2030. Level 2: analyse the contribution to the targets (relevant targets) on the short term both positive or negative. This second level depends on the analysis of literature and are often scarce. Therefore the sentence should read "... wider need for sustainable development, and to 2015 UN 'transforming... Agenda for Sustainable Development'. no reference to the sole 17 SDGs are needed here. Then, the question is how to use it in the evaluation as a structure. It complements the TS Table 2 on assessment of barriers, but in another space. It cannot be combined as proposed in section 6 on energy. Doing so will recognize the position of Agenda 2030, and the evaluation proposed in the report.	Marc Daras	France	Noted - text revised
14345	4	18	4	18	"adopted" is not the right word here "set out" would be better.	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	noted
28203	4	26	4	26	Replace "growing number of 'net zero' emission commitments" with "growing number of 'net zero' emission announcements".	Eleni Kaditi	Austria	accepted
53089	4	27	4	27	Ch1: Omit "More diverse" and add the word pathways after development.	Government of Saudi Arabia	Saudi Arabia	accepted

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
53081	4	28	4	28	Ch1: 2018/9 not clear, is it 2018 or 2019?	Government of Saudi Arabia	Saudi Arabia	accepted
72891	4	28	4	29	« The increasing but nonetheless slowing trend of GHGs to 2018/9 reflect significant partial decoupling of emissions from economic growth... ». The use of the world « decoupling » to characterize « partial decoupling » is misleading.	Antoine BONDUELLE	France	Noted - text revised
24299	4	28	4	30	A 'slight absolute reduction' is not compatible with a 'significant decoupling'	Government of France	France	Noted - addressed in chapters
66401	4	30			Presumably means developed	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	noted
14347	4	30	4	30	"as has the developing world" should presumably read "as has the developed world".	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	accepted text revised
30335	4	30	4	30	Many extra spaces after "basis"	Vanessa Lamers	United States of America	accepted
7207	4	31	4	31	Who does "their" refer to? The sentence is hard to understand.	Debra Roberts	South Africa	accepted text revised
83261	4	38	4	38	A more general decision needs to be made whether to prioritize net zero CO2 (as done here) or net zero GHG (as done by policymakers), or both - and then carried through	Geden Oliver	Germany	Noted - addressed in chapters- TS text revised
66403	4	40			This should also refer to the Figures TS.11 and TS.17 and the authors should strive to either combine or reconcile these two different versions of possible trajectories to 2050 and their implications for net zero. It is not sufficient to assume that "recent studies provide a better understanding of trajectories" refers only to global long-term modelling developments. National plans and modelling, particularly in the context of legislated net zero goals and pathways, are at least equally relevant.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
53085	4	40	4	40	Ch1: Replace the phrase "The associated IAMs also" with "Recent studies also"	Government of Saudi Arabia	Saudi Arabia	accepted - text revised
83263	4	41	4	42	Unclear why CDR is presented as something different from mitigation (it isn't), and even if treated as one strand of mitigation, why it would need to be singled out. Demand reduction would also reduce challenges associated with accelerating nuclear, biofuels, hydrogen, dietary changes or building renovation (maybe not with Brexit, though)	Geden Oliver	Germany	accepted - text revised
53087	4	43	4	43	Ch1: omit the phrase "Improved representation of system dynamics" since it is vague and does not say exactly what specific system dynamics	Government of Saudi Arabia	Saudi Arabia	accepted - text deleted
24301	4	44	4	44	We suggest to replace "avoids reliance on net ..." with "limits reliance on long-term net ..."	Government of France	France	accepted - text revised
53091	5	3	5	4	Ch1: What conceptual framework? Also replace "helps" with "is needed"	Government of Saudi Arabia	Saudi Arabia	noted
24303	5	13	5	13	a word is missing between these two words : "and to the end-use ..."	Government of France	France	accepted
24305	5	14	5	14	please replace TS 5.9 with TS 6.1 which is connected to "Demand, services and social aspects of mitigation" also TS.5.9 is connected to "Mitigation potential across sectors and systems"	Government of France	France	Noted - TS structure revised
24307	5	15	5	17	We do not understand this point: comparing abatement costs requires to examine potential trade-offs, synergies, risks and opportunities	Government of France	France	Noted - text revised
7209	5	18	5	18	This section points to the main transition areas highlighted by SR15: energy, land, cities, industry... it would be helpful to highlight these clearly and early.	Debra Roberts	South Africa	noted - links to prior reports highlighted - also in chapters
7211	5	21	5	21	Suggest: ". Some of these could help deliver"	Debra Roberts	South Africa	accepted
66405	5	23			Not much use to policymakers to just say its changed – how? My reading of the sectoral sections of this TS, and the tables from Chapters 5 and 17, is that the balance has improved. See also	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - text revised
7213	5	23	5	23	"trade-offs and synergies" – please specify between what and what.	Debra Roberts	South Africa	accepted - clarified

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66407	5	24	5	25	This is dramatic but a bit misleading, since wind and solar have much lower load factors	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	noted - addressed in chapter
66409	5	25			I suggest, "both fuelled by and amplifying the falling costs ..." – to make point that deployment has been a major driver of cost reductions	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	noted - addressed in chapter - TS text updated
83265	5	25	5	25	probably more appropriate to compare to renewable power capacity	Geden Oliver	Germany	noted
66411	5	26	5	28	This suggests direct causal link. Actually sustained emission reductions have been driven by varied combinations of improved efficiency, new energy sources, and coal to gas switching	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - text revised
7215	5	29	5	29	"Modern food production systems can lead to lower direct emissions" – this sounds like a contradiction. Modern food production systems are a source of emissions: fertilizer, eco-unfriendly monoculture, factories, etc. Suggest "Modern food production systems, an important source of emissions, can be modified to reduce direct emissions..."	Debra Roberts	South Africa	Noted - Text relating to food updated to be consistent with chapter executive summary
20281	5	29	5	31	Reference needed TS section or chapter.	Avelino G. Suarez	Cuba	accepted
30337	5	29	5	31	I suggest a reference here. Some consider this to be the opposite.	Vanessa Lamers	United States of America	accepted
7217	5	32	5	32	Suggest to mention first that urban areas house x% of the human population, and produce x% of total emissions (x% through direct usage and x% through demand-side...) followed by mitigation message.	Debra Roberts	South Africa	accepted - included in TS section on urban
72211	5	34	5	35	The suggestions that it is common practice to have NZEBs both in new construction and retrofits is far from reality. There are some examples but it is not yet the widespread practice. The EU has mandated for new construction to be near zero energy buildings from 2021, which are still far away from NZEBs, perhaps a more moderate tone indicating that there are examples in some jurisdictions should be used in this statement. It is in general advisable to be realistic rather than convey wrong messages to policy makers that they have already taken the right actions.	bertoldi paolo	Italy	accepted - Chapt 9 executive summary revised
67361	5	34	5	35	the suggestions that it is common practice to have NZEBs both in new constructions and retrofits is far from reality. There are some examples but not yet the widespread practice. In the EU will should have near zero energy buildings, which are still far away from NZEBs, perhaps a more moderate tone indicating the there are example could be used here.	Philippe Tulkens	Belgium	accepted - Chapt 9 executive summary revised
10469	5	35	5	35	what does the {ES Ch 9} reference mean?	Philippe Waldteufel	France	accepted
54407	5	39	5	39	The technology suite is well beyond hydrogen.	Government of United States of America	United States of America	noted
54409	5	40	5	41	Implies each sector individually vs. economy-wide net zero, potentially including CDR/CCUS, afforestation, etc.	Government of United States of America	United States of America	noted - addressed in chapter
53093	6	1	8	38	Ch1: The box contains several speculative statements (P7-L7,9,19, P8-L18) using the word "may", and it is not clear if the statement is based on an assessment of the peer-reviewed scientific literature or the authors' opinion and speculation. Rework.	Government of Saudi Arabia	Saudi Arabia	accepted - text revised
24309	6	8	6	8	We suggest to indicate in a footnote that the concept of "just transition" is defined further in the text, in the box TS.8	Government of France	France	Accepted - JT box included
66413	6	30			Text refers to challenges, which may be a better term	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - text revised
7219	6	30	6	30	Please refer to WGI Covid box, to put especially the opening sentence into perspective. This paragraph implies that Covid has had a major impact on climate change, but it hasn't.	Debra Roberts	South Africa	Accepted - Box completely revised
7221	6	30	6	30	This box seems to contain highly relevant and important information but currently the language is very inaccessible. Please revise the text for more generalised audience.	Debra Roberts	South Africa	Accepted - Box completely revised
83267	6	30	7	13	Why the focus on 2019-2021 CO2 emissions? Better to give the full picture with GHGs, which probably means that the decline was not so drastic, and the rebound will not be so drastic	Geden Oliver	Germany	Accepted - Box completely revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
14349	6	30	8	38	Box TS.1 contains important material, but it doesn't make sense to set this material out in the form of a box, when that box covers one full and two half pages. Either retain the box, but present on (just) <u>two facing pages, or include as a narrative section, without a box.</u>	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Accepted - Box completely revised
12661	6	30	9	9	Several chapters have sections on covid-19. A lot of repetition could be avoided by consolidating the discussion in one place. Furthermore, it could be much shorter. By the time AR6 is adopted in 2022 virtually all of the covid stimulus packages will be history and governments will be focused on how the deal with the debt incurred for the stimulus packages. It might be sufficient to limit the discussion to the statement that the green component of the covid stimulus was smaller (larger?) than the 2009 depression stimulus with some analysis of the reasons for the difference.	Erik Haites	Canada	Accepted - Box completely revised
81449	6	31	6	31	It's missing the hyphen from COVID-19 (Box TS.1)	Luana Ferreira	Brazil	Accepted - Box completely revised
7223	6	40	6	42	Can this sentence be written more clearly? E.g. mention "this failure to anticipate enormous, complex and indirect knock-on effects". Also reword the next sentence to make it clearer what is meant. E.g. "compared to these unforeseen impact costs, the cost of preparatory action was negligible".	Debra Roberts	South Africa	Accepted - Box completely revised
24311	6	42	6	42	We suggest to precise what this comparison refers to	Government of France	France	Noted
85249	6		7		For the COVID box, I suggest to not just focus on the "low probability, high impact" dimension of climate-related risks, but more generally information on climate-related risks. Regarding the statement that air pollution itself amplifies vulnerability to COVID19, this seems a point that requires careful consideration of the emergent literature (including discussion related to the effects of air quality versus the effects of weather situations leading to both increased pollution levels and affecting respiratory systems). This requires careful coordination with the COVID19 box in the health chapter of WGII. Note that WGI provides an assessment of air quality implications of lockdown measures (contrasted effects for different aspects) (see WGI chapter 6).	Valérie Masson-Delmotte	France	Accepted - Box completely revised
7225	7	6	7	6	Please explain "e-micromobility"	Debra Roberts	South Africa	noted - clarified in text and chapter
63991	7	6	7	6	Remove the ")"	Government of Canada	Canada	accepted
77083	7	7	7	8	The statement that at 2018 levels, the global "carbon budget will be exhausted before 2030" is clearly implausible and demands a reality-check in the light of real-world observations, as in <u>Comment #1 above.</u>	Jim O'Brien	Ireland	Noted - comprehensive discussion in chapter 3 and chapt 4
86259	7	8	7	9	There is no consensus at all about a transmission of COVID19 by pollution particules.	Sophie Szopa	France	Noted - Box completely revised
77271	7	9			The sentence "and that the virus may be carried on diesel particles" adds little, also because of its uncertainty, and might be perceived as factionist. It is proposed to remove it.	Giacomo Grasso	Italy	Noted - Box completely revised
81451	7	9	7	9	It's missing the hyphen from COVID-19 (Box TS.1)	Luana Ferreira	Brazil	Noted - Box completely revised
65331	7	10	7	15	It would be helpful to know if there is at least one developing country included in the 50% GHG reduction country examples, and if so, to note that 'there individual examples include both developed and developing country economies. Appreciate that the graph on the next page shows this is unlikely, but if any individual developing countries have achieved 50% reduction, it would be <u>inspiring to highlight a success.</u>	Lindsey Cook	Germany	Noted - additional detail in chapter 2
46729	7	14	7	27	Please add the inequality in the access to vaccination.	Government of Germany	Germany	Noted - Box completely revised
81453	7	15	7	15	It's missing the hyphen from COVID-19 (Box TS.1)	Luana Ferreira	Brazil	accepted
63993	7	17	7	17	Please detail what IMF means	Government of Canada	Canada	accepted - text revised
81455	7	22	7	22	It's missing the hyphen from COVID-19 (Box TS.1)	Luana Ferreira	Brazil	accepted
7227	7	23	7	23	Replace the phrase "raises the spectre" for non-first language English speakers.	Debra Roberts	South Africa	accepted
64439	7	25	7	26	I consider relevant clarify which new inequities could arise because COVID-19 pandemic	Adriana Silva	Venezuela	Noted - Box completely revised
81457	7	27	7	27	Sug+H126:H127gestion, not mandatory: see paper Jurjonas et al. (2020). Uncovering climate (in)justice with an adaptive capacity assessment: a multiple case study in rural coastal North Carolina. Land use Policy. 94, 104547	Luana Ferreira	Brazil	Noted - addressed in chapter

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
24313	7	29	7	29	please rephrase such as "whilst transport reduction has mostly affected oil demand"	Government of France	France	noted - rephrased
77273	7	32			Strictly speaking, renewables were not the "only energy sector to increase output": nuclear as well increased.	Giacomo Grasso	Italy	accepted
24315	7	35	7	35	replace 15.2.1 with 15.2.3	Government of France	France	accepted TS structure and line of sight to chapters revised
7229	7	37	7	44	Is there evidence that this is happening, or is this a hopeful statement? Next paragraph suggests the latter. Suggest to rephrase and include information on how this opportunity might be realised.	Debra Roberts	South Africa	Noted
7231	8	14	8	14	Please spell out what the "the role of 'just transition' approaches" might look like. The paragraph illustrates the problem, but not the solution.	Debra Roberts	South Africa	Noted - Box on JT added
7233	8	22	8	22	What are "incumbent (meso-level) systems"?	Debra Roberts	South Africa	accepted - explanation included in legend and chapter
7235	8	27	8	28	This sentence seems to be about institutional change in general. What does 'leapfrogging' mean in this context? It is normally associated with jumping to low carbon technologies.	Debra Roberts	South Africa	accepted - text revised
28205	8	29	8	31	Delete "Given the unambiguous risks of climate change, and consequent stranded asset risks from new fossil fuel investments (Box TS.9), the most robust recoveries are likely to be those which emerge on lower carbon and resilient pathways.", as this statement does not take into consideration national circumstances and capabilities.	Eleni Kaditi	Austria	Noted - text in box updated to reflect chapter
81459	8	38	8	38	It's missing space between 'l' and 'in' (Box TS.1)	Luana Ferreira	Brazil	accepted
81461	9	1	9	1	What does mean 'Power' on Panel b, figure TS.1? Does mean electric power industry?	Luana Ferreira	Brazil	Noted - explained in chapter
53095	9	1	9	1	Ch1: In P1-L32, the chapter mentions that the pandemic has led to the lowest dip in CO2 since WWII. The top panel should be extended to 1930 instead of 1970 to capture that point.	Government of Saudi Arabia	Saudi Arabia	noted
18615	9	1	9	9	Figure TS.1 - the vertical axis label is used for both graphs (a) and (b). Graph (a) should have the label 'Daily fossil carbon emissions (MtCO2/day)' and graph (b) should have the label 'Change in Daily fossil carbon emissions (MtCO2/day)'.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	accepted - figure revised
28207	9		9		Figure TS.1: replace "fossil CO2 emissions" with "energy related CO2 emissions".	Eleni Kaditi	Austria	Noted - figure revised
83269	10	2	10	2	If this is about the temperature goal only (as "GHG emissions trends" seem to indicate) then please use the singular, as in LTTG	Geden Oliver	Germany	accepted
66415	10	3			Policy prescriptive?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised
24317	10	11	10	12	We suggest adding the UN graph of the 17 SDGs and referring to that figure anytime it is relevant	Government of France	France	accepted - SDGs spelt out
63995	10	12	10	12	Again, need to refer to a description of the SDGs	Government of Canada	Canada	accepted - SDGs spelt out
28209	10	12	10	14	Delete "While the falling cost of some low carbon technologies enhances opportunities for mitigation, low fossil fuel prices, combined with institutional and political inertia, could pose challenges.", as this is not a policy neutral statement, and energy demand is not determined by prices and policies only, but also by economic and population growth.	Eleni Kaditi	Austria	Noted - chapter provides extended discussion
66417	10	21			More specific insights can also be drawn from Figure TS.2. These include that (a) many developing country regions have developed with lower per capita emissions than the historical global average, (b) there are large variations in emissions between regions at similar levels of HDI, with (c) particularly wide variations at higher levels of HDI. Ideally, referring back to the component panels in Chapter 1 Figure 6, clear relationships between income and per-capita emissions largely break down for income above US\$10-15,000/capita / HDI of 0.5 or above.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - chapter provides extended discussion
7237	10	21	10	21	What kind of "International co-operation" would help? Please be specific. For example, International cooperation that aims to reduce inequalities and injustice and build wealth, capacity and capabilities in particularly under-resourced regions?	Debra Roberts	South Africa	Noted - chapter provides extended discussion

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
85251	10		10		Please consider carefully the choice of examples of extreme events provided line 5 and the possibility to more closely reflect the WGI assessment of changes in characteristics of a changing climate (means, trends, extremes, values above tolerance thresholds...) that have already been experienced and are attributed to the human influence to the climate system (suggestion to consider tropical cyclones rather than just hurricanes, and also extreme heat).	Valérie Masson-Delmotte	France	Noted
46731	11	0			Figure TS.2 Panel A: The green dashed lines and the words "Negative GHG ..." are unclear, country groupings not explained and do not seem to follow a clear logic; it is unclear why the caption refers to both HIHD and HDI. Panel B is entirely unclear. Please see also our comment on country groupings on the Entire Report. We suggest deletion of this figure or significant improvement.	Government of Germany	Germany	Noted - Figure comprehensively revised
7239	11	0	11	0	Figure TS.2 (a) it would be better to label the countries/regions on the graph itself, the colour legend is not helpful.	Debra Roberts	South Africa	Noted - Figure comprehensively revised
84681	11	0	11	0	The panel a) is difficult to read. Hoping to have more contrast in the colors. The panel b) is difficult to understand.	Kaisa Kosonen	Finland	Noted - Figure comprehensively revised
66419	11	1			I think this is a really important chart, but clearly the layout needs improving so that one can actually tell the different regions apart. Personally I think it should be elevated to the SPM. If it is considered too complex and/or politically sensitive for SPM, note that Chapter 1 Figure 1.3 presents per-capita emissions data at level 2 disaggregation (and could be considered instead for SPM) in which case underline that this chart contains the more disaggregated, 'level 3', per-capita data, shown in relation to income levels for added insight .	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised
8195	11	1	11	1	Figure TS.2: Please revise figure. The contrast of the colouring in panel a) is too weak, several regions can hardly be distinguished, and the 1.5 and 2°C emissions curves are not legible, too.	Joachim Rock	Germany	Noted - Figure comprehensively revised
8197	11	1	11	1	Figure TS.2, panel b: Please revise figure. If the x-axis displays the mean or a cumulative measure of the SDGs and other sustainability goals, a transformation pathway that lowers this mean / accumulation is very unlikely to be accepted. Societies will strive to compensate reductions in one aspect by gains in another, so the mean of / sum over all aspects should not decrease for developed countries (nor for any other country, too).	Joachim Rock	Germany	Noted - Figure comprehensively revised
15397	11	1	11	1	Panel a: Some of the colors of bubbles are not distinguishable each other. Why don't you attach numbers for them?	Hiroaki Kondo	Japan	Noted - Figure comprehensively revised
15399	11	1	11	1	Panel b: Why are there three SDG rings? Is the horizontal axis the same as that of panel a?	Hiroaki Kondo	Japan	Noted - Figure comprehensively revised
53097	11	1	11	1	Ch1: The quality of the figure is poor, and it is hard to read. Also, the dashed lines and the phrase "Negative GHG emission zone" below the x-axis is not explained in the text nor in the caption. Omit	Government of Saudi Arabia	Saudi Arabia	Noted - Figure comprehensively revised
63997	11	1	11	1	Figure TS.2: Panel (a) - Major comment - while we understand the multiple green dashed lines are indicating a transition to net zero per capita GHG emissions, we suggest these unnecessarily complicate what is otherwise a very straightforward figure. Consider deleting these from the Figure. Also, suggest adding the year 2015 to both x and y-axis labels.	Government of Canada	Canada	Noted - Figure comprehensively revised
63999	11	1	11	1	Figure TS.2: Panel (b) - The message from this panel is that all countries should be aiming for zero per capita GHG emissions. While this is consistent with aiming for a global net zero GHG emissions world, as committed to in the Paris Agreement, it may be surprising to those less familiar with this goal. It would be useful to add this context to the figure caption.	Government of Canada	Canada	Noted - Figure comprehensively revised
14351	11	1	11	10	Panel a provides useful information, but the colours are not sufficiently distinct.	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised
83489	11	1	11	10	In panel B, an indication of the direction along which the various trajectories are followed might help the reader understand the visual more quickly.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised
18617	11	1	11	10	Figure TS.2 contains some useful information but requires more work. In particular, the caption is inadequate and requires much more detail for the reader to understand what is being shown.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
18619	11	1	11	10	Figure TS.2 (panel a) - It's not clear what the "negative emissions zone" is trying to show or what the horizontal 1.5C/year lines are trying to indicate - presumably they are targets? Could they be explained?	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised
18621	11	1	11	10	Figure TS.2 (panel b) - I think this graph (or is it more of a conceptual model of sustainable development?) is confusing and needs much more explanation or should be removed. What is the scale of the horizontal axis? (e.g. what does "high SDG mean"?) Why are there 3 SDG circles? What do the dotted lines mean? A clear conceptual model of how different groups of countries reduce GHG emissions and met the SDGs would be good but this plot does not do that yet.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised
64001	11	2	11	2	Panel b of the Figure TS2 is hard to understand without further explanations in the figure caption	Government of Canada	Canada	Noted - Figure comprehensively revised
10471	11	2	11	2	colour code of panel 1 in figure TS.2 is not easy to discriminate	Philippe Waldeufel	France	Noted - Figure comprehensively revised
53099	11	7	11	8	Ch1: "closely related to this" what is meant by "this" here? "global average trends" it is only one trend shown in the figure (the red line), and it should be 1987 to 2014 rather than present.	Government of Saudi Arabia	Saudi Arabia	Noted - Figure comprehensively revised
66421	11	8	11	9	The regional disaggregations are actually quite fundamental and given the effort to be consistent, surely they should be summarised in a box here that readers can refer to easily to understand the coverage at the 3 different levels.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised
1371	11	9	11	10	The key message in Panel B is hardly understandable. The figure is unclear and need improvement. For instance, how is defined the position in axis X corresponding to the SDG ?	Julien Demenois	France	Noted - Figure comprehensively revised
67363	11		11		Figure TS2 - presumably the historic emissions per capita (red line) merely shows progress over time - i.e. the HDI axis does not apply to this series. That could be clarified.	Philippe Tulkens	Belgium	Noted - Figure comprehensively revised
28211	11		11		Figure TS.2: panel (b) is not clear. Based on which assumptions were the presented pathways analysed?	Eleni Kaditi	Austria	Noted - Figure comprehensively revised
24319	11		11		Figure TS.2 is informative but rather difficult to fully understand. More detailed explanations in the legend would be useful. A better contrast between the various colors used would make the diagram easier to read. The key message in Panel B is hardly understandable. How is defined the position in axis X corresponding to the SDG ?	Government of France	France	Noted - Figure comprehensively revised
72215	12	1	12	18	The sociological framework perspective shall also be mentioned here. Very often, social norms dictate people behaviour. In addition, MLG is mentioned in the highlighted text but not indicated why it is important (and of course it is of key importance for mitigation), several chapters deals with MLG.	bertoldi paolo	Italy	Noted text revised
67365	12	1	12	18	The sociological framework or perspective shall also be mentioned here, Very often social norms dictate people behaviour. In addition, MLG is mentioned in the highlighted text but not indicated why it is important (and of course it is of key importance for mitigation).	Philippe Tulkens	Belgium	Noted text revised
7241	12	1	12	18	The key message re "integration of broadened assessment frameworks" should come earlier. Suggest to shorten sentence. Entire two paragraphs are difficult to understand. In comparison, the following paragraph on transitions is short, punchy and clear.	Debra Roberts	South Africa	Noted text revised
77085	12	1	12	2	The text refers to "dangerous" anthropogenic interference: using the word "dangerous" is neither justified nor appropriate to a scientific report, nor consistent with Comment #1 above.	Jim O'Brien	Ireland	noted - text reflect chapter
24321	12	2	12	2	Please make the formulation more precise by writing: "a stabilization of the increase in temperature"	Government of France	France	noted - text revised
53101	12	7	12	9	Ch1: what is meant by the "trend" of economic assessments of costs and benefits? This whole paragraph and the next one talk about the need of holistic modeling framework. Also the term "Likely" should be Italic. Omit this sentence. It is repeated again in P30, L40-45 & P33, L7-13.	Government of Saudi Arabia	Saudi Arabia	accepted - text revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
46733	12	7	12	9	We doubt that the statement "The trend of economic assessment of costs and benefits suggests that temperature stabilization below 2 °C is likely to be economically optimal at the global level and over the full century." can be true. Stabilization at 2°C could include overshooting of any degree resulting in triggering non-reversible tipping points and large-scale losses and damages. And does this calculation include damages versus avoided damages, and how are non-monetary values factored in? Please reconsider and revise this statement. It would also be interesting to learn about <u>the economic assessment at 1.5°C global warming</u>	Government of Germany	Germany	accepted - text revised
46735	12	7	12	9	Please add information on 1.5°C	Government of Germany	Germany	Noted
84683	12	7	12	9	"The trend of economic assessment of costs and benefits suggests that temperature stabilisation below 2°C is likely to be economically optimal at the global level and over the full century" . This sentence, without broader context of how this was arrived at and what the 'economic assessment of costs and benefits' contain and what not, is highly confusing and could be read as the IPCC favouring 2°C as the 'smart' objective. Given the limitations of cost-benefit analysis elaborated on elsewhere in the report, and the warnings of using IAMs as a stand-alone analysis tool, I find it <u>contradictory to find such blunt statement in the Technical Summary</u>	Kaisa Kosonen	Finland	Noted - paragraph revised
24507	12	8	12	8	Make the formulation more precise by writing: "a stabilization of the increase in temperature"	Government of France	France	Noted - paragraph revised
30339	12	19	12	19	I believe this should be a semi colon (;) not a colon (:)	Vanessa Lamers	United States of America	accepted
81463	12	24	12	24	What does mean 'R&D', figure TS.3?	Luana Ferreira	Brazil	accepted - spelt out in first use
81465	12	24	12	24	Suggestion, not mandatory: Budget is an important point to be considered into this transition, mainly in <u>the third pillar</u>	Luana Ferreira	Brazil	noted
66423	12	25			The Figure in Chapter 1 has legal description in the panel which is missing here.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	noted - figure revised
7243	12	30	12	32	Can policies culminate in transformations? This is confusing. The sentence starting with "Avoiding" is also not clear, and reads like a circular argument. This sentence can be deleted, as the idea is <u>expressed more clearly in the last sentence of this paragraph</u> .	Debra Roberts	South Africa	accepted - text revised
7245	13	3	13	3	This bold statement states the obvious, that our choices determine the outcome. Try capture the message of the supporting sentences which talk about lock-in, failure for general commitments to <u>lead to action, the role of policies</u> .	Debra Roberts	South Africa	noted - lock in addressed elsewhere in TS
7247	13	11	13	15	This paragraph implies 'reduced' demand, but doesn't say so explicitly. Shifting demand is also <u>valuable, but the biggest mitigation is through lower consumption</u> .	Debra Roberts	South Africa	Noted - paragraph no longer included
50025	13	12	13	12	The statement "Lifestyle changes can rapidly ..." needs qualification about conditions. For instance, <u>a shift away from red meat could be controversial in some regions</u> .	Masahiro Sugiyama	Japan	Noted - paragraph no longer included
24323	13	16	13	18	The word unanticipated or the word mis-perceived could be added before "risks from policy, behaviours and technological change". If the risk was correctly anticipated, there would be no need for <u>regulations</u> .	Government of France	France	Noted - paragraph no longer included
84685	13	16	13	24	Please include here the finding from Chapter 15 (page 3, lines 6-7) that "Yet, climate-related financial risks are still massively underestimated by financial institutions and markets, limiting the <u>capital reallocation needed for the low-carbon transition</u> ."	Kaisa Kosonen	Finland	Noted - paragraph no longer included
24325	13	21	13	22	We suggest to add "or worldwide long term climate policy" at the end of the sentence	Government of France	France	Noted - paragraph no longer included
28213	13	22	13	24	Delete "Central banks' regulatory, and policy barriers for commercial funding include a mismatch between capital and investment needs, home bias considerations, and risk perceptions between developed and developing countries." <u>as this is not a policy neutral statement</u> .	Eleni Kaditi	Austria	Noted - paragraph no longer included
7249	13	22	13	24	This sentence is not clear. Does the 'mismatch' refer to all three examples?	Debra Roberts	South Africa	Noted - paragraph no longer included
7255	14	0	14	0	Figure TS 4 (a) the bars for AR2 do not seem to agree with the graph in 1996 (the year AR2 was published) ; "Waterfall diagrams juxtaposes" – reword, just call them bars ; (b) the Y-axis units are strange: 0.9, 1.2, 1.5? and X-axis should show the decades as in panel (a). Can you add a graph for <u>the fluorinated gases?</u>	Debra Roberts	South Africa	accepted - figure revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66425	14	1			This is a rich but long sector. I wonder if could be clearly organised into global, regional, and sector trends, then then technology trends? Also note my TS cross-cutting comment – to extent possible it would be good if any notably positive trends could be flagged and linked to policies?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - TS structure revised
75655	14	1	23	31	The draft text fails to report the recent unexpected and extraordinary increase in global methane levels, an event not foreseen by the AR5 report nor by the models undergirding the Paris Climate Agreement. As such, this increase is a particular salient development that should be highlighted in the Technical Summary. Saunois et al 2016 report that "Unlike CO2, atmospheric methane concentrations are rising faster than at any time in the past two decades and, since 2014, are now approaching the most greenhouse-gas-intensive scenarios....Additional attention is urgently needed to quantify and reduce methane emissions. Methane mitigation offers rapid climate benefits and economic, health and agricultural co-benefits that are highly complementary to CO2 mitigation." Jackson et al 2020 report that "Increased emissions from both the agriculture and waste sector and the fossil fuel sector are likely the dominant cause of this global increase highlighting the need for stronger mitigation in both areas. Our analysis also highlights emission increases in agriculture, waste, and fossil fuel sectors from southern and southeastern Asia, including China, as well as increases in the fossil fuel sector in the United States." Starting in 1990s, the growth in global methane levels began to slow down, and global methane became relatively stable over the period of 2000-2006. A resurgence of global methane was not anticipated and came as a surprise (Nisbet et al., 2019. Turner, Frankenberg, and Kort, 2019. Underwood, 2019.) Crucially, methane levels were considered stable in the pathway models prepared for the Paris Climate Agreement (Nisbet et al., 2019). Nevertheless, global methane levels resumed rapid growth starting in 2007. Growth accelerated further starting in 2014 and extending through 2018 (Nisbet et al., 2019. Turner, Frankenberg, and Kort, 2019. Underwood, 2019). This exceptional growth appears to have continued in 2020 NOAA Earth System Research Laboratory Global Monitoring Division. https://esrl.noaa.gov/gmd/ccgg/trends_ch4/ . The two biggest 1-year jumps over the last 20 years occurred in 2014 and 2015, when the resurgence in global methane that began in 2007 accelerated even further. The most recent six years has recorded the five biggest jumps over the last 20 years.	Cutting Hunter	United States of America	Noted - TS section reflects broader discussion in chapters
83271	14	2	14	2	I'm not aware of such a list but I'm not sure that the majority of countries has made such a (absolute) emissions reduction commitment (let's say in NDCs leading to 2030), and even if, why we would expect an effect already by 2018. So the "despite" is a little problematic	Geden Oliver	Germany	Noted - paragraph revised
84133	14	2	14	9	These comparisons would be much more useful if the rises in GHG were stated separately for CO2 and the non-CO2 gases. As shown in Fig TS.4 the precise values (and changes) vary depending on the precise values of the emission metrics used. And would vary even more strongly if different metrics (GWP20, GTP100) were used.	William Collins	United Kingdom (of Great Britain and Northern Ireland)	accepted text revised
46737	14	2	21	10	It does not get clear in section 3 of the TS, when and why there is data presented from the AFOLU (e.g. p.14, line 8; p.29, line 28; fig. TS.7) and the FOLU-sector (e.g. fig. TS.4 + 5). For the reader it might be difficult to follow why there are changes in the terminology and why the agricultural sector is left out in some figures / sentences. If this is the result of missing data, it could be mentioned in a footnote to increase understanding for the switches.	Government of Germany	Germany	accepted - addressed in chapters

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
11335	14	3	14	3	The global GHG emissions in 2018 reported here (59±5.9 GtCO ₂ eq) is different from the figure reported by UN Emissions Gap Report 2019 (55.3 GtCO ₂ eq) (https://www.unenvironment.org/resources/emissions-gap-report-2019). Also, UN Emissions Gap Report 2020 (https://www.unep.org/emissions-gap-report-2020) has already published the figure of global GHG emissions in 2019 while the latest emissions figure reported by WGIII AR6 is still that of 2018. Since both WGIII AR6 and UN Emissions Gap Report are authoritative UN publications, suggest including 2019 data, giving a brief explanation of the disparity in the main text and adding a footnote in the TS.	SAI MING LEE	China	noted - data used is explained in chapter	
7251	14	3	14	9	What does "this" refer to – the level of the rise? The supporting sentences with numerical details that repeat information from the Figure can be deleted. Instead, one or two sentences interpreting the results would be better.	Debra Roberts	South Africa	accepted - text revised	
18623	14	4	14	4	"this is higher than any previous point in history" This sentence is also mentioned in the SPM but is given medium confidence statement there. No confidence statement is provided here but clarity on how this statement derived. It would be helpful if the two statements were consistent.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	accepted - text revised	
28215	14	5	14	7	Present data using "decades" as defined in Annex B, page 12.	Eleni Kaditi	Austria	noted	
8187	14	8	14	8	Please correct: the sector is called "agriculture, forestry, and other land use". Naming it "AFLUC" as done here would exclude emissions from other land uses than agriculture and forestry. Land-use change is included in AFOLU without being explicitly named.	Joachim Rock	Germany	accepted	
18625	14	10	14	12	The rate of growth of global GHG emissions has slowed with respect to the percentage change but it has not done so with respect to the absolute values. The change from 1990-1999 to 2000-2009 was 7 Gt. The change from 2000-2009 to 2009-2018 was 9 Gt. Therefore in absolute terms the rate of growth has increased from 7Gt in a decade to 9Gt in a decade. To say that the rate has slowed could be misleading and overly positive.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised	
7253	14	10	14	16	Please explain the particular problem with fluorinated gases.	Debra Roberts	South Africa	Noted - Figure comprehensively revised and highlights F-gases more clearly	
66427	14	11	14	12	See Whole Report comment MG7 suggesting to separate, 2010-14 and 2015-19 – gives much greater insight into trends. Also, the slowdown – notwithstanding the continued rise of China – does seem to follow upon the large surge in climate legislation (partially associated with entry-into-force of the KP) noted in Chapter 13? Also - regional trends possibly related to Chapter 2's own section 2.8?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised	
24327	14	13	14	13	Please precise the meaning of the word "levels" in this finding. Is it the concentration of F-gas in the atmosphere or the levels of emission?	Government of France	France	Noted - Figure comprehensively revised	
53103	14	14	14	16	Ch2: Why not show the Fgas in the bottom panel similar to the rest? Also, use a different color for Fgas in the top panel to avoid mixing up with CO ₂ FFI.	Government of Saudi Arabia	Saudi Arabia	accepted	
80485	14	18	14	18	As these graphs are relative to 1990, it would be good to have a horizontal line at 1, as well. (note: typo in "noramlised" on y-axis)	Moritz Riede	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised	
8199	14	18	15	6	Figure TS.4: Please check and revise text: does "Forestry and other land-use" include CO ₂ -Emissions from agriculture (agricultural land use) and fossil fuels from agricultural management or is this excluded, and if excluded, where are these emissions included? This should be explained here.	Joachim Rock	Germany	Noted - Figure comprehensively revised	
84135	14	19	14	19	Fig TS.4 This graph should assess the variation in total CO ₂ eq from using different metrics (GWP20, GWP100, GTP100) for instance as in Tanaka et al. 2020. The small variation between metrics in SAR, AR5 and AR6 is not at all an indication of the uncertainties which are of the order of 30% (as assessed in those WG I reports).	William Collins	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised	
84137	14	19	14	19	Fig TS.4. The percentages here are not useful as they only apply to a very specific metric, they don't account for the uncertainty in that metric ~ 30% and don't account for the uncertainty in using different metrics. The contribution from methane would only be 5% using GTP100 or would be ~ 50% using GWP20.	William Collins	United Kingdom (of Great Britain and Northern Ireland)	Noted - Figure comprehensively revised	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
85253	14		14		See also my remarks on the corresponding SPM section. Please consider reporting emissions trends gas by gas and not only using the aggregated CO2-e metrics. This is important due to the cumulative effect of CO2 on the climate system, and role in terms of effective radiative forcing, and the second most important role for effective radiative forcing of methane (which has a shorter lifetime, and affects atmospheric chemistry and air quality).	Valérie Masson-Delmotte	France	noted - CO2 e metrics only used where necessary	
7257	15	0	15	0	Figure TS 5 The regions used here are unhelpful and uninformative. Are they UN regions? But there seem to be discrepancies? Please consider simple continental groupings, possibly subdividing Asia into developed/emerging/developing ; ideally Africa and Middle East should not be combined. A map should be included.	Debra Roberts	South Africa	Noted - Figure comprehensively revised	
53105	15	4	15	4	Ch2: In the caption, it says panels b-f, but there are only panels a and b.	Government of Saudi Arabia	Saudi Arabia	Noted - Figure comprehensively revised	
67367	15	7	15	14	Figure TS5 - has a curious regional classification that includes 'developed countries' as a region. It is better to split them (e.g. Europe, North America, Asia-Pacific) since the historical emissions trends of these regions have been very different. Figure 1.3 (with its purely regional split) is a better example in this regard.	Philippe Tulkens	Belgium	Noted - Figure comprehensively revised	
83287	15	7	15	9	The uniform reduction rates (Panel b, right) might be perceived to be in conflict with equity considerations	Geden Oliver	Germany	Noted - Figure comprehensively revised	
24587	15	9	15	9	Biomass emissions remain difficult to estimate at large scales in tropical regions, because data from satellites (L-band SAR data) cannot quantify values exceeding 100 Mg.ha-1. After reaching a maximum value, SAR backscatter correlates negatively with forest biomass {2.2.1.2} It should also be noted that current large-scale biomass maps show strong disparities due to a flaw in the validation methods, which ignore spatial autocorrelation in data, leading to overoptimistic assessment of model predictive power	Government of France	France	Noted	
1373	15	12	15	13	That would be useful to add on panel B a boxplot for historical GHG emissions change at global scale to make the comparison easier with the boxplots for the different scenario reduction rates on the right side.	Julien Demenois	France	Noted - Figure comprehensively revised	
24329	15		15		There is only panel b n the figure TS.4. Delete "-e"	Government of France	France	Noted - Figure comprehensively revised	
24331	15		15		That would be useful to add on panel B a boxplot for historical GHG emissions change at global scale to make the comparison easier with the boxplots for the different scenario reduction rates on the right side.	Government of France	France	Noted - Figure comprehensively revised	
28217	15		15		Figure TS.5: to also present cumulative and per capita emissions per region.	Eleni Kaditi	Austria	Noted - Figure comprehensively revised	
7259	16	0	16	0	Box TS 2: some examples would help a non-specialist reader understand the issues, e.g. the life-time and relative warming power of fluorinated gases, versus methane, versus CO2, and comparing two time horizons. Refer to WGI.	Debra Roberts	South Africa	Noted- box revied in TS and chapter to take comments into account	
83487	16	2	16	42	Here one could consider to include the important context that the meaning and ambitious/stringency of emissions targets (such as Article 4.1 of the Paris Agreement) changes if one switches between metrics, and that this ambition would be weakened if one switches to GWP*.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Noted- box revied in TS and chapter to take comments into account	
77087	16	2	16	44	See comment #8 above. In respect of methane emissions, it is unacceptable not to use the latest metrics on GWP*. More importantly account should be taken of the work of Happer & Wjngaarden proving that CH4 (and N2O) have negligible GWP, see https://arxiv.org/abs/2006.03098 .	Jim O'Brien	Ireland	Noted- box revied in TS and chapter to take comments into account	
81759	16	2	16	44	It would be useful to add a note to the metric discussion (in Box 2) that more detailed consideration of different metrics, their physical basis and related literature is given in Annex B.	Government of New Zealand	New Zealand	Noted- box revied in TS and chapter to take comments into account	
30303	16	3	16	3	Please add a sentence upfront: Since all anthropogenic climate drivers impacting the climate system, it is important to include all climate drivers when developing a comprehensive climate policy (and not only CO2).	Government of Norway	Norway	Noted- box revied in TS and chapter to take comments into account	
30305	16	3	16	3	Please insert "are one of several tools that" after GHG emission metrics.	Government of Norway	Norway	Noted- box revied in TS and chapter to take comments into account	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
30289	16	3	16	8	Please consider to mention and elaborate on the issue that an alternative to using metrics would for many appliances be to run resource demanding climate models.	Government of Norway	Norway	Noted- box revied in TS and chapter to take comments into account	
24591	16	17	16	17	we propose to illustrate time and spatial consideration by this example: A study in subsaharian africa address the carbon balance of a sahelian pastoral landscape by using an ecosystem approach that takes account of all ecological functions. The research shows that the carbon balance of the landscape is neutral, even if it varies according to the place and the season. It means that, in the Sahel, storage of carbon in trees, shrubs and soils offsets the greenhouse gas emissions produced by pastoral livestock through their feeding and their faeces. This approach help to identify operational mitigation options at the local level. In addition to the recognised option of efficient use of natural resources in livestock feeding (for example by storing fodder when it is abundant and high quality), three techniques are suited to pastoralism: developing watering points, making use of animal waste through anaerobic digestion, and tree planting, s uch as the Great Green Wall initiative in Africa. {7.6.5.2} If not included in this box, this comment could apply to another part of the TS	Government of France	France	Noted- box revied in TS and chapter to take comments into account	
46739	16	21			Please replace "accounting" by "reporting", since the first specifically refers to market mechanisms.	Government of Germany	Germany	Noted- box revied in TS and chapter to take comments into account	
18627	16	21	16	22	Parties can report information using other metrics in addition to GWP100	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted- box revied in TS and chapter to take comments into account	
18629	16	25	16	28	"the literature available to date demonstrates that using GWP100 to inform future abatement choices between gases would help meet the long-term temperature goal of the Paris Agreement at or close to least global cost and with limited overshoot (high confidence)." This is a very important point and useful information for policymakers.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted- box revied in TS and chapter to take comments into account	
30291	16	29	16	30	In the para below you state that all metrics have limitations with resepect to the physical climate system responds. Therefore we question the need to highlight limitation for one type of metric with one time horizon and for one limited application (remaining carbon budget).	Government of Norway	Norway	Noted- box revied in TS and chapter to take comments into account	
30307	16	29	16	35	It seems somewhat strange that GWP* and CGTP are highlighted as more suitable for calculating the remaining carbon budget, especially since calculations of the remaining carbon budget itself is not itself dependent on choice of metric. Our understanding is that this report uses scenarios when calculating influence from non-CO2 forciers in the carbon budget. Therefore, it is at least important that the text describes that metrics have not been used when calculating the carbon budget and the way short lived climate forciers are included in the carbon budget. Therefore the comparisons between GWP/GTP and GWP* /CGTP is arbitrary since GWP is not commonly used in that way.	Government of Norway	Norway	Noted- box revied in TS and chapter to take comments into account	
29687	16	30	16	31	Quotation: "mixed step change/pulse metrics such as GWP*" could be clarified. While GWP(100) is a pulse metrics, GWP* is the opposite, namely a metric for impacts of sustained (step change) perturbations, which is exactly what is needed to represent methane and other short lived perturbations (including black carbon and albedo)	Government of Norway	Norway	Noted- box revied in TS and chapter to take comments into account	
83483	16	30	16	33	This statement should reflect that the literature does not provide wide-spread applicability of GWP* for SLCF, but mainly focusses on methane. It should accurately reflect the current weak literature basis for the application of GWP* to all SLCF, which include greenhouse gases and aerosols.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Noted- box revied in TS and chapter to take comments into account	
30293	16	30	16	33	We understand that you are trying to provide a rationale for introducing recent development in metrics. However this sentence is written in an unnecessary complicated manner, and we are worried that this may introduce a lot of confusion. We feel that it is not possible for the reader to understand what GWP* represents. Please also consider if the wording "in close similarity..." which seems rather strong is appropriate. In our view this illustrates that the science around new metrics are immature and need further development and consideration before extensively discussed in IPCC reports, besides in WG1 context	Government of Norway	Norway	Noted- box revied in TS and chapter to take comments into account	

IPCC AR6 WGIII Second Order Draft Government and Expert Review Comments Responses (Technical Summary)									
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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
29683	16	32	16	33	Quotation "a near-linear relationship between multi-decadal cumulative emissions of SLCFs" may seem somewhat misleading as SLCFs are not so much cumulative. What the metrics do is to provide a "relationship between a time series of SLCFs and temperature" (and this includes not only emissions but also biogeophysical perturbations).	Government of Norway	Norway	Noted- box revised in TS and chapter to take comments into account	
29685	16	32	16	35	We propose to mention that one of the features with new metrics is how black carbon and other short lived perturbations are included when estimating warming levels	Government of Norway	Norway	Noted- box revised in TS and chapter to take comments into account	
30287	16	33	16	33	Please add a sentence about the limitations for GWP* e.g. "GWP* requires much more input data and calculations to estimate and will pose difficulties if applied in climate agreements due to the dependency of multi-decadal historical timeseries of emission data and the assumptions that the reductions in SLCFs will have to be maintained". CGTP might also have limitations.	Government of Norway	Norway	Noted- box revised in TS and chapter to take comments into account	
83485	16	33	16	35	This statement is inaccurate and misleading. A specific metric can only be "better" in comparison to something else. Here, the comparison is to a strawman argument that GWP-100-weighted non-CO2 greenhouse gas emissions are used to assess the impact of non-CO2 forcers on the remaining carbon budget. This is not the case. The warming of non-CO2 emissions is taken into account as accurately as possible through AR6-calibrated emulators that simulate the non-CO2 warming consistent with the AR6 WG1 physical science assessment (See WG1 Chapter 5).	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Noted- box revised in TS and chapter to take comments into account	
30295	16	33	16	35	The content of this sentence is problematic because it only focuses on the remaining carbon budget, and might be interpreted by the reader as a recommendation from the IPCC for using specific metric also under other circumstances and applications.	Government of Norway	Norway	Noted- box revised in TS and chapter to take comments into account	
30301	16	36	16	41	Please consider to move this para up to line 9, and add perspectives about how other supporting tools such as scenarios, pathways and climate models can assist policy makers in developing climate policy.	Government of Norway	Norway	Noted- box revised in TS and chapter to take comments into account	
24333	16	41	16	41	Please replace "Box 2,2" with "Cross-Chapter Box 2"	Government of France	France	Noted- box revised in TS and chapter to take comments into account	
24593	16	42	16	42	Concerning AFOLU sector, a focus should be placed on livestock, which would represent a large part of the AFOLU sector's emissions, and in particular in the South. On enteric methane emission factors, but also on diversified rationing methods, including on raw materials used in animal feed for which there are few inventories (in global models and power systems are too often caricatured). This could lead to an overestimation of estimates of livestock systems in the South. There is an evidence that the ruminant population must be reduced at a global scale, but how can we maintain grasslands and pastoral lands –which represent half of the agricultural area in the world - with less animals as they represent a source of biodiversity to maintain and a carbon sink? And how could we transfer fertility from grasslands to crop areas without ruminants? As well, reducing quality nutrient from animals can result in a change of land use, with the cultivation of grasslands (and the corresponding GHG emissions). {7.3.2.1} If not included in this box, this comment could apply to another part of the TS	Government of France	France	Noted- box revised in TS and chapter to take comments into account	
85255	16		16		I encourage WGIII authors to implement as much as possible the reporting greenhouse gas by greenhouse gas as stated in the box.	Valérie Masson-Delmotte	France	Noted	
7265	17	0	17	0	Figure TS.6: Panel c information is very useful. But how realistic is a steady 2% or 5% reduction – also, is that in relation to previous year or in relation to 2018 levels? Is it not more likely to start slowly and speed up? Note the legend says 3% and 7%. A line graph over time showing what these reductions would look like would help. Consider super-imposing the Covid-related dip in emissions as comparison. Could be added to the end of Panel (a) as a kind of projection. Consider abbreviating the 1850-1900-1950 to spot-measures, e.g. bars connected with dotted lines, allowing the 1950-period to be spread out, and adding projection up to 2050 (or even 2100).	Debra Roberts	South Africa	Noted- Figure revised	
46749	17	1			Figure TS.6: Remaining future carbon budgets shown here are "as of 1.1.2019", while Figure 2.6 shows the remaining future carbon budgets "as of 1.1.2020" (see Figure 2.6 in Chapter 2, page 2-31). Please verify and ensure consistency.	Government of Germany	Germany	Noted- Figure revised	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
46751	17	1			Figure TS.6: The remaining carbon budgets to keep warming below 1.5 °C and 2 °C shown in this Figure are at the 50th percentile of the transient climate response to cumulative CO2 emissions, NOT at the 67th percentile (see also Figure 2.6 in Chapter 2, page 2-31). Please verify.	Government of Germany	Germany	Noted- Figure revised	
15361	17	1	17	1	The annotation of Figure TS.6 adopts the usage of Forestry and land-use (FOLU). But throughout the whole text, AFOLU is used everywhere. Please verify whether this expression is true.	LEI HUANG	China	Noted- Figure revised	
7261	17	1	17	1	What is a "historic drop"? Do you mean unprecedented?	Debra Roberts	South Africa	Noted- Figure revised	
18631	17	1	17	2	It might be clearer to say "historic temporary drop" in CO2 emissions, as suggested by the text that follows.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted- Figure revised	
66429	17	5	17	6	I couldn't immediately find the ref in section 2.2. My impression has been that economies tend to return to trend growth rates after shocks, but from lowered base and do not get back to the ex-ante projections? But this will be for wider discussion with better data in the final report.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - paragraph revised	
64003	17	7	17	17	This is a difficult paragraph to read and yet the information on remaining carbon budgets is crucial to convey clearly. Recommend stating explicitly if these remaining carbon budgets are assessed by WGIII or if these are estimates from WGI. Also recommend deleting the values for a 33% likelihood of achieving the target. This information is not highly relevant and adds unnecessary complexity to the paragraph. On line 11, what is the uncertainty range (± 250 GtCO ₂) due to, and does this same uncertainty range also apply to the estimate for a 50% chance of staying below 1.5C? It would be helpful to put the various estimates for remaining carbon budgets into a table.	Government of Canada	Canada	accepted - paragraph revised	
64007	17	7	17	17	This doesn't seem to have been included in the SPM, but this information seems crucial and we suggest to add it in the SPM	Government of Canada	Canada	Noted - Text substantially revised	
83491	17	7	17	17	Ensure to update with latest remaining carbon budget assessment from WG1 Ch5.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Noted - Text substantially revised	
28219	17	7	17	17	It should be explained how and by how much the remaining carbon budget has been adjusted compared to AR5 and SR1.5.	Eleni Kaditi	Austria	Noted - Text substantially revised	
7263	17	7	17	17	This paragraph contains important information. The supporting sentences contain too many numbers which make them hard to read. Please replace with a few sentences in plain English that explain the situation.	Debra Roberts	South Africa	Noted - Text substantially revised	
46741	17	7	17	17	Given the uncertainties associated with the budget, the quantitative information provided is much too accurate and pretends a prediction potential that is not realistic. Please add information about the sources of uncertainties and their respective amounts. Please include these uncertainties in the ranges for the C-budgets and the timings when they will be exhausted.	Government of Germany	Germany	Noted - Text substantially revised	
18633	17	7	17	17	How do these numbers compare with the carbon budget numbers provided by WGI and its findings about when 1.5C will be reach?	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted - Text substantially revised	
67369	17	7	17	8	The sentence refers to 2018 "rate" of emissions. It might be better to say "level" of emissions. Rate typically implies rate of change, which is not (I think) the intention in this case.	Philippe Tulkens	Belgium	Noted - Text substantially revised	
72895	17	7	17	8	Wouldn't it be more logical to express the time when the remaining carbon budget will be exhausted taking into account the projected emission growth rate? It seems more consistent to reason in terms of status quo (growing emission rates) than in terms of stabilization.	Antoine BONDUELLE	France	Noted - Text substantially revised	
85165	17	8	17	9	This statement is rated in the respective Executive Summary (p.:2-4; l.:29) as (high confidence). -> Mismatch of rating? Please check.	Jens Tambke	Germany	noted	
24335	17	11	17	12	What is the link in between the figures of the text and those within the brackets?	Government of France	France	Noted- Figure revised	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
46743	17	11	17	12	"the remaining carbon budget of 310±250 (390, 500) GtCO ₂ for keeping global warming below 1.5°C": the remaining carbon budget depends on the method to determine the global air temperature (land and ocean). Please add a reference, whether Global mean surface air temperature (GSAT) or Global mean surface temperature (GMST) is used.	Government of Germany	Germany	Noted- Figure revised	
53107	17	11	17	13	Ch2: Inconsistency in what value is being reported up front and what comes inside the (). It looks like that the value with 66% probability is shown upfront in other places, so keep it consistent. Also, show the values with 66% probability in Figure 6 panel b to keep it consistent. In the sentence it says 67% instead of 66%, but in other places it is 66%.	Government of Saudi Arabia	Saudi Arabia	Noted- Figure revised	
53109	17	11	17	13	Ch2: why don't the values in () have the +/- values next to them?	Government of Saudi Arabia	Saudi Arabia	Noted- Figure revised	
66431	17	11	17	16	These data need better alignment with the data from Chapter 3 and a clear definition of carbon budget (is it net emissions to point of net zero, or to end of century with possibly modest overshoot)? As it stands, the last sentence in particular seems inconsistent ..	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted- Figure revised	
53111	17	14	17	15	Ch2: The sentence "At the 2018 rates..." needs to specify that the 7/22 periods are associated with the 1.5/2 C targets.	Government of Saudi Arabia	Saudi Arabia	Noted- Figure revised	
67371	17	15	17	17	Why make specific mention of "2% of 5% per year" in this sentence? If the budget will be exhausted even at 5% reduction, what is the need to mention 2%?	Philippe Tulkens	Belgium	Noted- Figure revised	
84687	17	15	17	17	"Even if global CO ₂ emission decrease at 2% or 5% per year, the 1.5°C budget will be exhausted before 2030 highlighting the dependence of 1.5°C pathways on the availability of substantial CO ₂ removal capacities." Where do the 2 % and 5 % come from? The Figure SPM.3 illustrates that 1.5°C limit implies scenario reduction rates (2020-2040) of about 7 % (which is consistent with the UNEP Emission Gap Report estimation of needed 7.6 per cent annual emission reduction rates). So why not starting from the needed rate and then concluding that the farther we are from that rate, the more CO ₂ removal will be needed?	Kaisa Kosonen	Finland	Noted- Figure revised	
46747	17	18			Figure TS.6 is useful in putting the remaining carbon budget into context. However, Panel C would need to be revised please: 1) given the uncertainties associated with the budget the years provided are much too accurate and pretend a prediction potential that is not realistic; 2) the grey text in the boxes is unclear: why is overshoot excluded in the upper panel with current emissions, how is overshoot quantified and what does the second year of budget exceedance mean in the two lower ones? how do the timings shown for net-zero link to 2055/2070 which are given on T-S27-30 and SPM-17-18 for 1.5°C? 3) please indicate "reduction/year" in the three boxes on the right.	Government of Germany	Germany	Noted- Figure revised	
15401	17	18	17	29	Panel c: There are no a), b) or c) in the panel c. The reduction rate is different between in the panel c and text in legend..	Hiroaki Kondo	Japan	Noted- Figure revised	
83297	17	18	17	29	The enormous uncertainties in the WG1 carbon budget calculations and the many substantial changes in the WG1 methodology (between SR1.5 and AR6) might warrant to avoid the countdown language used here	Geden Oliver	Germany	Noted- Figure revised	
66433	17	19			In contrast to the previous two Figures, this sector-based chart includes significant added information also on projections which is not so easy to 'locate' without the wider scenario context which comes later. I wonder if this might be moved later in the TS? Which might also create a natural place to include Chapter 1 Figure 1.3 (one or both panels) to illustrate the distributional points above?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted- Figure revised	
8201	17	19	17	29	Figure TS.6: Please check and revise text: does "Forestry and other land-use" include CO ₂ -Emissions from agriculture (agricultural land use) and fossil fuels from agricultural management or is this excluded, and if excluded, where are these emissions included? This should be explained here.	Joachim Rock	Germany	Noted- Figure revised	
67373	17	23	17	29	There is a labelling mismatch in Panel c. The panel shows 2% & 5% annual reduction while the legend mentions 3% & 7%.	Philippe Tulkens	Belgium	Noted- Figure revised	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
64005	17	26	17	26	Figure TS.6: the lower left hand panel Figure shows carbon budgets for a 50% chance of limiting global warming to 1.5C and 2C, not 67% chance (as per text on lines 11-14 of the same page).	Government of Canada	Canada	Noted- Figure revised	
1375	17	28	17	29	A reduction of 5% is written on the figure, not 7%.	Julien Demenois	France	Noted- Figure revised	
2431	17	28	17	29	b) global annual emission reductions at 3% and global annual emission reductions at 7% → b) global annual emission reductions at 2% and global annual emission reductions at 5%	Nyun-bae Park	Republic of Korea	Noted- Figure revised	
84689	17	28	17	29	The numbers here (7 % and 3%) are inconsistent with the numbers in the graph referred to (2 % and 5 %).	Kaisa Kosonen	Finland	Noted- Figure revised	
85257	17		17		Coordination with WGI is underway to ensure coherency and clarity related to the remaining carbon budget.	Valérie Masson-Delmotte	France	Noted	
24337	17		17		In TS.3, page lines 24-25 and 28-29 the dates are not consistent between the text of the legend and the figures. It is not in accordance with what is written on the panel	Government of France	France	accepted	
24339	17		17		A reduction of 5% (resp. 2%) is written on the figure, not 7% (resp.3%).	Government of France	France	accepted figure revised	
7267	18	1	18	1	Remove "There is" and "that". Also in second sentence.	Debra Roberts	South Africa	accepted	
30275	18	1	18	11	Please consider including Fig. 2.11 from Chapter 2 in the Technical Summary, to make the information regarding which 36 countries more accessible for the readers.	Government of Norway	Norway	Noted - Text substantially revised	
18635	18	1	18	11	Can anything be said about the reason for these sustained emissions? Is it in response to climate change policies and targets or something else?	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted - Text substantially revised	
30341	18	1	18	3	It's unclear what the use of "ones" means here, is it in reference to the countries or the GHG emissions?	Vanessa Lamers	United States of America	Noted - Text substantially revised	
72897	18	3	18	4	It is misleading to talk about territorial-based CO2 emission reduction without speaking of the limits of this indicator. It doesn't really give reliable information on whether a country is on a sustainable path or not, as the country can externalize a big share of its consumption-based CO2 emission to industry countries. Gives the general impression that decoupling	Antoine BONDUELLE	France	Noted - Text substantially revised	
66435	18	4			Some indication of contribution of policies, including Kyoto participation, would be relevant here	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - this has now been addressed in a box on policy attribution	
83299	18	6	18	8	If "some of which" are mainly Post-Socialist economies (mainly in Eastern Europe) than I'm not sure they should be presented as an example that would be easy to follow, given the specific historical circumstances, and not linked to deliberate climate policymaking	Geden Oliver	Germany	Noted. Additional detail is provided in the chapter . TS text has been ammended	
67375	18	8	18	9	Suggest referring to the 4% average reduction rate only as a global average. Implying that this should be the rate at national level is problematic since countries differ so much in their present-day emissions and emissions intensity, historical emissions reduction performance, level of development etc. Also, the idea that an ambitious transformation path will be approximately linear over time is misleading.	Philippe Tulkens	Belgium	Thank you for your comment. This paragraph has been comprehensively revised	
18637	18	10	18	11	"overall there are..." this is a useful point to note. Could it be placed higher in the paragraph, or combined with the statement in bold?	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted - Text substantially revised	
29465	18	12	18	20	To TS: We appreciate the inclusion of consumption-based estimates.	Government of Norway	Norway	Noted - Text substantially revised	
11337	18	13	18	15	The source of the statement "In developed countries consumption-based CO2 emissions from fossil fuel combustion and industrial processes peaked at 16.8 GtCO2 in 2007 with a subsequent 12% decline until 2015" cannot be identified in the main text (Ch.2). Please check.	SAI MING LEE	China	Noted - Text substantially revised	
11339	18	18	18	20	The source of the statement "Asia and Developing Pacific has been a major contributor to consumption-based CO2 emission growth since 2000 with an average growth rate of 6.4% per year" cannot be found in the main text (Ch.2). Please check.	SAI MING LEE	China	Noted - Text substantially revised	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
7269	18	21	18	24	Is this "absolute decoupling" really true, in the light of historic and locked in emissions, global trade and whole life cycle analysis? Please substantiate. The concept of decoupling could also perhaps be better explained. Especially in the light of comments on page 19 lines 3-6.	Debra Roberts	South Africa	Noted - Text substantially revised
67377	18	21	18	28	It is worth mentioning that international climate governance is typically based on territorial rather than consumption-based approaches. Some (non-political) reasons for this include i) consumption-based emissions are difficult to measure accurately; ii) they are harder for countries (esp small, open economies) to control. Emissions embodied in imports are the responsibility of other jurisdictions, while decarbonisation of exports is 'credited' to the importing country.	Philippe Tulkens	Belgium	Noted - Text substantially revised
46753	18	21	18	28	The achievement of absolute decoupling of Consumption-Based Emissions (CBE) from GDP of many countries should be described more critically. Limitations, such as those described later in chapter 2, are not mentioned here [2.3.3 "Decoupling of emissions from economic growth" on page 46. (cf. comment above)]. E.g., no reference is made to the existing controversial debate on this issue; decoupling is taking place because of the shift in environmental challenges; it can only be achieved at the national level, but not at the global; Decoupling is temporary for many countries; Decoupling CO2-Emissions doesn't mean decoupling from other resources. REFERENCE: EEB 2019, Decoupling debunked – Evidence and arguments against green growth as a sole strategy for sustainability https://eeb.org/library/decoupling-debunked/	Government of Germany	Germany	Noted - Text substantially revised
72899	18	21	18	28	This paragraph seems misleading if it is not counterbalanced by a few lines on the type of decoupling necessary (rapid, important, global, permanent) to wait for objectives 1.5-2° and the reasons for being sceptical about achieving such decoupling (developed in this article: Parrique T., Barth J., Briens F., C. Kerschner, Kraus-Polk A., Kuokkanen A., Spangenberg J.H., 2019. <i>Decoupling debunked</i>).	Antoine BONDUELLE	France	Noted - Text substantially revised
66437	18	22			Worth clarifying why the number is larger than for territorial emissions: presumably mix of trade stabilisation combined with the declining carbon intensity of developing country exporters?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - Text substantially revised
18639	18	23	18	23	Do you mean some countries in Europe?	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted - Text substantially revised
85167	18	24	18	24	To illustrate the message, please add names of examples:some developing countries, e.g. Cuba and Iran, have successfully achieved....(as referred in the respective Executive Summary (p.:2-5; l.:15))	Jens Tambke	Germany	Noted - Text substantially revised
66439	18	26	18	27	This frankly is meaningless. I suggest, "Excluding outliers, ..." I'd guess the extremes are exceptional cases of little relevance to the actual point being made	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - Text substantially revised
2433	18	27	18	27	The per capita emissions of decoupled economies ranges from 0.1 to 32 tCO2 per capita. → The per capita consumption-based emissions of decoupled economies ranges from 0.1 to 32 tCO2 per capita.	Nyun-bae Park	Republic of Korea	Noted - Text substantially revised
24341	18	29	18	29	the term "moderate" seems to be lacking precision without context, moderate relative to what?	Government of France	France	Noted - Text substantially revised
24343	18	30	18	30	Please define what "carbon intensity means"	Government of France	France	accepted
24345	18	33	18	37	Figure 2.18 in chapter 2 do not show evidence of a reverse after 2011. It seems that emission from trade have increased and are still high	Government of France	France	noted
7271	18	38	18	46	This is an important point with regard to justice and equity and needs to be unpacked further. Instead of transferring capacity and technology to support low-carbon development in developing regions, developed regions are transferring emissions and reporting 'improvements' at home. A critical analysis would be welcome.	Debra Roberts	South Africa	accepted - addressed in revised version and chapters

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66441	18	39			Of what? Of global emissions?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted
24347	18	47	18	48	the paragraph below the headline lacks arguments to prove the causality which is implicit when using the term "driver".	Government of France	France	accepted - paragraph revised
18641	18	47	18	48	This sentence currently it reads like the strongest drivers of CO2 emissions are affluence and population (and therefore to reduce CO2, you must reduce affluence and/or population). I'd argue a country's affluence isn't in and of itself a driver, but it's how they spend that wealth. Likewise with population where there are all sorts of global differences. Could the authors please consider re-wording to something like 'historically, increased CO2 emissions have correlated with increasing GDP growth and population, but this masks significant inequalities in both which influence their carbon impact'?	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	accepted - paragraph revised
11341	19	1	19	2	Re: "affluence (GDP per capita) and population growth increasing emissions by 2.3% and 1% per year, respectively". "1%" should read "1.2%" according to Figure 2.20 of Ch.2. Please check and revise.	SAI MING LEE	China	accepted - paragraph revised
67379	19	3	19	7	This paragraph appears to suggest that nowhere has succeeded in absolute decoupling of energy demand from economic growth. However, Europe has achieved this since at least 2005. See European Environment Agency, Trends & Projections in Europe, 2020 .	Philippe Tulkens	Belgium	accepted - paragraph revised
67381	19	4	19	6	Replace "decarbonisation" with "reduction in the GHG emission intensity". It is more precise in general, and more appropriate in the context, as the phenomenon described does not meet the definition of "decarbonisation" in the glossary ("aim to achieve zero").	Philippe Tulkens	Belgium	noted- para now refers to rapid decarbonisation as reflected in chapter
66443	19	6			This is far from universally true. If country-level cannot be considered, at least check the 3rd-level disaggregated data underlying Figure TS.2; the 2nd-level (Chapter 1 Figure 1.3) shows it is not even true for 2nd level disaggregation, as EU is now lower than east Asia. I suggest an integrated discussion including Chapters 1 and 2 on the most appropriate data to present	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	noted - paragraph substantially revised
14353	19	8	19	8	"Developing countries have lower per-capita emissions...". This is not universally correct. It is well-known that some developing countries have per-capita emissions above those of some developed countries. Perhaps add "Most" or another qualifier.	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	accepted - paragraph revised
7273	19	8	19	8	Please quantify this "lower per-capita emissions" in developed vs developing and least developed regions to put the "major accelerators" into perspective.	Debra Roberts	South Africa	accepted - paragraph revised
15183	19	10	19	13	In the paragraph "While energy intensity declined to a similar extent in OECD and non-OECD countries between 2010 and 2018, economic growth has been much stronger in non-OECD member countries. Very strong emissions growth in Eastern Asia has been slowing in recent years due to fewer coal power stations being added to the system", the first half indicates the higher economic growth of non-OECD countries than OECD ones, and the second half mentions the slowdown of "very strong emissions growth" in East Asia in recent years, from which it can be seen that the second half outweighs the first one in tone and subjectivity. In order to balance the relevant expressions, it is suggested to revise the latter paragraph to "Emissions growth in Eastern Asia has been slowing in recent years due to fewer coal power stations being added to the system".	Government of China	China	accepted - paragraph revised
72217	19	15	19	16	How is energy efficiency defined in this section? If it is energy intensity should be called in this way. Progresses in energy efficiency in developed countries are far from the full economic and technical potentials.	bertoldi paolo	Italy	noted - paragraph revised
67383	19	15	19	16	How is energy efficiency defined in this section? If it is energy intensity, it should be called that way. Progress in energy efficiency in developed countries are far from the full economic potential	Philippe Tulkens	Belgium	noted - paragraph revised
66445	19	17	19	18	I am not sure this is true for period 2015-2019 – relevant to check	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	noted - paragraph revised
7277	19	19	19	19	It would be very useful to include a graphic or graph showing regional-sectoral disaggregation of demand-side emissions, which the following paragraphs could refer to. Totals, per capita, and percent change – as each of these tell a different story.	Debra Roberts	South Africa	noted- additional information provided in chapter

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
7275	19	19	19	31	The high density of numbers make these two paragraphs hard to read. Can the text refer to a figure or table instead? And rather interpret the numbers?	Debra Roberts	South Africa	accepted - revised in FGD
66447	19	20			At first mention, useful to explain at least roughly. Clarify in Fig TS.7?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted
11343	19	20	19	24	The information provided here cannot be reconciled with the main text in Section 2.2.4 of Ch.2. Please check and revise as appropriate.	SAI MING LEE	China	accepted - section revised
66449	19	23			Explain on first mention (maybe simplest – “indirect (mainly electricity-related..)” ?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	noted
66451	19	25	19	26	Help the reader. Eg. In 2018, 34% (20 Gt CO ₂ eq) of the 59 GtCO ₂ eq GHG emissions came from the energy sector, two-thirds of this being from electricity and heat. Direct emissions from industry and AFOLU each accounted for 23% (13 Gt CO ₂ eq) with smaller direct GHG emissions from transport [] and buildings []. However, industry and buildings are both major consumers of electricity, increasing their overall emissions contribution to Respectively.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - section revised
80487	19	25	19	31	please check that the numbers in the text match those in figure TS.7 (for example 34% of energy sector (text), but 23.7+11% in direct emissions graph TS.7) and please make it clearer whether direct OR direct+indirect emissions are meant.	Moritz Riede	United Kingdom (of Great Britain and Northern Ireland)	figure and text revised
54411	19	25	19	31	The SPM (page 9, lines 30-33) states: "In 2018, 34% (20 GtCO ₂ -eq) of global GHG emissions came from the energy sector, 23% (13 GtCO ₂ -eq) from industry, 23% (13 GtCO ₂ -eq) from AFOLU, 14% (8.3 GtCO ₂ -eq) from transport and 6% (3.4 GtCO ₂ -eq) from buildings. Once indirect emissions from energy use are considered, the relative shares of industry and buildings emissions are 33% and 17%, respectively." The second sentence above from the SPM (page 19, lines 25-31) says: "Allocating the CO ₂ emissions from energy production to the sector of final energy use increased the share of the building and industry sector in total GHG emissions for the year 2018 by 11% and 10%, respectively." Here, in the Technical Summary, it would be best to use the wording of the SPM, which is clearer. In the case of the TS wording, the reader has to add the increased shares to get the total whereas the total is provided in the SPM text, which is easier to understand.	Government of United States of America	United States of America	accepted - section revised
11345	19	27	19	27	"34%" should read "35%" (Ch.2 Section 2.2.4, P.39, line 9). Please revise.	SAI MING LEE	China	accepted - revised
72219	19	29	19	31	It is important to allocate to the building sector the CO ₂ emissions embedded in the building materials (cement, glass, bricks, steels, etc.) in particular for future new constructions. A reduction of construction material demand is key for the decarbonisation of the industry and this reduction is driven by the building sector.	bertoldi paolo	Italy	accepted addressed in FGD version
67385	19	29	19	31	it could be interesting also to allocate to the building sector the CO ₂ emission for the building materials (cement, glass, bricks, steels, etc.) included in new constructions.	Philippe Tulkens	Belgium	Noted
11347	19	32	19	33	The source of the statement "Average annual growth in GHG emissions dropped from 3.2% for 2000-2010 to 1.4% in energy supply for 2000-2018" cannot be found in the main text (Ch.2). Please check.	SAI MING LEE	China	accepted - text removed
7279	19	32	19	39	The second half of this paragraph does not support the headline statement. This is a serious problem and requires a separate paragraph with its own headline statement.	Debra Roberts	South Africa	accepted - section revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
15185	19	33	19	35	In the paragraph "Average annual growth in GHG emissions dropped from 3.2% for 2000-2010 to 1.4% in energy supply for 2010-2018. The slowing of growth was due to a reduction of coal power capacity additions in China, a structural shift to gas in the United States, and the increasing penetration of renewables in Europe", the reduction of coal power capacity additions in China is mentioned as the reason for the slowing of global greenhouse gas emission growth. In fact, in recent years, China's additional energy demand is largely met by additional renewable energy. China has become the world's largest manufacturer of wind power and photovoltaic, as well as the world's largest new energy market. The cumulative installation of wind power and photovoltaic, new installations, and new energy investments have ranked first in the world for many years running. So, it is suggested to change "due to a reduction of coal power capacity additions in China" to "due to the rapid growth of renewable energy capacity and consumption in China". The supporting literature is as follows: [1] Jackson et al.2017. Warning signs for stabilizing global CO2 emissions. Environ. Res. Lett. 12, 110202. https://doi.org/10.1088/1748-9326/aa9662 [2] Peters et al. 2017. Key indicators to track current progress and future ambition of the Paris agreement. Nat. Clim. Change, 7, 118-122	Government of China	China	accepted - section revised
54413	19	35	19	38	Add "without targeted interventions ..."	Government of United States of America	United States of America	Text in this section substantially revised
15835	19	35	19	39	"Despite these trends, large investments in fossil-fuel-based energy infrastructure have locked in technological pathways and institutional structures that will continue driving emissions in the future and impede the transitioning to renewables. More efforts are required to actively phase out all fossil fuels in the energy sector, rather than relying on fuel switching alone." One can add: avoid premature phase-out of existing decarbonised technologies (hydro, nuclear).	Jean-Michel Trochet	France	Text in this section substantially revised
66453	19	36			This may be considered presumptive. Maybe "impede the transition, or increase the system costs associated with transitions to cheaper zero carbon sources such as wind and solar (See box on stranded assets)."	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Text in this section substantially revised
66455	19	36	19	37	I think this is trying to imply something about risk of lock-in from simply switching coal to gas, but as expressed it comes over as simplistic and policy-prescriptive	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Text in this section substantially revised
28221	19	37	19	38	Delete "and impede the transitioning to renewables. More efforts are required to actively phase out all fossil fuels in the energy sector, rather than relying on fuel switching alone.", as this is not a policy neutral statement.	Eleni Kaditi	Austria	Text in this section substantially revised
77275	19	38			For a broader scope, it would be better to replace "renewables" with "low-carbon technologies".	Giacomo Grasso	Italy	Text in this section substantially revised
24349	19	38	19	38	the sentence is ambiguous. It must be precised or rewritten	Government of France	France	Text in this section substantially revised
18643	19	40	19	47	Isn't there a link between the growth of the service-based sector of economy in developed countries which often relies on manufacturing that is outsourced to developing countries, some of which are in East Asia?	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Text in this section substantially revised
11349	19	41	19	44	The text tends to convey the message that East Asia now has a greater share of responsibility for causing climate change. The text could be misleading because climate change is the result of long-term cumulative release of greenhouse gases (GHG) into the atmosphere instead of GHG emissions in a couple of decades. According to Global Carbon Budget 2020 (https://www.globalcarbonproject.org/carbonbudget/20/files/GCP_CarbonBudget_2020.pdf , P.88), the cumulative GHG emissions during 1850-2019 by Asia is still below those emissions by Europe and North America. It is suggested to provide a proper historical perspective to the readers before discussing recent changes in GHG emissions by region.	SAI MING LEE	China	Text in this section substantially revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
7281	19	43	19	43	Any apparent declines in industry related emissions must never be cited without considering the effect of global trade and regional transfer of emissions, as this may be very misleading. Is Europe simply buying more products made in China? Then this must be stated clearly, as the case may be.	Debra Roberts	South Africa	Noted - addressed comprehensively in the chapter
7283	20	0	20	0	Figure TS.7 (and SPM Figure 4) "Energy" here is confusing, as each of the other components (industry, transport, buildings, etc) each have a considerable energy component. If you added all the energy related emissions together, the total would point to the main culprit of climate change: fossil fuel energy. That is a message worth delivering more clearly.	Debra Roberts	South Africa	Figure comprehensively reworked
46755	20	3			Figure TS.7, middle panel: The relation between the smaller bar and the larger one is unclear, the latter does not seem to be a magnification of the first - but what is it? Please explain.	Government of Germany	Germany	Figure comprehensively reworked
64009	20	3	20	9	Figure TS.7. (here and for all the report): This figure brings to mind the question of how GHG emissions for natural disturbances (i.e. wildfires, insect outbreaks, hurricanes, etc.) are integrated in the calculation of direct and indirect emissions. We suggest that the figure caption clarifies how or whether changes in emissions from natural disturbances on managed lands are included in the estimates for AFOLU.	Government of Canada	Canada	Figure comprehensively reworked
69949	20	4	20	9	Figure TS.7: energy systems emissions could more or less be allocated to buildings and industry (for coal mining fugitive emissions 2.5%), transports (petroleum refining 1.1%), buildings, industry and transports (oil and gas fugitive emissions, biomass energy systems 0.3%, indirect N2O emissions 3.1%)	Cédric PHILIBERT	France	Figure comprehensively reworked
11351	20	13	20	16	The text tends to convey the message that East Asia now has a greater share of responsibility for causing climate change. The text could be misleading because climate change is the result of long-term cumulative release of greenhouse gases (GHG) into the atmosphere instead of GHG emissions in a couple of decades. According to Global Carbon Budget 2020 (https://www.globalcarbonproject.org/carbonbudget/20/files/GCP_CarbonBudget_2020.pdf , P.88), the cumulative GHG emissions during 1850-2019 by Asia is still below those emissions by Europe and North America. It is suggested to provide a proper historical perspective to the readers before discussing recent changes in GHG emissions by region.	SAI MING LEE	China	accepted - text revised
66457	20	18			Awkward word for IPCC – by what metric? From my limited knowledge, the really significant thing is that transport efficiency improvements seem to have slowed, underlining that deep emission reductions are likely to hinge on moving to non-fossil-fuel transport.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	no longer in Ts
66459	20	20			Actually it seems startling – EV sales risen at average of over 40%/yr for at least the last five years. Which if sustained exponential, results in 100% by 2030 ...	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	noted
72221	20	20	20	20	Here again the term energy efficiency must be better defined, it is the improvement of vehicles efficiency, which has improved over time? Or it is the efficiency of the transport system, including the demand for transport, for example passenger/km. What is important is to capture also the GHG gains of using public transport, cycling and walking and move away from the concept that every person should will have an electric vehicle and we decarbonise the transport sector.	bertoldi paolo	Italy	noted
67387	20	20	20	20	Here again the term energy efficiency must be better defined, it is the improvement of vehicles efficiency, which has improved over time or the efficiency of the transport system, for example passenger/km where for example public transport is much more efficient.	Philippe Tulkens	Belgium	noted
54415	20	24	21	2	Recommend providing context of aviation activity during 2000-2010.	Government of United States of America	United States of America	noted - a more comprehensive discussion is in the chapter
54417	20	24	21	3	This paragraph says that domestic and international aviation emissions are growing faster than road transport emissions. This does not take into account ICAO's globally accepted Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). This should be acknowledged as, if effective, it would mean international aviation emissions would not exceed 2019 baseline year emissions through 2035, even if the agreement is (as indicated on TS-122) insufficient for Paris Agreement achievement. If this projection for emissions growth doesn't give credit for offsetting, that should also be clarified.	Government of United States of America	United States of America	Noted. Additional detail is provided de the chapter. Impacts of policies are in part addressed in the policy attribution box

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
51619	20	25	21	2	"The average annual growth rates of domestic and international aviation emissions are 3% and 2.1% respectively between 2010 and 2018." These numbers are inconsistent with the statement of Chapter 10, p. 60 lines 7-8, which says the growth of CO2 emissions of aviation for the period 2010-2018 was about 4% per year.	eric lombard	France	noted - text has been revised to be consistent with chapter 10	
24351	20		20		Some shades of colours (blue and green) have no legend. Is it intentional that the same shade of blue is used in the right bar for both "non-residential" and "residential"? Is it intentional that all AFOLU subsectors use the same shade of green in the right bar? The meaning of the colours used in the small bar at the top of the central graph is not clear (using the same shades of colours than in the larger bar would clarify their meaning).	Government of France	France	Thank you for your comment. This figure has been comprehensively revised to enhance visual communication. This includes flipping the figure, as well as further distinguishing between the colours. Lines have been added more clearly to show direct vs indirect emissions in the figure	
1377	21	4	21	10	That would be useful to add something about N2O as well to address the different GHG from AFOLU	Julien Demenois	France	Discussion on AFOLU emission has been reworked and extended	
24355	21	4	21	4	That would be useful to add something about N2O as well to address the different GHG from AFOLU	Government of France	France	Discussion on AFOLU emission has been reworked and extended	
24357	21	6	21	6	Accounting should be replaced with "account"	Government of France	France	Discussion on AFOLU emission has been reworked and extended	
24359	21	8	21	9	A focus should be placed on livestock, which would represent a large part of the AFOLU sector's emissions, and in particular in the South. In particular on enteric methane emission factors, but also on diversified rationing methods, including on raw materials used in animal feed for which there are few inventories (in global models and power systems are too often caricatured). This could lead to an overestimation of estimates of livestock systems in the South. {7.7}	Government of France	France	Discussion on AFOLU emission has been reworked and extended	
81429	21	13	21	20	There are three concerns with this two paragraphs: it's difficult to understand why and how greater inequality is associated with higher GHG emissions Just saying that these are associated is also a weak statement because it does not say anything on the underlying factors for this association, even if there is a causality between these two things is unclear. Secondly the first paragraph says that providing modern energy services is not leading to a substantial increase in GHG. The next paragraph says that rural to urban migration (urbanisation) is increasing carbon footprint because of greater consumption and affluence. Reading this I'm not sure if in the first paragraph suppressed demand has been factored in. Because this is what happens in developing countries when people migrate from rural to urban settings, that they now have access to energy and the consumption increases. I would also question this: is the increasing energy consumption in countries with increasing urbanisation really caused by the rural to urban migration? It seems to me that many of these countries have a growing urban middle class and growing coconsumption in this class?	Hans Poertner	Germany	Discussion on AFOLU emission has been reworked and extended	
24361	21	14	21	14	the word "these" is missing between in and contexts	Government of France	France	accepted	
7285	21	14	21	15	What does "limited evidence" mean here? Some? Or not much? What does "in contexts greater inequality" mean? "higher GHG emissions" in relation to what? The supporting sentences of this paragraph are not very clear, and do not link up well with the bold sentence. This message is worth explaining clearly, especially how inequality and poverty relates to the message of the previous paragraph, as well as the next paragraph.	Debra Roberts	South Africa	This statement no longer included in the TS in this form	
7287	21	17	21	20	Changes in emissions should be placed in context of current emissions, as a doubling in one setting may be the same absolute value of emissions as a halving in another. So for example, what were urban emissions in 2000 and 2018 in developed vs developing vs least developed (or rapidly urbanizing vs already urbanized) regions? Total as well as per capita? This information would be very illuminating.	Debra Roberts	South Africa	No longer included in TS	
7289	21	21	21	21	Well-written, clear message in this paragraph.	Debra Roberts	South Africa	noted	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
24353	21	22	21	22	Nothing is said about the negative impact of battery manufacturing on the environment of the countries in which the rare metals involved in their manufacture are extracted. Should not this issue be addressed? They also include environmental degradation linked to the extraction of the necessary rare metals.	Government of France	France	accepted - revised TS includes a paragraph on this	
66461	21	25			Rapidly globalise?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - text revised	
7291	21	29	21	29	Recommend rewording: "A rapid, global transition to low-carbon energy, necessary to stabilize climate change, will require finance..."	Debra Roberts	South Africa	accepted text revised	
66463	21	30			As generally included in models and scenarios Or, "than expected by most experts, and projected in most scenarios". Here it would be fantastic if possible to include Ch.2 Figure 2.30, on turn-out vs predictions/expectations for different technologies, or else refer directly to it?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted - this section has been reworked	
24363	21	39	21	39	delete one of the references 2.5	Government of France	France	accepted	
7299	22	0	22	0	Figure TS.8 (SPM Figure 5) It would be interesting and revealing to disaggregate costs and adoption of these technologies in developed, transition and developing/least developed regions. This could link to the message on technology transfer.	Debra Roberts	South Africa	Noted - This is addressed in part in chapters 2 and 16, but was not included in the TS.	
7293	22	8	22	13	Could you add a sentence about the issue of existing infrastructure in developed regions, that supports economic activity and growth, while this infrastructure does not yet exist in developing regions? The legacy effect of historic emissions and development.	Debra Roberts	South Africa	Accepted, this is addressed, at least in part, in the revised text	
7295	22	15	22	15	If inequality between countries has decreased (line 8), is it possible to discuss briefly why / how inequality within countries has increased? What is this attributable to?	Debra Roberts	South Africa	Noted, this falls somewhat out of the scope of the TS, and the evidence presented in the chapter	
7297	22	17	22	17	Re: the top 10% global emitters, could you specify the denominator, i.e. two thirds live in high-income regions (total population?) while one third live in emerging economies (total population?).	Debra Roberts	South Africa	Noted - This is not addressed in the TS, although additional information is provided in the chapter	
66465	22	17	22	19	I cant find this in 2.6 and it would be interesting to see this more carefully – is it talking about national averages or what? Averaged by aggregate emissions per aggregate population – in which case the OECD is dominated by US Canada and Australia, but it MAY (I don't know) be very different if looking at China/East Asia compared the other 30 or so OECD countries?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - no longer included in TS	
66467	22	17	22	19	My comment here is not at all to apportion responsibilities – it is asking for this fantastic data effort to try and trying to illuminate whether any countries are yet following the trajectory that is probably needed, of rich countries getting their per-capita emissions below those of emerging economies which are still constructing their basic infrastructure. It relates to fundamental questions about equitable and practical global pathways towards deep decarbonisation. The attention to rich consumers, wherever they are, is of course a vey important part of this – on which the evidence doesn't look good (though, to what extent are they also constrained by the technologies and infrastructure available particularly vis-à-vis travel?)	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - addressed in part in revised TS, with more substantial discussion in the underlying chapter	
18645	22	20	22	24	Wealthy consumers can also afford to change their consumption patterns to be less carbon-intensive, whilst the poorer segments of society may not have this option (i.e. purchase of electric vehicles, retrofitting homes).	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Noted	
47097	22		22		Incorrect data: TS-8 This note is only for the upper right subplot in this figure titled "Electric LI-ON battery packs" of this figure. The upper right subplot in this figure titled "Electric LI-ON battery packs" shows Li-Ion battery (LIB) pack cost at approximately \$75/kWh in 2018, and \$50/kWh in 2020, which is much lower than available data on LIB cost, See Review Visual 4 at https://bit.ly/ipcc_review_wg3_figs . Despite the reference in the caption to Section 2.5, the cost plot for LIB cannot be found in the cited Section. I note that nearly the same figure also appears as Figure SPM.5. I recommend this part of Fig TS-8 be removed or corrected.	Kenneth Laberteaux	United States of America	Thank you for your comment. The data behind this figure has been checked and updated accordingly.	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
47099	22		22		Missing/incorrect citation: TS-8 This note is only for the upper right subplot in this figure titled "Electric LI-ON battery packs" of this figure. The upper right subplot in this figure titled "Electric LI-ON battery packs" shows Li-Ion battery (LIB) pack cost at approximately \$75/kWh in 2018, and \$50/kWh in 2020, which is much lower than available data on LIB cost. See Review Visual 4 at https://bit.ly/ipcc_review_wg3_figs . Despite the reference in the caption to Section 2.5, the cost plot for LIB cannot be found in the cited Section. I recommend adding a citation for this subplot.	Kenneth Laberteaux	United States of America	Thank you for your comment. The data behind this figure has been checked and updated accordingly. Cross-reference to the appropriate sections in the underlying chapter has also been expanded
84691	23	0	23	3	Here the 1.5°C carbon budget assumed is 420-580 Gt. This is different from the 1.5°C budget outlined earlier in the TS (page 17, lines 11-12), as well as from the numbers used in the page 23, lines 9-10. Please ensure consistency.	Kaisa Kosonen	Finland	This figure has been substantially revised to include updated regions, 1.5 and 2C scenarios
84693	23	0	23	3	So what this figure is showing is that assuming 'well below 2°C' with at least 66%, it is possible to keep all existing and have all proposed fossil infra? Based on which assumptions on CCS?	Kaisa Kosonen	Finland	This figure has been substantially revised to include updated regions, 1.5 and 2C scenarios
66469	23	1			Consider carefully consistent terminology relating to future emissions from capital stock – Future (title) – Committed (y-axis) – or other? Other words to consider: expected / anticipated / ... ? My personal inclination would be "anticipated", but it implies that those who financed and built this stock anticipate it operating for years or decades as expected - but their anticipation may be wrong, either because of overt climate policy, or because operating conditions change, maybe because of momentum in renewables, consumer preference for low carbon, or other factors Also note the bar on carbon budgets is not consistent with TS p.17	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	This figure has been substantially revised to include updated regions, 1.5 and 2C scenarios
64011	23	1	23	1	Figure TS.9: What is the source of the carbon budgets for limiting global warming to 1.5C in this Figure - not consistent with values provided on Page TS-17 lines 7-17.	Government of Canada	Canada	This figure has been substantially revised to include updated regions, 1.5 and 2C scenarios
67389	23	1	23	3	Readability of the table: suggest that the colours used are more distinctive; Asia and developing Pacific - orange and Developed Countries - red are too close to one another. Or just attributing them to other country groups so that they do not appear next to each other.	Philippe Tulkens	Belgium	This figure has been substantially revised to include updated regions, 1.5 and 2C scenarios
67391	23	1	23	3	Figure TS.9 - is it possible to distinguish between existing and proposed infrastructure in this figure? i.e. how much of this infrastructure is already in place?	Philippe Tulkens	Belgium	This figure has been substantially revised to include updated regions, 1.5 and 2C scenarios
1379	23	2	23	3	Additional information would be necessary to explain the different categories for axis X	Julien Demenois	France	This figure has been substantially revised to include updated regions, 1.5 and 2C scenarios
64013	23	3	23	3	Figure TS.9 caption: the phrase "Paris carbon budgets" is a short-form. Write out a complete explanation (i.e. carbon budgets for global temperatures bracketing the the Paris Agreement long term global temperature goal of limiting global warming to well below 2C and pursuing efforts to limit it to 1.5C). Currently, it seems that only a range of the carbon budget for 1.5C is shown in the figure.	Government of Canada	Canada	This figure has been substantially revised to include updated regions, 1.5 and 2C scenarios
83493	23	5	23	19	Ensure to update with latest remaining carbon budget assessment from WG1 Ch5.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	accepted - numbers updated
83355	23	5	23	19	The enormous uncertainties in the WG1 carbon budget calculations and the many substantial changes in the WG1 methodology (between SR1.5 and AR6) might warrant to avoid the countdown language used here	Geden Oliver	Germany	accepted - paragraph revised
7301	23	5	23	5	Please highlight the fact that the carbon budget is set to be expended by regions that already produce the most emissions. This is contrary to considerations of equity which would see the remaining budget going to setting up the least developed regions for a low-carbon future (the development itself requiring emissions). Perhaps a separate paragraph could be added.	Debra Roberts	South Africa	accepted - addressed, at least in part by revised wording in this section
67393	23	6	23	10	The sentence gives two emissions figures: 715 & 658. What is the difference? Also, it would be useful to define fossil fuel infrastructure in the paragraph. Presumably it is broader than just power plants. What % of fossil fuel emissions does it cover?	Philippe Tulkens	Belgium	accepted - paragraph revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
64015	23	8	23	8	We think the first set of numbers here (715 (546-909)) are a typo since they are followed by a second set of numbers which do match the values in the figure.	Government of Canada	Canada	accepted - paragraph revised
84695	23	8	23	8	Please explain where this 715 GtCO ₂ figure is coming from? The latter number (658 Gt) is explained by the figure above.	Kaisa Kosonen	Finland	accepted - paragraph revised
64017	23	9	23	10	Two comments: 1. should 'well below 1.5C' be 'below 1.5C', or 'to 1.5C'? 2. Here, the range of ± 250 GtCO ₂ associated with the carbon budget for limiting global warming to 1.5C is given for both the 67% and 50% chance estimates. Hence our query on page 17 about whether or not this uncertainty range applies to all estimates. Ensure consistency between pages 17 and 23.	Government of Canada	Canada	accepted - paragraph revised
80165	23	10	127	15	This section should use the academic terms of art for each of these phenomena, namely; moral hazard, slippery-slope, technological lock-in, and polarization driving social and geopolitical conflict, which are used in each of the papers cited. Their omission both impedes understanding and policy relevance, and threatens neutrality. See, as referenced in Ch.12: Minx, Jan C., et al. "Negative emissions—Part 1: Research landscape and synthesis." Environmental Research Letters 13.6 (2018): 063001.	Kelly Wanser	United States of America	Noted - a more comprehensive discussion is in the chapters
84697	23	12	23	12	This "well below 2°C" definition is inconsistent with the "below 2°C" definition of the very same budget on page 17.	Kaisa Kosonen	Finland	accepted - paragraph revised
84699	23	13	23	14	But is this true for 2°C, given the budget given above? The current and planned infrastructure seem to fit within the 2°C budget.	Kaisa Kosonen	Finland	accepted - paragraph revised
81467	23	14	23	14	The meaning of CCS only appears on page 27, line 47	Luana Ferreira	Brazil	noted. Meaning of all abbreviations provided at their first appearance
85261	23	16	23	17	check sentence	Valérie Masson-Delmotte	France	Noted. Revised
29501	23	17	23	19	To TS: Please consider expanding similar assessment for other key sectors or drivers, such as industry. For example, chapter 8, page 4, line 34-39 concludes that expected development of urban infrastructure embodies carbon emissions ranging from 8,4-14 GtCO ₂ annually up to 2030. Towards 2050, this infrastructure development alone would confiscate a significant part of remaining carbon budgets, in the order of 1/4 to 1/8 depending on target temperature limit. This could be translated in a number of years shortened lifetime for existing coal and gas power plants. This is key assessment for policymakers and industry alike, and should be included in SPM.	Government of Norway	Norway	accepted - more information now presented in the parts of the TS that relate to sectors
15403	23	18	23	18	19(11-16): 19 is not included between 11 and 16. Why is the time until retirement of gas power shorter than that of coal power?	Hiroaki Kondo	Japan	Accepted - addressed in chapter. And reporting scenario findings
10473	23	20	23	30	There is an apparent contradiction between the beginning and end of this paragraph; does not the "newly built energy infrastructure" correspond to added commissioning?	Philippe Waldeufel	France	accepted - text revised
24365	23		23		Additional information would be necessary to explain the different categories for axis X, Please explain what "Paris carbon budgets mean.	Government of France	France	This figure has been substantially revised to include updated regions, 1.5 and 2C scenarios
28223	23		23		Figure TS.9: In the title do not use "Paris carbon budgets", but explain whether this is a 1.5 of 2C aligned carbon budget.	Eleni Kaditi	Austria	This figure has been substantially revised to include updated regions, 1.5 and 2C scenarios
7303	24	0	47	0	Section TS 4.2 is easier to follow than TS 4.1, simpler language, more understandable. Nice concise headline statements. It also seems more important / immediately relevant. Can TS 4.1 be integrated into 4.2, topic by topic, to avoid redundancy, or moved after 4.2? In TS 4.2 the third level subsections are very useful.	Debra Roberts	South Africa	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
80129	24	1			<p>The observations by Grubb, Wieners and Yang (2021) on climate models are equally applicable to the planning models used in the energy sector. These generally fall into two categories: those using a general system equilibrium function, and those using an optimization model to minimize an objective function, usually total cost. In neither case is innovation explicitly represented.</p> <p>Instead, laborious efforts must be made to incorporate per-technology cost projections on an ex-ante or ex-post basis, often reflecting linear trends rather than innovation dynamics as expressed, for example, by experience curve analysis. This reflects both institutional conservatism or "inertia," and at times the desire to protect the existing high emissions asset base.</p>	Fred Heutte	United States of America	Accepted. Text has been completely revised.
80131	24	1			<p>To achieve rapid uptake of technology innovation requires more than a direct cost perspective. The cost reduction rate for innovative technologies is not the only important factor to consider. Some innovations, particularly for energy efficiency, induce little sectoral change other than the effect of reducing the use of highest-cost and highest-emissions resources at the margin.</p> <p>For generation and storage technology, including but not limited to solar, wind and batteries, emergent technical challenges also occur. For example, for power grids, the replacement of synchronous resources with inverter-based resources poses the need to develop new strategies for grid formation. However, technical solutions are already apparent that require further study and development, but do not appear to pose any limitations in ultimately achieving 100% clean energy grids.</p> <p>Finally, accelerated technology innovation will also have positive spillovers in for energy system decoupling, redundancy and resilient design. These are essential outcomes to assist with climate adaptation.</p>	Fred Heutte	United States of America	Accepted. Text has been completely revised.
80133	24	1			<p>We must select optimal policy choices for accelerating climate mitigation response and achievement of the needed emissions pathways.</p> <p>The lack of a technology innovation term in the core of our climate and energy planning models is a significant and growing constraint. This is a problem that can be addressed within a few years and help avoid path dependence toward less effective policy choices that result in massive capital misallocation and dramatically delay effective climate response.</p> <p>Grubb, M, Wieners, C, Yang, P. Modeling myths: On DICE and dynamic realism in integrated assessment models of climate change mitigation. WIREs Clim Change. 2021:e698. https://doi.org/10.1002/wcc.698</p>	Fred Heutte	United States of America	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
80123	24	1			<p>In both the Technical Summary and Chapter 6, "innovation" appears sparingly and usually only as a descriptive term. There is very little consideration of innovation process, yet our overall response to climate change, especially for mitigation, is highly dependent on the success of technology innovation across many sectors and at a far more accelerated pace.</p> <p>Technology innovation is a learning process including both the direct development of materials and equipment and the social and physical infrastructure to support that development, involving policy, investment and education. There is a vast literature on technology development and diffusion addressing these matters, but it is not highly visible in the climate literature.</p> <p>Experience curve assessment shows that policy choice, investment and learning are key to acceleration of beneficial technology development and diffusion, and that forward projections of innovation rates and related metrics such as cost can be estimated in a robust fashion.</p>	Fred Heutte	United States of America	Accepted. Text has been completely revised.
80125	24	1			<p>Therefore, the lack of a term for innovation in the core of both climate and energy planning models is a fundamental source of error in not providing policy makers and the public with a clear view of the potential scale and pace of technology development. This leads to unnecessary pessimism about progress on climate response and to poor policy choices.</p> <p>Recently, Michael Grubb has pointed out that despite our strategic reliance on innovation to achieve the needed emissions pathways to stabilize the climate system, the core models such as the IAMs effectively treat innovation exogenously, requiring ex-ante and ex-post adjustments that miss the mark time and time again.</p>	Fred Heutte	United States of America	Accepted. Text has been completely revised.
80127	24	1			<p>The rapid decline of solar PV module costs in the last decade is now a commonplace, as noted at numerous points in the SOD. Yet the general feeling is that "nobody predicted that would happen."</p> <p>To the contrary, the potential for rapid cost decline and saturation of PV technology has been understood for over four decades. As a survey paper I wrote in 2012 shows, the roots of this understanding are found in the view of "learning rates" and "experience curves."</p>	Fred Heutte	United States of America	Accepted. Text has been completely revised.
66471	24	2			<p>My sense is that this section – and the TS overall - suffers from the ordering and lack of integration across Chapters 2-4 materials. It would seem to flow more naturally to go from "emission trends and drivers", to the chapter 4-based material and views from aggregating trends and projections to 2050 "bottom up", before setting out the big global model-based projections – this might also help to ease the dilemma over how to handle "net zero" dates? <u>See also my final cross-cutting TS remark on broader structure</u></p>	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
7305	24	3	24	3	<p>"Reductions... in all countries" is not true. Some least developed countries have virtually no emissions to reduce. It may be worth differentiating here between 'reducing current' and 'avoiding future' emissions.</p>	Debra Roberts	South Africa	Accepted. Text has been completely revised.
72901	24	6	24	7	<p>Chance instead of change ?</p>	Antoine BONDUELLE	France	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
64019	24	9	24	12	As written, this sentence could be understood to equate 'carbon neutrality' with GHG emission neutrality ("a balance between anthropogenic emissions by sources and removals by sinks"). Recommend making a distinction between carbon neutrality (net zero carbon emissions) and GHG neutrality (net zero GHG emissions).	Government of Canada	Canada	Accepted. Text has been completely revised.	
7307	24	9	24	9	Please briefly explain "no net negative emissions while still allowing carbon dioxide removal"	Debra Roberts	South Africa	Accepted. Text has been completely revised.	
18647	24	10	24	10	"Carbon neutrality". It's worth being explicit about what this term mean here as it's one of those terms that has several different interpretations (along with "climate neutrality", "net zero" etc).	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.	
7309	24	12	24	12	"SSP2 socioeconomic assumptions" – please specify what these are?	Debra Roberts	South Africa	Accepted. Text has been completely revised.	
66473	24	20			I think a para is needed here underlining that the global scenarios in the literature almost all stem from global optimising models with perfect foresight, and the IPs are constructed similarly. And perhaps a word on their behaviour, that with improvements to technology assumptions (and lower discount rates) they tend to general early rapid emission reductions if there are ambitions long term goals. =>See my Whole Report comments on Chapter 1 – 4 consistency MG 9 -12. A clearly stated consistent terminology would help – probably, "Least cost global mitigation pathways ..." ?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.	
30277	24	22	25	19	This box is very central and very useful to understand the concept and basis for the use of illustrative pathways. Please ensure that readers of the SPM is also guided appropriately to such kind of information. Please also also consider giving the readers some more background on the choice of focusing almost entirely on SSP2.	Government of Norway	Norway	Accepted. Text has been completely revised.	
7311	24	35	24	35	"Paris Agreement" – are there also scenarios where transformation goes beyond the ambition of the governments as expressed in the Paris Agreement? Can this be mentioned here?	Debra Roberts	South Africa	Accepted. Text has been completely revised.	
18649	25	3	25	4	Comment relevant to the whole report: Need to be clear about what's meant by "current policies" given the timing of the expected release of the report and what's happened in relation to NDCs and net zero goals since Dec 2020.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.	
84701	25	6	25	7	This sentence reads as if the 66 % chance applied to both 2°C and 1.5°C. That would be incorrect, as in the Chapter 1 Annex C page 39 it is explained that the 1.5°C IPs are pathways consistent with 50 % likelihood of limiting to 1.5°C (not 66% likelihood).	Kaisa Kosonen	Finland	Accepted. Text has been completely revised.	
69951	25	7			I suppose on should read "66% chance of staying below 2°C, not "66% change below 2°C".	Cédric PHILIBERT	France	Accepted. Text has been completely revised.	
67395	25	7	25	7	correct the phrase "66% change below 2°C"	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.	
64021	25	9	25	9	Add 'global' before 'emissions' (i.e. net negative global emissions).	Government of Canada	Canada	Accepted. Text has been completely revised.	
64023	25	11	25	13	Recommend explaining in brief the kind of worlds the SSP2 and SSP1 scenarios describe (e.g. using at a minimum short descriptors such as 'middle-of-the-road' and 'sustainability' development pathways).	Government of Canada	Canada	Accepted. Text has been completely revised.	
69953	25	14			The expression "Chapter 1, Annex C" is confusing, one may look for an Annex C to Chapter 1, while it is an Annex to the whole volume.	Cédric PHILIBERT	France	Accepted. Text has been completely revised.	
66475	25	15			There are some minor differences between this box and the text and Figure in Chapter 1 – it would be good to align. These include whether we are explicit about the 'Current' in the CurPol (and that it doesn't include NDCs as policies), and the ordering of the scenarios – including naming since Supply side is confusing since obviously renewables are supply side and indeed the most plausible based upon acceleration of current trends (hence the revised ordering in the Chapter 1 box)?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
46757	25	16			Figure TS.10: Please indicate to which warming levels to CurPol and ModAct refer, consistent with the names of the other Ills.	Government of Germany	Germany	Accepted. Text has been completely revised.
66477	25	20	25	22	There has been some controversy around this. May be worth just flagging extent to which the tech trends shown in previous section may (or may not) change this.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
7313	25	21	25	21	Please include "from current xx GtCO2eq yr-1 in 2018" as reference point.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
77089	25	21	25	23	The statement that "global GHG emissions will grow (from 59 GtCO2eq now) to 63-110 GtCO2eq by 2050", the wide range demonstrating that WGIII really has little idea how the future will transpire. It actually also demonstrates that IPCC has not narrowed down climate sensitivity since the Charney report of 1979, despite \$ trillions being spent on climate research over 40+ years.	Jim O'Brien	Ireland	Accepted. Text has been completely revised.
64025	25	21	25	24	Box TS.3 directly above this paragraph said that the illustrative path called Current Policies was based on the SSP2 development path. Please clarify that the large range of future GHG emissions here (63-110 GtCO2eq/yr) is not only for 'no new policies' within the SSP2 family, but also, presumably, includes 'no new policy' scenarios from other development paths (e.g. the fossil fuel driven SSP5 pathway).	Government of Canada	Canada	Accepted. Text has been completely revised.
83495	25	21	25	29	Only providing emissions ranges until 2050 and temperature outcomes until 2100 is a bit strange. At least also report the implied warming by 2050. This would illustrate that both the 1.5°C and 2°C limits would most likely (no calibrated IPCC language!) be exceeded.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
64027	25	22	25	22	Is this calibrated 'likely'?	Government of Canada	Canada	Accepted. Text has been completely revised.
11353	25	22	25	22	The temperature projection figures presented here (3.3 -5.4) do not tally with those figures presented in Ch.3 (P.4, line 28). Please check and revise as appropriate.	SAI MING LEE	China	Accepted. Text has been completely revised.
24367	25	26	25	26	The population range (upper bound) in 2050 in Figure 3.7 seems to be higher than 9.5 billion people in 2050	Government of France	France	Accepted. Text has been completely revised.
11355	25	26	25	26	The figures "8.5-9.5 billion people" do not tally with the main text ("8.5-11 billion people", Ch.3, P.25, line 16-17). Please check and revise as appropriate.	SAI MING LEE	China	Accepted. Text has been completely revised.
11357	25	27	25	27	The source of the statement "the increase in the global GDP of 2.5-4.2% per year between 2015 and 2050" cannot be found in the main text (Ch.3). Please check.	SAI MING LEE	China	Accepted. Text has been completely revised.
81469	25	29	25	29	What does mean 'EJ'? This meaning doesn't appear in the entire file.	Luana Ferreira	Brazil	Thanks. EJ means exaJoules or 10 ¹⁸ Joules. It is a well know energy unit.
64029	25	30	25	30	It would be informative to add a paragraph here providing information about future GHG emissions and global warming levels under assumptions of implementation of NDC commitments/moderate action thereafter (i.e. ModAct scenario). Such a statement was included in the SR1.5 and it was useful to have such a statement in an IPCC assessment report.	Government of Canada	Canada	Accepted. Text has been completely revised.
83497	26	1	26	19	It would be valuable if this box on Net-zero emissions can integrate the insights of box TS.2 with the insights from across the WG3 chapters about the outcome of global net-zero greenhouse gas emissions as applied under the Paris Agreement and subsequent UNFCCC decisions. In particular, as statement as follows could be added at the end of the second paragraph (after line 9): "Because of the way in which greenhouse gas emissions and removals are reported under the Paris Agreement (ref to TS.2 box), achieving net-zero greenhouse gas emissions under the Paris Agreement would result in global temperatures peaking and subsequently gradually starting to decline (WG1 Section 7.6)." This is further supported by evidence provided in Rogelj, Geden, Cowie & Reisinger, Nature, 2021.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
83357	26	1	26	19	This box should be extended further, and specifically clarify the differences between net zero CP2 and net zero GHG, including timing and uneven distribution of efforts among regions/countries/sectors	Geden Oliver	Germany	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
18651	26	1	26	19	This box focuses on net zero GHG emissions only. It would be helpful to explain the relationship with net zero CO2 here and what's most important. Plus some clarity over the role of short-lived climate forcers, e.g. methane, would be helpful - the text hints at something ("near net zero") but doesn't give enough information to help understanding. Also, I would avoid the term "GHG neutrality" to avoid confusion.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
64031	26	2	26	3	Should this be "stabilizing global temperature" instead of "stabilizing global temperature change"? Secondly, here it refers to bringing GHG emissions down to net zero, whereas IPCC assessments have previously emphasized the need for net zero carbon emissions to stabilize global temperature. The supporting text in Ch. 3 section 3.1 (page 11, lines 9-10) says stabilizing global avg temperature requires CO2 emissions be reduced to net zero or near net zero. These are important concepts to convey - what is needed to stabilize global temperature vs. declining global temperature.	Government of Canada	Canada	Accepted. Text has been completely revised.
64033	26	4	26	5	Ensure consistent text with Paris Agreement article 4.1 by adding 'anthropogenic' before "sources and sinks" and adding "in the second half the century" to the end of this sentence.	Government of Canada	Canada	Accepted. Text has been completely revised.
24369	26	4	26	5	We recommend to specify that this balance addresses anthropogenic sources and sinks as in the text of the Paris Agreement	Government of France	France	Accepted. Text has been completely revised.
28225	26	4	26	5	Specify that "The Paris Agreement also calls for reaching a balance of sources and sinks of GHG emissions" at a global level.	Eleni Kaditi	Austria	Accepted. Text has been completely revised.
66479	26	10	26	12	It is vital to articulate clearly the relationship of peaking date – and rate of early reduction – to the date of net zero. The popular narrative taken from the SR1.5 report was that the date of "net zero" drives the need for urgent action. If anything the opposite is surely true – the deeper the early cuts, the more net zero can be pushed back in a long tail of low emissions. But that makes the message more complex, and also means the date of net zero is contingent upon the extent to which the global model optimisation assumptions of abrupt steep reductions are plausible. See my Whole Report comments MG9-12 on this : this box, or at least section, may be the place to clarify.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
7315	26	11	26	11	It would be useful to explain "cost of abatement" concept at first mention.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
53113	26	12	26	12	Ch3: "Typically" what does that mean in term of likelihood? Or at least in term of the fraction of the 1600 scenarios that show this? Clarify.	Government of Saudi Arabia	Saudi Arabia	Accepted. Text has been completely revised.
15405	26	13	26	13	What is meant by 'before the economy as a whole'? The same phrase appears L44, P28.	Hiroaki Kondo	Japan	Accepted. Text has been completely revised.
18655	26	21	26	28	It would be helpful to explain why there is a spread in the net zero GHG dates, and provide some detail on the relationship with near-term action.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
18653	26	22	26	22	Suggest it says: "most modelled pathways" if this is based on the IAM results.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
66481	26	23	26	24	Surely it would be more precise to say, "for all groups below and including 2.5C, the least-cost pathway involves emission reductions from the first moment allowed in the model (ie. peak immediately)". – at least that would seem the implication from Table TS.1 Column 1 .	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
53115	26	24	26	24	Ch3: categories C1-C3 have not been defined in this chapter yet	Government of Saudi Arabia	Saudi Arabia	Accepted. Text has been completely revised.
66483	26	24	26	25	See previous comment on the pathway interactions, also need to clarify CO2 from GHG. I this is potentially easy to misunderstand – or misrepresent. Maybe integrate / juxtapose with the para below. "In terms of CO2 emissions?"	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
83499	26	25	26	26	This statement is misleading in that these scenarios do not have an even chance of limiting warming to 1.5°C. They have much lower chance over the course of the century, and only have a 50% chance to recover from this overshoot by 2100. This should be reflected accurately in the text.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
7317	26	25	26	26	Re "even chance" – does this mean 'as likely as not' or a 50:50 chance? Is "likely chance" a 2:3 or 1:2 chance? Please remind the reader here – it is probably defined somewhere in the report. Is there a better way of saying this in common English for the TS?	Debra Roberts	South Africa	Accepted. Text has been completely revised.
64035	26	25	26	27	Need consistent descriptors for the scenarios. In Table TS.1, categories C1 and C2 are described as <1.5C scenarios, and C3 as a <2C scenario. Secondly, please state when the other 75% of C3 scenarios achieve net-zero GHG emissions. Is it after the year 2100?	Government of Canada	Canada	Accepted. Text has been completely revised.
84703	26	25	26	27	Please give separately a net zero date for those 1.5°C scenarios that try to avoid overshoot and extensive reliance on CDR / BECCS.	Kaisa Kosonen	Finland	Accepted. Text has been completely revised.
67397	26	26	26	31	Lines 26-28 could be interpreted as a 75% chance that net zero emissions by 2100 are not required in order to limit warming to below 2°C. Is this really so? The finding that 2°C is associated with net zero CO2 around 2070 (from line 46) seems more relevant. Also, introducing the concept of scenarios "consistent with the Paris Agreement" is confusing. Does this mean anything other than that the scenarios are consistent with 1.5/2°C?	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.
83501	26	29	26	30	The expression "consistent with the Paris Agreement" can only be used if IPCC WG3 is willing to explicitly define what this means. This should be included in the core concepts of the TS and SPM. Otherwise, accurately describing the temperature outcomes one is actually referring to would be the least misleading and least policy prescriptive way forward.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
84705	26	29	26	31	"Scenarios consistent with the Paris Agreement typically reach net zero CO2 emissions early in the second half of the 21st century." Since the SR1.5, the benchmarks established there for a 1.5°C compatible CO2 global emission reduction pathway have broadly been understood as the Paris Agreement compatible benchmarks. Hence, the sentence here muddies the waters.	Kaisa Kosonen	Finland	Accepted. Text has been completely revised.
53117	26	30	26	34	Ch3: The use of net zero CO2 and net zero carbon to mean the same thing, and net zero GHG is a broader concept that also includes non-CO2s. It is not clear how would the reduction of non-CO2 emissions affect the pathways to net zero CO2 emissions. Net zero carbon emissions is not a term in the glossary chapter. There is net zero CO2, net zero GHGs, carbon neutrality, and ghg neutrality. Ensuring these terms are used consistently throughout the whole report is very important.	Government of Saudi Arabia	Saudi Arabia	Accepted. Text has been completely revised.
77277	26	32			Broader scope if "renewable energy" is replaced by "low-carbon energy".	Giacomo Grasso	Italy	Accepted. Text has been completely revised.
7319	26	35	26	35	What does "Cost-effective mitigation" mean in this context? Cost effective in relation to? Future costs of impacts? What is the main message of this paragraph? The second sentence perhaps says it a bit more clearly. Consider swapping.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
84707	26	35	26	35	Please always present the findings for 1.5°C first, rather than what is done here, where the results for 2°C and presented first and bolded, which could be understood as "below 2°C" being the preferred goal.	Kaisa Kosonen	Finland	Accepted. Text has been completely revised.
64037	26	35	26	46	please clarify what the ranges are in these 2 paragraphs. Are these interquartile ranges?	Government of Canada	Canada	Accepted. Text has been completely revised.
7321	26	37	26	37	Please include "from current xx GtCO2eq yr-1 in 2018" as reference point. To illustrate, it may help to quote here the reductions in GHG seen early in the Covid period, which, this has been mentioned elsewhere, corresponds to the required level of reduction.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
84709	26	38	26	42	Given the well known "IPCC benchmarks" for 1.5°C outlined by the IPCC SR1.5 (i.e. -45 % CO2 cuts from 2010 levels by 2030 and net zero around 2050), many readers will be wondering how these AR6 ranges compare to those SR1.5 benchmarks (which have since become THE science-based benchmarks for Paris Agreement compatible climate action). Given different base years and scopes (CO2 / GHG), a reader might get lost. Please provide an explanation of how the two compare (and in what sense the AR6 provides an updated assessment of the needed 1.5°C compatible emission cuts).	Kaisa Kosonen	Finland	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
46759	26	43	26	43	In terms of CO2 emissions, a warming limit of 1.5°C (50% probability): can you please explain, why you use here "50% probability" and 67% at page 3-17, line 13 or 66% at page 4-25, line 7?	Government of Germany	Germany	Accepted. Text has been completely revised.
24371	26	43	26	45	In table SPM1, or table 3.2, the year of net zero CO2 for such pathways is 2056 and not 2057	Government of France	France	Accepted. Text has been completely revised.
83503	26	43	27	5	Ensure consistent units (GtCO2 yr-1) throughout when referring to annual emissions	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
83505	26	43	27	5	The range of net-zero timing can be made significantly more policy-relevant by highlighting how near-term emissions reductions by 2030 correlate with the time of reducing to net-zero CO2 with weaker near term action resulting in earlier net zero dates.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
24373	26	46	26	46	Why is there a range of year here, including a typo, as there is no upper bound in table SPM1 or table 3.2?	Government of France	France	Accepted. Text has been completely revised.
28227	26	46	26	46	Please correct the time period presented in the parenthesis (2060-2100095).	Eleni Kaditi	Austria	Accepted. Text has been completely revised.
53119	26	46	26	46	Ch3: (2060-2100095) -- supposed to be (2060-2100).	Government of Saudi Arabia	Saudi Arabia	Accepted. Text has been completely revised.
4613	27	1	27	5	The text says "to a smaller degree - on the reduction of non-CO2 emissions." Does this statement also take into consideration methane emissions from the thawing permafrost in the Arctic? Reference (not listed in Chapter 3 of which this paragraph is referring to): Martens et al. 2020. Remobilization of dormant carbon from Siberian-Arctic permafrost during three past warming events. <i>Science Advances</i> Vol 6, No 42. DOI: 10.1126/sciadv.abb6546.	Glenn Bark	Sweden	Accepted. Text has been completely revised.
64039	27	2	27	4	Unless we are mistaken, this TS has not yet introduced the idea that peak warming generally occurs around the time of net zero CO2 emissions; therefore, this sentence stating that "the time of net zero CO2 emissions can lag peak warming by 10 years (0-27)" if non-CO2 emissions are reduced rapidly, is confusing. It needs to be unpacked for readers. An illustration would help convey this message.	Government of Canada	Canada	Accepted. Text has been completely revised.
67399	27	3	27	4	The following sentence is surely not scientifically sound. "The more non-CO2 emissions are reduced until the time of net zero CO2 emissions, the more CO2 emissions can be emitted cumulatively until then." Presumably the authors are attempting to communicate the notion that non-CO2 reductions will have a more immediate impact on temperature. The argument that this 'buys time' for slower CO2 reduction is too nuanced to be stated so bluntly. A pulse of CO2 has atmospheric permanence that SL CF pulses do not, as the WG1 report explains in detail.	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.
67401	27	4	27	4	The second "emissions" should be deleted. Emissions cannot be emitted.	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.
7323	27	4	27	4	"the more CO2 emissions can be emitted cumulatively until then." – This makes 1.5 sound like a target to aim for rather than a higher level to avoid. Consider rephrasing this to say, if other GHGs can also be reduced, that will bring the warming peak forward and avoid associated impacts, and make everything more feasible. The focus should be on the benefit of reducing other GHGs, not the extra amount of CO2 that would 'allow' us to emit. Same comment for "allow for increased emissions from other sectors" in page 29, line 5.	Debra Roberts	South Africa	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
7327	27	6	27	38	It may help the reader if the text was worded to make it clear that these paragraphs describe different pathways that were developed in various modelling exercises, and describe how especially the pathways that lead to the 1.5 or 2 deg limits unfold. For example: "Modelled future pathways that have a 1.5°C peak warming, with no overshoot, all ... say something they all have in common... Pathways that start out along the NDC trajectory (assuming NDCs are met), reach 1.5°C sooner (yyyy), and only avoid a large overshoot if they have very much higher rates of decarbonization after that.... Pathways that start out more ambitiously than the NDCs, Pathways that continue at current emission levels (which exceed NDC commitments by xx), Pathways that do not incorporate any major mitigation at first, This would help readers get a better handle on the content and the key message (that early high ambition is better than prevarication).	Debra Roberts	South Africa	Accepted. Text has been completely revised.
7325	27	6	27	7	Please rephrase, currently it sounds like "reliance on ... temperature overshoot". e.g. "...decrease temperature overshoot and reliance on negative emissions."	Debra Roberts	South Africa	Accepted. Text has been completely revised.
7329	27	7	27	7	please add "...temperature overshoot AND THE ASSOCIATED IMPACTS ON NATURE AND SOCIETY" (which are non-linearly related to level of warming.)	Debra Roberts	South Africa	Accepted. Text has been completely revised.
66485	27	9			The place to align understandings (and numbers)? The Glossary actually leaves it ambiguous whether it refers to cumulative to net zero date, or cumulative to 2100 (which is substantially larger in Table TS.1 even for NBZ scenarios)	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
24375	27	11	27	11	We think replacing "there is a chance" with "it is likely" would better reflect the definition of the carbon budget.	Government of France	France	Accepted. Text has been completely revised.
46761	27	13	27	17	The statement on the concerns of large-scale deployment of CDR options is overly positive. The assessment in chapters 3. 6. 7. and 12 clearly show that indeed all - not some - of these options come with concerns. In addition, this report also shows that it is not known, if the implementation of large-scale CDR is feasible because of technological, economic, political and sustainability constraints. Please amend the text accordingly.	Government of Germany	Germany	Accepted. Text has been completely revised.
84711	27	13	27	17	"This requires large-scale deployment of carbon dioxide removal (CDR) options, some of which come with concerns relating..." This suggests that some, but not all CDR options come with concerns related to sustainability. Please specify the CDR options that are not associated with such concerns.	Kaisa Kosonen	Finland	Accepted. Text has been completely revised.
7333	27	14	27	14	Suggest to replace "food prices" with "food security" and add "biodiversity"	Debra Roberts	South Africa	Accepted. Text has been completely revised.
7331	27	14	27	15	Consider adding "negative impacts on ecosystems and biodiversity" ; Also add "interregional equity issues" especially if the remaining carbon budget goes once again to high-emitting regions and countries, as suggested earlier.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
7335	27	15	27	15	Suggest to start a new sentence here. "Higher levels of warming also threaten future performance..."	Debra Roberts	South Africa	Accepted. Text has been completely revised.
28655	27	16	27	16	Suggest deleting "geological storage reservoirs" because geological storage of CO2 is considered permanent if done as required by CCS regulations. See IPCC GHG Inventory Guidelines 2006 and Dixon et al (2015) "Legal and regulatory developments on CCS", International Journal on Greenhouse Gas Control 40 (2015) 431-448 (SI to review 10 years since IPCC SR on CCS). And this was not flagged in Chp6 as an issue.	Tim Dixon	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
66487	27	16	27	17	Here could link also with the Net zero box / timing issue?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
7337	27	18	27	18	Please check for overlap/duplication in this paragraph compared to previous paragraph.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
7339	27	19	27	19	Suggest adding "SIGNIFICANTLY increases climate impacts"	Debra Roberts	South Africa	Accepted. Text has been completely revised.
7341	27	21	27	21	Consider adding "escalating impact costs – health, economic, environmental"	Debra Roberts	South Africa	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
11359	27	26	27	26	The figures "49-62 GtCO ₂ -eq" do not tally with the main text (52.4-64.6 GtCO ₂ -eq, Ch.3, P.62, line 6). Please check and revise as appropriate.	SAI MING LEE	China	Accepted. Text has been completely revised.
62091	27	26	27	28	Do you refer to the unconditional or conditional NDCs ? Please explain. I would also reformulate: if the conditional NDCs are implemented.	Michel den Elzen	Netherlands	Accepted. Text has been completely revised.
80167	27	26	27	31	The statement that staying below 1.5 degrees "not possible" is not accurate given the potential use of SRM. Not mentioning it in the context of risk of insufficient mitigation ambition is misleading by omission and therefore policy-prescriptive. As per SR1.5, "SAI is the most-researched SRM method, with high agreement that it could limit warming to below 1.5°C" (SR1.5, Ch4, Cross-chapter box 10)	Kelly Wanser	United States of America	Accepted. Text has been completely revised.
7343	27	26	27	31	"If NDCs are followed until 2030" – elsewhere this has been worded in a way that highlights that currently NDCs are not being followed, e.g. "Even if NDCs were followed ... warming would reach..." in other words, NDCs are not ambitious enough. "It would also strongly increase challenges of staying below 2°C warming with high likelihood." - this sentence is confusing, consider rewording. What does the first "It" refer to? This whole paragraph is a bit confusing. What is the key message?	Debra Roberts	South Africa	Accepted. Text has been completely revised.
7345	27	29	27	29	Consider adding the fact that higher warming levels render some mitigation options less effective, and create climate feedbacks that speed warming further – ref WGII. So there are multiple good reasons to opt for earlier strong mitigation and this needs to be spelled out clearly.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
67403	27	29	27	31	This sentence is not clear. Is the intention to say that continued high emissions up to 2030 exhaust the carbon budget sooner, bringing the necessary net zero time forward by decades?	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.
46763	27	33			Is it correct that for 1.5 and 2°C the emissions need to fall below NDC levels by around 10 GtCO ₂ in 2030? We would assume that it would be less for 1.5°C. Please check or explain if there is no difference.	Government of Germany	Germany	Accepted. Text has been completely revised.
66489	27	36			Energy ?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
64041	27	39	27	43	What is being referred to here in terms of "reductions in demand" - is this demand in energy, demand in materials? Does this include energy efficiency improvements leading to reductions in demand? Please clarify.	Government of Canada	Canada	Accepted. Text has been completely revised.
7347	27	39	27	43	Please expand with whatever information is available, as demand reduction (lower consumption) is an important consideration for individuals. Later in the TS there is some information on this, which raises the question of redundancy.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
67405	27	39	28	29	It would be useful to clarify in these paragraphs to clarify where the statements reflect lack of granularity of IAMs, and where they reflect important findings. The paragraphs seem to imply that demand-side mitigation option and decarbonisation of transport happens last. But there is scope for faster decarbonisation than the IAMs currently project if low-cost technologies develop more quickly than expected by the current IAMs and/or behavioural barriers on the demand-side are overcome.	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.
66491	27	41			The further I read into this section 4.1, the more convinced I become that it would flow more logically, and be easier to understand and position, if it followed after 4.2.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
24377	27	41	27	42	We suggest to add that there are yet too few models for studying in depth changes in behaviour and consumption.	Government of France	France	Accepted. Text has been completely revised.
46765	27	42			Please quantify the fraction of pathways that include demand side mitigation.	Government of Germany	Germany	Accepted. Text has been completely revised.
77279	27	42			Proposed to extend "renewable energy" into "renewable and other low-carbon energy"	Giacomo Grasso	Italy	Accepted. Text has been completely revised.
54419	27	44	28	4	Seems inconsistent with Chapter 6 and TS page 28, lines 45-47, regarding CDR, CCU vs. BECCS, and the importance of CCS.	Government of United States of America	United States of America	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
28995	28	2	38	4	This statement is not in agreement with the Summary for Policymakers, which presents BECCS potential at a relatively small median 0.8 GtCO ₂ /a. More consistency across the report and summaries about how and which potentials are presented/highlighted is necessary.	Jasmin Kemper	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
7349	28	3	28	3	"can contribute" – recommend wording that is less optimistic, because bioenergy – depending on how it is obtained – has important potential trade-offs for human and ecosystem health and wellbeing.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
46767	28	4	28	4	Please include a reference to the risks associated to BECCS, as covered in chapter 6 (carbon storage, section 6.4.2.5), 7 (biomass production, section 7.6.4) and 12.5.	Government of Germany	Germany	Accepted. Text has been completely revised.
72223	28	5	28	10	In the building sector, what is important is the share of renewable energies, for example renewable gas and renewable heat, rather than the electricity share. A scenario could also have Energy Positive Buildings by 2010 with the building surplus energy powering electric vehicles or sold to the grid.	bertoldi paolo	Italy	Accepted. Text has been completely revised.
67407	28	5	28	10	In the building sector what is important is the share of renewable energies, for example renewable gas and renewable heat, rather than the electricity share. A scenario could also have energy positive buildings by 2010 with the building surplus energy powering electric vehicles.	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.
24379	28	12	28	13	The beginning of the sentence "Absent mitigation efforts, the transport sector shows ..." is unclear	Government of France	France	Accepted. Text has been completely revised.
53121	28	17	28	18	Ch3: "of these options is limited in these pathways...? Clarify options/pathways being referred to.	Government of Saudi Arabia	Saudi Arabia	Accepted. Text has been completely revised.
64043	28	23	28	29	Suggest adding information to clarify how the industrial sector achieves net negative CO ₂ emissions: is this from initiatives outside the sector (e.g. with AFOLU measures, or BECCS) or is this with DACCS? Since lines 26-27 refer to CCS systems, and there is often confusion between CCS and negative CO ₂ emissions (CDR), adding information about how the negative emissions are achieved would help avoid such confusion.	Government of Canada	Canada	Accepted. Text has been completely revised.
24381	28	30	28	38	In the chapter 3.4.5, the mitigation pathways for the AFOLU sector remain very much oriented towards afforestation/reforestation and BECCS (see Section). The chapter does not consider possible emissions reductions from efficiency gains, including the pathways to increase food production without expanding agricultural land. There is very little on non-CO ₂ gases whose emissions remain surprisingly constant, while substantial potential for cost-effective emissions reductions have been identified, e.g., regarding the methane emissions from livestock production. This chapter therefore seems to retain only a small part of the reduction potentials identified in Chapter 7. Section 3.4.5 does not rely on the same scenarios framework used elsewhere in the report, which reduces somewhat its significance. Results from scenarios of low demand (1.5-LD) or without net negative emissions (1.5-NBZ or <2-NBZ) would have greatly enriched the analysis. It is unfortunate that they have not been reported in this section.	Government of France	France	Accepted. Text has been completely revised.
11361	28	32	28	32	The source of the statement "Total cumulative AFOLU CO ₂ emissions vary widely across scenarios, with as much as 415 GtCO ₂ sequestered between 2010 and 2100 in the most stringent mitigation scenarios" cannot be found in the main text (Ch.3). Please check.	SAI MING LEE	China	Accepted. Text has been completely revised.
53123	28	32	28	32	Ch3: Justify using year 2010 instead of year 2015 used in previous text.	Government of Saudi Arabia	Saudi Arabia	Accepted. Text has been completely revised.
24383	28	34	28	34	More thought should be given to the definition of the word "forest", as in the SROCC glossary, to which the word "deforestation" is closely related, and to the relationships that should be established between national, legal and ecological definitions of this word.	Government of France	France	Accepted. Text has been completely revised.
46769	28	35	28	38	The link between the reductions of CH ₄ and N ₂ O and the implications for water use and risk of hunger does not get clear in this sentence. Could you specify the causality here?	Government of Germany	Germany	Accepted. Text has been completely revised.
7351	28	39	28	39	This would make a good introductory paragraph to this section.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
66493	28	42	28	43	Maybe, "utilise at least some CDR to compensate ... whether or not global emissions 'go negative'".	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
29691	28	45	29	2	CDRs mentioned include only afforestation and BECCS that increase the demand/competition for land, and therefore are under debate for feasibility and sustainability. Consider including, if appropriate, other CDR options such as soil carbon sequestration as these may be implemented within existing land uses and might improve sustainability without increased demand for land.	Government of Norway	Norway	Accepted. Text has been completely revised.	
64045	28	47	29	2	it should be clarified why BECCS and afforestation are the predominant CDR options in currently modelled emission pathways - because these are the only options currently mature and deployable at scale?	Government of Canada	Canada	Accepted. Text has been completely revised.	
66495	29	4	29	26	This is crying out for a Figure which shows, even if in semi-stylised way (a) representative economic growth projections (to help explain the consistency of the < 0.1%/yr with the 1.6% to 4.3%) along with maybe (b) something illustrative investment and returns/fuel savings over time, and /or (c) Chapter 3 Figure 3.33 to also remind about [co-] benefits and how they shift over time ? Probably should include a brief cross reference to box 15.7 on macroeconomics in the finance chapter This could plausibly be integrated with Figure TS.12	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.	
46771	29	4	29	6	Please change "can allow" in "could allow". Comment: The feasibility of DACCS as a CDR option is very uncertain too, inter alia due to its energy penalty. Rubin, E., Meyer, L., de Coninck, H. et al., Carbon Dioxide Capture and Storage – Technical summary, IPCC Special Report, 2018	Government of Germany	Germany	Accepted. Text has been completely revised.	
46773	29	7	29	20	Please consider to move these highly important messages on global economic activity and mitigation costs contained this paragraph to the SPM.	Government of Germany	Germany	Accepted. Text has been completely revised.	
67409	29	10	29	15	Consider breaking up this sentence to make the main points more concisely. i.e. 1) mitigation costs are an underestimate since they do not typically include avoided damages (noting also that the benefit of avoided damages will continue beyond the horizon of the mitigation scenario). 2) economic growth can continue. Reductions are compared to a counterfactual.	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.	
46775	29	16			What is a "carbon value"? Please define.	Government of Germany	Germany	Accepted. Text has been completely revised.	
83509	29	21	29	26	The statement could be formulated in a less misleading way by first mentioning that GDP change estimates under pathways assessed in Ch3 typically disregard any benefits of avoiding climate change impacts, then followed by the caveated numerical values.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.	
28229	29	21	29	37	Refer to regional discrepancies on mitigation costs, with some regions facing substantial adverse impacts of mitigation action, as analysed in Chapter 3 of the SOD WG III contribution. In addition, analysis should elaborate further on mitigation costs, providing quantitative findings. Based on AR5, WG III, SPM p. 18. "There is a wide range of possible adverse side-effects as well as co-benefits and spillovers from climate policy that have not been well-quantified (high confidence). Whether or not side-effects materialize, and to what extent side-effects materialize, will be case- and site-specific, as they will depend on local circumstances and the scale, scope, and pace of implementation. Mitigation policy could devalue fossil fuel assets and reduce revenues for fossil fuel exporters, but differences between regions and fuels exist (high confidence). Most mitigation scenarios are associated with reduced revenues from coal and oil trade for major exporters (high confidence). The effect of mitigation on natural gas export revenues is more uncertain, with some studies showing possible benefits for export revenues in the medium term until about 2050 (medium confidence). The availability of CCS would reduce the adverse effect of mitigation on the value of fossil fuel assets (medium confidence)."	Eleni Kaditi	Austria	Accepted. Text has been completely revised.	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
84713	29	21	29	37	question the relevance of providing such precise numbers for estimated GDP losses entailed by 1.5°C and 2°C mitigation pathways, and presenting them as bolded headline findings, when there are so many things that these numbers ignore. Yes, the numbers indicate minor losses, but we're still talking about economic losses rather than gains. And we're still focused on GDP rather than on actual well-being. The paragraph might as well be leading with the bigger picture conclusion - that when economic benefits from avoided climate impacts and co-benefits are accounted for, mitigation can be a welfare-enhancing strategy (see for example section 3.6.2). Or build on the framing in the TS (page 4 lines 43-46) "Recent IAM intercomparisons, with improved representation of system dynamics, show that rapid decarbonization towards net zero emissions (...) is associated with higher economic output in the long term (even aside from the benefits from avoided climate impacts), compared to deferred action."	Kaisa Kosonen	Finland	Accepted. Text has been completely revised.
11363	29	23	29	23	The figures "1.6% and 3.5%" cannot be reconciled with panel (b) of Figure 3.36 in Ch.3. Please check.	SAI MING LEE	China	Accepted. Text has been completely revised.
11365	29	24	29	24	The figures "2.1% and 4.3%" cannot be reconciled with panel (b) of Figure 3.36 in Ch.3. Please check.	SAI MING LEE	China	Accepted. Text has been completely revised.
80489	29	25	29	26	Please clarify better why the benefits of avoided climate change impacts etc are not considered in the mitigation cost of many pathways	Moritz Riede	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
77281	29	30	29	31	The sentence "not including benefits of avoided climate change impacts nor co-benefits or co-harms of mitigation action" has been already stated few lines above, in bold, and there's no need to repeat it. Notably, this specific phrase is out of the context of the rest of the period (reduction of consumption growth).	Giacomo Grasso	Italy	Accepted. Text has been completely revised.
24385	29	36	29	36	Figure TS1 should be replaced with TS.1	Government of France	France	Accepted. Text has been completely revised.
46777	29	38	29	40	What is a "peak temperature limit", in particular in the context of a low temperature pathway?	Government of Germany	Germany	Accepted. Text has been completely revised.
67411	29	38	29	48	Consider combining these investment insights with those on stranded assets and lock-in from page 23 and costs of delayed action from p33 (lines 14-22). i.e. the extra investment compared to baseline is not independent from the composition of current and planned assets, continuing down a carbon-intensive path increases the investment premium. Qualitatively, what does this extra investment consist of? Are these figures consistent with the claim that PV offers the "cheapest electricity in history"? (IEA World Energy Outlook 2020)	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.
77283	29	39			Proposed to change "renewable" into "low-carbon".	Giacomo Grasso	Italy	Accepted. Text has been completely revised.
66497	29	41	29	42	Even I have no idea what these are ... ?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
11367	29	41	29	45	The source of the statement "Increased investment needs in the energy sector for scenarios below 2°C (C3) are, on average, about 3-50% higher than in baselines, and about 50%-65% higher for 1.5°C scenarios (C2 and C1) than baselines (or absolute numbers: 3,780 billion USD2010 yr-1 over 2023-2050 on average for C1 scenarios, 3,370 billion for C2 scenarios, 3,090 billion for C3 scenarios and 2,290 billion for baselines)." cannot be found in the main text. Please check.	SAI MING LEE	China	Accepted. Text has been completely revised.
83507	29	45	29	46	Are there truly scenarios that do not assume any (gross) land-based CO2 removal? Note that land-use CO2 emissions in the emissions database represent net emissions. The gross contributions of land-use CO2 emissions and removals are masked by this reporting assumption.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
46779	29	46	29	48	The meaning of this sentence is not clear, and why is pollution relevant for mitigation targets? Please revise.	Government of Germany	Germany	Accepted. Text has been completely revised.

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If any fields are not readable, please ensure to expand relevant cells. If reading this in PDF format, please refer to the Excel format version of this document available on: https://www.ipcc.ch/report/ar6/wg3/downloads/drafts-and-reviews								
Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
7353	30	0	30	0	This box is extremely helpful and very well written! Much clearer than paragraphs on page 29 and before/after. Can those paragraphs be revised? The key message that instant action is the only logical option and a "welfare-enhancing strategy" must come across clearly.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
67413	30	2	31	18	Box TS.5 - please consider adding the ecosystem services, i.e. the contribution made by nature, which should be taken into account. Especially if the ecosystem services are threatened in the future and their natural contribution declines.	Philippe Tulkens	Belgium	Taken into account. Thank you for your comment. We noted this in the introductory paragraph. However, assessment of ecosystem services is outside the scope of WGIII, and outside the scope of this box, especially when considering the limited space. Please check WGII 16.5.2 for more details.
10475	30	9	30	20	This paragraph lacks clarity. It begins by comparing cost-effectiveness (CEA) against cost-benefit (CBA) approaches, and stresses the limitations of the CEA approach. While one should then expect further indications about benefits, what is given is a discussion about costs.	Philippe Waldeufel	France	Noted. Thank you for your comment. The paragraph indeed first defines CEAs and CBAs then moves to discussing CEAs in detail. The discussion on CEAs continues in the subsequent paragraph. However, after that the discussion moves to CBAs then continues to other aspects.
64047	30	9	30	9	Move "(CEA)" after "approach"	Government of Canada	Canada	Taken into account in the revised text
64049	30	11	30	11	Delete "approach" as it is included in "CEA"	Government of Canada	Canada	Accepted.
24387	30	21	30	22	Delaying mitigation leads to higher overall costs also because damages depend on the rate of warming and not only on final warming (e.g. ecosystem adaptation takes time)	Government of France	France	Rejected. Thank you for your comment. This paragraph is focused on mitigation costs, and not adaptation costs.
66499	30	30			Of course!	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted
64051	30	30	30	30	Delete "Cost-benefit analysis" as it has already been defined at I.10.	Government of Canada	Canada	Accepted.
64053	30	35	30	36	Delete "Cost-benefit analysis" as it has already been defined at I.10.	Government of Canada	Canada	Accepted.
46781	30	40	30	45	We doubt that the statement "Whilst emerging literature has started to address those gaps, evidence suggests that even with such limitations and if broader representation of climate risks are included, empirical estimates of damages, risk, consistent inter- and intra-generational discounting, and equity are taken into account, pathways associated with least-cost delivery of the global temperature stabilization below +2°C are likely to be economically optimal at the global level and over the full century." is true. Stabilization at 2°C could include overshooting of any degree resulting in triggering non-reversible tipping points and large-scale losses and damages. And does this calculation include damages versus avoided damages, and how are non-monetary values factored in? Please reconsider and revise this statement.	Government of Germany	Germany	Accepted. Thank you for your comment. We have revised the text and provided qualification to the literature from which these estimates are derived.
46783	30	40	30	45	Can this include overshooting of any degree? Are damages / avoided damages included, or side effects of ambitious mitigation? How are non-monetary goods factored in, e.g. the higher losses at 2°C?	Government of Germany	Germany	Accepted. Thank you for your comment. We have revised the text and provided qualification to the literature from which these estimates are derived.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
84715	30	40	30	45	This reads as a strong advocacy for 2°C (and against 1.5°C). In this the intention?	Kaisa Kosonen	Finland	Accepted. Thank you for your comment. We have revised the text and provided qualification to the literature from which these estimates are derived.
66501	30	47			And local,	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted
85259	30		30		What about the consideration of ecosystem services in a changing climate in Box TS.5?	Valérie Masson-Delmotte	France	Taken into account. Thank you for your comment. We noted this in the introductory paragraph. However, assessment of ecosystem services is outside the scope of WGIII, and outside the scope of this box, especially when considering the limited space. Please check WGII 16.5.2 for more details.
61229	31	9	32	20	Some mitigation measures also require adaptation measures to ensure their successful implementation. For example, solar energy, wind energy, forestry, agriculture and other measures also require adaptation measures to ensure their successful implementation. These issues also need to be pointed out in D4.	Jianguo WU	China	Rejected. Thank you for your comments. Adaptation is outside the scope of this box. The interlinkages between mitigation and adaptation (when it comes to this particular topic) are covered in Cross working group box 1 in chapter 3.
66503	31	12	31	14	This is sensitive, and definitely avoid the phrase "are allowed...". The "burden sharing" language is also maybe unclear in context of dynamic evolution and transition pathways. I think it also needs more careful analytic scrutiny – given that we now have cheap technologies to largely decarbonise energy and land transport, and rich countries have far more developed infrastructure, there is surely a case that even per-capita emissions from developing countries may need to exceed those of developed countries as welfare-optimal. Also, without explicit international financial transfers, GDP maximisation is not same as welfare maximisation. But anyway, my main suggestion would be just take this final sentence out of the box, it risks hugely distracting from the core message	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Thank you for your comment. Indeed, such a sensitive topic can't be adequately addressed in a small box. We have deleted the sentence.
24389	31	14	31	18	several articles report that co-benefits may also more than offset mitigation costs. So it is also possible that "Mitigation pathways resulting from policies designed to reach multiple sustainable development pathways instead of focusing exclusively on emissions reductions, result in no additional costs compared to the increased benefits (3.6). Vandyck, T., Keramidas, K., Kitous, A., Spadaro, J.V., Van Dingenen, R., Holland, M., Saveyn, B., 2018. Air quality co-benefits for human health and agriculture counterbalance costs to meet Paris Agreement pledges. Nat. Commun. 9. https://doi.org/10.1038/s41467-018-06885-9	Government of France	France	Accepted. Text has been completely revised.
24391	31	16	31	18	In this sentence what costs refer to? only mitigation costs or also damage costs from climate change? This sentence is really not clear and the link with the previous sentence is not obvious.	Government of France	France	Accepted. Thank you for your comment. Upon reflection on other comments received regarding this sentence, it requires a more in-depth discussion to provide adequate qualifiers, which is not possible in the small space for this box. We have deleted the sentence. Please note that this discussion is covered more adequately in Ch3, section 3.6.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
84717	32	0	32	0	Please assess (in a text explaining the table TS.1) which of the scenario categories best meets the Paris Agreement Article 2 goal of: *holding* the increase in the global average temperature to *well below* 2°C above pre-industrial levels and pursuing efforts to *limit* the temperature increase *to* 1.5°C above pre-industrial levels. In my understanding of the table, only C1 category scenarios really meet all the definitions in the Article 2. But is this a correct reading?	Kaisa Kosonen	Finland	Accepted. Text has been completely revised.
84719	32	0	32	0	The "Cumulative net-negative CO2 emissions Gt CO2" values for C1 category pathways (from 0 to -477) shows how very large a variety there exists in the underlying scenarios regarding their assumptions on CDR/BECCS. Hence, the average of these scenarios doesn't, eventually, tell much for policymaking that would try to minimise the need to rely on CDR. Would it be possible to specify, with an additional line on the table, what these numbers would be in scenarios that contain little to no reliance on BECCS (or at least for 1.5-1-D and 1.5-SP)?	Kaisa Kosonen	Finland	Accepted. Text has been completely revised.
83511	32	1	32	5	The cumulative gross CDR until net zero, and until 2100 would be really valuable additional information for policy decisions over the coming decades.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
83513	32	1	32	5	This table in the TS should attempt to better integrate insights from various chapters. Currently the pathways per category are shown as an amorphous set of which all members are equally feasible, reliable, desirable when also considering SDGs etc. That is misleading in context of the evidence provided in other chapters and other parts of the TS, including Box TS.6. An attempt should be made to integrate these assessments.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
10477	32	3	32	3	table TS.1 : font is generally too small, especially for footnotes and references to them. Is the content of column 2 (#scenarios) the number of scenarios?	Philippe Waldeufel	France	Accepted. Text has been completely revised.
29507	32	4	32	5	To TS: Table SPM.1, footnote 9. Please clarify what is ment by the probabilistic climate model emulators, or preferably use formulations that are more easily available for policymakers. In addition, it is not intuitively clear if all temperature levels have the same reference year, i.e. if expected temperature change 50% probability is compared to pre-industrial (1750), 1990, 2005 or 2010. We are aware of footnote 2, but perhaps it would be better to include the information regarding reference year in the text above the Table itself?	Government of Norway	Norway	Accepted. Text has been completely revised.
85263	32		32		There will be a need for clarity to combine the WGI and WGIII approaches and for non CO2 effects here. Could there be a focus on CH4 emissions too?	Valérie Masson-Delmotte	France	Accepted. Text has been completely revised.
24393	32		32		Please precise in the title of the 7th column the definition of the temperature change considered here (projected GSAT versus pre-industrial GSAT? - please refer to WG1 definition).	Government of France	France	Accepted. Text has been completely revised.
66505	33	4	33	22	These are incredibly important paras para, but I fear too compact, and somewhat technical language. Would deserve more attention	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
66507	33	6	33	13	Confirm alignment with the box. This wording is precise but incredibly compact.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
24395	33	7	33	13	This sentence is much too long and not very clear.	Government of France	France	Accepted. Text has been completely revised.
46785	33	14			Please specify what you mean with "global cooperation".	Government of Germany	Germany	Accepted. Text has been completely revised.
66509	33	16			Modelled carbon prices, I assume?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
24397	33	18	33	18	The space given to co-benefits is very limited compared to the impact they have on net costs of mitigation. Costs of mitigation have almost all the page 29, but issues about co-benefits only a few sentences. It would be useful to describe several types of co-benefits as it is done in chapter 3, section 7.	Government of France	France	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
28231	33	21	33	22	Delete "The efficiency-sovereignty trade off can be resolved by allowing for partly differentiated regional carbon prices.", as this is not a policy neutral statement, and other policy options exist apart from carbon pricing.	Eleni Kaditi	Austria	Accepted. Text has been completely revised.
84721	34	0	34	0	In the Figure TS.11, down left, it would be very helpful to have the dark green bars of "energy supply" further opened up into DACCS and BECCS, with different colors, so one could see what, indeed, is the assumed role of BECCS in each IP.	Kaisa Kosonen	Finland	Accepted. Text has been completely revised.
84723	34	0	34	0	As it is said in the SPM (page 24, rows 39-41) "In scenarios published since SR1.5, the mitigation estimate from CCS (BECCS) has fallen and is now 0.8 median (0-6.3) GtCO ₂ yr ⁻¹ in 2050." Would it be possible to have this finding added the Figure TS.11 / SPM.7 with a dotted line (or a footnote, at least), which would help to see that out of the 9 illustrated pathways, 7 seem to be above this median.	Kaisa Kosonen	Finland	Accepted. Text has been completely revised.
46787	34	1			We have strong concerns with this figure, please see our comments on Figure SPM.7.	Government of Germany	Germany	Accepted. Text has been completely revised.
15407	34	1	34	1	The length of positive GtCO ₂ /yr may be the same as that of negative GtCO ₂ /yr for 1.5-Sp	Hiroaki Kondo	Japan	Accepted. Text has been completely revised.
15409	34	1	34	10	There is no symbol indicating a, b, c, or d on the four panels of the figure.	Hiroaki Kondo	Japan	Accepted. Text has been completely revised.
64055	34	1	34	10	Figure TS.11: See comments on this same figure in the SPM (Figure SPM.7). Additional comments here relate to panels c+d. 1. While the main messages of panel c is clear - the timing of net zero carbon emissions varies across regions and with scenario - it is unclear how to interpret the shaded green and orange vertical bars for the C1-2, and C3 categories and how these relate to the ranges provided by the box and whisker plots. The same comment applies to panel (d) as well. The percentages to the right of panels c+d also need explaining (editorial comment), as they were for Figure SPM.7	Government of Canada	Canada	Accepted. Text has been completely revised.
62093	34	1	34	4	The net-zero targets of countries' announcements are mainly for all GHG emissions, in the form net-zero GHG emissions reach net-zero by 2050. I would recommend to present this figure also for all GHG emissions, expressed in CO ₂ equivalent emissions. If the results are shown for GWPs for IPCC AR6, I would also indicate what the effect would be if you would move to GWPs IPCC AR4.	Michel den Elzen	Netherlands	Accepted. Text has been completely revised.
10479	34	2	34	10	figure TS.11 is overcrowded. On line 4 the b subplot should not be a capital B.	Philippe Waldteufel	France	Accepted. Text has been completely revised.
81471	34	2	34	2	Suggestion, not mandatory: although in the description of figure are mentioned about a,b,c and d, put these letters aside of the figure titles help the fast understanding of the information	Luana Ferreira	Brazil	Accepted. Text has been completely revised.
2437	34	4	34	4	B. → b.	Nyun-bae Park	Republic of Korea	Accepted. Text has been completely revised.
64057	34	9	34	10	Figure TS.11 Last line of caption. Which shaded ranges are being referred to here? If this is only for panel (a) or also for the green and orange shaded areas in panels C+D? If only panel (a), the grey shaded areas are identified as representing the 5-95th percentiles, not the 10-90th percentiles. How should we interpret the box and whisker plots in panels C+D - 10-90th percentiles for the entire set of scenarios?	Government of Canada	Canada	Accepted. Text has been completely revised.
24399	34		34		The lines 2-4 of the legend need to be rewritten. The a, b, c and d have to be written under the corresponding parts of the figure, and all in small or all in capital letters	Government of France	France	Accepted. Text has been completely revised.
24401	34		34		Figure TS.11 conveys a considerable amount of relevant information but some of it is rather difficult to understand. Much more detailed explanations are required in the legend.	Government of France	France	Accepted. Text has been completely revised.
46789	35	1			Please show also cumulated costs by 2100 in the right panel.	Government of Germany	Germany	Accepted. Text has been completely revised.
66511	35	1			See my comment above about integrating into a more comprehensive diagram on mitigation costs. We know that people find it hard to set diagrams like this in context of the scale of global growth. Assuming these are annual GDP losses from mitigation at given point in time, I presume the vertical numbers are not % - ie. around 2-4%, not 0.02- 0.04% ?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
64059	35	2	35	2	No figure caption	Government of Canada	Canada	Accepted. Text has been completely revised.	
53125	35				Ch3: Only showing the global GDP losses globally misses an important aspect about the regional differences. Figure 3.37 in chapter 3 should be added as another panel to this figure to highlight the regional story. This would be in line with the previous figure (TS.11) which shows the global as well as the regional stories for emissions.	Government of Saudi Arabia	Saudi Arabia	Accepted. Text has been completely revised.	
53127	35				Ch3: The legend p2/P3b not clear. It needs to be spelled out.	Government of Saudi Arabia	Saudi Arabia	Accepted. Text has been completely revised.	
28233	35		35		Figure TS.12 to also include estimations for different regions, as per Figure 3.37, of Chapter 3 of SOD WG III contribution.	Eleni Kaditi	Austria	Accepted. Text has been completely revised.	
24403	35		35		This figure requires detailed explanation in its legend, including whether avoided impacts are accounted or not. P2 and P3b should be defined. C1 to C7 are not "temperature categories" but "pathways categories associated with different warming levels". Do these figures relate to Annualized mitigation cost (GDP losses)?	Government of France	France	Accepted. Text has been completely revised.	
64061	36	1	36	21	Not sure these lines are needed here as this information is not presented anywhere in the TS Table 2 or elsewhere	Government of Canada	Canada	Accepted. Text has been completely revised.	
66513	36	3			Try this sentence on people outside the IPCC bubble – will it make sense, what does it mean to them?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.	
72225	36	4	36	8	It is strongly recommended to state that the feasibility has been initially developed by the IPCC SR 1.5 C.	bertoldi paolo	Italy	Accepted. Text has been completely revised.	
67415	36	4	36	8	It is strongly recommended to state that the feasibility has been initially developed in the SR 1.5 C	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.	
66515	36	8			Below, in application to global scenarios?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.	
15411	36	20	36	21	Is it OK that this sentence is not shown in italic?	Hiroaki Kondo	Japan	Accepted. Text has been completely revised.	
64063	36	24	36	24	Please add specific chapters of sections for each listed dimension	Government of Canada	Canada	Accepted. Text has been completely revised.	
85265	36		36		Does "geophysical feasibility" include accounting for operating in a changing climate (affecting means, trends, extremes, values above tolerance thresholds, hydroclimate aspects...)?	Valérie Masson-Delmotte	France	Accepted. Text has been completely revised.	
24405	36		36		A word is missing : must be implemented, or will be implemented	Government of France	France	Accepted. Text has been completely revised.	
83515	37	2	39	6	I'm wondering whether a conscious decision was made as to when use the term "feasibility concerns" or "feasibility challenges". For consistency, I would streamline this and refer to "feasibility challenges" throughout.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.	
83517	37	2	39	6	Insights from this section should be integrated in the discussion of ranges of pathways consistent with various temperature outcomes.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.	
31005	37	10	38	2	The paragraph says that developed countries account for 35% of GHG emissions and LDCs 3%, but it does not explicitly state that the remaining 62% comes from middle-income and emerging countries. China and India are among the top 10 emitters, and emissions from these countries are expected to increase. There are some developed countries that have low emissions, and vice versa. It is not appropriate to simply divide the world into rich and poor countries in the context of this discussion.	Government of Japan	Japan	Accepted. Text has been completely revised.	
46791	37	11			What is meant with "disruptiveness" - is this a positive or a negative feature?	Government of Germany	Germany	Accepted. Text has been completely revised.	
24407	37	12	37	12	a word is missing : "are determined through"	Government of France	France	Accepted. Text has been completely revised.	
24409	37	14	37	14	delete the point, it's the same sentence	Government of France	France	Accepted. Text has been completely revised.	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
24411	37	24	37	25	If it is the end of BOX TS.6 , it has to be precised	Government of France	France	Accepted. Text has been completely revised.
66517	37	26	37	39	All this would make more sense if it came after the Ch.4-derived discussions. It doesn't make sense to discuss feasibility concerns beign concentrated in next 2-3 decades, note they are congigent on enabling conditions – followed by a section called "mitigation and development pathways in the near- to mid-term". PARTICUARLY when the previous section (TS2.3) was on emission trends and drivers	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
72227	37	30	37	34	It is better to indicated that it is not only institutional capacity, but also a combination of 3 equally important elements: Political Acceptance; Institutional Capacity and Multi-level Governance. These are complemented by cross-sectoral coordination; and legal and administrative capacity. Many chapters discuss this point including section 9.9.7, which discuss this point extensively.	bertoldi paolo	Italy	Accepted. Text has been completely revised.
67417	37	30	37	34	It is better to indicated that it is not only institutlional capacity, but a cominbation of 3 elements: 1) political acceptance; 2) institutional capacity and governance, cross-sectoral coordination; and 3) legal and administrative capacity. Section 9.9 discuss this point extensively	Philippe Tulkens	Belgium	Accepted. Text has been completely revised.
7355	38	0	38	0	The fonts are too small to read. The graph is hard to understand.	Debra Roberts	South Africa	Accepted. Text has been completely revised.
15413	38	1	38	15	The letters in the panels are too small.	Hiroaki Kondo	Japan	Accepted. Text has been completely revised.
46793	38	16			It is unfortunate that the quality of some figures is too low to allow reviewing them since this was the last chance.	Government of Germany	Germany	Accepted. Text has been completely revised.
81473	38	16	38	16	Please, increase font size in the subtitles of the figure TS.13. It's very short and it's necessary using zoom of 150% to better visualize he information.	Luana Ferreira	Brazil	Accepted. Text has been completely revised.
64065	38	16	38	16	Legends are unreadable in Figure TS13	Government of Canada	Canada	Accepted. Text has been completely revised.
50027	38	16	38	18	The vertical axis of Figure TS13 is not defined or described. It is confusing.	Masahiro Sugiyama	Japan	Accepted. Text has been completely revised.
24413	38		38		the figures and font are too small, the colour legend is illegible	Government of France	France	Accepted. Text has been completely revised.
24415	38		38		The left graph of Figure TS.14 requires much more detailed explanations. The meaning of the expression "impact on the feasibility of the system transition" is not clear. Since most data exhibit a mixed evidence, would it be possible to distinguish the respective level of positive and negative values, for example by splitting the concerned cells into a light blue and a dark blue cells of sizes reflecting the ratio between positive and negative impacts ? Is it "Cross sectional" or "Cross sectoral?"	Government of France	France	Accepted. Text has been completely revised.
46795	39	1			We have strong concerns with this figure, please see our comments on Figure SPM.10.	Government of Germany	Germany	Noted, thank you, we will cross-refer to the separate comments on the figure SPM.10.
66519	39	1			As per SPM comment on this chart: I cant speak for AFOLU, but I think the evidence in Chapter 2 points to clear evidence on the positive environmental, technological and economic feasibility at least) of energy transitions.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text has been completely revised.
64067	39	1	39	1	Figure TS.14: what is the category 'cross sectional' referring to in this Figure?. The only reference to this Figure we could find in the text is on page 37 in the box on scenario feasibility. There, pg 37 lines 24-25, this figure is described as displaying "the aggregated results of the feasibility assessment for the pathway level and response level". What is meant by 'response level' and how are the response levels and pathway levels indicated in Flgure TS.14 panel (a), or does this language only refer to panel (b)?	Government of Canada	Canada	Accepted. Text has been completely revised.
50029	39	1	39	6	The left panel of Figure SPM10 should describe the scale for which feasibility has been assessed. There is no clear definition of the vertical axis of the right panel.	Masahiro Sugiyama	Japan	Accepted. Text has been completely revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
81475	39	2	39	2	Enhancing a little the contrast among colors white (not applicable) and grey (no evidence) and font, in the figure TS.14.	Luana Ferreira	Brazil	Thank you for your comment. This figure has been substantially revised to provide more in-depth information on feasibility of various mitigation options. The colours have also been revised accordingly.
66521	40	5	40	6	Says it all The short to medium term does not normally follow the long term! The SPM is not trapped by the Chapter order – nor should the TS be	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted.
24417	40	7	40	7	There is a strong contradiction between the very relevant and fundamental message delivered in this box and the content of chapter 3, which produces scenarios using models that take into account structural changes only with difficulty or not at all, particularly on the demand side, and which calculate GDP losses compared to a reference scenario with mainly changes in the energy system only. I readily admit that all this is very difficult, but it is also not very coherent. Chapter 3 should really highlight the limits of the modeling and clearly display in the preamble- before going into the details of the description of the scenarios, costs, etc.- the assumptions in terms of the scope of costs considered and not considered, and the limits on structural changes poorly or not represented by these models.	Government of France	France	Noted.
84725	40	7	41	27	The Box TS.7 would benefit from concrete examples of shifting development paths. Now it's quite theoretical and somewhat difficult to grasp in concrete, policy relevant terms	Kaisa Kosonen	Finland	Thank you for your comment. Partly accepted. The box was revised in FGD, but concrete examples are provided in the sectorial chapter sections.
66523	40	9	40	10	Havent seen these terms in any earlier material. Nor can I see it helps to link TS.15 to this terminology But aside from that – this box does a good job of synthesising the messages from the long box in Chapter 4. I only wonder if it should be a more integrated part of the TS narrative than a box?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Global North and Global South replaced with developed and developing regions.
53129	40	10	40	10	Ch4: The use of the global north vs global south is not clear why that distinction is critical in this context.	Government of Saudi Arabia	Saudi Arabia	Noted. Global North and Global South face different levels of development. The sentence aims to reinforce this difference.
46797	40	13	40	22	Please consider moving these paragraphs into the SPM, they are clearer than the current paragraphs in D.1.	Government of Germany	Germany	Noted.
81477	42	1	42	1	Suggestion, not mandatory: the middle of the figure, mainly before tool box, could be simpler. Also, replacing the color red for brown, for example, become the figure more comfortable in terms of accessibility in design.	Luana Ferreira	Brazil	Taken into account. Thanks for non-mandatory suggestion, considered in revision of figure [Follow up with Renee]
64071	42	2	42	2	It seems to me that some lines should not be there, or at least showed as broken lines to express harder or uneasy paths. Furthermore, it may be obvious but it is suggested to add a horizontal arrow pointing toward the right to express time.	Government of Canada	Canada	Accepted. Will seek to show less regular lines
66531	42	6	42	9	The first thing, 30 years after first IPCC and UNFCCC, and 15-20 years after significant climate legislation began to accumulate, is to understand why such limited progress. As well as more detailed analysis on this, The Four Analytic Frameworks might help to illuminate this question – Chapter 1 core contention is that inadequate progress can be largely traced to a failure to integrate these different perspectives into a coherent understanding of the challenges.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted.
66525	42	7			Explain. Eg. Current NDCs collectively fall well short of least-cost pathways towards the Paris goals and would render 1.5C practically impossible (the 'emissions gap'); Moreover, most assessments indicate that even these NDCs will not be delivered with current policies (the 'implementation gap')	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. The sentence has been revised to make implementation gap clearer

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
28235	42	7	42	24	Elaborate on the fact that the estimated emissions gap and implementation gap are not considering the latest NDC submissions (after November 2020).	Eleni Kaditi	Austria	Accepted. The sentence has been revised and updated following latest estimations from chapter 4.2.	
84727	42	7	42	24	Please, in both these paragraphs, change the order of temperature goals so that the results for 1.5°C are always presented before the results for 2°C because, since the Paris Agreement and SR1.5, the primary focus has shifted from 2°C to 1.5°C.	Kaisa Kosonen	Finland	Rejected. The order follows that in the Paris Agreement; the claim that focus has shifted is not substantiated. This is AR6, not SR 1.5.	
67419	42	7	42	8	"implementation gap" should be singular. Also "near universal" NDCs is not clear.	Philippe Tulkens	Belgium	Accepted. The sentence has been revised to reflect singular. Near universal means almost all countries in the world have communicated NDCs	
46799	42	11	42	13	"Current policies lead to median global GHG emissions of 63 GtCO ₂ eq with a full range of 57-70 by 2030 and unconditional and conditional NDCs to 59 (55-65) and 56 (52-61) GtCO ₂ eq, respectively (medium evidence, high agreement) {4.2.2 Table 4.2}...": "current policies" (= 2018 ?) reflects the actual state of the national policies and NDCs but they are subject to constant change. How will you deal with this to keep the statements in this area up to date?	Government of Germany	Germany	Noted. GHG emissions will be updated before the FGD, based on available literature, including the UNEP EGR 2021 to be published in October 2021.	
64069	42	13	42	13	Add 'in 2030' after the words "estimated emissions gap".	Government of Canada	Canada	Accepted. The sentence has been revised.	
46801	42	13	42	15	The numbers as cited here are not matching correctly the numbers as given in the ES of chapter 4 (p. 4-3; l. 14-15), which are backed by the numbers in the original text (p. 4-21; l.28-30).	Government of Germany	Germany	Noted. GHG emissions will be updated before the FGD to ensure consistency will all documents of AR6.	
24421	42	14	42	15	Please check the consistency with Chapter 4 Cross Chapter box 3: "Second, the comparison of unconditional (conditional) NDCs and cost-effective long-term mitigation pathways gives rise to a 2030 median emissions gap of 25-34 GtCO ₂ eq (22-31 GtCO ₂ eq) for limiting warming to 1.5°C with no or low (<0.1°C) overshoot (50% chance) and 14-23 GtCO ₂ eq (11-20 GtCO ₂ eq) for limiting warming to 2°C (66% chance)."	Government of France	France	Noted. GHG emissions will be updated before the FGD to ensure consistency will all documents of AR6.	
66527	42	14	42	15	What and where is this – it doesn't look like Box TS.3?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted.	
46803	42	18	42	18	The cited table here should be table 4.1, as noticed in the ES (p.4-3; l. 20) and not table 4.2.	Government of Germany	Germany	Noted. This has been revised in FGD.	
24419	42		42		We suggest to insert an horizontal axis at the bottom with a few illustrative time milestones such as 2020, 2030, 2050 ,2075. It would help the policy-makers to understand that some of the development pathways require immediate decisions.	Government of France	France	Rejected. The figure is conceptual, not quantitative. Therefore, no precise timeline is required.	
50119	43	1	43	1	Suggest to standardise. There are various iteration e.g. "COVID19" , "COVID-19" and "covid-19" etc found within the report.	Government of Singapore	Singapore	Noted. This has been revised in FGD.	
66529	43	2	42	4	Clearly in the final draft we will have much more information on projections after Covid and need to develop cross-chapter dialogue for consistency. My current guess is that "would not differ by more than a few percent" – but if so this could actually turn out to be significant if it helps to avoid a lot of lock-in and turns a slight increase into a slight decrease in global trend	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Literature on impacts of the COVID-19 pandemic crisis to be updated	
24423	43	2	43	2	In the sentence "However, the available information does not suggest that median/ average near-term emissions would be significantly different than estimated above" we suggest to add the available information at the time of writing this report (precise the date). Nevertheless chapter 4 says page 17 lines 11-14 "the impact of the general slowdown of the economy due to the COVID-19 pandemic and its associated policy responses would lead to a reduced estimate of global GHG emissions in 2030 of about 2 to 6 GtCO ₂ eq, equivalent to 3 to 9 per cent, compared to the pre-COVID-19 estimates". This is not nothing compared to the gap with 1.5 and 2°C trajectories.	Government of France	France	Accepted. The sentence has been revised based based on laest available literature.	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
46805	43	2	43	4	Many countries embark on a "green recovery", does this not suggest a long-term effect of the COVID-19 crisis? Please address this issue in the underlying chapter and in the TS.	Government of Germany	Germany	Accepted. Literature on the long-term impacts of the COVID-19 pandemic crisis have been included. Most (about 3/4) of the recovery packages announced by governments are actually supporting carbon-intensive industries.	
46807	43	9	43	9	Instead of the term 'robust evidence' regarded to this para you can find 'medium evidence, high agreement' with regard to the identical content in the ES of chapter 4 (p. 4-3; 1.32). Please make sure to state here the correct level of evidence.	Government of Germany	Germany	Accepted. The confidence level has been revised in accordance with guidance on uncertainty.	
24425	43	14	43	14	We suggest to add "{17.2}"	Government of France	France	Accepted.	
72229	43	14	43	16	Here I suggest adding to "information technology/internet-of-things" Artificial Intelligence and Big Data Analytics.	bertoldi paolo	Italy	Accepted. adding "artificial intelligence"	
67421	43	14	43	16	Here I suggest to add to "information technology/internet-of-things" artificial Intelligence or data analytics.	Philippe Tulkens	Belgium	Accepted. adding "artificial intelligence"	
53131	43	17	43	17	Ch4: This statement is unclear "The multiple non-state initiatives". Also, "global emissions have the potential to reduce emissions" not clear. Both need to be rewritten.	Government of Saudi Arabia	Saudi Arabia	Accepted. Text revised to read "A.If the commitments and goals of multiple non-state international cooperative initiatives are fully implemented and do not replace efforts elsewhere, they have the potential to reduce emission by up to about 20 GtCO ₂ eq in the period up to 2030, though this is assessed with low confidence (limited evidence, medium agreement) {4.2.3}." FRANCK, this is OPTION A in a Word doc I will send. please revise, finalise and apply the same response to all the comments highlighted in yellow	
24427	43	17	43	19	There is a problem with this sentence: "global emissions have the potential to reduce emission..." What does this mean? Moreover, before this, it would be useful to present and describe non-state initiatives. "Various actors have developed an increasing number of mitigation strategies up to 2050 (mid-term). A growing number of such strategies aim at net zero / carbon neutrality. Non-state actors are also engaging in a wide range of mitigation initiatives. When adding up emission reduction potentials, sub-national and non-state international cooperative initiatives could reduce up to about 20 Gt of CO ₂ eq in 2030" (chapt 4, page 3 lines 42-47)	Government of France	France	Accepted. Text revised to read: "If the commitments and goals of multiple non-state international cooperative initiatives are fully implemented and do not replace efforts elsewhere, they have the potential to reduce emission by up to about 20 GtCO ₂ eq in the period up to 2030, though this is assessed with low confidence (limited evidence, medium agreement) {4.2.3}."	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
67423	43	17	43	20	Sentence needs to be revisited due to conflicting message on evidence and confidence. Would confidence be greater if the sentence stated that NSA efforts with a mitigation potential of up to 20 GtCO _{2e} have been identified? This is presumably a safer conclusion than deciding whether or not this action can be considered additional to action elsewhere.	Philippe Tulkens	Belgium	Accepted. Text revised to read "A.If the commitments and goals of multiple non-state international cooperative initiatives are fully implemented and do not replace efforts elsewhere, they have the potential to reduce emission by up to about 20 GtCO _{2eq} in the period up to 2030, though this is assessed with low confidence (limited evidence, medium agreement) {4.2.3}." FRANCK, this is OPTION A in a Word doc I will send. please revise, finalise and apply the same response to all the comments highlighted in yellow
46809	43	18	43	18	Please add to be more precise: ...efforts elsewhere, the sum of emission reduction potentials, sub-national and non-state international cooperative initiatives could reduce up to 20 Gt of CO _{2eq} in 2030 (limited evidence, medium agreement) {4.2.3}. (p.4-3; 1.46-47)	Government of Germany	Germany	Accepted. Text revised to read "A.If the commitments and goals of multiple non-state international cooperative initiatives are fully implemented and do not replace efforts elsewhere, they have the potential to reduce emission by up to about 20 GtCO _{2eq} in the period up to 2030, though this is assessed with low confidence (limited evidence, medium agreement) {4.2.3}." FRANCK, this is OPTION A in a Word doc I will send. please revise, finalise and apply the same response to all the comments highlighted in yellow
66533	43	18	43	19	For this – but also maybe for other aspects of the Ch.4 mitigation assessment – note my comment to SPM on mitigation costs and potentials to 2030 (drawn from Ch.12): "SPM p.26 lines 3-7. It could be very useful to translate this data also into GtCO ₂ removed by 2030 and to liaise closely with Chapter 4 materials on projections to 2030, including their estimates that private initiatives, if taken as face value, could add up to 20GtCO ₂ ."	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. This is a comment on SPM, with a suggestion for chapter 12 to pick up the language in TS.
66535	43	18	43	19	it would also be interesting to compare these estimates with indications of the impact of exponential growth in renewables and EVs extrapolating the exponential growth rates illustrated in Chapter 2 (/Figure SPM..5) – in absence of more detailed S-curve/dynamic extrapolations, see Grubb, M., Drummond, P. and Hughes, N. (2020) The Shape and Pace of Change in the Electricity Transition: Sectoral dynamics and indicators of progress. Available at: https://www.wemeanbusinesscoalition.org/wp-content/uploads/2020/10/Shape-and-Pace-of-Change-in-the-Electricity-Transition-1.pdf (Accessed: 14 October 2020)	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted.
46811	43	22	43	22	Please add: ... sample (medium evidence; low agreement) {4.2.4}. As written in the ES of chapter 4 (p.4-3; 1.45)	Government of Germany	Germany	Accepted. adding (medium evidence; low agreement)
7357	43	24	43	24	What is meant by "endowments with different energy resources"? Does this refer to energy poverty in some regions?	Debra Roberts	South Africa	Noted. Energy resources refer to available energy resources potential to supply energy supply to full fill energy needs.
24429	43	25	43	27	This paragraph is not really understandable , nor is the link with the above	Government of France	France	Accepted. The sentence/paragraph has been revised.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
46813	43	25	43	27	Please check the content of this para, since it is with regard to demand-side options and system analyses not in line with the description in the ES of chapter 4 (p. 4-3; l. 36-38)	Government of Germany	Germany	Accepted. The sentence/paragraph has been revised.
67425	43	28	43	35	The first two sentences of this paragraph are unnecessary since synergies and trade-offs with SDGs are already addressed in a more nuanced manner elsewhere in this TS. The remainder (on distributional and social impacts) adds value in its own right, but there is no need to blend it with the more abstract issue of SDG interaction overall.	Philippe Tulkens	Belgium	Rejected. Other review comments suggest trade-offs are important.
53133	43	29	43	30	Ch4: The insight that accelerated mitigation can have large economic implications to some economies should be highlighted in the SPM document	Government of Saudi Arabia	Saudi Arabia	Noted.
46815	43	30	43	30	Please insert a key-message here, from p.4-4; l. 6: ...level. In all reviewed studies, however, GDP continues to grow even with mitigation (robust evidence, high agreement). The....	Government of Germany	Germany	Accepted.
46817	43	42	43	42	Please delete 'Cross-Chapter Box 3'. It is 'Cross-Chapter Box 4', as written correctly in the ES of chapter 4 (p. 4-4, l. 14) and p. 4-64.	Government of Germany	Germany	Accepted.
46819	43	45	43	45	Please insert: ..., policies as listed in table 4.9 are typically as correctly in the ES of chapter 4 (p.4-4; l.21) and in chapter 4 (p.4-69)	Government of Germany	Germany	Accepted.
46821	44	5	44	5	Please check: in the ES of chapter 4 this message is ranked as (medium evidence, medium agreement) (p. 4-4; l.25)	Government of Germany	Germany	Accepted. The confidence level has been revised to ensure consistency with other AR6 products.
53135	44	8	44	8	Ch4: Change "concrete examples are from" to "concrete examples from"	Government of Saudi Arabia	Saudi Arabia	Accepted.
46823	44	15	44	15	Please add '4.4.3' in the brackets with regard to complexity and delay.	Government of Germany	Germany	Accepted.
46825	44	20	44	20	Please delete "equity is an ethical imperative" as this statement is not supported by scientific evidence, but rather a normative statement that is not inline with the IPCC mandate.	Government of Germany	Germany	Partly accepted. revised in response to another reviewer of ch 4, to read "Hence, equity is an ethical concept that is instrumentally important."
46827	44	20	44	20	Please change the number of the cited figure from 4.10 to 4.8, since this is the correct reference (p. 4-94). The cited Fig. 4.10 doesn't exist.	Government of Germany	Germany	Accepted. This has been corrected in FGD.
24431	44	22	44	22	We strongly recommend to write "Urgent actions are the only way to respond to climate crisis."	Government of France	France	Partly accepted. Sentence has been revised to reinforce the need of urgency, but we did not use prescriptive language.
64073	44	22	44	24	This needs to be included in some way in the Figure TS15	Government of Canada	Canada	Noted.
46829	44	24			Please replace "pursue efforts at 1.5°C" by "pursue efforts to limit temperature to 1.5 °C" as in the Paris Agreement.	Government of Germany	Germany	Accepted. This has been corrected in FGD.
69959	44	25	40	28	I would not seem to restrict the electrification of end-uses to transport, and let "other uses" to be converted to low or zero carbon fuels. I would keep electrification of end-uses, then convert hard-to-electrify sub-sectors (e.g. deep sea shipping, aviation) to low- or zero-carbon fuels and feedstocks (to take in account that electrification alone of cement making and steel making would leave process emissions unabated).	Cédric PHILIBERT	France	Noted.
46831	44	25	44	31	Please consider moving these paragraphs into the SPM, they provide clear and strong messages. Page 43-12 to 43-14 mentions the relevance of the land and food sectors, why are they not mentioned in these paragraphs as well?	Government of Germany	Germany	Noted.
7359	44	25	44	40	Watch out for prescriptive language and imperatives. e.g. "Accelerated mitigation" instead of "Accelerate" and "Broader mitigation opportunities that focus on development pathways". Sentence starting on line 34: instead of "it is urgent to put in place" rather say "Development pathways that increase sustainability need conditions to shift..." but then include more detail. Currently it is not clear what is meant by 'conditions'. What does "(big systems, with lots of inertia)" refer to? Next paragraph: "Increased supportive enabling conditions that are possible in the near term".	Debra Roberts	South Africa	Accepted. This has been corrected in FGD.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
24433	44	27	44	28	Including SLC targets in the NDCs raises several issues: the question of the equivalence metric to compare it to CO2 (Cain et al. (2019), Improved calculation of warming-equivalent emissions for short-lived climate pollutants), the equity of this metric (Rogelj et al. (2019), Unintentional unfairness when applying new greenhouse gas emissions metrics at country level), the impact on food security (Smith et al. (2013), How much land based greenhouse gas mitigation can be achieved without compromising food security and environmental goals?) and consistency with other climate targets	Government of France	France	Noted. Non-GHG emissions and carbon budgets are detailed in WG I AR6 and WG III AR6 Chapter 7.
86257	44	28	44	28	CH4 is part of the SLCF, I suggest to rather say "including SLCFs such as CH4"	Sophie Szopa	France	Accepted
7361	44	29	44	29	"We need to" is policy prescriptive. Rather point out that there are other measure available, that can broaden the mitigation response.	Debra Roberts	South Africa	Accepted. This has been corrected in FGD.
80169	44	35	44	37	"Decision-makers might consider a broader toolbox of enablers and levers that is available in domains that have not traditionally been climate policy. Putting in place more supportive enabling conditions can be done in the near-term –" *** COMMENT*** In the context of a broad portfolio of potential response options, both CDR and SRM should be explicitly mentioned, as they are both necessary for avoiding overshoot and are highly immature despite their potential significance for protecting human and natural systems.	Kelly Wanser	United States of America	Reject. This section is about short-mid-term measures. As the reviewer correctly mentioned, CDR and SRM are immature technologies not available in the near-term.
80171	44	37	44	40	This recommendation is missing research and development in currently immature technologies necessary to meet temperature targets, particularly CDR and SRM. The scaled deployment of CDR is an element of all scenarios preventing overshoot of 1.5, but are critically lacking in understanding sufficient to drive assessment and investment.	Kelly Wanser	United States of America	Noted.
66537	45	1			May be relevant to also ref the conclusions of Chapter 1 section 6 on some of the analytic foundations of Just Transitions? Overall this box needs to be tightened – some of the language at least is careless. Though I agree integration with Stranded Assets wouldn't work, cross-referencing Box TS.9 could be useful since the concepts are clearly somewhat linked.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted.
77091	45	1	45	40	On the subject of a "just transition", the current WGIII recommendations will, it is feared, only widen the gap between those in developing and developed countries.	Jim O'Brien	Ireland	Noted.
7363	45	3	45	3	Re: the words "left behind" – the SDGs in fact bring the furthest behind to the forefront. Equity involves preferential treatment for the least privileged. It would be good to see this reflected here.	Debra Roberts	South Africa	Accepted.
81431	45	10	45	21	It's great to have the box in the TS explaining the concept of Just Transition. However, I'm not sure if it's a good idea to have the example of the oil producing economies as the example for just transtions in the box. It's clear that with the example some of the consequences of a dropping fossile fuel price for an economy should be illustrated and COVID 19 price drop gave a foretaste of this. However, from the oil producing economies I think only Norway has signed the Just Transition Silesia Declaration as an oil producing country and there has been no evidence that during COVID price drop Norway did cut cown public spending or reduce social safety net. Just transition from fossil fuels is a problem for almost all countries (e.g. job-loss in coal production; job-loss in car manufacturing industry etc.)	Hans Poertner	Germany	Accepted.
15415	45	16	45	16	"positions structural inequality": Is this sentence, right?	Hiroaki Kondo	Japan	Accepted. The sentence has been revised.
24435	45	16	45	17	We suggest to change "inequality, poverty" with "inequality and poverty" in order to avoid the current ambiguity of the sentence.	Government of France	France	Noted.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66539	45	18	45	19	Oil prices seem quite unstable. The impacts of low oil prices on major producers can indeed be serious but should also be balanced with reference to the benefits to importers, many of whom are even poorer developing countries. We need analysis of the overall distributional impacts of higher or lower oil (in particular) prices – its not clear to me, could the chapter identify literature on this? This doesn't negate the validity of concerns but it is important to offer balanced analysis of the <u>distributional consequences</u>	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Taken into account. Detailed analysis of the implications of oil prices might be taken up in chapter 6. analysis
7365	45	20	45	20	Is that fossil fuel producer countries?	Debra Roberts	South Africa	Accepted. The sentence has been revised.
66541	45	24			Not appropriate for IPCC ... what is the evidence and determining factors?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted.
7367	45	25	45	25	Re: "fossil fuels will rebound" – check that they have not done so already, by final draft, check with WGI Covid information.	Debra Roberts	South Africa	Partly accepted. Will check for evidence of rebound in near-term. The long-term impact will not be known by <u>time of publication</u>
24437	45	29	45	31	Just transition also needs systematic evaluation of distributive impacts of climate policies.	Government of France	France	Noted. This topic will be further assessed in chapter 4.
7369	45	31	45	31	Re: "benefits are maximised" – please consider here literature about the economic opportunities of renewable energy provided for the first time in areas that have no energy currently, e.g. a large part of Africa has no electricity grid. In this sense developing areas are not just "not left behind" but they are <u>upgraded and set up for a sustainable future, by leapfrogging.</u>	Debra Roberts	South Africa	Noted. This topic will be further assessed in chapter 4.
66543	45	32			Wow! What does this mean? Is there literature on this	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Text to be revised, toned down and substantiated with line of sight to literature.
66545	45	37	45	39	Again I struggle with the language, "there is increased recognition". Was there not before? Is this a reference to Covid (if so say so)? Liaise with Ch.15 to pin down evidence	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Revise to read "The literature recognises ..."
7371	46	0	46	0	Figure TS 16 – it is worrying to see no entries of just transition in South America, Africa (excl SA), and SEAsia? Any comments on this?	Debra Roberts	South Africa	Accepted. This figure will be updated before FGD submission.
15417	46	2	46	3	Isn't it necessary to add the explanation for panels (b) and (c)?	Hiroaki Kondo	Japan	Accepted. This figure will be updated before FGD submission.
64075	46	3	46	3	Grey background really hard to distinguish	Government of Canada	Canada	Noted
24439	46		46		The legend of the Figure 16 has to be completed with more detailed elements from the figure. We also suggest mentioning the Convention Citoyenne sur le Climat for France (L-G Giraudet 2021, "Deliberating on Climate Action: Insights from the French Citizens' Convention for Climate" https://ideas.repec.org/p/hal/wpaper/hal-03119539.html)	Government of France	France	Accepted. This figure will be updated before FGD submission.
7373	47	0	47	0	Figure TS 17 – is it possible to add an indication of the final warming level for each of these <u>pathways? Just to always keep that in the forefront.</u>	Debra Roberts	South Africa	Noted
46833	47	2			Please see our comments on Figure SPM.6	Government of Germany	Germany	Noted
24441	47		47		The current representation of the time scale (x-axis) in Figure TS.17 is very confusing because of the magnification of the period around 2030. We invite the authors to improve its design. We suggest to reproduce the pathway numbers 1) to 6) used in the legend in the caption and on the different <u>curves.</u>	Government of France	France	Noted
64077	48	1	48	1	I'm really suprised to see the absence of hydropower details in the Energy section; there is a need to include GHG emissions for this type of energy and an evaluation of its role for potential mitigation or <u>not (TS and entire report)</u>	Government of Canada	Canada	Noted - discussed in part with respect to land use. Underlying chapter <u>provides more details</u>
66547	48	2			There is quite a lot of repetition in this section which could be replaced by cross references to material elsewhere in the TS (or even within the section). And in several places it is very unclear what it considers in scope of Energy Sector ... eg. see p.51!	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. Section has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
10481	48	3	48	3	typo on "achive"	Philippe Waldteufel	France	accepted
66549	48	3	48	4	This appears inconsistent with results of Chapter 3 – even assuming the radical rapid reductions of the models are feasible – the energy sector has to reach net zero before other sectors (except AFOLU) – and move into provide net negative to compensate for transport, buildings and industry	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	accepted - section revised
83519	48	3	48	8	The pathways from which this statement is derived do not keep warming to 1.5°C. They exceed it and then return below it at a later stage. Unless this is accurately reflected, the statement is misleading and underestimates the emissions reductions required to keep warming to 1.5°C.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	accepted - section revised
7375	48	3	48	8	This paragraph is probably THE key message and needs to come up this clearly, early in the SPM and TS.	Debra Roberts	South Africa	accepted
10483	48	6	48	7	This is ambiguous to say the least. A decrease by 3,3% per year will result in a value about 36% of the initial value. If you want to obtain net zero it is necessary to stipulate that the annual percentage applies to the initial value through the whole 30 years period.	Philippe Waldteufel	France	accepted - percentages given relative to initial value
46835	48	6	48	8	AR5 WG III SPM Figure SPM.5 indicates an annual rate of change in CO2 emissions between 2030 and 2050 of -3% to - 6% per year for scenarios approximately in line with the Paris Agreement temperature targets in 2100. Since the energy system will have to be decarbonized second (shown in AR6 WG III SOD Figure SPM.7, after AFOLU that contributes a smaller fraction of emissions than energy), we are surprised to read in this report that the decrease in emissions only needs to be about 2.3 to 3. 5 % per year for the next 30 years to reach net zero by about 2050. Please explain this new, much slower rate of decarbonisation of the energy sector.	Government of Germany	Germany	accepted - section revised
84729	48	6	48	8	"Global energy sector emissions need to decline at about 2.2-3.3 % per year through to 2050 to limit warming to 1.5 (...)" A clarification is needed here on why the needed global emission reduction rate would be so low, when earlier in the Figure SPM.3 one has learned that 1.5°C compatible emission reduction rates (2020-2040) would be in the order of 7 % in average for all GHG. What would explain so much slower reduction rate for the energy sector, when it's the energy sector than should decarbonise faster than average?	Kaisa Kosonen	Finland	accepted - section revised
11369	48	8	48	8	The source of the text "average growth of over 2% per year from 2000 to 2018" cannot be identified in the main text (Ch.6). Please check.	SAI MING LEE	China	accepted - section revised
53137	48	11	48	11	Ch6: 2019 should be 2018. In TS-3-14-L7, it states that the FFI CO2 emissions in 2018 are estimated as 38Gt	Government of Saudi Arabia	Saudi Arabia	accepted - section revised - changes now given as percentages in 2019
53139	48	15	48	16	Ch6: Wind is it left out in this statement. Chapter 6.3 talks about the cost drops in all three technologies. Include Wind.	Government of Saudi Arabia	Saudi Arabia	Accepted - revised text includes wind
18657	48	15	48	21	While battery and electric car costs have dropped, the knock-on effect from an increase in demand on batteries may be an increase in GHG emissions from the mining and refining of precious metal ores used in the manufacturing process.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	accepted - revised TS includes a paragraph on knock-on effects
61565	48	15	48	31	It is recommended to add the conclusion from the Energy Systems chapter (6) (line 8 to 14, p 5) regarding the increasing viability of the grid with a higher penetration rate of renewables into a paragraph after line 31 on page 48 of the Technical Summary. The linkages between technologies and grid stability are important to keep together and they should not be viewed separately.	Kent Buchanan	South Africa	Section has been revised
81479	48	16	48	16	One time least, writting the meaning of solar PV (photo-voltaic).	Luana Ferreira	Brazil	accepted - spelt out in first use
11371	48	16	48	16	The source of the statement "Investment costs for PV dropped 80% from 2010-2020" cannot be identified in the main text (Ch.6). Please check.	SAI MING LEE	China	accepted - refers to unit cost
11373	48	17	48	17	The source of the statement "Battery costs dropped by two thirds between 2015 and 2020" cannot be found in the main text (Ch.6). Please check.	SAI MING LEE	China	accepted - data presented in chapt 2
7377	48	19	48	19	Re: "in many regions " Please comment on pricing of renewables in developed vs developing regions, especially as a proportion to GDP or mean personal income or some measure like that. Is there a difference? Often developing countries get new technology later, and at higher (relative? absolute?) prices. Please consider in the light of climate justice, as per box on p 45.	Debra Roberts	South Africa	Noted . Addressed in part across chapters 4, 16, 13, 14. not included in TS

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
53141	48	19	48	21	Ch6: This statement does not specify whether it is viable or not. It is only stating that it is increasingly viable which gives the impression that large grid-scale battery storage is a done deal or something of the past. Chapter 6.3 states that 96% of existing electricity storage is pumped hydro and the largest utility scale battery storage is only 100MW in Australia. So obviously much more work is needed which needs to be clearly stated here.	Government of Saudi Arabia	Saudi Arabia	accepted - revised text includes qualification
11375	48	22	48	23	The source of the text "Installed wind and solar PV capacity has increased substantially in recent years. Combined they constituted 9% of global electricity generation in 2020" cannot be found in the main text (Ch.6). Please check.	SAI MING LEE	China	accepted - addressed in TS.3. chapt 2 section 2.5 and chapt 6 section 6.3
7379	48	22	48	40	There is a strange leap from the first to next paragraph: cost of renewables is now lower than fossil fuels, despite this fossil fuels are still growing and investment continues. Could you make some sense of this for the reader?	Debra Roberts	South Africa	accepted - section rephrased
11377	48	26	48	26	The source of the statement "From 2013 to 2018, low-carbon electricity generation increased by 23% " cannot be identified from the main text (Ch.6). Please check.	SAI MING LEE	China	accepted - section revised
11379	48	26	48	27	The source of the text "The vast majority of the growth was solar PV and wind power, which grew by 215% and 75% " cannot be found in the main text (Ch.6). Please check.	SAI MING LEE	China	accepted - section revised
53143	48	28	48	31	Ch6: While in chapter 6, it is pointed that several authors have argued that 100% renewable is feasible (box 6.6) and some made the arguments that regionally that would be viable in some regions (P6-105, L13-26), but the chapter does not cite any studies that make the argument that almost 100% is needed. The statement here says low carbon electricity and not specifically renewable, but this statement is then out of place and should be omitted. The same for the sentence before it because it talks about low carbon when the bolded text and the follow on sentences are about renewables specifically.	Government of Saudi Arabia	Saudi Arabia	accepted - additional material on nuclear and hydro included
77285	48	29			After "less than 40% of global electricity", it could be worth to specify "(including 16% from hydropower and 10% from nuclear energy)", to complete the picture.	Giacomo Grasso	Italy	accepted - additional material on nuclear and hydro included
24443	48	29	48	30	Consistency could be made with the summary for policymakers (C5.4) that says "Low-carbon technologies will need to supply 90% or 100% of global electricity by 2050 to limit warming to 2°C or 1.5°C"	Government of France	France	accepted
28237	48	29	48	31	Allow consistency with the SPM, where it is stated that low-carbon technologies will need to supply 90% or 100% of global electricity by 2050.	Eleni Kaditi	Austria	accepted - paragraph revised
66551	48	31			This appears inconsistent with results of Chapter 3 – even assuming the radical rapid reductions of the models are feasible – the energy sector has to reach net zero before other sectors (except AFOLU) – and move into provide net negative to compensate for transport, buildings and industry	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. Section has been revised
46837	48	32	48	33	Please consider lifting this very clear statement to the SPM.	Government of Germany	Germany	noted
72231	48	35	48	36	At the same time "Institutions, laws, and regulations" can also start or accelerate the transition, this was the experience in the EU with PV and wind energy (see section 9.9.5). In addition, for the phase out of coal, a national climate law would be a very powerful instrument. Therefore, legislation and law are not an obstacle, but a key enabler, which can rapidly accelerate the transition.	bertoldi paolo	Italy	accepted - addressed in section on enabling conditions
67427	48	35	48	36	At the same time "Institutions, laws, and regulations" can also start or accelerate the transition, this was the experience in the EU with PV and wind (see section 9.9), also for the phase out of coal, a law could be a very powerful instrument. Therefore legislation and law is not only an obstacle but could rapidly accelerate the transition.	Philippe Tulkens	Belgium	accepted - addressed in section on enabling conditions
53145	48	37	48	40	Ch6: Is this estimate under current settings (existing infrastructure) or under the assumption that fossil-based investments will continue to happen in the future? Clarify.	Government of Saudi Arabia	Saudi Arabia	Noted - partially addressed in revised TS
81481	48	39	48	39	Suggestion, not mandatory: include a short sentence summarizing and reinforcing the idea of keep need investments and governmental support (e.g. regulation, tax) to enhance the use of renewable energy, mainly in developing countries. Check if this suggestion makes sense with the conclusion of Box TS.9.	Luana Ferreira	Brazil	revised TS includes an extended treatment of policy

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
28239	48	39	48	40	Delete "The combined economic impacts of stranded fossil fuel resources and capital could amount to trillions of dollars.", as such statement does not consider national circumstances and matters related to sustainable development, including energy access.	Eleni Kaditi	Austria	Noted- statement refers to global impacts. Revised TS includes more extended treatment of topic
87045	48	29	48	30	Consistency could be made with the summary for policymakers (C5.4) that says "Low-carbon technologies will need to supply 90% or 100% of global electricity by 2050 to limit warming to 2°C or 1.5°C"		France	Accepted. Consistency with the SPM and underlying chapters have been checked
46839	49	4	49	5	Please use gender-neutral language and replace "man-made" by "human-made". Please check throughout the report.	Government of Germany	Germany	accepted
66553	49	6			"Limiting warming to 2°C would imply ... " ? [and, (50% probability, or 66% - ie. roughly in C3 or C4 categories?]	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. Section has been revised
46841	49	7			"If we intend to limit..." - please amend the formulation since the world has committed in the Paris Agreement to limit warming to 2°C or even 1.5°C.	Government of Germany	Germany	accepted - wording revised
54421	49	7	49	11	This section in the underlying chapter originally made reference to both 1.5°C and 2°C pathways, but in this abbreviated form the references between sentences no longer align in the Technical Summary.	Government of United States of America	United States of America	accepted - point no longer in box. Treated elsewhere in TS
84731	49	7	49	11	Would it be possible to have these estimated for 1.5°C too (either in chapter 6 or in chapter 15 and then referenced here in the TS)?	Kaisa Kosonen	Finland	accepted - point no longer in box. Treated elsewhere in TS
28241	49	7	49	8	Delete "If we intend to limit warming to 2°C, about 30% of oil, 50% of gas, and 80% of coal reserves will remain unburnable", as this statement does not consider technological options such as CCUS, and hydrogen.	Eleni Kaditi	Austria	accepted - point no longer in box. Treated elsewhere in TS
53147	49	7	49	8	Ch6: The paragraph needs to show the estimates compared when CCS/CCUS/DAC/etc. will be deployed at large scale.	Government of Saudi Arabia	Saudi Arabia	Box comprehensively revised
50363	49	8	49	11	It appears If the payback period of fossil fuel power plants is around 10 years and their lifetime is around 25 yeras, there can be still new investments on fossil fuel power plants (perhaps using CCS technology) up to 2025 unless there are some missing factors.	Government of Iran	Iran	Box comprehensively revised
43457	49	8	49	11	It appears If the payback period of fossil fuel power plants is around 10 years and their lifetime is around 25 yeras, there can be still new investments on fossil fuel power plants (perhaps using CCS technology) up to 2025 unless there are some missing factors.	sadegh zeyaeayan	Iran	Box comprehensively revised
28243	49	19	49	26	Delete "Interest groups affected by asset stranding are likely to oppose climate policy. Such challenges will increase in disruptive economic circumstances, and in particular where large multinational interests develop investments in countries of limited state capacity {17.3}. Both individuals and business are subject to loss aversion and desire to keep own assets in operation even if financial, social, or environmental concerns mandate retirement. Loss aversion can be avoided if the risks of stranded assets are communicated, if sustainability reporting is mandated and enforced, and if corporations are protected with novel legal arrangements that shield them from short-term shareholder value maximization (Chapter 5)."	Eleni Kaditi	Austria	Box comprehensively revised
66555	49	21	49	22	Can it ? I thought loss aversion was a structural human characteristic, but so is myopia, and herd behaviour	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Box comprehensively revised
66557	49	23	49	24	I believe at least EU has made it plain that fiduciary duties include responsibilities in managing climate risks	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Box comprehensively revised
84733	49	23	49	26	This is highly policy relevant and concrete information that should be lifted to the SPM.	Kaisa Kosonen	Finland	Box comprehensively revised
66559	49	30	49	31	Apologies haven't managed to read the chapter but this sounds spurious precision – and even the meaning is far from clear to me	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Noted - line no longer included

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
7381	49	32	49	32	It would also be helpful to add any information on retrofitting fossil fuel plants with CCS, or reusing infrastructure for other energy generation, like solar concentrated heat, or any other repurposing methods that have been piloted. Does the USD 11.8 trillion take account of this or is it a figure that assumes complete scrapping of all infrastructure? Does this figure include or exclude lost revenue from untapped fossil fuels in the ground? This figure needs a little more explanation.	Debra Roberts	South Africa	Box comprehensively revised
53149	49	32	49	33	Ch6: This statement should be highlighted upfront and, in the SPM, as well as the regional distribution of the stranded assets based on existing infrastructures	Government of Saudi Arabia	Saudi Arabia	Thank you for your comment. Noted
28245	49	32	49	34	Delete "Already USD 11.8 trillion in assets will need to be stranded by 2050 for 2°C world; further delaying action for another 10 years would result in an additional USD 7.7 trillion in stranded assets by 2050".	Eleni Kaditi	Austria	Box comprehensively revised
72233	49	35	49	37	What shall be avoided, is building today an asset that will be stranded in 10 -20 years. This will save public finance in future for compensation of the stranded asset that should never been built in first instance. Public finance shall be used now to build the alternative to a possible future stranded asset.	bertoldi paolo	Italy	Thank you for your comment. This paragraph has been revised
67429	49	35	49	37	This is what should be avoided in future, the idea of building now an asset that will be stranded in 10 years and saved with public finance in wrong, public finance should be used now to build the alternative to a possible stranded asset.	Philippe Tulkens	Belgium	Thank you for your comment. This paragraph has been revised
50365	49	35	49	37	Please mention the references here especially for the developing countries if there is any.	Government of Iran	Iran	Thank you for your comment. This paragraph has been revised
43459	49	35	49	37	Please mention the references here especially for the developing countries if there is any.	sadegh zeyaeyan	Iran	Thank you for your comment. This paragraph has been revised
7383	49	39	49	47	It would be so useful to have some numbers about these various economic impacts of unabated warming, and how it compares with the 11.8 trillion in stranded assets. How much of this information exists?	Debra Roberts	South Africa	Box comprehensively revised
7385	49	42	49	42	Re: stranded assets, just a philosophical comment: throughout history there have been cases of stranded assets and loss of wealth for those who invested in an outdated technology, and benefits to those who speculated 'correctly'. The world needs energy, not fossil fuels. How do we ensure that access to energy happens equitably?	Debra Roberts	South Africa	Box comprehensively revised
24445	49	43	49	43	delete one of the terms "be	Government of France	France	Noted. Section has been revised
74027	50	1	50	8	In this line the term CCUS is not correctly employed and should be replaced by CCS. A sentence concerning CCU should be added to complement the information, as these two concepts are quite different concerning their business models and technology readiness levels. CO2 has already been used for decades with mature technologies in various industrial processes such as the food and beverage industry, urea production, water treatment and the production of fire retardants and coolants. But there are now many new CCU technologies at various stages of development from R&D to commercialization stage (e.g. about 50 large-scale projects at high Technology Readiness Level are currently ongoing in Europe and will reach commercialization in the near-term. Some examples are: North CCU Hub, Norsk e-fuel, STEELANOL, JUPITER 1000, INITIATE, C2Fuel, Carbon2Chem, CO2Fokus, COLUMBUS). Some examples of already commercialised CCU technologies: Carbon8Systems (UK), Climeworks (Switzerland), Carbon Upcycling (Canada), Covestro (Germany), Orbix (Be), Lanzatech (US), UR One (Canada), Carbon Recycling International (Iceland); SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2. (Bushuyev et al., 2018, Joule, 2(5), pp.825-832).	Ana Machado	Portugal	accepted - text revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
83767	50	1	50	8	In this paragraph the term CCUS is not used the right way. The term CCUS should be replaced by CCS and a sentence about CCU should be added as the level of readiness of both types of methodologies are not the same and the challenges related to their deployment also not. CO2 has already been used for decades with mature technologies in various industrial processes such as the food and beverage industry, urea production, water treatment and the production of fire retardants and coolants. But there are now many new CCU technologies at various stages of development from R&D to commercialization stage (e.g. about 60 large-scale projects at high Technology Readiness Level are currently ongoing in Europe and will reach commercialization in the near-term. Some examples are: North CCU Hub, Norsk e-fuel, STEELANOL, JUPITER 1000, INITIATE, C2Fuel, Carbon2Chem, CO2Fokus, COLUMBUS). Some examples of already commercialised CCU technologies: Carbon8Systems (Uk), Climeworks (Switzerland), Carbon Upcycling (Canada), Covestro (Germany), Orbix (Be), Lanzatech (US), UR One (Canada), Carbon Recycling International (Iceland). •SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2./ •Bushuyev et al. 2018, table 2(F) pp 825-827	Christian Breyer	Finland	accepted - text revised
78555	50	1	50	8	In this paragraph the term CCUS is not used the right way. The term CCUS should be replaced by CCS and a sentence about CCU should be added as the level of readiness of both types of methodologies are not the same and the challenges related to their deployment also not. CO2 has already been used for decades with mature technologies in various industrial processes such as the food and beverage industry, urea production, water treatment and the production of fire retardants and coolants. But there are now many new CCU technologies at various stages of development from R&D to commercialization stage (e.g. about 60 large-scale projects at high Technology Readiness Level are currently ongoing in Europe and will reach commercialization in the near-term. Some examples are: North CCU Hub, Norsk e-fuel, STEELANOL, JUPITER 1000, INITIATE, C2Fuel, Carbon2Chem, CO2Fokus, COLUMBUS). Some examples of already commercialised CCU technologies: Carbon8Systems (Uk), Climeworks (Switzerland), Carbon Upcycling (Canada), Covestro (Germany), Orbix (Be), Lanzatech (US), UR One (Canada), Carbon Recycling International (Iceland). • SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2./ • Bushuyev et al. 2018, table 2(F) pp 825-827	Sylvain Nizou	France	accepted - text revised
60381	50	1	50	8	In this paragraph the term CCUS is not used the right way. The term CCUS should be replaced by CCS and a sentence about CCU should be added as the level of readiness of both types of methodologies are not the same and the challenges related to their deployment also not. CO2 has already been used for decades with mature technologies in various industrial processes such as the food and beverage industry, urea production, water treatment and the production of fire retardants and coolants. But there are now many new CCU technologies at various stages of development from R&D to commercialization stage (e.g. about 60 large-scale projects at high Technology Readiness Level are currently ongoing in Europe and will reach commercialization in the near-term. Some examples are: North CCU Hub, Norsk e-fuel, STEELANOL, JUPITER 1000, INITIATE, C2Fuel, Carbon2Chem, CO2Fokus, COLUMBUS). Some examples of already commercialised CCU technologies: Carbon8Systems (Uk), Climeworks (Switzerland), Carbon Upcycling (Canada), Covestro (Germany), Orbix (Be), Lanzatech (US), UR One (Canada), Carbon Recycling International (Iceland). •SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2./ •Bushuyev et al. 2018, table 2(F) pp 825-827	Célia Sapart	Belgium	accepted - text revised
69961	50	2	50	8	I would suggest "widespread electrification of end uses, particularly in areas such as ground transportation, space heating, cooking, and industry".	Cédric PHILIBERT	France	accepted
46843	50	3	50	8	Both i) and vi) contain CDR, please revise.	Government of Germany	Germany	Noted. Section has been revised
53151	50	5	50	5	Ch6: the third characteristic seems to be hinged on the notion of little room for solutions pertaining to carbon recycling, reusing, and removing. Include here these solutions as Aall options should be considered for decision making.	Government of Saudi Arabia	Saudi Arabia	accepted CCS and CCU included

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
74029	50	5	50	6	CO2-based fuels / e-fuels should be added together with H2, bioenergy and amonia in this sentence (Ampelli et al. 2015 Phil. Trans. R. Soc. A 373: 20140177).	Ana Machado	Portugal	accepted - revised text includes these options
83775	50	5	50	6	CO2-based fuels / e-fuels should be added together with H2, bioenergy and amonia in this sentence	Christian Breyer	Finland	accepted - revised text includes these options
66271	50	5	50	6	CO2-based fuels / e-fuels should be added together with H2, bioenergy and amonia in this sentence	Deepak PANT	Belgium	accepted - revised text includes these options
60389	50	5	50	6	CO2-based fuels / e-fuels should be added together with H2, bioenergy and amonia in this sentence	Célia Sapart	Belgium	accepted - revised text includes these options
69963	50	9	50	11	This is challengeable claim. Supplying the entire energy system with renewables will mostly consist in electrification of buildings, industry and transport, and electrolysing water to produce hydrogen and hydrogen-rich feedstocks and fuels. Most of these new uses of electricity could have their power needs reduced or even be stopped during the demand peaks of today's uses of electricity. This sector coupling would thus finance a vast expansion of the renewable electric capacity basis, which will increase the delivery of green electricity during times of low solar and wind outputs, thereby reducing the volumes of dispatchable electricity needed to ensure electricity security in a context of very large shares of variable renewables	Cédric PHILIBERT	France	Noted paragraph discusses challenges
15837	50	9	50	16	"Electricity systems powered predominantly by renewables will be increasingly viable over the coming decades, but it will be challenging supply the entire energy system entirely with renewables (high confidence).": this point is rightly highlighted. "Research increasingly indicates that large shares of variable solar PV and wind power can be incorporated in electricity grids through batteries, other forms of storage, broader transmission systems, advanced controls, and greater demand side responses (high confidence).": this latter statement seems, in contrast, at odds with the analysis of chapter 6 pages 82-86. Batteries are not yet seen as the general storage technology for 2050 (see, among others, recent publications of professor R. Schmalensee and other authors from MIT-CEEPR). Decarbonised and dispatchable generating technologies are still considered inescapable and contribute to a least cost strategy to support the development of variable renewables.	Jean-Michel Trochet	France	Noted paragraph discusses challenges
29439	50	9	50	17	Consider to include more information on the system cost of energy production with high contribution from solar and windpower. Source of information could be the UK Department for Business, Energy and Industrial Strategy (BEIS) report on Electricity Generation Costs 2020 (Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/911817/electricity-generation-cost-report-2020.pdf)	Government of Norway	Norway	Noted paragraph discusses challenges
53153	50	10	50	10	Ch6: missing 'to' before 'supply' and remove 'entirely' from the phrase '... the entire energy system entirely...'	Government of Saudi Arabia	Saudi Arabia	Noted. Section has been revised
69965	50	11	50	13	As it currently represents over 90% of on-grid electricity storage, and is still growing more rapidly than batteries in absolute terms, and finally as it untapped global potential remains considerable, I would name in first place here the technology of pumped-storage hydropower.	Cédric PHILIBERT	France	Noted, paragraph refers to a range of storage options
54423	50	14	50	15	This is inaccurate given existing knowledge of operating power systems with high VRE shares.	Government of United States of America	United States of America	Accepted - revised wording highlights continued existence of practical constraints
28247	50	15	50	17	Delete "Beyond electricity, hard-to decarbonise sectors, such as aviation, industry, and agriculture, will make 100% renewable energy systems more difficult to attain", or ensure consistency with the analysis incorporated in the respective chapter.	Eleni Kaditi	Austria	Accepted - additional context included
50367	50	15	50	17	This section implies that it is necessary to make every single system 100% running on renewables to reach the goals of Paris Agreement by 2050. Based on the literature, the entire balance can be managed somehow to make it zero carbon emission even if there are some industries such as steel or cement which are very complicated to be carbon neutral.	Government of Iran	Iran	Noted - revised wording makes constraints and context clearer
43461	50	15	50	17	This section implies that it is necessary to make every single system 100% running on renewables to reach the goals of Paris Agreement by 2050. Based on the literature, the entire balance can be managed somehow to make it zero carbon emission even if there are some industries such as steel or cement which are very complicated to be carbon neutral.	sadegh zeyaeyan	Iran	Noted - revised wording makes constraints and context clearer

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
69967	50	16	50	16	I would suggest deleting "industry" and add "deep sea shipping" in this sentence; Recent research (quotes in my comments to chapter 6) has shown it is not more difficult to electrify industry than buildings or transports, in particular aviation (as mentioned) and deep sea shipping (not mentioned). Indeed, even with 100% renewable energy, some process emissions may remain: while those from steel making can be eliminated with renewables through electrolytic hydrogen and direct iron reduction, those resulting from the calcination of limestone in cementmaking cannot.	Cédric PHILIBERT	France	accepted
7387	50	18	50	29	Some more information on progress on energy storage options would be useful here.	Debra Roberts	South Africa	Noted - additional information is available in the chapter
7389	50	18	50	29	What about geothermal energy? (including in relation to repurposing old and deep mines.)	Debra Roberts	South Africa	Noted - additional information is available in the chapter
24447	50	19	50	29	The paragraph is unbalanced since it presents the political and societal constraints related to the development of nuclear power, as well as the environmental constraints related to the development of hydropower, without mentioning similar constraints affecting solar PV and wind power. To balance the arguments, soil artificialisation related to the development of ground-based photovoltaic plants could be mentioned, as well as biodiversity impacts of offshore wind turbines or the weak social acceptability for wind power turbines in sparsely populated rural areas.	Government of France	France	Accepted - text revised
72235	50	21	50	21	Does the cost effectiveness of nuclear technology include the cost of processing the spent fuels and the long-term storage? And the increased security and control costs of nuclear waste?	bertoldi paolo	Italy	accepted - revised text notes that nuclear is an established technology
67431	50	21	50	21	Does the cost effectiveness of nuclear technology include the cost of processing the spent fuels and the long-term storage? And the increased security and control costs?	Philippe Tulkens	Belgium	accepted - revised text notes that nuclear is an established technology
76647	50	21	50	23	This sentence is policy prescriptive	Charlotte MIJEON	France	Noted. Section has been revised
76649	50	21	50	23	The challenge for nuclear power is not only broader use, but also merely maintaining its share while facing competition with other less expensive low-carbon options.	Charlotte MIJEON	France	accepted - revised text notes that nuclear is an established technology
82599	50	21	50	23	<p>"Nuclear Power is economically viable in some circumstances" gives an inaccurate impression. We suggest rewriting it as "Nuclear Power is economically viable in many countries."</p> <p>The latest IEA-NEA publication of the Projected Costs of Generating Electricity (https://www.iea.org/reports/projected-costs-of-generating-electricity-2020) says the following...</p> <p>"Electricity from new nuclear power plants has lower expected costs in the 2020 edition than in 2015. Again, regional differences are considerable. However, on average, overnight construction costs reflect cost reductions due to learning from first-of-a-kind (FOAK) projects in several OECD countries. LCOE values for nuclear power plants are provided for nth-of-a-kind (NOAK) plants to be completed by 2025 or thereafter.</p> <p>Nuclear thus remains the dispatchable low-carbon technology with the lowest expected costs in 2025. Only large hydro reservoirs can provide a similar contribution at comparable costs but remain highly dependent on the natural endowments of individual countries. Compared to fossil fuel-based generation, nuclear plants are expected to be more affordable than coal-fired plants. While gas-based combined-cycle gas turbines (CCGTs) are competitive in some regions, their LCOE very much depend on the prices for natural gas and carbon emissions in individual regions. Electricity produced from nuclear long-term operation (LTO) by lifetime extension is highly competitive and remains not only the least cost option for low-carbon generation - when compared to building new power plants - but for all power generation across the board."</p>	Jonathan Cobb	United Kingdom (of Great Britain and Northern Ireland)	accepted - revised text notes that nuclear is an established technology

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
46845	50	21	50	23	This sentence implies that "broader use" of nuclear power is intended ("will be important to allow..."), and it does not mention the long-term environmental risks associated with this energy supply option, including from nuclear waste. The risks of nuclear energy (e. g. operational risks, uranium mining risks, financial and regulatory risks, unresolved waste management issues, nuclear weapon proliferation concerns) should be mentioned in the technical summary as they are a central issue in the elaborations on nuclear energy in Chapter 6.4.2.4. Please make sure to use objective scientific language when writing about the social acceptance of nuclear energy (e. g. not: nuclear power continues to suffer from limited public and political support, better: receive limited public and political support (Ch. 6, p. 36 31))	Government of Germany	Germany	accepted - revised text notes that nuclear is an established technology
77287	50	22			According to comment 17 above, it is proposed to remove "along with improved construction management and reactor designs to lower costs".	Giacomo Grasso	Italy	accepted
47979	50	23	50	24	Biofuels are already cost-effective in many countries and regions (e.g. Brazil, EU, the U.S.). This statement in lines 23-24 of the Technical Summary seems to simply ignore and discard biofuels currently used for land transportation, even though in many countries they play a key role - and are expected to keep playing that role at least in the near- to mid-term - in reducing GHG emissions of the transport sector. Since near-term ambition is so important, why ignore such an important mitigation option for many countries? This should be corrected. It should be noted that a similar paragraph was included in Chapter 6 (p. 5, l. 22-24) and also should be reviewed accordingly (specific comment below)	Marcelo moreira	Brazil	accepted
50897	50	23	50	24	Biofuels are already cost-effective in many countries and regions (e.g. Brazil, EU, the U.S.). This statement in lines 23-24 of the Technical Summary seems to simply ignore and discard biofuels currently used for land transportation, even though in many countries they play a key role - and are expected to keep playing that role at least in the near- to mid-term - in reducing GHG emissions of the transport sector. Since near-term ambition is so important, why ignore such an important mitigation option for many countries? This should be corrected. It should be noted that a similar paragraph was included in Chapter 6 (p. 5, l. 22-24) and also should be reviewed accordingly (specific comment below)	Government of Brazil	Brazil	accepted
53155	50	23	50	25	Ch6: This is overstating the role of biofuels. It also faces similar environmental constraints (land competition, deforestation, water quality and quantity, ...) which need to be clarified here.	Government of Saudi Arabia	Saudi Arabia	accepted - these issues are addressed elsewhere in the TS
7391	50	24	50	24	What do "next generation conversion processes" refer to?	Debra Roberts	South Africa	accepted - text deleted
24449	50	24	50	25	We suggest to mention here the main challenges associated with bioenergy crop productions.	Government of France	France	accepted - these issues are addressed elsewhere in the TS
24451	50	24	50	25	Please precise the definition of the term "next generation", some advanced biofuels, and biofuels produced from used cooking oils and animal fats are already mature. https://www.ecologie.gouv.fr/sites/default/files/Panorama%202019%20des%20biocarburants%20incorpor%C3%A9s%20en%20France.pdf	Government of France	France	accepted - text deleted
81483	50	25	50	25	The meaning of CCUS only appears on page 70, figure TS.25, line 7	Luana Ferreira	Brazil	accepted defined at first use
7393	50	25	50	25	Please define CCUS	Debra Roberts	South Africa	accepted defined at first use
69969	50	25	50	27	I would use CCS here, as the rest of the sentence is about storage, not utilisation. By and large I would discourage the use of CCUS, which is confusing, as utilisation and storage are actually combined only in enhanced oil recovery operations, but otherwise are very different with respect to their implications for GHG emissions, especially when net zero is the target.	Cédric PHILIBERT	France	Accepted - text revised

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46847	50	25	50	27	<p>Please delete "is technology ready, but", sentence should read "CCUS remains in the demonstration stage and will always cost more than comparable processes in which CO2 is not captured and stored, necessitating strong policy support." Comment: High technology readiness level do not apply to all parts of the CCUS chain, e.g. for storage the level is rather low, and no fully operational market does exist for any of the components. Please add this information and the reference Markewitz et al. also to the underlying chapter 6.</p> <p>---</p> <p>Markewitz, P., Zhao, L., Robinius, M., Technologiebericht 2.3 CO2-Abscheidung und Speicherung (CCS), in: Wuppertal Institut, ISI, IZES (Hrsg.): Technologien für die Energiewende. Teilbericht 2 an das Bundesministerium für Wirtschaft und Energie (BMWi), Wuppertal, 2017.</p>	Government of Germany	Germany	Accepted - text revised
83793	50	26	50	27	<p>Here the term CCUS means CCS, so it should be replaced by CSS and an independent sentence on CCU should be added. CSS and Carbon Capture and Use (CCU) distinctly differ regarding their CO2 reduction potential, the underlying technical processes and outcomes, their effects on climate mitigation, their business models and their environmental policy targets. Therefore, presenting commingling CCS and CCU does not do justice to the specific characteristics of the two concepts and could be counterproductive for the further development particularly of CCU. Therefore the term CCUS should be separated in CCS and CCU and both options should be clearly addressed independently (Cuéllar-Franca and Azapagic, 2015, Bruhn et al., 2016, SAPEA, 2018, Arning et al., 2019). Here a proposition for the sentence on CCU. CCU technologies are at a various stage of development from R&D to commercialisation. In the current context where the environmental and social externalities of incumbent fossil based technologies are not fully integrated in market prices, the speed of the commercial deployment of innovative CCU solutions will largely depend on the development of a strong supportive policy framework, composed of regulations and market incentives (e.g. ICEF, 2017, SAM, 2018, IEAGHG, 2019b, Zhang et al., 2020). •Zhang et al., 2020, Renewable and Sustainable Energy Reviews, 117, 109495. •SAM, 2018: Novel carbon capture and utilisation technologies, Scientific Advice Mechanism (SAM), Independent scientific advice for policy making.</p> <p>•SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2. •IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency. •Arning et al. 2019, Energy Policy, 125, 235–249. •Bruhn et al., 2016, Environmental Science & Policy, 60, 38–43. •Cuéllar-Franca and Azapagic, 2015, J.CO2.Utili., 9, 82-102. •ICEF, 2017: Carbon dioxide</p>	Christian Breyer	Finland	Accepted - text revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
78563	50	26	50	27	<p>Here the term CCUS means CCS, so it should be replaced by CSS and an independent sentence on CCU should be added. CSS and Carbon Capture and Use (CCU) distinctly differ regarding their CO2 reduction potential, the underlying technical processes and outcomes, their effects on climate mitigation, their business models and their environmental policy targets. Therefore, presenting commingling CCS and CCU does not do justice to the specific characteristics of the two concepts and could be counterproductive for the further development particularly of CCU. Therefore the term CCUS should be separated in CCS and CCU and both options should be clearly addressed independently (Cuéllar-Franca and Azapagic, 2015, Bruhn et al., 2016, SAPEA, 2018, Arning et al., 2019). Here a proposition for the sentence on CCU. CCU technologies are at a various stage of development from R&D to commercialisation. In the current context where the environmental and social externalities of incumbent fossil based technologies are not fully integrated in market prices, the speed of the commercial deployment of innovative CCU solutions will largely depend on the development of a strong supportive policy framework, composed of regulations and market incentives (e.g.ICEF, 2017, SAM, 2018, IEAGHG, 2019b, Zhang et al., 2020). • Zhang et al., 2020, Renewable and Sustainable Energy Reviews, 117, 109495. • SAM, 2018: Novel carbon capture and utilisation technologies, Scientific Advice Mechanism (SAM), Independent scientific advice for policy making.</p> <p>• SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2. • IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency. • Arning et al. 2019, Energy Policy, 125, 235–249. • Bruhn et al., 2016, Environmental Science & Policy, 60, 38–43. • Cuéllar-Franca and Azapagic, 2015, J.CO2.Utili., 9, 82-102. • ICEF, 2017: Carbon dioxide</p>	Sylvain Nizou	France	Accepted - text revised	
66289	50	26	50	27	<p>The term CCUS should be replaced by CSS and a separate sentence on CCU should be added. CSS and Carbon Capture and Use (CCU) distinctly differ regarding their CO2 reduction potential, the underlying technical processes and outcomes, their effects on climate mitigation, their business models and their environmental policy targets. Therefore, presenting the two approaches of CCS and CCU does not do justice to the specific characteristics of the two concepts and could be counterproductive for the further development particularly of CCU. Therefore the term CCUS should be separated in CCS and CCU and both options should be clearly addressed independently (Cuéllar-Franca and Azapagic, 2015, Bruhn et al., 2016, SAPEA, 2018, Arning et al., 2019). Here a proposition for the sentence on CCU. CCU technologies are at a various stage of development from R&D to commercialisation. In the current context where the environmental and social externalities of incumbent fossil based technologies are not fully integrated in market prices, the speed of the commercial deployment of innovative CCU solutions will largely depend on the development of a strong supportive policy framework, composed of regulations and market incentives (e.g.ICEF, 2017, SAM, 2018, IEAGHG, 2019b, Zhang et al., 2020). •Zhang et al., 2020, Renewable and Sustainable Energy Reviews, 117, 109495. •SAM, 2018: Novel carbon capture and utilisation technologies, Scientific Advice Mechanism (SAM), Independent scientific advice for policy making.</p> <p>•SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2. •IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency. •Arning et al. 2019, Energy Policy, 125, 235–249. •Bruhn et al., 2016, Environmental Science & Policy, 60, 38–43. •Cuéllar-Franca and Azapagic, 2015, J.CO2.Utili., 9, 82-102. •ICEF, 2017: Carbon dioxide Utilization Roadmap 2.0, Innovation and Cool Earth Forum (ICEF).</p>	Deepak PANT	Belgium	Accepted - text revised	

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60407	50	26	50	27	Here the term CCUS means CCS, so it should be replaced by CSS and an independent sentence on CCU should be added. CSS and Carbon Capture and Use (CCU) distinctly differ regarding their CO2 reduction potential, the underlying technical processes and outcomes, their effects on climate mitigation, their business models and their environmental policy targets. Therefore, presenting commingling CCS and CCU does not do justice to the specific characteristics of the two concepts and could be counterproductive for the further development particularly of CCU. Therefore the term CCUS should be separated in CCS and CCU and both options should be clearly addressed independently (Cuéllar-Franca and Azapagic, 2015, Bruhn et al., 2016, SAPEA, 2018, Arning et al., 2019). Here a proposition for the sentence on CCU. CCU technologies are at a various stage of development from R&D to commercialisation. In the current context where the environmental and social externalities of incumbent fossil based technologies are not fully integrated in market prices, the speed of the commercial deployment of innovative CCU solutions will largely depend on the development of a strong supportive policy framework, composed of regulations and market incentives (e.g. ICEF, 2017, SAM, 2018, IEAGHG, 2019b, Zhang et al., 2020). •Zhang et al., 2020, Renewable and Sustainable Energy Reviews, 117, 109495. •SAM, 2018: Novel carbon capture and utilisation technologies, Scientific Advice Mechanism (SAM), Independent scientific advice for policy making. •SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2. •IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency. •Arning et al. 2019, Energy Policy, 125, 235–249. •Bruhn et al., 2016, Environmental Science & Policy, 60, 38–43. •Cuéllar-Franca and Azapagic, 2015, J.CO2.Utili., 9, 82-102. •ICEF, 2017: Carbon dioxide	Célia Sapart	Belgium	Accepted - text revised
69971	50	27	50	29	How modest is "modest", when it comes to the deployment of hydroelectric power? Chapter 6 notes that "Many developing countries have major undeveloped hydropower potential". The IEA Technology Roadmap Hydropower (2012) says the same. The IEA WEO 2020 in its SDS sees it delivering 6690 TWh globally by 2040, vs. 4305 in 2019, a 55% increase (while nuclear power would grow to 4320 TWh from 2789 TWh in 2019, a similar growth in relative terms, but smaller in absolute terms: +2385 TWh for hydropower vs. +1531 TWh for nuclear according to the IEA, which is not known as a anti-nuclear organisation	Cédric PHILIBERT	France	Accepted - text revised
66561	50	30			What does it mean for energy mix to increase?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted - text revised
72237	50	30	50	36	Here the role of prosumers should be mentioned and section 9.9.5 could also be cited. If all end-users will offer RES production, storage and demand flexibility a 100% RES electricity systems can work.	bertoldi paolo	Italy	text removed from final TS
67433	50	30	50	36	Here the role of prosumers should be mentioned at section 9.9 could also be cited. If all end-users will offer own RES production, storage and demand flexibility a 100% RES electricity systems can work.	Philippe Tulkens	Belgium	text removed from final TS
54425	50	30	50	36	Consider additional bullet on RDD&D needs to advance technology solutions for net zero energy systems that are cost-effective at scale and in needed time.	Government of United States of America	United States of America	Accepted - This point is now covered in section TS.6
53157	50	38	50	38	Ch6: add 'on' after 'depend'	Government of Saudi Arabia	Saudi Arabia	Noted. Section has been revised
24453	50	43	50	43	We suggest to include mobility in the list of examples provided here.	Government of France	France	The text has been substantially revised

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7395	50	43	50	44	Re "Energy system transformation will not occur if it strongly conflicts with these goals." Is it possible to rather say that , if strong conflicts exist, that innovative solutions will need to be found to allow the energy system transformation to occur? If policymakers were to get creative and look more cross-sectorially, solutions may well be found, with multiple co-benefits. For example, coal mining jobs may be transferred to the land sector, in reforestation or land restoration projects, or other mitigation related public works, with creative financing from the renewable energy sector.	Debra Roberts	South Africa	The text has been substantially revised
66563	50	44			Hopefully we seek to mitigate not the system but its emissions ...	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. Section has been revised
84735	50	47	51	1	This is a very clear and policy relevant statement that should be lifted to the SPM.	Kaisa Kosonen	Finland	Noted
31083	50	50	18	29	A detailed treatment of nuclear energy could be improved in the Technical Summary. This ought to include information about the current plans of about 30 new nations to develop new nuclear power programs, thereby doubling the number of countries with nuclear power programs. The text ought also to include a treatment of nationalism and the risk of nuclear arms proliferation as new countries develop the technology. Some will be dishonest actors, looking to develop arms instead of energy. A pathway for the safest development of nuclear energy by these nations ought to be explicitly laid out and a new treaty ought to be promoted, banning the use of any experimental or research reactors by these new countries, and instead mandating small modular reactors. New protocols related to materials enrichment facilities also ought to be adopted. Note that Saudi Arabia is now developing nuclear materials enrichment, and whether this is strictly for its new nuclear power program remains to be seen.	Daniel Helman	Micronesia, Federated States of	Noted. The TS text has been revised substantially with nuclear addressed in various sections
87047	50	19	50	29	The paragraph looks unbalanced as it presents the political and societal constraints related to the development of nuclear power, as well as the environmental constraints related to the development of hydropower, without mentioning similar constraints affecting solar PV and wind power. To balance the arguments, soil artificialisation related to the development of ground-based photovoltaic plants could be mentioned, as well as biodiversity impacts of offshore wind turbines or the weak social acceptability for wind power turbines in sparsely populated rural areas.		France	Accepted - Text substantially revised
54427	51	1	51	3	Consider NG systems used with net zero gases vs. retirement.	Government of United States of America	United States of America	The text has been substantially revised
84737	51	3	51	3	"many countries"? Why not in all countries?	Kaisa Kosonen	Finland	The text has been substantially revised
28249	51	3	51	4	Delete "Investments in refining may be stranded with a move to electric transportation infrastructure."	Eleni Kaditi	Austria	Accepted
66565	51	8	51	14	It would be nice to try and synthesise and explain these stateemnts ... have to spent more ... new economic oportunity – not clear if higher cost. Presumably with reference to financial flows over time, terms of borrowing etc, and in consultation with Chapter 15 (finance).	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. Section has been revised
28251	51	9	51	11	Delete "Investments in low-carbon electricity generation, for example, could be around USD700 billion per year by 2030, as comparison to overall electricity generation investment today of USD350 billion."	Eleni Kaditi	Austria	The text has been substantially revised
64079	51	12	51	12	Is this calibrated "likely"?	Government of Canada	Canada	Noted. Section has been revised
66567	51	17			Err ...	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	The text has been substantially revised
53159	51	21	51	22	Ch6: Earlier in page 33 lines 8-13, it is stated that hitting below 2 C which requires net zero ghg emissions is economically optimal, but here it is not economically attractive. Also attractive over what? Fossil-based? Clarify.	Government of Saudi Arabia	Saudi Arabia	The text has been substantially revised. The previous instance refers to aggregate macroeconomic costs, while the second instance refers to energy systems costs.

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24455	51	22	51	24	The long term economic attractiveness of these systems emitting net-zero GhG will also depend on public policy, like carbon pricing, making those systems profitable.	Government of France	France	Noted
69973	51	28	51	30	I suggest replacing "process heat" here, which is not really hard to decarbonise with green electricity, with "industry process emissions", although ways to decarbonise them have been identified (though only partially for cement making).	Cédric PHILIBERT	France	The text has been substantially revised
24457	51	31	51	31	second-generation biofuels should be defined	Government of France	France	The text has been substantially revised
46849	51	34	52	25	Box TS.10 on electrification does not mention challenges due to electricity grid expansion and storage capacities. Would it be possible to identify the most relevant challenges and their reasons as well perspectives to overcome them? In the Ts and the underlying chapter?	Government of Germany	Germany	The text has been substantially revised
74321	51	36	51	36	The first full sentence should be amended to include nuclear after "oil" as it currently supplies 10% of the world generation of electricity and 35% of current carbon free generation.	Jeffrey Merrifield	United States of America	Noted
24459	51	40	51	40	Could the authors precise the meaning of "unit" in this context?	Government of France	France	The text has been substantially revised
53161	51	43	51	43	Ch6: 'doing useful work' is too broad/generic. Be specific.	Government of Saudi Arabia	Saudi Arabia	Noted. Section has been revised
77289	51	47	52	1	It should be made clear that a shift to "demand flexibility" is very challenging, and only possible to a limited extent, as well as that storage becomes significantly more challenging (when talking of relevant capacities for meaningful systems) as the timescale extends from the minute to the seasonal scale.	Giacomo Grasso	Italy	The text has been substantially revised
53163	52	6	52	8	Ch9: There is text in Box 9.6 to support this statement. The statement "Efficiency of 200-300%" not correct. Revise.	Government of Saudi Arabia	Saudi Arabia	Thank you for your comment. Revised
69975	52	12	52	12	In this remarkable box, I would replace "hydrogen carriers" with "hydrogen-rich feedstocks and fuels" (more likely to be transported and stay in that form than being used as a source from which pure hydrogen would be extracted).	Cédric PHILIBERT	France	Noted-clarified in the box
24461	52	12	52	12	Please define green and blue hydrogen	Government of France	France	Text has been completely revised
18659	52	12	52	12	The term "blue hydrogen" is not used in {10} despite there being reference to production of hydrogen from natural gas {10.3.2.2}. These terms weren't familiar to me and might be better to be expanded "green hydrogen, from electrolysis using sustainable electricity, and blue hydrogen, extracted from natural gas, ...". It might also be emphasised that most hydrogen for use in vehicles is produced currently. AIJL from FF generation of electricity {10.4.2} (para.3).	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Text completely revised
77291	52	14			Replace "renewable" with "low-carbon".	Giacomo Grasso	Italy	Box has been revised
74033	52	19	52	20	This sentence should be rephrased. As electricity is not easily stored, storage of excess electricity at a seasonal scale can only be done by high energy density electro-fuels obtained through CCU technologies (Breyer et al., 2015, Energy Procedia, 73, 182-189; Dimitrou et al., 2015, Energy Environ. Sci, 8, 1775-1789; Anwar et al., 2020, J. of Env. Manag., 260, 110059; Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980; Shih et al., 2018, Joule, 2, 1925-1949; Sternberg and Bardow, 2015, Energy Environ. Sci, 8, 389-400).	Ana Machado	Portugal	The text has been substantially revised
83795	52	19	52	20	This sentence should be rephrased, because it does not take into account the assets of CCU and hydrogen to store energy, which is especially interesting and impactful for the deployment of renewable energy systems. The storage of excess electricity at a seasonal scale can only be done by high energy density electro-fuels obtained through CCU technologies. (e.g. Breyer et al., 2015, Sternberg and Bardow, 2015, Dimitrou et al., 2015, Fasihi et al., 2017, Shih et al. 2018, Anwar et al., 2020). •Breyer et al., 2015, Energy Procedia, 73, 182-189. •Dimitrou et al., 2015, Energy Environ. Sci, 8, 1775-1789. •Anwar et al., 2020, J. of Env. Manag., 260, 110059. •Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980. •Shih et al., 2018, Joule, 2, 1925-1949. •Sternberg and Bardow, 2015, Energy Environ. Sci, 8, 389-400.	Christian Breyer	Finland	The text has been substantially revised

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66291	52	19	52	20	This sentence needs rephrasing, as it does not take into account the assets of CCU and hydrogen to store energy, which is especially interesting and impactful for renewable energy systems. The storage of excess electricity at a seasonal scale can only be done by high energy density electro-fuels obtained through CCU technologies. (e.g. Breyer et al., 2015, Sternberg and Bardow, 2015, Dimitrou et al., 2015, Fasihi et al., 2017, Shih et al. 2018, Anwar et al., 2020). •Breyer et al., 2015, Energy Procedia, 73, 182-189. •Dimitrou et al., 2015, Energy Environ. Sci, 8, 1775-1789. • Anwar et al., 2020, J. of Env. Manag., 260, 110059. • Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980. • Shih et al., 2018, Joule, 2, 1925-1949 • Sternberg and Bardow, 2015, Energy Environ. Sci. 8, 389-400	Deepak PANT	Belgium	The text has been substantially revised
60409	52	19	52	20	This sentence should be rephrased, because it does not take into account the assets of CCU and hydrogen to store energy, which is especially interesting and impactful for the deployment of renewable energy systems. The storage of excess electricity at a seasonal scale can only be done by high energy density electro-fuels obtained through CCU technologies. (e.g. Breyer et al., 2015, Sternberg and Bardow, 2015, Dimitrou et al., 2015, Fasihi et al., 2017, Shih et al. 2018, Anwar et al., 2020). •Breyer et al., 2015, Energy Procedia, 73, 182-189. •Dimitrou et al., 2015, Energy Environ. Sci, 8, 1775-1789. •Anwar et al., 2020, J. of Env. Manag., 260, 110059. •Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980. •Shih et al., 2018, Joule, 2, 1925-1949 •Sternberg and Bardow, 2015, Energy Environ. Sci. 8, 389-400	Célia Sapart	Belgium	The text has been substantially revised
28253	52	19	52	25	Delete "As a general rule, and across all sectors, it is more efficient to use electricity directly and avoid conversion losses from producing hydrogen or hydrocarbon electro-fuels through CCU. What hydrogen does is add option value to clean electricity, for use as hydrogen, future electricity, or as an industrial feedstock. Furthermore, electrification involves a range of general-purpose technologies such as electric motors, power electronics, batteries, electrolysis, fuel cells etc. that have different applications across sectors but that has economies of scale benefits from development and adaptation to different applications."	Eleni Kaditi	Austria	The text has been substantially revised
81485	52	20	52	20	The meaning of CCUS only appears on page 68, line 12	Luana Ferreira	Brazil	The text has been substantially revised
7397	52	24	52	24	Re "economies of scale benefits" – please elaborate.	Debra Roberts	South Africa	The text has been substantially revised
66569	53	1			Nice section – would be nice to see some interaction with low carbon cement and steel from industry chapter?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	The text has been substantially revised
53165	53	1	53	1	Ch8: the summary is missing a statement about emission changes. Add the 3rd statement in the executive summary of chapter 8 here (Page 8-4, lines 17-22)	Government of Saudi Arabia	Saudi Arabia	Noted.
7399	53	1	53	1	The section on urban mitigation is a very important one, the text should be easy to understand, with clear numbers and specific options laid out clearly. The proportion of global emissions associated with urban areas should be mentioned, both production and consumption related. It will be useful to bring together relevant information from buildings, transport, energy, industry etc and show how they all come together in the urban setting, and how it intercepts with finance and policy and other social aspects. This section could be more cross-cutting, also with regard to WGII themes.	Debra Roberts	South Africa	Noted and accepted.
66571	53	4	53	5	Simple, "more than two-thirds of global population are expected to live in cities..?"	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted and accepted.
84739	53	9	53	10	This should be lifted to the SPM, as it is highly relevant information in the context of assessing the future role of land-based CDR.	Kaisa Kosonen	Finland	Noted.
53167	53	9	53	19	Ch8: put these estimates in % as well to give a better sense of how they compare in term of the larger picture of emissions to justify the term 'significant'	Government of Saudi Arabia	Saudi Arabia	Noted and edited.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
7401	53	11	53	11	How are these changes distributed across regions? This raises questions about urban sprawl vs dense informal cities, urbanization rates in different regions, and then the projected emission changes in Figure TS 19. Some interpretation would be useful.	Debra Roberts	South Africa	Noted. We don't have data on sprawl v. informal cities, but in the main chapter, there is a figure that shows the distribution of urban land growth v. urban population growth across regions.
31009	53	12	53	12	The meaning of "urban footprint" is unclear. It would be better to be replaced by "carbon footprint in urban area", etc.	Government of Japan	Japan	Noted and clarified.
81487	53	13	53	13	The number 2 is not superscript	Luana Ferreira	Brazil	Noted and changed. Thank you.
7403	53	26	53	26	Perhaps include the work-from-home trend that has been catapulted forward through Covid.	Debra Roberts	South Africa	Noted. The Covid section has been completed rewritten.
7405	53	26	53	26	Include rooftop solar and wind and prosumers as major mitigation options in cities, integrated grid and distributed energy, energy self-sufficiency, which are particularly feasible in cities.	Debra Roberts	South Africa	Noted and included in text.
11381	53	36	53	38	The figures "8.5 GtCO2 to 14 GtCO2 annually" do not tally with the figures presented in the main text (10-14 GtCO2 annually, Ch.8, P.31, line 10-12). Please check and revise as appropriate.	SAI MING LEE	China	This has been changed to reflect the ES and chapter.
11383	53	38	53	40	The source of the statement "Total urban emissions based on consumption-based accounting are estimated to be 28.6 GtCO2-eq in 2020, or about 70% of global CO2 and CH4 emissions" cannot be found in the main text. Please check (Ch.8).	SAI MING LEE	China	This has been changed to reflect the ES and chapter.
53169	54	1	54	12	Ch8: Not much content added by including this figure here. The 4 values that are given in the figure are called out explicitly in the above text. Omit this figure from the TS document.	Government of Saudi Arabia	Saudi Arabia	Noted and accepted.
28255	54	13	54	22	If possible, use IPs as presented in previous sections of the TS and not SSP-RCP scenarios.	Eleni Kaditi	Austria	Noted.
7407	54	20	54	20	What does "innovative pathways of informality" refer to?	Debra Roberts	South Africa	This section has been completely rewritten. Noted and accepted.
81489	55	1	55	1	Increase the font size in the subtitles of the figure TS.19, panel a	Luana Ferreira	Brazil	Noted and accepted.
53171	55	1	55	10	Ch8: Omit the top panel since the above text does not talk about the 2100 results. Also, in the text SSP2RCP4.5 is mentioned, but SSP4-RCP3.4 is shown. Also, in the caption, SPA is mentioned, but it is not in the figure or in the text. The legend is too small to read.	Government of Saudi Arabia	Saudi Arabia	Noted.
50031	55	1	55	9	Illustrative pathways should be used (maybe they are already IPs, but if so, please use the consistent labeling.)	Masahiro Sugiyama	Japan	Noted and accepted.
67435	55	11	55	19	Under NBS for Cities and other settlements, please also consider the coastal areas; blue carbon, and other soft coastal adaptation measures that have multiple benefits (mitigation and adaptation and natural capital).	Philippe Tulkens	Belgium	Noted and accepted
83353	55	14	55	15	The potential given for "annual global urban tree carbon sequestration [...] on the order of 217 million tons" seems very optimistic. Looking at the underlying chapter, it shows it's about C, not only CO2, and based on a limited range of literature. Please check with colleagues from chapter 7	Geden Oliver	Germany	Noted and contextualized.
24463	55	17	55	17	We suggest to precise what "water-sensitive design" means in this context	Government of France	France	Noted. This section has been rewritten
7409	55	18	55	18	Fruit trees for food are worth mentioning especially in low income settings.	Debra Roberts	South Africa	Noted. The chapter doesn't address this.
67437	55	20	55	21	Should the sentence read "from private motor vehicles TO non-motorised modes"?	Philippe Tulkens	Belgium	Accepted.
72239	55	20	55	23	Local pollution, e.g. PMs and NOX are also generated by traditional fossil fuel burning heating systems (e.g. boilers and furnaces) in heating countries. In addition, reduced private vehicles usage in cities has also some benefits in reduced road accidents involving cyclist and pedestrians. Road vehicles are one of the major barriers to cycling and scooters.	bertoldi paolo	Italy	Noted.
67439	55	20	55	23	Local pollution, e.g. PMs and NOX are also generated by traditional fossil fuel burning heating systems. In addition reduced private vehicles usage in cities has also some benefits in reduced accidents involving cyclist and pedestrians.	Philippe Tulkens	Belgium	Noted. Same comment as 77239?
24465	55	21	55	21	It seems that "towards" should be inserted between "vehicles" and "non-motorised".	Government of France	France	Noted, accepted.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
85267	55		55		What is the significance of carbon sequestration by urban forestry and green infrastructure (an order of magnitude would be relevant).	Valérie Masson-Delmotte	France	Noted and accepted. Scale included now.
28257	55		55		Figure TS.19: If possible, use IPs as presented in previous sections of the TS and not SSP-RCP scenarios.	Eleni Kaditi	Austria	Noted.
53173	56	1	56	8	Ch8: Omit this figure as it is way too complicated to digest and it is hardly discussed in the above text to make it a useful figure to include in the TS document.	Government of Saudi Arabia	Saudi Arabia	Accepted. We have replaced this figure with another figure on GHG emissions trends
24467	56	4	56	4	A possibility could appear through the association with a Vegan diet, as this diet appears to be the one with the higher mitigation potentials (§7.4.5.1). But a Vegan diet is completely incompatible with crop-livestock systems which appear to be models of farming for agroecological transitions. With the specialization process, a lot of farmers (including OF) consider that cropping systems, without livestock, are conducting to an agronomic standoff (for organic matter of the soil and control of weeds)	Government of France	France	Noted, but outside the scope of the chapter.
7411	56	9	56	9	What is "debt financing" and how does this help? This paragraph is not clear.	Debra Roberts	South Africa	Noted and clarified.
72241	56	11	56	16	It is strongly recommended to mention the role of transnational cities initiatives such as the Global Covenant of Mayors or C40 which are promoting carbon neutral cities by mid-century.	bertoldi paolo	Italy	Noted. Chapter 8 does highlight climate networks and transnational governance in the "Multilevel Governance" and "Urban Climate Network" sections, as well as the box on net-zero
67441	56	11	56	16	It is strongly recommended to mention the role of transnational cities initiatives such as the Covenant of Mayors or C40 which are focusing on carbon neutral cities by mid-century	Philippe Tulkens	Belgium	Noted. Chapter 8 does highlight climate networks and transnational governance in the "Multilevel Governance" and "Urban Climate Network" sections, as well as the box on net-zero
7413	56	11	56	16	Text could be clearer to give practitioners guidance. Mention global city networks?	Debra Roberts	South Africa	Noted. Chapter 8 does highlight climate networks and transnational governance in the "Multilevel Governance" and "Urban Climate Network" sections, as well as the box on net-zero
7415	56	24	57	5	This paragraph could be better explained. Consider how much emission comes from urban areas, and how vast the potential here is. The text should be very clear, giving policy makers good guidance.	Debra Roberts	South Africa	Noted. This has been edited.
46851	57	1			Figure TS.20: Do all options have high priorities and most also high ability? In this case your scale might be too coarse since the figure does not provide valuable information. Why are there four levels of priority and of ability in the icons but only three to describe them (low, medium, high)? The mitigation potential estimates are unclear, what do the percentages in the third row mean?	Government of Germany	Germany	Noted. This figure has been completely redrawn.
67443	57	1	57	2	Please also add the coastal NBS and sinks. Green and blue.	Philippe Tulkens	Belgium	Accepted and expanded in the chapter text.
7417	57				Figure TS20: nearly all items in this table are marked as 'high priority'. Is there perhaps a rational way to spread this out? E.g. tCO2e that can be mitigated? It could also make sense here to distinguish between reducing current emissions and avoiding future emissions. The icons in the table cells are not very easy to assimilate visually.	Debra Roberts	South Africa	Noted. This figure has been completely redrawn.
24469	57		57		Figure TS.10 is of great interest. However, almost all mitigation strategies exhibit a high priority, which limits the scope of the message conveyed by the figure. We suggest to change the scale of the priority levels in order to change the distribution of the values given to the different strategies.	Government of France	France	Noted. This figure has been completely redrawn.
53175	58	1	58	1	Ch10: There is no mention of the results from the 11 illustrative pathways with respect to the transport sector. A figure similar to TS.23 for transport would be informative.	Government of Saudi Arabia	Saudi Arabia	Thank you for your comment. A paragraph has been added

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54429	58	1	62	40	TS.5.3 makes no mention of rail emissions. While rail is a small share of transportation emissions today, that share is likely to grow considerably over time as onroad transport decarbonizes and freight rail traffic grows globally. It will become even more relevant if efforts are made to transfer some share of onroad truck freight to rail to improve systemwide freight efficiency. Efforts that are serious about total decarbonization of the transportation sector must make at least some effort to address rail, if only to observe that more effort is needed to develop zero carbon rail technologies. Since rail is discussed in Sections 10.4.2 and 10.4.3, it would be appropriate to make some mention of it here	Government of United States of America	United States of America	Accepted-added	
54431	58	1	62	40	TS.5.3 appears to completely ignore most classes of nonroad engines and equipment, such as agricultural, mining, and construction machinery. It also does not address ports cargo handling equipment or forklifts. Understanding that this is a summary and that not every single type of machinery can have its own paragraph, there needs to be at least some acknowledgement of the significant contribution of nonroad engines and equipment to emissions.	Government of United States of America	United States of America	Thank you for your comment. Section has been revised	
54433	58	1	62	40	In TS.5.3, there is no mention of some potentially significant changes to transportation -- for example, automation, shared mobility, and the blurring of passenger vehicles and delivery vehicles. It is possible that these (and other) systemic changes could have a large impact on future transportation and associated emissions, and should be discussed.	Government of United States of America	United States of America	Thank you for your comment. Section has been revised	
48389	58	1	75	2	In some descriptions in bold for each sector, it is unclear whether it is in the context of current situation or that in the future mitigation pathways. For example, line 16 of TS-58, the texts "Decarbonization options for long-haul trucks, ships, and planes are still lacking", is it also applicable for the future mitigation pathways?	Ken Oshiro	Japan	Thank you for your comment. Section has been completely revised	
53177	58	2	58	2	Ch10: specify the departure from year 2010 as well in addition to 1990 to provide a contrast with AR5 and to remain consistent with previous statements	Government of Saudi Arabia	Saudi Arabia	Thank you for your comment. Section has been revised	
24471	58	6	58	6	73% is mentioned before (page 20 - line 17). "Road transport for passengers and freight represent by far the largest component of transport sector emissions (73%) which continued to grow at a rate of about 2% per year over the last three decades (high confidence)."	Government of France	France	Thank you for your comment. This paragraph has been revised	
11385	58	6	58	7	The figure "75% of transport emissions came from road vehicles" is different from that presented in the main text (73%, Ch.10, P.10, line 7 and Figure 10.1). Please check and revise as appropriate. According to Figure 10.1, emissions from rail should be 1% instead of 3%. Emissions from international/domestic aviation and international/inland shipping appear to add up to 21%, not 22%. Please check and revise as appropriate.	SAI MING LEE	China	Thank you for your comment. This paragraph has been revised	
7419	58	9			Suggest to add "in developing regions of the world, CURRENTLY CONTRIBUTING XX% OF TOTAL TRANSPORT EMISSIONS, have increased..." Conversely, are transport emissions in developed countries projected to decrease, with the spread of electric vehicles, saturation effect and population stabilization?	Debra Roberts	South Africa	Thank you for your comment. A paragraph has been added	
54435	58	11	58	15	This paragraph seems to contain a contradiction. In Row 11-12, it says that there have been divergent developments for light duty and heavy duty. But the very next sentence states that electrification options are now commercially available for both light duty (bikes, autorickshaws, cars) and heavy duty (trucks, buses). The second sentence seems to imply that developments for these subsectors have been similar.	Government of United States of America	United States of America	Thank you for your comment. Section has been revised	
24473	58	12	58	12	Electrification is no commercially available option for long-haul trucks (cf. infra and SPM-22) ; rather use "vans" or "light commercial vehicles" than "trucks"	Government of France	France	Thank you for your comment. This paragraph has been revised	
47981	58	12	58	13	Biofuels for light-duty vehicles are not mentioned; only electrification is mentioned as an option. Why? Biofuels can an important mitigation option for light transport for countries and regions with potential for sustainable production, especially in the near- and mid-term. Excluding such an option is hardly consistent with the importance of promoting near-term ambition in both developed and developing countries.	Marcelo moreira	Brazil	Thank you for your comment. Section has been revised	
50899	58	12	58	13	Biofuels for light-duty vehicles are not mentioned; only electrification is mentioned as an option. Why? Biofuels can an important mitigation option for light transport for countries and regions with potential for sustainable production, especially in the near- and mid-term. Excluding such an option is hardly consistent with the importance of promoting near-term ambition in both developed and developing countries.	Government of Brazil	Brazil	Thank you for your comment. Section has been revised	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
9059	58	13	58	14	This part, "When charged with low-carbon electricity" is very important necessary condition for the electrification option and should be empathized in the SPM, too.	Shigeki KOBAYASHI	Japan	Noted. Thank you
77293	58	16			It is not true that decarbonization options for ships are lacking: nuclear propulsion is a reality. To better reflect the situation, the sentence could be extended adding "or not broadly deployed (e.g., maritime nuclear propulsion)".	Giacomo Grasso	Italy	Thank you for your comment. Section has been revised
54437	58	16	58	18	As currently written, this paragraph implies that decarbonization and electrification of long-haul trucking is similarly challenging to decarbonization of aviation and shipping. From a technology readiness perspective, this is not accurate. Truly emissions-free solutions for aviation and shipping, such as battery electric or carbon-free H2 fuel cell drivetrains, are not yet commercially available for the most part. A few small prototype BEV and FCEV aircraft have been built and there are some battery electric and fuel cell ferry boats in service. But there are no commercial-scale models available for large passenger aircraft or ocean-going vessels. By contrast, several heavy duty truck manufacturers already offer BEV and FCEV models. These technologies are still developing, but one can buy them on the open market. Electrification of long-haul trucking is closer in readiness to light duty vehicles than it is to aviation or shipping. It is not accurate to say with any confidence, much less with "high confidence", that long haul trucking will require drop-in fuels or any other type of liquid fuel. One could just as confidently state that long haul trucks may be able to electrify using either batteries or hydrogen fuel cells.	Government of United States of America	United States of America	Thank you for your comment. This paragraph has been revised
7421	58	17			Please explain "drop-in fuels" and "high energy density fuels" with examples.	Debra Roberts	South Africa	Noted- section revised, line doesnot exist now
81491	58	18	58	18	What does mean 'R&D'? Research and development?	Luana Ferreira	Brazil	Noted- abbreviation expanded in page 17
24475	58	19	58	19	Please unify the use of "advanced" biofuels or "second generation"	Government of France	France	Thank you for your comment. Noted
54439	58	19	58	27	This paragraph currently conflates battery electrification with electrification more broadly. For example, electrolytic hydrogen is a form of electrification. Lithium ion batteries and hydrogen fuel cells are both chemical energy carriers for energy derived from electricity and are both appropriately considered forms of vehicle electrification. For some transportation sectors, especially rail, overhead catenary technologies are yet another form of electrification. Where this report means to refer to battery electrification, it should be more specific. Where it means to refer to electrification broadly, it should be inclusive rather than excluding electrolytic hydrogen.	Government of United States of America	United States of America	Thank you for your comment. This paragraph has been revised
54441	58	19	58	27	Presumably when this paragraph says "electrification" it means battery electrification? Assuming that is so, the paragraph correctly lists the major technology options for transportation decarbonization in the first two sentences. However, the rest of the paragraph fails to discuss hydrogen appropriately. For land-based heavy-duty transport applications specifically, hydrogen fuel cell vehicles are approximately coequal with battery electrification in terms of technology readiness level, and is at a substantially higher TRL than non-food-based synthetic hydrocarbons/e-fuels. (Chapter 10 correctly states that hydrogen fuel cells in these applications are at a higher TRL than synthetic hydrocarbons/e-fuels, but the TS does not currently reflect that distinction well). It is correct to state that both battery and fuel cell-based electrification likely will be cost competitive "in the near future", but what is less clear is which of these two electrification technologies will be more competitive with diesel in the many different types of land-based heavy duty transport. For smaller vehicles and those with short and predictable daily duty cycles, low peak power needs, and significant daily downtime, batteries seem to have an edge. Conversely, for larger vehicles and those with long and/or unpredictable duty cycles, high peak power needs, or the need to run 24/7, hydrogen seems to currently have an edge. One cannot confidently state which technology is further along as a general statement.	Government of United States of America	United States of America	Thank you for your comment. This paragraph has been revised
7423	58	19	58	27	This paragraph contains some redundancies.	Debra Roberts	South Africa	Thank you for your comment. Section has been revised
53179	58	19	58	32	Ch10: this statement is supposedly about decarbonization of the land-based, heavy-duty transport, but the current text goes into light duty (lines 22-25)	Government of Saudi Arabia	Saudi Arabia	Thank you for your comment. Section has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
47983	58	20	58	22	This assessment on the technology readiness level (TRL) of biofuels should be reevaluated. Advanced biofuels such as cellulosic ethanol and especially HVO already present a higher TRL, particularly in comparison to synthetic hydrocarbons, e-fuels and hydrogen.	Marcelo Moreira	Brazil	Thank you for your comment. Section has been revised
50901	58	20	58	27	This assessment on the technology readiness level (TRL) of biofuels should be reevaluated. Advanced biofuels such as cellulosic ethanol and especially HVO already present a higher TRL, particularly in comparison to synthetic hydrocarbons, e-fuels and hydrogen. This should be explicitly stated in the text	Government of Brazil	Brazil	Thank you for your comment. Section has been revised
24477	58	22	58	25	This should be moved towards line 15 to gather what deals with light-duty vehicles on one hand and leave what deals with heavy-duty vehicles on the other hand here	Government of France	France	Thank you for your comment. Section has been completely revised
69977	58	24	52	25	Electrification of ground vehicles are commercial already.	Cédric PHILIBERT	France	Thank you for your comment. Section has been revised
74031	58	25	58	27	This sentence does not reflect the current state of the art. CCU technologies include some that are close to commercialization, others are at the pilot scale, and some are still in research phase. Thermochemical and bioelectrochemical are the most advanced technologies These pathways are the closest to commercialization and are ready to be upscaled in near-term (5-10 years) while other routes such as the direct electrochemical, near room temperature pathways are promising on the long-term but will take at least 10 years to overcome the current technical barriers (Diaz et al., 2018, Green Chem., 2018, 20, 620-626; Messias et al. Reaction Chem. & Eng. , 2019, 4, 1982-1990; Edwards et al. Applied Energy , 2019, 261, 114305; Bushuyev et al., 2018, Joule, 2(5), pp.825-832; Masel et al. Nature Nanotechnology, 2021, 16, 118-128). In Europe exist ca. 50 high Technology Readiness Level (TRL) projects on CO2 to fuel many of them will reach commercialisation in the near-term (before 2030). Examples of forecasted production of CO2-based fuel in near-term (within 5 years) are: - Norsk-efuel (DAC to jet-fuel)=> 100 Million ton of jet-fuel/year - Carbon Recycling International => 4000 tons of methanol/year - Jupiter 1000 (CO2 flue gas to CH4) : 25Nm3/h of methane - North CCUhub (CO2 to methanol)=> 44000 tons of methanol/year - Mo-Industrial e-fuel (CO2 to methanol)=> 80 000 tons of methanol/year - C2Fuel (CO2 to formic acid) => 2.4 Million tons of formic acid/year	Ana Machado	Portugal	Thank you for your comment. Section has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
83769	58	25	58	27	<p>The statement on the readiness level of alternative CO2 based fuel does not reflect the current literature nor the current state of the art in this field. In term of technologies, recent advances in the CCU field offer untapped potential for the realization of CO2 conversion to fuels. Today, a large palet of technologies exist, some are close to commercialization, others are at the benchtop/pilot scale, and some have yet to be scientifically proven. Thermochemical and bioelectrochemical routes offer the most technically feasible near-term opportunities for CO2-based fuels, representing immediately deployable pathways to high-value and relatively high-volume products. These pathways are the closest to commercialization and are ready to be upscaled in near-term (5-10 years) while other routes such as the direct electrochemical pathways are promising on the long-term but will take several decades to overcome the current technical barriers (Diaz et al., 2018, Messias et al. 2019, Edwards et al., 2019, Bushuyev et al., 2020, Masel et al., 2021). Close to 50 high Technology Readiness Level (TRL) projects on CO2 to fuel exist in Europe and many of them will reach commercialisation in the near-term (before 2030). Please find a few examples of high TRL CO2 to fuel projects below with the forecasted production of CO2-based fuel in near-term (well before 2030):</p> <ul style="list-style-type: none"> -Norsk-efuel (DAC to jet-fuel)=> 100 Million ton of jet-fuel/year -Carbon Recycling International => 4000 tons of methanol/year -Jupiter 1000 (CO2 flue gas to CH4) : 25Nm3/h of methane -North CCUhub (CO2 to methanol)=> 44000 tons of methanol/year -Mo-Industrial e-fuel (CO2 to methanol)=> 80 000 tons of methanol/year -C2Fuel (CO2 to formic acid) => 2.4 Million tons of formic acid/year -Audi e-gas plant (CO2 to methane => 1000 tons of methane/year <p>REFERENCES: •Masel et al. Nature Nanotechnology, 2021, 16, 118-128. •Messias et al. Reaction Chem. &Eng. , 2019, 4, 1982-1990. •Bushuyev et al., 2018, Joule, 2(5), pp.825-832. •Diaz et al. Green Chem., 2018, 20, 620-626. •Edwards et al. Applied Energy , 2019, 261, 114305.</p>	Christian Breyer	Finland	Noted-section has been completely revised
69979	58	25	58	27	<p>Low-carbon synthetic HCs are only required for aviation (given appropriate specific energy, a.k.a. "gravimetric" energy density. Short sea shipping is getting electrified already (notably in Nordic countries), while deep sea shipping can be fuelled with green ammonia in existing but modified <u>internal combustion engines</u>.</p>	Cédric PHILIBERT	France	Thank you for your comment. Noted
24479	58	25	58	27	<p>In Europe there are already some projets : See for instance Norsk e-fuel, with an entry into service foreseen in 2023 : https://www.norsk-e-fuel.com/en/</p>	Government of France	France	Thank you for your comment. Noted
54443	58	25	58	27	<p>This sentence indicates that low carbon drop-in fuels for aviation and shipping are in the research stage. While e-fuels specifically are still in the research/bench scale phase, that is not the case for drop-in synthetic hydrocarbons. First, seven processes have been issued specifications by ASTM for the production of synthetic alternative jet fuels, proving they are safe and have similar performance to kerosene. Second, there are already commercially available drop-in alternative aviation fuels (e.g., World Energy Paramount (since 2016), Neste (similar timeframe)) with multiple additional commercial scale facilities under construction/due to commence activity in the next year. There is also a significant amount of existing and construction-under-way renewable diesel production that can be used in shipping (e.g., REG, Diamond Green Diesel, World Energy). In addition, there are several Net Zero project commitments underway (e.g., Gevo). So it would be more accurate to use the language from Section 10.5 indicating that SAF are "not widely available at economic prices yet" (see page 10-62, lines 39-40), and focus the statement about "research stage" on e-fuels only. This should also be addressed on page TS-61, lines 17-18.</p>	Government of United States of America	United States of America	Thank you for your comment. Section has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66265	58	25	58	27	<p>The statement on the readiness level of alternative CO2 based fuel does not reflect the current literature nor the current state of the art in this field. In term of technologies, recent advances in the CCU field offer untapped potential for the realization of CO2 conversion to fuels. Today, a wide spectrum of technologies exist, some of which are close to commercialization, others are at the benchtop/pilot scale, and some have yet to be scientifically proven (Gutiérrez Sánchez, et al., 2019). Thermochemical and bioelectrochemical routes offer the most technically feasible near-term opportunities for CO2-based fuels, representing immediately deployable pathways to high-value and relatively high-volume products. These pathways are the closest to commercialization and are ready to be upscaled in near-term (5-10 years) while other routes such as the direct electrochemical pathways are promising on the long-term but will take several decades to overcome the current technical barriers (Diaz et al., 2018, Messias et al. 2019, Edwards et al., 2019, Bushuyev et al., 2020, Masel et al., 2021). Close to 50 high Technology Readiness Level (TRL) projects on CO2 to fuel exist in Europe and many of them will reach commercialisation in the near-term (before 2030). Here are some examples of high TRL CO2 to fuel projects below with the forecasted production of CO2-based fuel in near-term (well before 2030):</p> <ul style="list-style-type: none"> -Norsk-efuel (DAC to jet-fuel)=> 100 Million ton of jet-fuel/year -Carbon Recycling International => 4000 tons of methanol/year -Jupiter 1000 (CO2 flue gas to CH4) : 25Nm3/h of methane -North CCUhub (CO2 to methanol)=> 44000 tons of methanol/year -Mo-Industrial e-fuel (CO2 to methanol)=> 80 000 tons of methanol/year -C2Fuel (CO2 to formic acid) => 2.4 Million tons of formic acid/year -Audi e-gas plant (CO2 to methane => 1000 tons of methane/year <p>REFERENCES: •Gutiérrez Sánchez, et al., 2019. Current Opinion in Green and Sustainable Chemistry, 16, 47-56.</p> <ul style="list-style-type: none"> • Masel et al. Nature Nanotechnology, 2021, 16, 118-128. •Messias et al. Reaction Chem. &Eng. , 2019, 4, 1982-1990. •Bushuyev et al., 2018, Joule, 2(5), pp.825-832. •Diaz et al. Green Chem., 2018, 20, 620-626. •Edwards et al. Applied Energy , 2019, 261, 114305. 	Deepak PANT	Belgium	Thank you for your comment. Section has been revised
78557	58	25	58	27	<p>The statement on the readiness level of alternative CO2 based fuel does not reflect the current literature nor the current state of the art in this field. Please find below a list of projects and references that show that CCU technologies have reached a high technology readiness level and represent an actual way for fossil resources substitution while reducing GHG emissions.</p> <ul style="list-style-type: none"> - Norsk-efuel (DAC to jet-fuel)=> 100 Million ton of jet-fuel/year - Carbon Recycling International => 4000 tons of methanol/year - Jupiter 1000 (CO2 flue gas to CH4) : 25Nm3/h of methane - North CCUhub (CO2 to methanol)=> 44000 tons of methanol/year - Mo-Industrial e-fuel (CO2 to methanol)=> 80 000 tons of methanol/year - C2Fuel (CO2 to formic acid) => 2.4 Million tons of formic acid/year - Audi e-gas plant (CO2 to methane => 1000 tons of methane/year <p>REFERENCES: • Masel et al. Nature Nanotechnology, 2021, 16, 118-128.</p> <ul style="list-style-type: none"> • Messias et al. Reaction Chem. &Eng. , 2019, 4, 1982-1990. • Bushuyev et al., 2018, Joule, 2(5), pp.825-832. • Diaz et al. Green Chem., 2018, 20, 620-626. • Edwards et al. Applied Energy , 2019, 261, 114305. 	Sylvain Nizou	France	Thank you for your comment. Section has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
60383	58	25	58	27	The statement on the readiness level of alternative CO2 based fuel does not reflect the current literature nor the current state of the art in this field. In term of technologies, recent advances in the CCU field offer untapped potential for the realization of CO2 conversion to fuels. Today, a large palet of technologies exist, some are close to commercialization, others are at the benchtop/pilot scale, and some have yet to be scientifically proven. Thermochemical and bioelectrochemical routes offer the most technically feasible near-term opportunities for CO2-based fuels, representing immediately deployable pathways to high-value and relatively high-volume products. These pathways are the closest to commercialization and are ready to be upscaled in near-term (5-10 years) while other routes such as the direct electrochemical pathways are promising on the long-term but will take several decades to overcome the current technical barriers (Diaz et al., 2018, Messias et al. 2019, Edwards et al., 2019, Bushuyev et al., 2020, Masel et al., 2021). Close to 50 high Technology Readiness Level (TRL) projects on CO2 to fuel exist in Europe and many of them will reach commercialisation in the near-term (before 2030). Please find a few examples of high TRL CO2 to fuel projects below with the forecasted production of CO2-based fuel in near-term (well before 2030): -Norsk-efuel (DAC to jet-fuel)=> 100 Million ton of jet-fuel/year -Carbon Recycling International => 4000 tons of methanol/year -Jupiter 1000 (CO2 flue gas to CH4) : 25Nm3/h of methane -North CCUhub (CO2 to methanol)=> 44000 tons of methanol/year -Mo-Industrial e-fuel (CO2 to methanol)=> 80 000 tons of methanol/year -C2Fuel (CO2 to formic acid) => 2.4 Million tons of formic acid/year -Audi e-gas plant (CO2 to methane => 1000 tons of methane/year REFERENCES: •Masel et al. Nature Nanotechnology, 2021, 16, 118-128. •Messias et al. Reaction Chem. &Eng. , 2019, 4, 1982-1990. •Bushuyev et al., 2018, Joule, 2(5), pp.825-832. •Diaz et al. Green Chem., 2018, 20, 620-626. •Edwards et al. Applied Energy , 2019, 261, 114305.	Célia Sapart	Belgium	Thank you for your comment. Section has been revised
81493	58	32	58	32	Home-based/remote job might also contribute for this approach post-covid: less commute, cars and buses etc.	Luana Ferreira	Brazil	Thank you for your comment. Noted
84741	59	0	59	0	The full warming effect of aviation was not considered, right? If so, please note that.	Kaisa Kosonen	Finland	Figure revised
46853	59	1			Does this show emissions per kilometre for each transport mode?	Government of Germany	Germany	Figure revised
48391	59	1	59	2	Figure TS21 looks less informative to be included in the TS. If it is useful, I would suggest moving it to the section TS.3 with the emission trends in other sectors.	Ken Oshiro	Japan	Figure deleted
53181	59	24	59	24	Ch10: "may be overstated" gives the impression of that the authors are giving their own opinion rather than their finding from assessing the literature on the matter. Rewrite with accurate wording Given the importance of the critical materials aspect, it deserves its own statement.	Government of Saudi Arabia	Saudi Arabia	Thank you for your comment. Section revised
53183	59	41	59	41	Ch10: "few simple solutions" does it mean "fewer potential solutions" or "a few potential solutions"?	Government of Saudi Arabia	Saudi Arabia	Thank you for your comment. This paragraph has been revised
7425	59				Figure TS21: in the Road category it would help to differentiate between passenger cars and trucking, as the one is easier to decarbonise than the other.	Debra Roberts	South Africa	Figure deleted
7427	60	2			In this section, please report on cost and availability of EVs in developing countries, and how diffusion and technology transfer can be accelerated.	Debra Roberts	South Africa	Thank you for your comment. Section has been revised
9061	60	3	60	3	Why do you specify "Lithium Ion Battery" here? Just "battery" will do.	Shigeki	Japan	Thank you for your comment. Noted
47985	60	3	60	5	The statement that BEVs have significantly lower life cycle GHG emissions than ICEV seems to imply that ICEV is fueled only with fossil fuels. However, ICEV can be fueled by biofuels – something that is extensively done in many countries and regions. Moreover, hybrid vehicles (HEVs and PHEVs) are also an important option of low GHG emissions in transport that is simply omitted. It is not clear why this statement in lines 3-5 is calibrated as "high confidence", since citations were omitted.	Marcelo moreira	Brazil	Thank you for your comment. Section has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
50903	60	3	60	5	The statement that BEVs have significantly lower life cycle GHG emissions than ICEV seems to imply that ICEV is fueled only with fossil fuels. However, ICEV can be fueled by biofuels – something that is extensively done in many countries and regions. Moreover, hybrid vehicles (HEVs and PHEVs) are also an important option of low GHG emissions in transport that is simply omitted. It is not clear why this statement in lines 3-5 is calibrated as “high confidence”, since citations were omitted. Finally, no discussion is made about the fact that, in practice, BEVs are predominantly NOT charged with low carbon electricity, and that additional energy demand on already stressed fossil-based grids around the world will have as outcome a much inferior mitigation result from BEVs.	Government of Brazil	Brazil	Thank you for your comment. Section has been revised
77295	60	9			Change “renewable” with “low-carbon”.	Giacomo Grasso	Italy	Thank you for your comment. This paragraph has been revised
31011	60	11	60	14	Mitigation option of electro-mobility during peak demand periods is, as described in 10.3.1.3, to reduce peak loads rather than to minimise charging. It would be better to describe “reduce peak loads” instead of “conversely minimise charging.”	Government of Japan	Japan	Thank you for your comment. This paragraph has been revised
9063	60	16	60	20	I agree that the current Li-ion battery is very good one, but not good enough to compete with the conventional ICE vehicle in terms of the driving range. Further improvement of energy density is necessary condition for the further penetration of EVs in the road transport.	Shigeki KOBAYASHI	Japan	Thank you for your comment. Section has been revised
67445	60	21	60	22	Some of these issues of concern also apply to production of oil-based fuels. So it is important to address these issues, their existence does not automatically mean that battery-based systems are worse in these areas than oil-based systems.	Philippe Tulkens	Belgium	Thank you for your comment. Section has been revised
31013	60	21	60	24	It is not clear which metals are mentioned with the words “LIB metals”, as following sentence suggests that cobalt is not a matter of concern here. It would be better to specify types of metals relating to this issue.	Government of Japan	Japan	Line has been deleted
46855	60	21	60	26	Please add information on environmental concerns of these metals.	Government of Germany	Germany	Section revised-line has been deleted
46857	60	27	60	34	It might be useful to mention international agreements and regulatory measures - as assessed in the underlying chapters - to implement the measures mentioned in this paragraph.	Government of Germany	Germany	Thank you for your comment. Section has been revised
66573	60	34	60	38	Its really nice to have a clear statement of implications at the end of the section. Might this be a model that some other sections could follow?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	All sections revised substantially
54445	60	35	60	36	The importance of infrastructure to support electrification of the LD fleet should be discussed prior to the main conclusion here; a brief discussion on the current state of charging infrastructure and what’s needed in this area would be useful.	Government of United States of America	United States of America	Thank you for your comment. Section has been revised
47987	60	35	60	39	No evidence is presented to back the claim that phasing out ICEVs is best solution for light-duty vehicles in all circumstances, regardless of the role of biofuels in substituting fossil fuels. This statement should be revised with caution and references should be presented.	Marcelo moreira	Brazil	Thank you for your comment. Section has been revised
50905	60	35	60	39	No evidence is presented to back the claim that phasing out ICEVs is best solution for light-duty vehicles in all circumstances, regardless of the role of biofuels in substituting fossil fuels. This statement should be revised with caution and references should be presented.	Government of Brazil	Brazil	Thank you for your comment. Section has been revised
69981	60	41	60	43	If one is to judge by the increases in CO2 emissions over 2010-2018, heavy-duty trucks have not become the fastest growing source of GHG globally - first is the power sector, second is SUVs; Trucks only come third (see e.g. https://www.iea.org/commentaries/growing-preference-for-suvs-challenges-emissions-reductions-in-passenger-car-market)	Cédric PHILIBERT	France	Thank you for your comment. This paragraph has been revised
69983	60	41	60	43	The problem with heavy-duty trucks is not the small number of solutions, but rather the number of competing solutions, each with pros and cons: battery-electrification, electric road systems (catenaries or ground feeding rails) combined with on-board batteries, compressed hydrogen and fuel cells, e-gasoline (lower total efficiency but possibility to have it produced in areas with bountiful renewable resources), or even ammonia.	Cédric PHILIBERT	France	Thank you for your comment. Noted

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
74035	60	41	61	2	The comparison between e-fuels and batteries is not the most relevant, because there are two very different subjects, with different impacts and challenges. Batteries are today further in term of commercialisation, but the future of these technologies remains highly uncertain because of e.g. scarcity in lithium resources. It is important to note that e-fuels are the only near-term and drop-in solution for sectors such as aviation. This field is evolving at very high speed the first flight using CO2-based fuel has happened in the Netherlands early 2021 (https://www.transportenvironment.org/news/first-passenger-flight-performed-using-clean-fuels-sort). Also numerous project such as Norsk-e-fuel (https://www.norsk-e-fuel.com/en/) and Take-off (https://www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-co2-neutral-industry/biomass-to-fuels-and-feedstock/take-off-sustainable-aviation-fuels/) will provide large quantity of sustainable aviation fuel in the near term.	Ana Machado	Portugal	Thank you for your comment. This paragraph has been revised
83771	60	41	61	2	The comparison between e-fuels and batteries is not the most relevant, because there are two very different subjects, with different impacts and challenges. Batteries are today further in term of commercialisation, but the future of these technologies remains highly uncertain because of e.g. scarcity in lithium resources. It is important to note that e-fuels are the only near-term and drop-in solution for sectors such as aviation. This field is evolving at very high speed the first flight using CO2-based fuel has happened in the Netherlands early 2021 (https://www.transportenvironment.org/news/first-passenger-flight-performed-using-clean-fuels-sort). Also numerous project such as Norsk-e-fuel (https://www.norsk-e-fuel.com/en/) and Take-off (https://www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-co2-neutral-industry/biomass-to-fuels-and-feedstock/take-off-sustainable-aviation-fuels/) will provide large quantity of sustainable aviation fuel in the near term.	Christian Breyer	Finland	Thank you for your comment. This paragraph has been revised completely
9065	60	41	61	2	I agree that CO2 mitigation due to the efficiency improvement is limited, but still there are some hope. The reduction due to each option is limited but there are many options to improve efficiency including not only vehicle efficiency but also system-wide improvement to increase the load factor, such as consolidated service to transport mixed cargoes from different customers and reduce the empty running.	Shigeki KOBAYASHI	Japan	Thank you for your comment. Noted
66267	60	41	61	2	Here, the comparison between e-fuels and batteries is not quite relevant, since these are two very different subjects, with different impacts and challenges. Batteries are today further in term of commercialisation, but the future of these technologies remains highly uncertain because of e.g. scarcity in lithium resources. It is important to note that e-fuels are the only near-term and drop-in solution for sectors such as aviation. This field is evolving at very high speed the first flight using CO2-based fuel has happened already in the Netherlands early 2021. (https://www.transportenvironment.org/news/first-passenger-flight-performed-using-clean-fuels-sort). Also numerous project such as Norsk-e-fuel (https://www.norsk-e-fuel.com/en/) and Take-off (https://www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-co2-neutral-industry/biomass-to-fuels-and-feedstock/take-off-sustainable-aviation-fuels/) will provide large quantity of sustainable aviation fuel in the near term.	Deepak PANT	Belgium	Thank you for your comment. This paragraph has been revised completely
60385	60	41	61	2	The comparison between e-fuels and batteries is not the most relevant, because there are two very different subjects, with different impacts and challenges. Batteries are today further in term of commercialisation, but the future of these technologies remains highly uncertain because of e.g. scarcity in lithium resources. It is important to note that e-fuels are the only near-term and drop-in solution for sectors such as aviation. This field is evolving at very high speed the first flight using CO2-based fuel has happened in the Netherlands early 2021 (https://www.transportenvironment.org/news/first-passenger-flight-performed-using-clean-fuels-sort). Also numerous project such as Norsk-e-fuel (https://www.norsk-e-fuel.com/en/) and Take-off (https://www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-co2-neutral-industry/biomass-to-fuels-and-feedstock/take-off-sustainable-aviation-fuels/) will provide large quantity of sustainable aviation fuel in the near term.	Célia Sapart	Belgium	Thank you for your comment. This paragraph has been revised completely

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66575	61	2			Comment from a colleague at UCL: "Have you / reviewers taken UNEP EGR as an input. Ch. 6? This has some content on TRL. There are already investments and orders in for ammonia powered ships and GW scale green ammonia supply chains targeted at marine. There are bio/e-methanol powered ships and 2nd gen/waste bio fuels already in operation (which I don't fancy as scalable but still important as a stop gap as we scale ammonia). Both supply chain and fleet are therefore on track for full TR maturity by 2025. Most of the info is in the grey literature (and often specialist/shipping grey lit), so hard to use/access. What has perhaps confused authors/reviewers is that there are lobbying vested interests for different fuels which can give the impression that there is lack of clarity on tech pathway. Lots of content that could be leveraged here: https://wedocs.unep.org/xmlui/bitstream/handle/20.500.11822/34431/EGR20ch5.pdf?sequence=3 " Also review Figure TS.22 in light of this?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Noted
50907	61	3	61	5	These lines should also mention biofuels as one of the solutions to reduce GHG emissions for land-based, long-range, heavy duty trucks, with lower technological challenges than those faced by <u>batteries or hydrogen fuel cells</u>	Government of Brazil	Brazil	Thank you for your comment. Section revised
7429	61	3	61	8	The question of railways is very interesting in developing countries: railroads from colonial times, are they still utilized or not, effect on local economies, etc. Railways have lower emissions per passenger and per ton cargo than road vehicles. This warrants further discussion.	Debra Roberts	South Africa	Thank you for your comment. Section revised
54447	61	3	61	8	Recommend adding discussion on the number of years that heavy-duty vehicles are typically used in operations and the implications for when the majority of the heavy-duty fleet could be electrified or otherwise decarbonized; discussion could point to a need for governments to explore policies that <u>accelerate fleet turnover</u> .	Government of United States of America	United States of America	Thank you for your comment. Section has been revised
54449	61	3	61	8	Recommend adding some discussion or reference to the LD discussion regarding end-of-life and recycling of batteries and/or other components used in heavy-duty vehicles.	Government of United States of America	United States of America	Thank you for your comment. Section has been revised
54451	61	3	61	8	Consider adding a brief discussion on the potential implications of electrifying the heavy-duty fleet on electrical grid operations (both the potential to help stabilize through battery storage, and the high demands of <u>charging the large batteries used in heavy-duty vehicles</u>).	Government of United States of America	United States of America	Noted-section revised
54453	61	5	61	6	Recommend speaking to different subsegments of heavy-duty fleet rather than a blanket statement about when commercial operations will be feasible.	Government of United States of America	United States of America	Thank you for your comment. Section has been revised
69985	61	9	61	12	One should clearly distinguish here aviation and shipping. The weight of batteries is a much bigger issue for aviation, and electrification is likely to remain extremely marginal, while it can represent a more significant (though still quite limited) option for short sea shipping (ferries, etc.). For medium- and long-haul trips, ammonia is a good option for ships and have the great merit of not reintroducing carbon in the atmosphere, while for aviation the higher weight of ammonia is a significant issue, so that e-kerosene and biofuels are the only viable options in the next few decades, while hydrogen aircraft still require decades of development before any commercial qualification (not to mention <u>replacement of existing fleets and bunkering chains</u>).	Cédric PHILIBERT	France	Thank you for your comment. Section has been revised
9067	61	9	61	24	Yes, biofuels will be a solution for aviation and shipping, and there are many types of biofuels and some of them may provide sustainable and economical fuels in the near future before the low carbon biofuels become available. Current biofuel use in aviation is only 0.01% of whole jet fuels, and most of them is HVO; Hydrotreated Vegetable Oil. HVO can be produced from various feedstock's, including the used cooking oil and other waste. The number of commercial airlines to use biofuels has been increasing. In the near-term future, this HVO will play a large role to reduce CO2 emission <u>from aviation and shipping</u> .	Shigeki KOBAYASHI	Japan	Thank you for your comment. Noted

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
54455	61	9	61	24	The first sentence seems questionable and certainly not something authors can say with "high confidence". It is true that hydrogen fuel cells and Li-ion batteries are unlikely to gain a significant market share in aviation or shipping in the next decade. However, several companies, many of them very well-funded, are developing these technologies today. In the case of marine vessels, FCEV and BEV models are already in service as demonstration projects. It seems at the very least possible that these technologies could help address shipping sector emissions within the next 20 to 30 years. Aviation innovation may be on a longer track, but that is different from saying that these technologies are not an option in the long run for aviation. This conclusion needs to be revised or the level of confidence reduced, likely both.	Government of United States of America	United States of America	Thank you for your comment. This paragraph has been revised	
54457	61	9	61	24	Recommend separating the discussions of hydrogen and batteries from the discussion of biofuels rather than discussing both in one paragraph. These are distinct topics with different bodies of literature. They should be addressed in separate statements.	Government of United States of America	United States of America	Thank you for your comment. Section has been revised	
77297	61	9	61	24	Coherently with comment 64, it could be worth mentioning the option for nuclear propulsion in shipping.	Giacomo Grasso	Italy	Thank you for your comment. Section has been revised	
46859	61	11			No evidence is presented to back the claim that phasing out ICEVs is best solution for light-duty vehicles in all circumstances, regardless of the role of biofuels in substituting fossil fuels. This statement should be revised with caution and references	Government of Germany	Germany	Thank you for your comment. This paragraph has been deleted	
84743	61	13	61	14	Would it be possible to explain why the statement on biofuels is associated with "low agreement"?	Kaisa Kosonen	Finland	Thank you for your comment. Section revised completely	
47989	61	13	61	14	Biofuels for aviation present a much higher technology readiness level and cost-effectiveness than synthetic/e-fuels and hydrogen, and this should be clarified in this extract. Moreover, the sustainability impacts of biofuels are – as correctly recognized throughout the SOD – complex and context-specific, therefore it is incorrect to simply assume that biofuels used for aviation are by definition constrained. ICAO has developed extensive work on that within the context of CORSIA, including in the life cycle assessment of different aviation biofuels production pathways. Approved values in the published documentation results from extensive peer reviewed work (cf. https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx). The following alternative wording is suggested: "[...] Biofuels is currently the solution that presents the higher technology readiness level and cost-effectiveness, but, as shown in Chapter 2, 6, 7 and 12, there are multiple issues that should be addressed to ensure that production is sustainable."	Marcelo moreira	Brazil	Thank you for your comment. Section has been revised	
50909	61	13	61	14	Biofuels for aviation present a much higher technology readiness level and cost-effectiveness than synthetic/e-fuels and hydrogen, and this should be clarified in this extract. Moreover, the sustainability impacts of biofuels are – as correctly recognized throughout the SOD – complex and context-specific, therefore it is incorrect to simply assume that biofuels used for aviation are by definition constrained. ICAO has developed extensive work on that within the context of CORSIA, including in the life cycle assessment of different aviation biofuels production pathways. Approved values in the published documentation results from extensive peer reviewed work (cf. https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx). The following alternative wording is suggested: "[...] Biofuels is currently the solution that presents the higher technology readiness level and cost-effectiveness, but, as shown in Chapter 2, 6, 7 and 12, there are multiple issues that should be addressed to ensure that production is sustainable."	Government of Brazil	Brazil	Thank you for your comment. Section has been revised	
69987	61	14	61	16	I would say e-fuels... provide low-carbon jet fuels (and even near zero-carbon fuels if the carbon is taken out from the air or from biomass).	Cédric PHILIBERT	France	Thank you for your comment. Section has been revised	
31015	61	16	60	17	Generally it is said that synthetic fuels or e-fuels cannot reduce contrails-based climate impacts as they emit water vapor. It is necessary to refer to the evidence if this is correct.	Government of Japan	Japan	Thank you for your comment. This paragraph has been revised	
51597	61	16	61	17	"These fuels may also reduce contrails-based climate impacts and lower local noxious air pollutants." This statement is not supported for aviation by 10.5.3.3 (Page 10-64, lines 12-17)	eric lombard	France	Accepted-line deleted	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
46861	61	17	61	18	<p>Please consider that the technology is already on its entry into market, driven by e.g. national regulations like in Germany, fuel purchasers for aviation to provide for a minimum share of 0,5%, beginning in 2026. Some major production sites in Europe are already under construction, e.g. in Norway and Germany.</p> <p>References: Sunfire (2020, June 09): Norsk e-fuel is planning Europe's first commercial plant for hydrogen-based renewable aviation fuel in Norway. & Interatec. (n.d.). Industrial power-to-liquid pioneer plant 2022 in Germany "https://www.sunfire.de/en/news/detail/norsk-e-fuel-is-planning-europes-first-commercial-plant-for-hydrogen-based-renewable-aviation-fuel-in-norway" and "https://interatec.de/power-to-liquid-pionieranlage-2022-in-deutschland/"</p>	Government of Germany	Germany	Thank you for your comment. Section has been revised
74037	61	17	61	20	<p>This statement is not accurate concerning the readiness level of e-fuels. Several projects are close to commercialisation and the field is growing extremely fast. The chances for these CO2-based fuels to succeed will strongly depend on their compatibility with existing technology and infrastructure, with the growth and price of renewable energy and with the development of appropriate policy and market incentives. Despite these challenges, most of the boundary conditions (fuel composition, price, feedstock) for near- and medium-term deployment of CO2-based fuels are clear; now, it is a matter of finding the most economical route towards the synthesis of these fuels. Moreover, it is important to note that CO2-based fuels are drop-in alternatives, but it is erroneous to write that Hydrogen and its derivatives are drop-in fuels, because in most of the cases, massive changes in the distribution and transport infrastructure are required to allow for the distribution and use of such fuels. Grim et al., 2020, Energy & Environmental Science, 13(2), pp.472-494. Ramirez et al., 2020, Trends in Chemistry, 2-9, Pages 785-795.</p>	Ana Machado	Portugal	Accepted-line deleted
83773	61	17	61	20	<p>This statement is not reflecting the current literature and state-of-the art concerning the readiness level of e-fuels. Numerous projects are close to commercialisation and the field is growing extremely fast. The chances for these CO2-based fuels to succeed will strongly depend on their compatibility with existing technology and infrastructure, with the growth and price of renewable energy and with the development of appropriate policy and market incentives (Grim et al., 2020). Despite these challenges, most of the boundary conditions (fuel composition, price, feedstock) for near- and medium-term deployment of CO2-based fuels are clear; now, it is a matter of finding the most economical route towards the synthesis of these fuels. Also it is important to (Ramirez et al., 2020). Moreover, it is important to note that CO2-based fuels are drop-in alternatives, but it is erroneous to write that Hydrogen and its derivatives are drop-in fuels, because in most of the cases, massive changes in the distribution and transport infrastructure are required to allow for the distribution and use of such fuels. •Grim et al., 2020, Energy & Environmental Science, 13(2), pp.472-494. •Ramirez et al., 2020, Trends in Chemistry, 2-9, Pages 785-795.</p>	Christian Breyer	Finland	Accepted-paragraph revised substantially
66269	61	17	61	20	<p>This statement here does not reflect the most recent state-of-the art regarding the readiness level of e-fuels. Numerous projects are close to commercialisation and the field is growing extremely fast. The chances for these CO2-based fuels to succeed will strongly depend on their compatibility with existing technology and infrastructure, with the growth and price of renewable energy and with the development of appropriate policy and market incentives (Grim et al., 2020). Despite these challenges, most of the boundary conditions (fuel composition, price, feedstock) for near- and medium-term deployment of CO2-based fuels are clear; now, it is a matter of finding the most economical route towards the synthesis of these fuels, a topic which is being addressed in the Innovation Funds projects that will be launched soon. Moreover, it is important to note that CO2-based fuels are drop-in alternatives, but it is erroneous to write that Hydrogen and its derivatives are drop-in fuels, because in most of the cases, massive changes in the distribution and transport infrastructure are required to allow for the distribution and use of such fuels (Ramirez et al., 2020). •Grim et al., 2020, Energy & Environmental Science, 13(2), pp.472-494. •Ramirez et al., 2020, Trends in Chemistry, 2-9, Pages 785-795.</p>	Deepak PANT	Belgium	Accepted-paragraph revised substantially

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
78559	61	17	61	20	This statement is not reflecting the current literature and state-of-the art concerning the technology readiness level of e-fuels. Numerous projects are close to commercialisation and the field is growing extremely fast. (Grim et al., 2020). Moreover, it is important to note that CO2-based fuels are drop-in alternatives, but it is erroneous to write that Hydrogen and its derivatives are drop-in fuels, because in most of the cases, massive changes in the distribution and transport infrastructure are required to allow for the distribution and use of such fuels. <i>Grim et al., 2020, Energy & Environmental Science, 13(2), pp.472-494</i>	Sylvain Nizou	France	Accepted-paragraph revised substantially
60387	61	17	61	20	This statement is not reflecting the current literature and state-of-the art concerning the readiness level of e-fuels. Numerous projects are close to commercialisation and the field is growing extremely fast. The chances for these CO2-based fuels to succeed will strongly depend on their compatibility with existing technology and infrastructure, with the growth and price of renewable energy and with the development of appropriate policy and market incentives (Grim et al., 2020). Despite these challenges, most of the boundary conditions (fuel composition, price, feedstock) for near- and medium-term deployment of CO2-based fuels are clear; now, it is a matter of finding the most economical route towards the synthesis of these fuels. Also it is important to (Ramirez et al., 2020). Moreover, it is important to note that CO2-based fuels are drop-in alternatives, but it is erroneous to write that Hydrogen and its derivatives are drop-in fuels, because in most of the cases, massive changes in the distribution and transport infrastructure are required to allow for the distribution and use of such fuels. •Grim et al., 2020, Energy & Environmental Science, 13(2), pp.472-494. •Ramirez et al., 2020, Trends in Chemistry, 2-9, Pages 785-795.	Célia Sapart	Belgium	Accepted-paragraph revised substantially
46863	61	19	61	21	Please check recent developments regarding the use of ammonia in maritime motors, such as from Wärtsilä (Finland) (Wärtsilä Corporation. (2020, June 30). World's first full scale ammonia engine test - an important step towards carbon free shipping. Please see https://www.wartsila.com/media/news/30-06-2020-world-s-first-full-scale-ammonia-engine-test---an-important-step-towards-carbon-free-shipping-2737809 . Please include this information in the TS and the underlying report	Government of Germany	Germany	Noted. Thank you
69989	61	20	61	21	I would suppress "if the total cost can be reduced below biofuels and synthetic fuels/e-fuels", which tends to suggest that the latter are currently cheaper than the former, while they exist in very limited quantities (biofuels) or do not actually exist yet and are likely to cost significantly more than ammonia (synthetic fuels, where procurement of recycled carbon is likely to cost more than air separation to procure dinitrogen for ammonia synthesis)	Cédric PHILIBERT	France	Line has been deleted-paragraph revised
54459	61	22	61	24	It's unclear how automation of heavy-duty freight reduces the need for heavy-duty trucks; coupling automation with electrification of heavy-duty trucks (or passenger cars) is critical to avoid potential emission increases from higher VMT of automated transport. Automation of the heavy-duty fleet should be discussed under the heavy-duty section (lines 3- 8).	Government of United States of America	United States of America	Thank you for your comment. This paragraph has been revised
54461	61	26	61	28	This statement should be emphasized and perhaps brought into the SPM: "The integration between urban development, grid-based power and electromobility will require strategies that enable commercial outcomes to be derived. (robust evidence, high agreement) {10.3, 10.4}"	Government of United States of America	United States of America	Thank you for your comment. Noted
81495	61	36	61	36	What does mean 'ICT'?	Luana Ferreira	Brazil	Explanation added in P71L19
24481	61	36	61	36	We suggest to mention "home working" here and to remind the meaning of ICT (Information and Communication Technologies)	Government of France	France	Added in P71L19
31017	61	41	61	41	It would be better to delete the word "unnecessary", or at least modify to the words such as "avoidable", as travel is done with some sort of necessity.	Government of Japan	Japan	Word deleted
72243	61	41	61	45	While the statement is correct, the impact of pricing instruments are determined by the level of the taxes or charge and by the transfer of revenues to public transportation. In addition, regulation can also ban some transport mode in cities or part of the city, for example banning private vehicles or vehicles based fossil fuels ICE.	bertoldi paolo	Italy	Noted-Paragraph revised completely

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
69991	61	41	61	45	Mandates to incorporate biofuels/e-fuels, presumably significantly costlier than kerosene, would in practice 1. engage the decarbonisation of fuel; 2. provide incentives for further energy efficiency improvements; and 3. slow the growth of aerial traffic, that is, make taxation of aviation transport or aviation fuels unnecessary.	Cédric PHILIBERT	France	Thank you for your comment. Noted
67447	61	41	61	45	While the statement is correct, the role of pricing instruments is related to the level of the tax or charge, to the transfer of revenues to public transport. In addition, regulation could also ban some transport mode in cities, for example private vehicles or vehicles based on fossil fuels.	Philippe Tulkens	Belgium	Noted-Paragraph revised completely
24483	61	43	61	44	About reduced demand. Section 10.8 also mentions "criteria of socio-cultural acceptability where such changes are generally difficult to achieve". It may be appropriate to mention it in this section 5.3.3. For example : "[with mixed results probably due to the dominance of time savings in deciding most travel behaviour] or to the impact on households' purchasing power. In the later case, complementary measures could be implemented to support most vulnerable households if appropriate.	Government of France	France	Thank you for your comment. Noted
9069	62	8	62	9	"quarter of the scenarios compatible with the 1.5°C target suggest transport sector emissions be reduced by 68% (25th percentile) or more by 2050." This is very important message, which is contrast with the top message. You can empathize this by the bold letters.	Shigeki KOBAYASHI	Japan	Thank you for your comment. Section has been revised
46865	62	10	62	12	Please add to the enumeration "e-fuels".	Government of Germany	Germany	Word deleted
77299	62	11			Add "nuclear" among the options.	Giacomo Grasso	Italy	Paragraph completely revised
69993	62	13	62	15	The most useful role of governments and other jurisdiction here might to set clear infrastructure objectives and ensure stakeholder coordination, i.e. facilitate the deployment of charging stations (and/or electric road systems) adapted to the various customers.	Cédric PHILIBERT	France	Thank you for your comment. Noted
69995	62	29	62	31	I would suggest distinguishing aviation, which requires real drop-in fuels, and shipping, which can accommodate "near drop-in fuels" such as ammonnia.	Cédric PHILIBERT	France	Paragraph no longer exists
51599	62	29	62	31	"Fuel efficiency and demand reductions are the only strategies being adopted by the aviation and shipping sectors in recent decades with minimal commitment to new technologies. The most likely way to make further decarbonization in aviation and shipping is with low-carbon drop-in fuels." This statement is wrong, at least for aviation. Demand reduction is not a strategy that has been adopted by aviation in the recent decades. On the contrary, the aviation industry has always been fighting demand reduction measures. And the most likely way to further decarbonize aviation, at least in the next 2 decades, is not low-carbon drop-in fuels. See 10-4 lines 27-30. Demand reduction will be required and will happen anyway when drop-in fuels are available because their price is much higher than fossil fuels.	eric lombard	France	Paragraph no longer exists
54463	62	29	62	36	The historical portion of this statement is largely correct. However, this has begun to change and it is not the case that aviation and shipping are only making investments in efficiency today. In both sectors, manufacturers are beginning to pursue R&D on electric-hybrid, hydrogen fuel cell electric, and battery electric technologies. See for example AirBus's recent announcement that it will research and develop hydrogen fuel cell aircraft.	Government of United States of America	United States of America	Thank you for your comment. Section has been revised
15187	62	35	62	36	The statement in the paragraph "Some literature suggests that the governance of the international transport systems should now be made part of the Paris Agreement." violates the principle of policy neutrality of the IPCC Assessment Report and is suggested to be deleted. The statement in this paragraph relates to the revision of the Paris Agreement, and from a policy-neutral perspective, TS should not prejudge the revision of the Paris Agreement as a political process of international climate governance.	Government of China	China	Statement deleted
28259	62	35	62	36	Delete "Some literature suggests that the governance of the international transport systems should now be made part of the Paris Agreement.", as this is an outstanding negotiation issue under the UNFCCC.	Eleni Kaditi	Austria	Statement deleted
54465	62	35	62	36	CORSIA isn't mentioned in this summary. It would be useful to mention that international aviation is already subject to ICAO CORSIA, which is an international, UN-governed carbon cap. IMO has made similar commitments although the carbon scheme has not yet been implemented.	Government of United States of America	United States of America	Noted
15419	63	1	63	1	What is abbreviated by 'ASI' in this figure?	Hiroaki Kondo	Japan	Accepted- added in figure legend

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
81497	63	1	63	1	Put 'ASI' in the first time the entire meaning appears in the text (page 61, line 26).	Luana Ferreira	Brazil	Accepted
80497	63		63		white on yellow not really legible	Moritz Riede	United Kingdom (of Great Britain and Northern Ireland)	Figure redrawn
24485	63		63		Figure TS.22 is relevant but its design should be significantly improved for avoiding a potential ambiguity: - the order of the 4 bullet points listed in each box might be interpreted as associated with the 4 levels (high, medium, market commerciality, low), which is not the case. - the meaning of "market commerciality" between "medium" and "low" is not clear. ASI should be expanded (Avoid-Shift-Improve).	Government of France	France	Figure redrawn
7431	64	1			This section would benefit from an extra paragraph on new buildings in developing and fast urbanizing settings. What is the current understanding in this area?	Debra Roberts	South Africa	The text has been substantially revised
66577	64	3	64	5	Clarify consistency with Fig SPM.4 eg. by: . These comprise direct emissions produced on-site (6%), indirect emissions from electricity and heat produced off-site (11%), along with emissions from the use of cement, steel, and from halocarbons produced by building systems and appliances ("Scope 3 emissions - not included in SPM.4"	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	The text has been substantially revised
72245	64	10	64	10	The increased to GHG in the building sector is not due to policies (unless there are badly designed policies), but to socio-economics drivers as well indicated in the section, therefore I suggest to delete policies.	bertoldi paolo	Italy	The text has been substantially revised
67449	64	10	64	10	The increased to GHG in the building sector is not only due to policies, but to socio-economics drivers as well indicated in the section, therefore I suggests to delete policies.	Philippe Tulkens	Belgium	The text has been substantially revised
50369	64	10	64	19	The role of energy efficiency of HVAC sytems such as split units especially in developing countries could be considered here.	Government of Iran	Iran	Noted - HVAC systems are addressed in the underlying chapter
50371	64	10	64	19	Also, another important factor could be the energy labeling of HVAC equipment which has not been considered as serious as it should be.	Government of Iran	Iran	Noted - HVAC systems are addressed in the underlying chapter
50373	64	10	64	19	Also, the life habits for a large number of people in some developing countries are such that the energy efficiency is not important at all (for this group). The situation gets worse when the energy price is regulated and people do not pay the actual price for gas and electricity.	Government of Iran	Iran	Noted
43463	64	10	64	19	The role of energy efficiency of HVAC sytems such as split units especially in developing countries could be considered here.	sadegh zeyaeyan	Iran	Noted - HVAC systems are addressed in the underlying chapter
50375	64	10	64	19	The role of regulated energy price and subsidies in GHG emissions is thought to be an important factor.	Government of Iran	Iran	Noted
43465	64	10	64	19	Also, another important factor could be the energy labeling of HVAC equipment which has not been considered as serious as it should be.	sadegh zeyaeyan	Iran	Noted - HVAC systems are addressed in the underlying chapter
43467	64	10	64	19	Also, the life habits for a large number of people in some developing countries are such that the energy efficiency is not important at all (for this group). The situation gets worse when the energy price is regulated and people do not pay the actual price for gas and electricity.	sadegh zeyaeyan	Iran	Noted
43469	64	10	64	19	The role of regulated energy price and subsidies in GHG emissions is thought to be an important factor.	sadegh zeyaeyan	Iran	Noted
66579	64	12			Any 2050?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted
66581	64	14			Occupancy?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	The text has been substantially revised
53185	64	16	64	16	Ch9: "and existing ones, especially in developed countries" -- This is true for both developing and developed nations.	Government of Saudi Arabia	Saudi Arabia	The text has been substantially revised
28261	64	20	65	7	The quantitative analysis builds exclusively on a single scenario. Some elaboration on this matter should be provided.	Eleni Kaditi	Austria	The text has been substantially revised
84745	64	39	64	40	If the distinctly low potential in South America is explained by the IAMs prioritising land-based mitigation, then please explain it. 50 % as a potential by 2050 seems very low.	Kaisa Kosonen	Finland	The text has been substantially revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66583	64	41			explain	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Section has been revised
11387	64	45	64	47	The source of the statement "If only today's stated policies are implemented, CO2 emissions from the building use phase that would be locked in buildings by 2050 would reach 9.3 GtCO2 yr-1" cannot be found in the main text (Ch.9). Please check.	SAI MING LEE	China	The text has been substantially revised
81499	65	3	65	3	I didn't find gray bar in the chart, only in the description of the figure TS.23.	Luana Ferreira	Brazil	Thank you for your comment. This figure has been deleted
15421	65	3	65	4	The order of colors in the legend at right side should be taken as the same order of the cumulative bar chart at left side.	Hiroaki Kondo	Japan	Thank you for your comment. This figure has been deleted
50033	65	3	65	6	The order of color labels in the legend doesn't make sense to me. Also, there is no IP in Chapter 3 based on IEA scenarios, and the wording should be corrected.	Masahiro Sugiyama	Japan	Thank you for your comment. This figure has been deleted
66585	65	4			"Illustrative pathways" an unfortunate term ...	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	This figure has been deleted
84747	65	8	67	47	This whole concept of sufficiency, would merit to be better explained in the SPM, due to its novelty and relevance.	Kaisa Kosonen	Finland	Noted
66587	65	24			Missing word ... but this sounds a generous use of word "widespread". How much of building stock, or new build? Hard to equate with TS.23 Current policies>?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	The text has been substantially revised
80499	65	31	65	31	Maybe add what it means to be below 0 USD tCO2-1 (saving CO2 makes/saves money...?)	Moritz Riede	United Kingdom (of Great Britain and Northern Ireland)	The text has been substantially revised
24487	65		65		The order of the colors in both the graph and the legend are not in accordance	Government of France	France	Thank you for your comment. This figure has been deleted
11389	66	3	66	3	The figures "20-50 USD tCO2-1" are different from those presented in the main text (0-20 USD/tCO2, Ch.9, P.53, line 42-43). Please check and revise as appropriate.	SAI MING LEE	China	The text has been substantially revised
7433	66	6			Another problem is very high occupancy/density and inability to isolate, in low-cost and informal housing.	Debra Roberts	South Africa	The text has been substantially revised
69997	66	6	66	14	I would mention here the need of cold storage (in chilled water or icing/de-icing) to make the energy demand from cooling match even better the production of PV power and facilitates the integration of higher shares of PV.	Cédric PHILIBERT	France	The text has been substantially revised
7435	66	18	66	27	This is very optimistic paragraph. Some statistics on number of people currently with inadequate housing and some discussion on how this can be rectified, providing decent living standards and "guarantee wellbeing for all" as per next paragraph, with climate change in mind, would be useful. Maybe this goes beyond the IPCC mandate, but is there literature on this problem?	Debra Roberts	South Africa	Noted
15423	66	28	66	28	At the description of SDG 3 at left side: 22300 DALYs of avoided asthma-->22300 DALYs of avoided asthma	Hiroaki Kondo	Japan	Explanation of DALYs added as note in the figure
81501	66	28	66	28	Suggestion, not mandatory:changing the red color in the figure TS.24 by other smoother, e.g. blue	Luana Ferreira	Brazil	thank you.
50035	66	28	66	30	Figure TS24 lack the uncertainty information (e.g., health impacts).	Masahiro Sugiyama	Japan	Thank you for your comment. Noted
78541	66	29	66	29	Contribution of building sector on SDGs is presented well. Contribution of nuclear sector should be presented in the sam manner. See this reference: https://www.iaea.org/about/overview/sustainable-development-goals	Tomaž Žagar	Slovenia	Noted. This not addressed in the TS due to space constraint
86267	66		66		Figure TS 24: Is 90% of time spent indoor really representative for the world population, isn't it only in cities and/or at mid-high latitudes?	Sophie Szopa	France	Thank you for your comment. Range provided in the figure and explanation in the text
44095	67	1	67	14	I strongly support this summary except that there needs to be reassurance of water-security to serve nature-based solutions. This sufficiency can be served in the course of replacing thermal electricity generation with off-site wind farms and building-integrated PV. In short, I suggest that you add that building design should consider the local circumstances of the Energy-Water Nexus.	Eric Peterson	United Kingdom (of Great Britain and Northern Ireland)	The text has been substantially revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
46867	67	9	67	11	Based on the IUCN definition it is unclear if green roofs qualify as nature-based solutions. The formulation of the sentence may give the false impression that white walls are considered Nature-based solution. Please revise to prevent this impression.	Government of Germany	Germany	The text has been substantially revised	
72247	67	15	67	24	Another very important hindering element to GHG reductions in the building sector is the rebound effect. It is important to clearly indicate that policies must consider the rebound effect and be designed in a way to minimise its impact.	bertoldi paolo	Italy	Noted. The rebound effect concept address in section TS 6.5	
67451	67	15	67	24	Another very important hindering element to GHG reductions in the building sector is the rebound effect. It is important to clearly indicate that policies must consider the rebound effect and be designed in a way to minimise the impact.	Philippe Tulkens	Belgium	Noted. The rebound effect concept address in section TS 6.5	
66589	67	25			Does this relate to the ASI policy prioritisation framework of Chapter 5?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. The two concepts below to different strands of the literature	
72249	67	28	67	31	Most advanced building codes also require very low energy consumption per square meter (less than 10 kWh/m2 year) or net zero energy per square meter, including also existing buildings. In developed countries it is important to have policies forcing the deep renovation of existing buildings.	bertoldi paolo	Italy	The text has been substantially revised	
67453	67	28	67	31	Most advanced building codes also request very low energy consumption per square meter (less than 10 kWh/m2 year) or net zero energy per square meter, covering also existing buildings. In developed countries it is important to have policies forcing the deep renovation of existing buildings.	Philippe Tulkens	Belgium	The text has been substantially revised	
50037	67	37	67	38	"of a paramount" should be "of paramount importance."	Masahiro Sugiyama	Japan	The text has been substantially revised	
72251	67	37	67	47	It is also important to mention the policies needed for increasing the renewable energies in the building sector, for example feed-in tariffs and the new role of end-users, from energy consumers to prosumers, able to produce RES, store energy and be flexible.	bertoldi paolo	Italy	These topics are covered in other section in the TS	
67455	67	37	67	47	If space allows it is also important to mention the policies needed for renewable energies in the building sector, for example feed-in tariffs and the new role of end-users, from energy consumers to prosumers, able to produce RES, store energy and be flexible.	Philippe Tulkens	Belgium	These topics are covered in other section in the TS	
53187	67	42	67	42	Ch9: remove extra ""	Government of Saudi Arabia	Saudi Arabia	Noted. Section has been revised	
85269	67		67		There is a potential to be more accurate in the assessment of implications of the increased cooling demand due to increased extreme heat in a warming climate, building on information from WGI and available literature.	Valérie Masson-Delmotte	France	Noted	
66591	68	1			Excellent and informative section (not the only one of course..!). But I wonder, perhaps more than others, how well integrated is it with both other relevant sectors (urbanisation materials?) and the Chapters 3 and 4 scenarios?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted	
54467	68	2	68	7	This paragraph overlooks the impacts of other climate-induced effects such as storm, wildfire, and infrastructure disruptions that are driving industrial firms to engage on climate change.	Government of United States of America	United States of America	text removed from final TS	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
74039	68	8	68	13	CO2-based fuels/ e-fuels should be added in line 11. Unlike other options, CCU technologies provide drop-in solutions which can be implemented without requiring significant modification of existing production, distribution and use infrastructure. Another important asset of CCU technologies is the utilisation of CO2 as carbon feedstock to replace fossil resources and support the development of a circular economy, e.g. when CO2 is used together with industrial wastes to create materials. CCU technologies have the potential to provide solutions to hard-to-abate sectors, but also to generate revenues through producing marketable products. (Zhu, 2019, Clean Energy, Vol. 3, No. 2, 85–100; Sternberg et al., 2017, Green Chemistry, 9; Ampelli et al., 2015, Phil.Trans.R.Soc.A, 373; Daggash et al., 2018, Sustainable Energy Fuels, 2, 1153-1169; Kätelhön et al., 2019: Climate change mitigation potential of carbon capture and utilization in the chemical industry, PNAS, 116, 23, 11187-11194; Hepburn et al., 2019, Nature, 575, 87-97; Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93; Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496;Thonemann, 2019, Applied Energy, 263, 114599.	Ana Machado	Portugal	Noted. Section has been revised	
83777	68	8	68	13	On line 11, CO2-based fuels/ e-fuels should be added. Also on line 13, the term CCU is introduced as an extra option, but in fact CCU combines most the solution cited above.Unlike other options, CCU technologies provide drop-in solutions which can be implemented without requiring significant modification of existing production, distribution and use infrastructure (e.g. Ampelli et al., 2015, Hepburn et al., 2019). Another important asset of CCU technologies is the utilisation of CO2 as carbon feedstock to replace fossil resources (e.g. Sternberg et al., 2017, Daggash et al., 2018, Kätelhön, et al., 2019, Thonemann, 2019) and support the development of a circular economy, e.g. when CO2 is used together with industrial wastes to create materials (e.g. Di Maria et al., 2020, Ostavari et al., 2020). CCU technologies have the potential to provide solutions to hard-to-abate sectors, but also to generate revenues through producing marketable products (e.g. Hepburn et al., 2019, Zhu, 2019).•Zhu, 2019, Clean Energy, Vol. 3, No. 2, 85–100.•Sternberg et al., 2017, Green Chemistry, 9.•Ampelli et al., 2015, Phil.Trans.R.Soc.A, 373.•Daggash et al., 2018, Sustainable Energy Fuels, 2, 1153-1169.•Kätelhön et al., 2019: Climate change mitigation potential of carbon capture and utilization in the chemical industry, PNAS, 116, 23, 11187-11194.•Hepburn et al., 2019, Nature, 575, 87-97.•Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93.•Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496.•Thonemann, 2019, Applied Energy, 263, 114599	Christian Breyer	Finland	Noted. Section has been revised	
66263	68	8	68	13	Here in line 11, CO2-based fuels/ e-fuels needs to be added. Also on line 13, the term CCU is introduced as an extra option, but in fact CCU combines most the solution cited above. Unlike other options, CCU technologies provide drop-in solutions which can be implemented without requiring significant modification of existing production, distribution and use infrastructure (e.g. Ampelli et al., 2015, Hepburn et al., 2019). Another important asset of CCU technologies is the utilisation of CO2 as carbon feedstock to replace fossil resources (e.g. Sternberg et al., 2017, Daggash et al., 2018, Kätelhön, et al., 2019, Thonemann, 2019) and support the development of a circular economy, e.g. when CO2 is used together with industrial wastes to create materials (e.g. Di Maria et al., 2020, Ostavari et al., 2020). CCU technologies have the potential to provide solutions to hard-to-abate sectors, but also to generate revenues through producing marketable products (e.g. Elmekawy et al., 2016, Hepburn et al., 2019, Zhu, 2019).•Elmekawy, 2016, Bioresource technology, 215, pp.357-370• Zhu, 2019, Clean Energy, Vol. 3, No. 2, 85–100.•Sternberg et al., 2017, Green Chemistry, 9.•Ampelli et al., 2015, Phil.Trans.R.Soc.A, 373.•Daggash et al., 2018, Sustainable Energy Fuels, 2, 1153-1169.•Kätelhön et al., 2019: Climate change mitigation potential of carbon capture and utilization in the chemical industry, PNAS, 116, 23, 11187-11194.• Hepburn et al., 2019, Nature, 575, 87-97.•Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93.•Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496.•Thonemann, 2019, Applied Energy, 263, 114599	Deepak PANT	Belgium	Noted. Section has been revised	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66273	68	8	68	13	Here in line 11, CO2-based fuels/ e-fuels should be added. Also on line 13, the term CCU is introduced as an additional option, but in fact CCU combines most the solutions cited above. Unlike other options, CCU technologies can provide drop-in solutions which can be implemented without requiring significant modification of existing production, distribution and use infrastructure (e.g. Ampelli et al., 2015, Hepburn et al., 2019). Another important asset of CCU technologies is the utilisation of CO2 as carbon feedstock to replace fossil resources (e.g. Sternberg et al., 2017, Daggash et al., 2018, Kätelhön, et al., 2019, Thonemann, 2019) and support the development of a circular economy, e.g. when CO2 is used together with industrial wastes to create materials (e.g. Di Maria et al., 2020, Ostavari et al., 2020). CCU technologies have the potential to provide solutions to hard-to-abate sectors, but also to generate revenues through producing marketable products (e.g. Hepburn et al., 2019, Zhu, 2019).•Zhu, 2019, Clean Energy, Vol. 3, No. 2, 85–100.•Sternberg et al., 2017, Green Chemistry, 9. •Ampelli et al., 2015, Phil.Trans.R.Soc.A, 373. •Daggash et al., 2018, Sustainable Energy Fuels, 2, 1153-1169. •Kätelhön et al., 2019: Climate change mitigation potential of carbon capture and utilization in the chemical industry, PNAS, 116, 23, 11187-11194. •Hepburn et al., 2019, Nature, 575, 87-97. •Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93. •Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496. •Thonemann, 2019, Applied Energy, 263, 114599	Deepak PANT	Belgium	Noted. Section has been revised
60391	68	8	68	13	On line 11, CO2-based fuels/ e-fuels should be added. Also on line 13, the term CCU is introduced as an extra option, but in fact CCU combines most the solution cited above. Unlike other options, CCU technologies provide drop-in solutions which can be implemented without requiring significant modification of existing production, distribution and use infrastructure (e.g. Ampelli et al., 2015, Hepburn et al., 2019). Another important asset of CCU technologies is the utilisation of CO2 as carbon feedstock to replace fossil resources (e.g. Sternberg et al., 2017, Daggash et al., 2018, Kätelhön, et al., 2019, Thonemann, 2019) and support the development of a circular economy, e.g. when CO2 is used together with industrial wastes to create materials (e.g. Di Maria et al., 2020, Ostavari et al., 2020). CCU technologies have the potential to provide solutions to hard-to-abate sectors, but also to generate revenues through producing marketable products (e.g. Hepburn et al., 2019, Zhu, 2019). •Zhu, 2019, Clean Energy, Vol. 3, No. 2, 85–100. •Sternberg et al., 2017, Green Chemistry, 9. •Ampelli et al., 2015, Phil.Trans.R.Soc.A, 373. •Daggash et al., 2018, Sustainable Energy Fuels, 2, 1153-1169. •Kätelhön et al., 2019: Climate change mitigation potential of carbon capture and utilization in the chemical industry, PNAS, 116, 23, 11187-11194. •Hepburn et al., 2019, Nature, 575, 87-97. •Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93. •Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496. •Thonemann, 2019, Applied Energy, 263, 114599	Célia Sapart	Belgium	Noted. Section has been revised
54469	68	8	68	18	These paragraphs lay out many of the key technology pathways, but overlook the interconnectedness within the sector, reflected by complex supply chains and the need for optimization of these supply chains with a focus on industrial decarbonization. This may not be the same as minimizing energy.	Government of United States of America	United States of America	Accepted - systems integration emphasised in final TS
65583	68	16	68	18	Is sea level rise important/relevant only to industry? What about coastal management and development, local and native communities, food security? Elaborate.	Mônica M. C. Muelbert	Brazil	text removed from final TS
67457	68	20	68	21	This sentence claims emissions from industry have grown faster than any other sector. Meanwhile, page 60, lines 41-42 claim that HDVs have become the fastest growing source of GHG globally. There is a need to check the TS and SPM to make sure that superlatives such as these are consistent with each other.	Philippe Tulkens	Belgium	checked
54471	68	24	68	26	Provide the share of industrial GHG emissions if indirect emissions from power and heat generation are included. The SPM (page 9, lines 30-33) says 33%.	Government of United States of America	United States of America	accepted - text revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
2413	68	27	68	37	"The transition to net-zero emissions in industry may take longer" : would prefer "Net-zero emissions in industry will not be achieved by midcentury unless there is a dramatic ratcheting upward to transformational development and deployment programs, climate policies, and inter-institutional coordination."	Max Wei	United States of America	text removed from final TS	
54473	68	30	68	31	Too much is made of technology lock-in as a barrier. Industry has the ability to rapidly shift capital stock when the market demands it. The challenge is managing the transition and dealing with the stranded asset challenges which are policy not technology challenges.	Government of United States of America	United States of America	Noted. Section has been revised	
2415	68	35	68	37	I'm not sure of the definition of manufactured capital in the context of material stocks. One definition online is "Manufactured Capital comprises material goods or fixed assets which contribute to the production process rather than being the output itself – e.g. tools, machines and buildings", but the usage in this paragraph is ambiguous.	Max Wei	United States of America	noted - discussed further in underlying chapter	
11391	68	39	68	40	The period "2000–2017" is different from what is presented in the main text (Ch.11, P.13, line 18). Please check and revise as appropriate.	SAI MING LEE	China	Accepted - and revised	
54475	68	45	69	2	Also need to look at supply chain visibility and optimization afforded by IIoT/Industry 4.0/Smart Manufacturing. An individual technology focus is not sufficient for sector decarbonization.	Government of United States of America	United States of America	text removed from final TS	
54477	69	4	69	12	This paragraph again takes a technology focus and misses the complementarity required of system optimization.	Government of United States of America	United States of America	Accepted. Systems aspects addressed elsewhere in the TS	
2417	69	4	69	6	Repeat from comment #16 above: "Industrial decarbonisation is possible on the mid-century horizon": This is NOT supported by historical data, current trends, current policies, or current technology status. If this super optimistic language is used then it must be coupled with super strong clarification of how this would be possible: massive scale up of development and deployment, massive scale up in industrial/government/academia partnership and coordination, industrial policies at a scale not seen in 80 years, essentially war-time like mobilization for a couple of decades.	Max Wei	United States of America	accepted - this is a medium confidence statement	
54479	69	6	69	8	Suggest re-wording: "It requires continued improvements that reduce energy demand (e.g., energy efficiency) coupled with transformational changes ..."	Government of United States of America	United States of America	accepted - text revised	
74041	69	13	69	21	Carbon Capture and Utilisation is a typical climate mitigation option that is underrepresented in climate change scenario modelling and IAM's so they should be also cited in line 13 together with materials efficiency, circular material flows etc. Today there is no accurate quantification on the climate mitigation potential of this large variety of technologies. They play however a central role as mitigation measures (GCI, 2016: Global Roadmap Study of CO2U Technologies, LUX Research & Global CO2 Initiative; Detz and Zwaan, 2019, Energy Policy, 133, 110938; IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency; Wilson et al., 2016: A strategic european research and innovation agenda for Smart CO2 Transformation in Europe; Smart CO2 Transformation (SCO2T) project 978-0-9572588-5-3; Grüber et al, 2018: A low energy demand scenario for meeting the 1.5 C target and sustainable development goals without negative emission technologies', Nature Energy, 3, 6; GCI, 2016: Global Roadmap Study of CO2U Technologies, LUX Research & Global CO2 Initiative.	Ana Machado	Portugal	revised text focusses on CCS, which is also addressed elsewhere in TS	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
83779	69	13	69	21	Carbon Capture and Utilisation is a typical climate mitigation option that is underrepresented in climate change scenario modelling and IAM's so they should be cited in line 13 together with materials efficiency, circular material flows, etc...Indeed, because of their lack of granularity, Integrated Assessment Models (IAM's) have yet failed in simulating the complexity of the different CCU options to realize net zero or negative CO2 emissions (e.g. Detz and Zwaan, 2019). Consequently, no exhaustive quantification exists today on the climate mitigation potential of this large panel of technologies. However, their key role should be considered as one building block in a portfolio of mitigation measures (e.g. Wilson et al., 2016, GCI, 2016, Grüber et al., 2018, IEAGHG, 2019b, Detz and Zwaan, 2019). •Detz and Zwaan, 2019, Energy Policy, 133, 110938. •IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency. •Wilson et al., 2016: A strategic european research and innovation agenda for Smart CO2 Transformation in Europe. Smart CO2 Transformation (SCO2T) project 978-0-9572588-5-3. •Grüber et al, 2018: A low energy demand scenario for meeting the 1.5 C target and sustainable development goals without negative emission technologies', Nature Energy, 3, 6. •GCI, 2016: Global Roadmap Study of CO2U Technologies, LUX Research & Global CO2 Initiative.	Christian Breyer	Finland	revised text focusses on CCS, which is also addressed elsewhere in TS
66275	69	13	69	21	CCU is one of the climate mitigation option that is less represented in climate change scenario modelling and Integrated Assessment Models (IAM's) so they should be cited in line 13 together with materials efficiency, circular material flows, etc...Indeed, because of their lack of granularity, IAM's have yet failed in simulating the complexity of the different CCU options to realize net zero or negative CO2 emissions (e.g. Detz and Zwaan, 2019). As a result, no exhaustive quantification exists today on the climate mitigation potential of this large panel of technologies. However, their key role should be considered as one building block in a portfolio of mitigation measures (e.g. Wilson et al., 2016, GCI, 2016, Grüber et al., 2018, IEAGHG, 2019b, Detz and Zwaan, 2019). •Detz and Zwaan, 2019, Energy Policy, 133, 110938. •IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency. •Wilson et al., 2016: A strategic european research and innovation agenda for Smart CO2 Transformation in Europe. Smart CO2 Transformation (SCO2T) project 978-0-9572588-5-3. •Grüber et al, 2018: A low energy demand scenario for meeting the 1.5 C target and sustainable development goals without negative emission technologies', Nature Energy, 3, 6. •GCI, 2016: Global Roadmap Study of CO2U Technologies, LUX Research & Global CO2 Initiative.	Deepak PANT	Belgium	revised text focusses on CCS, which is also addressed elsewhere in TS
60393	69	13	69	21	Carbon Capture and Utilisation is a typical climate mitigation option that is underrepresented in climate change scenario modelling and IAM's so they should be cited in line 13 together with materials efficiency, circular material flows, etc...Indeed, because of their lack of granularity, Integrated Assessment Models (IAM's) have yet failed in simulating the complexity of the different CCU options to realize net zero or negative CO2 emissions (e.g. Detz and Zwaan, 2019). Consequently, no exhaustive quantification exists today on the climate mitigation potential of this large panel of technologies. However, their key role should be considered as one building block in a portfolio of mitigation measures (e.g. Wilson et al., 2016, GCI, 2016, Grüber et al., 2018, IEAGHG, 2019b, Detz and Zwaan, 2019). •Detz and Zwaan, 2019, Energy Policy, 133, 110938. •IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency. •Wilson et al., 2016: A strategic european research and innovation agenda for Smart CO2 Transformation in Europe. Smart CO2 Transformation (SCO2T) project 978-0-9572588-5-3. •Grüber et al, 2018: A low energy demand scenario for meeting the 1.5 C target and sustainable development goals without negative emission technologies', Nature Energy, 3, 6. •GCI, 2016: Global Roadmap Study of CO2U Technologies, LUX Research & Global CO2 Initiative.	Célia Sapart	Belgium	revised text focusses on CCS, which is also addressed elsewhere in TS

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
54481	69	13	69	32	The modeling of energy efficiency needs to evolve from a static view to a dynamic, systems optimization frame. Energy efficiency and optimization can diminish the cost associated with a transition to electricity and low-carbon energy sources. On the renewable electricity topic, it is important to also explore onsite renewable assets for industrial facilities, not just the decarbonization of the grid.	Government of United States of America	United States of America	Noted - role of EE emphasised
2419	69	24	69	25	"Electrification is emerging as a key mitigation option for industry in general and both for primary and secondary basic material production": I'm not sure I agree with this a key takeaway for several reasons: in general it may be possible to achieve significant reductions on the material demand side; electrification may be too costly for some applications such as high temperature process heating; direct electrification using low cost wind and solar may not be practical if low cost electricity is only available for a few hours of the day unless super inexpensive storage is available; and green hydrogen (or synthetic fuels derived from it and some green source of CO ₂) is still very expensive. Perhaps reword to say, "electrification is a key mitigation option for industry for primary and secondary basic material production but is limited by the availability of low-cost zero-carbon electricity for both direct electrification and indirect electrification (hydrogen production)." Figure TS-25 seems to feature many pathways including CCUS.	Max Wei	United States of America	Noted - text is revised, but the point here is substantiated in the chapter
83797	69	27	69	27	CO ₂ -based/efuels should be cited there as low carbon options too.	Christian Breyer	Finland	Noted - addressed elsewhere in TS
66293	69	27	69	27	As low carbon options, CO ₂ -based/efuels should be cited there.	Deepak PANT	Belgium	Noted - addressed elsewhere in TS
60411	69	27	69	27	CO ₂ -based/efuels should be cited there as low carbon options too.	Célia Sapart	Belgium	Noted - addressed elsewhere in TS
83799	69	32	69	32	The role of power-to-x to store energy should be added there. CCU can foster the transition towards renewable energy via the power-to-X approach, i.e. with the production of synthetic fuels/e-fuels to store energy (e.g. Sternberg and Bardow, 2015, Ram et al., 2019, Breyer et al., 2015, 2019, Fasihi et al., 2017, 2019, Anwar et al., 2020). Breyer et al., 2015, Energy Procedia, 73, 182-189. •Dimitrou et al., 2015, Energy Environ. Sci, 8, 1775-1789. •Anwar et al., 2020, J. of Env. Manag., 260, 110059. •Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980. •Shih et al., 2018, Joule, 2, 1925-1949. •Sternberg and Bardow, 2015, Energy Environ. Sci. 8, 389-400.	Christian Breyer	Finland	Noted - role of storage addressed elsewhere in TS
78561	69	32	69	32	The role of power-to-x to store energy should be added there. CCU can foster the transition towards renewable energy via the power-to-X approach, i.e. with the production of synthetic fuels/e-fuels to store energy (e.g. Sternberg and Bardow, 2015, Ram et al., 2019, Breyer et al., 2015, 2019, Fasihi et al., 2017, 2019, Anwar et al., 2020). Breyer et al., 2015, Energy Procedia, 73, 182-189. • Dimitrou et al., 2015, Energy Environ. Sci, 8, 1775-1789. • Anwar et al., 2020, J. of Env. Manag., 260, 110059. • Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980. • Shih et al., 2018, Joule, 2, 1925-1949. • Sternberg and Bardow, 2015, Energy Environ. Sci. 8, 389-400.	Sylvain Nizou	France	Noted - role of storage addressed elsewhere in TS
66295	69	32	69	32	The role of power-to-x to store energy needs to added there. CCU can foster the transition towards renewable energy via the power-to-X approach, i.e. with the production of synthetic fuels/e-fuels to store energy (e.g. Sternberg and Bardow, 2015, Ram et al., 2019, Breyer et al., 2015, 2019, Fasihi et al., 2017, 2019, Anwar et al., 2020). Breyer et al., 2015, Energy Procedia, 73, 182-189. •Dimitrou et al., 2015, Energy Environ. Sci, 8, 1775-1789. • Anwar et al., 2020, J. of Env. Manag., 260, 110059. • Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980. • Shih et al., 2018, Joule, 2, 1925-1949. •Sternberg and Bardow, 2015, Energy Environ. Sci. 8, 389-400.	Deepak PANT	Belgium	Noted - role of storage addressed elsewhere in TS
60413	69	32	69	32	The role of power-to-x to store energy should be added there. CCU can foster the transition towards renewable energy via the power-to-X approach, i.e. with the production of synthetic fuels/e-fuels to store energy (e.g. Sternberg and Bardow, 2015, Ram et al., 2019, Breyer et al., 2015, 2019, Fasihi et al., 2017, 2019, Anwar et al., 2020). Breyer et al., 2015, Energy Procedia, 73, 182-189. •Dimitrou et al., 2015, Energy Environ. Sci, 8, 1775-1789. •Anwar et al., 2020, J. of Env. Manag., 260, 110059. •Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980. •Shih et al., 2018, Joule, 2, 1925-1949. •Sternberg and Bardow, 2015, Energy Environ. Sci. 8, 389-400.	Célia Sapart	Belgium	Noted - role of storage addressed elsewhere in TS

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
54483	70	1	70	12	This graphic is a little confusing, particularly the pie chart. The waterfall chart on the left also doesn't communicate clearly the key message, which is the end product cost for consumer barely changes but the cost change for primary material may increase largely for low carbon/zero emission materials or technologies.	Government of United States of America	United States of America	Thank you for your comment- the figure has been revised	
7437	70				Figure TS25 Avoid acronyms inside the figure, spell out the terms CIE1, EE etc. Currently it looks like Cost rise is negative (- 35 – 115%) which implies a saving? Not likely? If "Indirect" simply refers to energy input then suggest to just label it Energy, or even Electricity, which makes more sense for the reader. Without this "indirect" energy for aluminium smelting for instance, there is no aluminium. Does it really make sense to separate out the indirect emissions?	Debra Roberts	South Africa	Thank you for your comment- the figure has been revised	
74055	70		70		This figure is a typical case where it is not scientifically correct and incoherent to use CCUS. Here this term only discuss CCS and not CCU, so it should be replaced by CCS and another representation of CCU should be made. The difficulty is that CCU contributes to several solutions (e.g. fuel switch, alternative carbon feedstock, material substituent, circularity and energy storage). This should be revised. References: e.g. Styring et al., 2011, Carbon Capture and Utilization in the Green Economy. Centre for Low Carbon Futures, York; Ampelli et al. 2015 Phil. Trans. R. Soc. A 373: 20140177, GCI, 2016: Global Roadmap Study of CO2U Technologies, LUX Research & Global CO2 Initiative; Bushuyev et al., 2018, Joule, 2(5) pp.825-832; SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2; Hepburn et al., 2019, Nature, 575, 87-97; Breyer et al., 2019, Joule, 3, 2053-2057, Kätelhön et al., 2019: Climate change mitigation potential of carbon capture and utilization in the chemical industry,; CCES, 2019: Carbon Utilization – A vital and effective pathway for decarbonization, Center for Climate and Energy Solutions.	Ana Machado	Portugal	Thank you for your comment- the figure has been revised	
83801	70		70		This figure is a typical case where it is not scientifically correct and incoherent to use CCUS. Here this term only discuss CCS and not CCU, so it should be replaced by CCS and another representation of CCU should be made. The difficulty is that CCU contributes to several solutions I (e.g. fuel switch, alternative carbon feedstock, material substituent, circularity and energy storage). This should be revised. References: e.g. Styring et al., 2011, Ampelli et al., 2015, GCI, 2016, , Bushuyev et al., 2018, SAPEA, 2018, Hepburn et al., 2019, Breyer et al., 2019, Kätelhön et al., 2019, CCES 2019	Christian Breyer	Finland	Thank you for your comment- the figure has been revised	
78565	70		70		This figure is a typical case where it is not scientifically correct and incoherent to use CCUS. Here this term only discuss CCS and not CCU, so it should be replaced by CCS and another representation of CCU should be made. The difficulty is that CCU contributes to several solutions I (e.g. fuel switch, alternative carbon feedstock, material substituent, circularity and energy storage). This should be revised. References: e.g. Styring et al., 2011, Ampelli et al., 2015, GCI, 2016, , Bushuyev et al., 2018, SAPEA, 2018, Hepburn et al., 2019, Breyer et al., 2019, Kätelhön et al., 2019, CCES 2019	Sylvain Nizou	France	Thank you for your comment- the figure has been revised	
66297	70		70		The figure mentioned here is not scientifically correct and incoherent to use of CCUS. It only discuss CCS and not CCU, so it should be replaced by CCS and another representation of CCU should be made. The issue here is that CCU contributes to several solutions such as fuel switch, alternative carbon feedstock, material substituent, circularity and energy storage. This needs revision. References: e.g. Styring et al., 2011, Ampelli et al., 2015, GCI, 2016, , Bushuyev et al., 2018, SAPEA, 2018, Hepburn et al., 2019, Breyer et al., 2019, Kätelhön et al., 2019, CCES, 2019.	Deepak PANT	Belgium	Thank you for your comment- the figure has been revised	
60415	70		70		This figure is a typical case where it is not scientifically correct and incoherent to use CCUS. Here this term only discuss CCS and not CCU, so it should be replaced by CCS and another representation of CCU should be made. The difficulty is that CCU contributes to several solutions I (e.g. fuel switch, alternative carbon feedstock, material substituent, circularity and energy storage). This should be revised. References: e.g. Styring et al., 2011, Ampelli et al., 2015, GCI, 2016, , Bushuyev et al., 2018, SAPEA, 2018, Hepburn et al., 2019, Breyer et al., 2019, Kätelhön et al., 2019, CCES 2019	Célia Sapart	Belgium	Thank you for your comment- the figure has been revised	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
72253	71	15	71	24	There is still a large untapped energy efficiency potential in industry in particular in SMEs. Very often, this does not require large investments (e.g. energy management, energy audits) and often it is very cost-effective. e.g. efficiency improvements in motor systems.	bertoldi paolo	Italy	accepted - additional material on light industry included
67459	71	15	71	24	There is still a large untapped energy efficiency potential in industry in particular in SMEs. Very often this does not require large investments (e.g. energy management) and often it is cost-effective, e.g. variable speed drives.	Philippe Tulkens	Belgium	accepted - additional material on light industry included
74043	71	21	71	24	CO2-based fuels / e-fuels should be mentioned here with H2. CCU is one of the few option to decarbonise/deffossilise the steel-industry, but again it does not have the same role as CCS, because it allows creating valuable products. A typical example of this is the EU project INITIATE that aims to valorise the flue gas of the steel industry to create fertilisers. (https://www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-co2-neutral-industry/reducing-co2-emissions-through-capture-use-and-storage/reduce-emissions-steel-industry/). The CO2 to mineralisation path is a specifically interesting option to decarbonise/deffossilise the steel industry. Di Maria et al., 2020 conducted an LCA of carbonated steel slag including CO2 capture and confirm that mineralization is a negative-carbon-footprint technology, since the amount of CO2 taken up and stored during the process is higher than the amount of CO2 emitted, considering the whole life cycle. While comparing the findings to Portland cement concrete blocks, they report GHG emission reductions of up to 77%. At endpoint, they report that concerning the damages to human health and ecosystems, the carbonated blocks have a lower impact compared to the traditional PC-based concrete, and an overall positive environmental impact.	Ana Machado	Portugal	Noted, role of novel fuels, in combination with CCS addressed in several places in final TS
83781	71	21	71	24	CO2-based fuels / e-fuels should be added together with H2 in this sentence. CCU is one of the few option to decarbonise/deffossilise the steel-industry, but again it does not have the same role as CCS, because it allows to create valuable product using CO2 as a feedstock and CCU technologies are drop-in solutions to decrease net CO2 emissions rapidly and then to reach net-zero or even negative emissions when it comes to Direct Air Capture and mineralisation .One (amongst others) typical example of this is the project Carbon2Chem (Wich et al., 2020: https://www.frontiersin.org/articles/10.3389/fenrg.2019.00162/full) or the EU-funded project INITIATE that aims to valorise the flue gas of the steel industry to create fertilisers. (https://www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-co2-neutral-industry/reducing-co2-emissions-through-capture-use-and-storage/reduce-emissions-steel-industry/). Or the project Steelanol (http://www.steelanol.eu/en) that recycle carbon into sustainable bio-ethanol.The CO2 to mineralisation path is also an interesting option to decarbonise/deffossilise the steel industry (e.g.SAPEA 2018, Ramboll 2019,). Di Maria et al., 2020 conducted an LCA of carbonated steel slag including CO2 capture and confirm that mineralization is a negative-carbon-footprint technology, since the amount of CO2 taken up and stored during the process is higher than the amount of CO2 emitted, considering the whole life cycle. While comparing the findings to Portland cement concrete blocks, they report GHG emission reductions of up to 77%. At endpoint, they report that concerning the damages to human health and ecosystems, the carbonated blocks have a lower impact compared to the traditional PC-based concrete, and an overall positive environmental impact. •Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93. Ramboll, the Institute for Advanced Sustainability Studies, CESR– Center for Environmental Systems Research at the University of Kassel, CEDelft, and IOM Law January – 2019•SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2. Wich et al. 2020,	Christian Breyer	Finland	Noted, role of novel fuels, in combination with CCS addressed in several places in final TS

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66277	71	21	71	24	e-fuels (based on CO2) should be added together with hydrogen here. CCU is one of the few option to decarbonise/deffossilise the steel-industry, but again it does not have the same role as CCS, because it allows to create valuable product. A typical example of this is the recently started EU project INITIATE that aims to valorise the flue gas of the steel industry to create fertilizers. (https://www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-co2-neutral-industry/reducing-co2-emissions-through-capture-use-and-storage/reduce-emissions-steel-industry/)	Deepak PANT	Belgium	Noted, role of novel fuels, in combination with CCS addressed in several places in final TS
60395	71	21	71	24	CO2-based fuels / e-fuels should be added together with H2 in this sentence. CCU is one of the few option to decarbonise/deffossilise the steel-industry, but again it does not have the same role as CCS, because it allows to create valuable product using CO2 as a feedstock and CCU technologies are drop-in solutions to decrease net CO2 emissions rapidly and then to reach net-zero or even negative emissions when it comes to Direct Air Capture and mineralisation .One (amongst others) typical example of this is the project Carbon2Chem (Wich et al., 2020: https://www.frontiersin.org/articles/10.3389/fenrg.2019.00162/full) or the EU-funded project INITIATE that aims to valorise the flue gas of the steel industry to create fertilizers. (https://www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-co2-neutral-industry/reducing-co2-emissions-through-capture-use-and-storage/reduce-emissions-steel-industry/). Or the project Steelanol (http://www.steelanol.eu/en) that recycle carbon into sustainable bio-ethanol.The CO2 to mineralisation path is also an interesting option to decarbonise/deffossilise the steel industry (e.g.SAPEA 2018, Ramboll 2019.) . Di Maria et al., 2020 conducted an LCA of carbonated steel slag including CO2 capture and confirm that mineralization is a negative-carbon-footprint technology, since the amount of CO2 taken up and stored during the process is higher than the amount of CO2 emitted, considering the whole life cycle. While comparing the findings to Portland cement concrete blocks, they report GHG emission reductions of up to 77%. At endpoint, they report that concerning the damages to human health and ecosystems, the carbonated blocks have a lower impact compared to the traditional PC-based concrete, and an overall positive environmental impact. •Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93. Ramboll, the Institute for Advanced Sustainability Studies, CESR– Center for Environmental Systems Research at the University of Kassel, CEDelft, and IOM Law January – 2019•SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2. Wich et al. 2020,	Célia Sapart	Belgium	Noted, role of novel fuels, in combination with CCS addressed in several places in final TS
54485	71	25	71	28	It's not just education, but a set of policies needs to be implemented to create the demand pull. For instance, mandatory targets, codes or standards, procurement programs, incentives, labeling and disclosure. etc.	Government of United States of America	United States of America	Text substantially revised
74045	71	32	71	33	CO2-based fuels should be mentioned. CCU technologies can not only produce alternative fuels for the cement industry (typically e-CH4, see Project Jupiter 1000 in France where e-CH4 is already injected into the National Natural Gas Grid: https://www.jupiter1000.eu/). But CCU via CO2 mineralisation can also create renewable material produced with CO2 and industrial waste) decreasing the cement demand and thus the emissions of this sector. These technologies are already commercialised , e.g. Carbon8Systems (https://c8s.co.uk/), CarbonUpCycling (https://carbonupcycling.com/), MCi (https://www.mineralcarbonation.com/). Life Cycle Analysis have been performed and have shown that all considered CCU technologies for mineralization could reduce climate impacts over the entire life cycle based on the current state-of-the-art (especially for the cement and steel sectors) and today's energy mix. (e.g. Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496; Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93.)	Ana Machado	Portugal	Noted, role of novel fuels, in combination with CCS addressed in several places in final TS

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
83783	71	32	71	33	CO2-based fuels/e-fuels should be cited here as well. CCU technologies can not only produce alternative fuels for the cement industry (typically e-CH4, see Project Jupiter 1000 in France where e-CH4 is already injected into the National Natural Gas Grid: https://www.jupiter1000.eu/). But CCU via CO2 mineralisation can also create renewable material produced with CO2 and industrial waste) decreasing the cement demand and thus the emissions of this sector. These technologies are already commercialised , e.g. Carbon8Systems (https://c8s.co.uk/), CarbonUpCycling (https://carbonupcycling.com/), MCI (https://www.mineralcarbonation.com/). Life Cycle Analysis have been performed and have shown that all considered CCU technologies for mineralization could reduce climate impacts over the entire life cycle based on the current state-of-the-art (especially for the cement and steel sectors) and today's energy mix. (e.g.Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496., •Di Maria et al, 2020, International Journal of Greenhouse Gas Control 02)	Christian Breyer	Finland	Noted, role of novel fuels, in combination with CCS addressed in several places in final TS
66279	71	32	71	33	e-fuels (based on CO2) should be cited here as well. CCU technologies are able to produce alternative fuels for the cement industry (typically e-CH4, see Project Jupiter 1000 in France where e-CH4 is already injected into the National Natural Gas Grid: https://www.jupiter1000.eu/). But CCU via CO2 mineralisation can also create renewable material produced with CO2 and industrial waste) decreasing the cement demand and thus the emissions of this sector. These technologies are already commercialised , e.g. Carbon8Systems (https://c8s.co.uk/), CarbonUpCycling (https://carbonupcycling.com/), MCI (https://www.mineralcarbonation.com/). Life Cycle Analysis have been performed and have shown that all considered CCU technologies for mineralization could reduce climate impacts over the entire life cycle based on the current state-of-the-art (especially for the cement and steel sectors) and today's energy mix. (e.g. Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496., •Di Maria et al, 2020, International Journal of Greenhouse Gas Control 02)	Deepak PANT	Belgium	Noted, role of novel fuels, in combination with CCS addressed in several places in final TS
60397	71	32	71	33	CO2-based fuels/e-fuels should be cited here as well. CCU technologies can not only produce alternative fuels for the cement industry (typically e-CH4, see Project Jupiter 1000 in France where e-CH4 is already injected into the National Natural Gas Grid: https://www.jupiter1000.eu/). But CCU via CO2 mineralisation can also create renewable material produced with CO2 and industrial waste) decreasing the cement demand and thus the emissions of this sector. These technologies are already commercialised , e.g. Carbon8Systems (https://c8s.co.uk/), CarbonUpCycling (https://carbonupcycling.com/), MCI (https://www.mineralcarbonation.com/). Life Cycle Analysis have been performed and have shown that all considered CCU technologies for mineralization could reduce climate impacts over the entire life cycle based on the current state-of-the-art (especially for the cement and steel sectors) and today's energy mix. (e.g.Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496., •Di Maria et al, 2020, International Journal of Greenhouse Gas Control 02)	Célia Sapart	Belgium	Noted, role of novel fuels, in combination with CCS addressed in several places in final TS

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
72497	71	35	71	45	CCU should also be considered as a solution to deffossilise the chemical industry. Oil consumption and GHG emission could be reduced, as CO2 can be captured from point sources or from the air and used as alternative carbon feedstock for chemicals. Carbon capture and utilisation (CCU) has the technical potential to decouple chemical production from fossil resources, reducing annual GHG emissions by up to 3.5 Gt CO2-eq in 2030 (Katelön et al., 2019). The relevance of Carbon Dioxide Utilization (CCU) to Innovation and Sustainability of the Chemical Industry and to the strategy of the Circular Economy is a key factor. CO2 can be converted into added-value chemicals, polymeric materials, and fuels which have each a market higher than 1 Mt/y, causing a significant reduction of CO2 emission. (Kondratenko et al., 2013, Centi et al., 2013, Klankermayer et al., 2015, Cuéllar-Franca and Azapagic, 2015, Sternberg et al., 2017, Al-Mamoori et al., 2017, Adalco et al., 2019, Dibenedetto et al. 2020, Aresta et al 2020, Aresta et al, 2021). •Aldaco et al., 2019, Science of the Total Environment, 663, 738-753. •Al-Mamoori et al., 2017, Energy Technol (Weinheim) 5:834–849 •Centi et al., 2013, Energy Environ, Science, 6:1711. •Cuéllar-Franca and Azapagic, 2015, J.CO2.Utilii., 9, 82-102. •Kätelhön et al., 2019: Climate change mitigation potential of carbon capture and utilization in the chemical industry, PNAS, 116, 23, 11187-11194. •Sternberg et al., 2017, Green Chemistry, 9. •Nocito, F., & Dibenedetto, A. (2020). Atmospheric CO2 mitigation technologies: carbon capture utilization and storage. Current Opinion in Green and Sustainable Chemistry, 21, 34-43; •Aresta, M., & Dibenedetto, A. (2020). Carbon Recycling Through CO2-Conversion for Stepping Toward a Cyclic-C Economy. A Perspective. Frontiers in Energy Research, 8; •Dibenedetto, A., & Nocito, F. (2020). The Future of Carbon Dioxide Chemistry. ChemSusChem, 13(23), 6219-6228. •Aresta, M., & Dibenedetto, A. (2021). The CO2 Revolution. In The Carbon Dioxide Revolution (pp. 219-228).	Angela Dibenedetto	Italy	Noted, role of novel fuels, in combination with CCS addressed in several places in final TS
74047	71	35	71	45	CCU should also be cited as solution to deffossilise the chemical industry. To reduce oil consumption and resulting greenhouse gas emissions, CO2 can be captured from point sources or from the air and utilized as alternative carbon feedstock for chemicals. Carbon capture and utilisation (CCU) has the technical potential to decouple chemical production from fossil resources, reducing annual GHG emissions by up to 3.5 Gt CO2-eq in 2030. CCU technologies can substitute the conventional production of various chemicals including basic chemicals, fine chemicals, and polymers (Aldaco et al., 2019, Science of the Total Environment, 663, 738-753; Al-Mamoori et al., 2017, Energy Technol (Weinheim) 5:834–849; Centi et al., 2013, Energy Environ, Science, 6:1711; Cuéllar-Franca and Azapagic, 2015, J.CO2.Utilii., 9, 82-102; Kätelhön et al., 2019: Climate change mitigation potential of carbon capture and utilization in the chemical industry, PNAS, 116, 23, 11187-11194; Sternberg et al., 2017, Green Chemistry, 9.	Ana Machado	Portugal	Noted, role of novel fuels, in combination with CCS addressed in several places in final TS
83785	71	35	71	45	CCU should also be cited as solution to deffossilise the chemical industry. To reduce oil consumption and resulting greenhouse gas emissions, CO2 can be captured from point sources or from the air and utilized as alternative carbon feedstock for chemicals. Carbon capture and utilisation (CCU) has the technical potential to decouple chemical production from fossil resources, reducing annual GHG emissions by up to 3.5 Gt CO2-eq in 2030 (Katelön et al., 2019). CCU technologies can substitute the conventional production of various chemicals including basic chemicals, fine chemicals, and polymers (Kondratenko et al., 2013, Centi et al., 2013, Klankermayer et al., 2015, Cuéllar-Franca and Azapagic, 2015, Sternberg et al., 2017, Al-Mamoori et al., 2017, Adalco et al., 2019). •Aldaco et al., 2019, Science of the Total Environment, 663, 738-753. •Al-Mamoori et al., 2017, Energy Technol (Weinheim) 5:834–849 •Centi et al., 2013, Energy Environ, Science, 6:1711. •Cuéllar-Franca and Azapagic, 2015, J.CO2.Utilii., 9, 82-102. •Kätelhön et al., 2019: Climate change mitigation potential of carbon capture and utilization in the chemical industry, PNAS, 116, 23, 11187-11194. •Sternberg et al., 2017, Green Chemistry, 9.	Christian Breyer	Finland	Noted, role of novel fuels, in combination with CCS addressed in several places in final TS

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
54487	71	35	71	45	For hydrogen to be able to reduce GHG from chemical feedstock, it has to come from 100% renewable energy; otherwise, it will increase the GHG emissions. Also, energy/heat use in the chemical sector is highly integrated and optimized for system efficiency. The solution for the chemical sector should be holistic and cannot only address one product or system.	Government of United States of America	United States of America	Accepted - this point has been included	
66281	71	35	71	45	CCU should also be cited as a potential solution to defossilise the chemical industry. To reduce oil consumption and resulting GHGs emissions, CO2 can be captured from point sources or from the air and utilized as alternative carbon feedstock for chemicals. CCU has the technical potential to decouple chemical production from fossil resources, reducing annual GHG emissions by up to 3.5 Gt CO2-eq in 2030 (Katelön et al., 2019). CCU technologies can substitute the conventional production of various chemicals including basic chemicals, fine chemicals, and polymers (Kondratenko et al., 2013, Centi et al., 2013, Klankermayer et al., 2015, Cuéllar-Franca and Azapagic, 2015, Sternberg et al., 2017, Al-Mamoori et al., 2017, Adalco et al., 2019, Kondaveeti et al., 2020). •Aldaco et al., 2019, Science of the Total Environment, 663, 738-753. •Al-Mamoori et al., 2017, Energy Technol (Weinheim) 5:834–849 •Centi et al., 2013, Energy Environ, Science, 6:1711. •Cuéllar-Franca and Azapagic, 2015, J.CO2.Util., 9, 82-102. •Kätelhön et al., 2019: Climate change mitigation potential of carbon capture and utilization in the chemical industry, PNAS, 116, 23, 11187-11194. •Sternberg et al., 2017, Green Chemistry, 9. Kondaveeti et al., 2019, Frontiers in Energy Research, 8,94.	Deepak PANT	Belgium	Noted CCS and CCU integrated into several parts of the TS	
60399	71	35	71	45	CCU should also be cited as solution to defossilise the chemical industry. To reduce oil consumption and resulting greenhouse gas emissions, CO2 can be captured from point sources or from the air and utilized as alternative carbon feedstock for chemicals. Carbon capture and utilisation (CCU) has the technical potential to decouple chemical production from fossil resources, reducing annual GHG emissions by up to 3.5 Gt CO2-eq in 2030 (Katelön et al., 2019). CCU technologies can substitute the conventional production of various chemicals including basic chemicals, fine chemicals, and polymers (Kondratenko et al., 2013, Centi et al., 2013, Klankermayer et al., 2015, Cuéllar-Franca and Azapagic, 2015, Sternberg et al., 2017, Al-Mamoori et al., 2017, Adalco et al., 2019). •Aldaco et al., 2019, Science of the Total Environment, 663, 738-753. •Al-Mamoori et al., 2017, Energy Technol (Weinheim) 5:834–849 •Centi et al., 2013, Energy Environ, Science, 6:1711. •Cuéllar-Franca and Azapagic, 2015, J.CO2.Util., 9, 82-102. •Kätelhön et al., 2019: Climate change mitigation potential of carbon capture and utilization in the chemical industry, PNAS, 116, 23, 11187-11194. •Sternberg et al., 2017, Green Chemistry, 9.	Célia Sapart	Belgium	Noted CCS and CCU integrated into several parts of the TS	
7439	72	1	72	18	A question that arises here is whether it is possible to use fossil fuels as feedstock but not as energy, or are the two linked? If plastic is needed for other mitigation options, and emissions can be avoided through closing the carbon loop, then are fossil based feedstocks necessarily 'bad'?	Debra Roberts	South Africa	Noted - addressed further in chapter	
28997	72	7	72	9	Could mention biopolymers and CO2-based polymers from CCU as examples.	Jasmin Kemper	United Kingdom (of Great Britain and Northern Ireland)	Accepted - this is addressed in Chapt 11 section of TS	
29511	72	7	72	9	In chapter 11.4, Box 11.2 there is no reference to underlying research that can underpin this conclusion, please check and expand the referencing at the end of this para accordingly.	Government of Norway	Norway	accepted text revised	
84749	72	12	72	18	Assessing the mitigation potential of the pulp and paper industry without taking into account their wood sourcing and related impacts on sinks could give a distorted picture.	Kaisa Kosonen	Finland	accepted - addressed also in the AFOLU section	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
46869	72	12	72	18	<p>Please delete lines 12-18. Rationale: The statement is not based on the cited chapters content. Instead of bioenergy the authors propose "The pulp and paper industry is energy intensive but not a large direct emitter if it uses continued energy efficiency, fuel switching and electrification, including use of high temperature industrial heat pumps". Due to efficiency reasons low temperature heat demands should not be addressed with high temperature heat sources. Technologies for direct use from low to medium temperature heat sources should be used instead (e.g. geothermal), possibly in combination with heat pumps, thus serving as the requested "sufficient heat source". High temperature sources like bioenergy should not be used when sustainable alternatives are available, furthermore trade-offs for other uses of biogenic feedstock should be avoided as discussed in this and other chapters.</p> <p>German literature can be translated if needed:</p> <p>Günther, J., Lehmann, H., Nuss, P., Purr, K., 2019, Resource-Efficient Pathways towards Greenhouse-Gas- Neutrality – RESCUE: Summary Report, Umweltbundesamt, Dessau-Roßlau, Germany, November 2019. https://www.umweltbundesamt.de/themen/klima-energie/klimaschutz-energiepolitik-in-deutschland/szenarien-konzepte-fuer-die-klimaschutz/rescue-wege-in-eine-ressourcenschonende.</p> <p>Sandrock, M., Maaß, C., Weisleder, S., Westholm, H., Schulz, W., Löschan, G., Baisch, C., Kreuter, H., Reyer, D., Mangold, D., Riegger, M., Köhler, C., 2020, Kommunaler Klimaschutz durch Verbesserung der Effizienz in der Fernwärmeversorgung mittels Nutzung von Niedertemperaturwärmequellen am Beispiel tiefergeothermischer Ressourcen, Climate Change 31/2020. www.umweltbundesamt.de/publikationen/effiziente-fernwaermeversorgung-mit-niedertemperaturwaerme.</p> <p>„Entwicklung einer Dampferzeugung zur Papiertrocknung auf Basis geothermaler Wärme in Hagen/NRW". https://www.kabelpaper.de/kabel-zero/.</p>	Government of Germany	Germany	accepted - text revised
54489	72	19	72	22	<p>This statement is misleading, implying that their processes are easy to decarbonize. It is important to understand that while "light" manufacturing is not carbon-intensive, it is a consumer of carbon-intensive products, so it is important to look at supply-chain optimization to minimize the carbon in the products/materials they purchase and in the products they produce. For example, over 90% on the embodied carbon in an automobile comes from the supply chain, not from the final production processes.</p>	Government of United States of America	United States of America	Noted - addressed in part in revised TS and discussion of systemic aspects across the TS

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
74049	72	24	72	41	CCU should be mentioned here. The role of policies, regulations and of CO2 pricing should be included in this paragraph. An increase in price of emitted CO2, can decrease costs of CCU. In the current context where the environmental and social externalities of incumbent fossil based technologies are not fully integrated in market prices, the speed of the commercial deployment of innovative CCU solutions will largely depend on the development of a strong supportive policy framework, composed of regulations and market incentives. Broad policy and regulatory changes that may support the appropriate scale-up of CO2 utilization include creating carbon prices of around \$40 to \$80 per tonne of CO2, increasing over time, to penalize CO2 emissions and to incentivize verifiable CO2 emissions reductions and removals from the atmosphere. It is crucial to foster demand for and competitiveness of climate neutral, circular economy solutions through demand-side measures, but also to investigate and develop alternative or complementary options for carbon pricing mechanisms considering their impact on emissions, markets and investments at all levels. HLEG on EII, 2019: Masterplan for a Competitive Transformation of EU EII Enabling a Climate-neutral, Circular Economy by 2050, High Level Expert Group on Energy Intensive industries; IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency; Hepburn et al., 2019, Nature, 575, 87-97. • ICEF, 2017: Carbon dioxide Utilization Roadmap 2.0, Innovation and Cool Earth Forum (ICEF); SAM, 2018: Novel carbon capture and utilisation technologies, Scientific Advice Mechanism (SAM), Independent scientific advice for policy making; Zhang et al., 2020, Renewable and Sustainable Energy Reviews, 117, 109495.	Ana Machado	Portugal	CCS is discussed in a dedicated section of the TS
83787	72	24	72	41	CCU should also be discussed there. The role of policies, regulations and of CO2 pricing should be stated here. with an increase in price of emitted CO2, CCU can decrease costs. In the current context where the environmental and social externalities of incumbent fossil based technologies are not fully integrated in market prices, the speed of the commercial deployment of innovative CCU solutions will largely depend on the development of a strong supportive policy framework, composed of regulations and market incentives (e.g.ICEF, 2017, SAM, 2018, IEAGHG, 2019b, Zhang et al., 2020). Broad policy and regulatory changes that may support the appropriate scale-up of CO2 utilization include creating carbon prices of around \$40 to \$80 per tonne of CO2, increasing over time, to penalize CO2 emissions and to incentivize verifiable CO2 emissions reductions and removals from the atmosphere (Hepburn et al., 2019). It is crucial to foster demand for and competitiveness of climate neutral, circular economy solutions through demand-side measures, but also to investigate and develop alternative or complementary options for carbon pricing mechanisms considering their impact on emissions, markets and investments at all levels. (HLEG on EIE, 2019). •HLEG on EII, 2019: Masterplan for a Competitive Transformation of EU EII Enabling a Climate-neutral, Circular Economy by 2050, High Level Expert Group on Energy Intensive industries. •IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency. •Hepburn et al., 2019, Nature, 575, 87-97. •ICEF, 2017: Carbon dioxide Utilization Roadmap 2.0, Innovation and Cool Earth Forum (ICEF). •SAM, 2018: Novel carbon capture and utilisation technologies, Scientific Advice Mechanism (SAM), Independent scientific advice for policy making. •Zhang et al., 2020, Renewable and Sustainable Energy Reviews, 117,	Christian Breyer	Finland	CCU and CCS are treated in detail elsewhere in the TS

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66283	72	24	72	41	CCU need to be discussed there with the role of policies, regulations and of CO2 pricing being stated. With an increase in price of emitted CO2, CCU can decrease costs. In the current context where the environmental and social externalities of incumbent fossil based technologies are not fully integrated in market prices, the speed of the commercial deployment of innovative CCU solutions will largely depend on the development of a strong supportive policy framework, composed of regulations and market incentives (e.g.ICEF, 2017, SAM, 2018, IEAGHG, 2019b, Zhang et al., 2020). Broad policy and regulatory changes that may support the appropriate scale-up of CO2 utilization include creating carbon prices of around \$40 to \$80 per tonne of CO2, increasing over time, to penalize CO2 emissions and to incentivize verifiable CO2 emissions reductions and removals from the atmosphere (Hepburn et al., 2019). It is crucial to foster demand for and competitiveness of climate neutral, circular economy solutions through demand-side measures, but also to investigate and develop alternative or complementary options for carbon pricing mechanisms considering their impact on emissions, markets and investments at all levels. (HLEG on EIE, 2019). •HLEG on EII, 2019: Masterplan for a Competitive Transformation of EU EII Enabling a Climate-neutral, Circular Economy by 2050, High Level Expert Group on Energy Intensive industries. •IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency. •Hepburn et al., 2019, Nature, 575, 87-97. •ICEF, 2017: Carbon dioxide Utilization Roadmap 2.0, Innovation and Cool Earth Forum (ICEF). •SAM, 2018: Novel carbon capture and utilisation technologies, Scientific Advice Mechanism (SAM), Independent scientific advice for policy making. •Zhang et al., 2020, Renewable and Sustainable Energy Reviews, 117, 109495.	Deepak PANT	Belgium	CCS is discussed in a dedicated section of the TS
60401	72	24	72	41	CCU should also be discussed there. The role of policies, regulations and of CO2 pricing should be stated here. with an increase in price of emitted CO2, CCU can decrease costs. In the current context where the environmental and social externalities of incumbent fossil based technologies are not fully integrated in market prices, the speed of the commercial deployment of innovative CCU solutions will largely depend on the development of a strong supportive policy framework, composed of regulations and market incentives (e.g.ICEF, 2017, SAM, 2018, IEAGHG, 2019b, Zhang et al., 2020). Broad policy and regulatory changes that may support the appropriate scale-up of CO2 utilization include creating carbon prices of around \$40 to \$80 per tonne of CO2, increasing over time, to penalize CO2 emissions and to incentivize verifiable CO2 emissions reductions and removals from the atmosphere (Hepburn et al., 2019). It is crucial to foster demand for and competitiveness of climate neutral, circular economy solutions through demand-side measures, but also to investigate and develop alternative or complementary options for carbon pricing mechanisms considering their impact on emissions, markets and investments at all levels. (HLEG on EIE, 2019). •HLEG on EII, 2019: Masterplan for a Competitive Transformation of EU EII Enabling a Climate-neutral, Circular Economy by 2050, High Level Expert Group on Energy Intensive industries. •IEAGHG, 2019b: Exploring Clean Energy Pathways: the role of energy storage, International Energy Agency. •Hepburn et al., 2019, Nature, 575, 87-97. •ICEF, 2017: Carbon dioxide Utilization Roadmap 2.0, Innovation and Cool Earth Forum (ICEF). •SAM, 2018: Novel carbon capture and utilisation technologies, Scientific Advice Mechanism (SAM), Independent scientific advice for policy making. •Zhang et al., 2020, Renewable and Sustainable Energy Reviews, 117,	Célia Sapart	Belgium	CCS is discussed in a dedicated section of the TS
7441	72	24	73	20	Re: materials: if this detail is not mature enough for the TS, does the chapter contains information on new carbon technology such as https://onlinelibrary.wiley.com/doi/abs/10.1002/adsu.201900056 and https://www.sciencedirect.com/science/article/abs/pii/S2212982019304974?via%3Dihub ? Technology is constantly evolving, it would be useful to have a list in the chapter of new climate-friendly technologies to look out for. Especially since, as your write, "materials efficiency are not well understood from a policy perspective. These are options that are mostly neglected in for example low-carbon industry roadmaps although they may represent significant potential."	Debra Roberts	South Africa	Noted - text in final TS substantially redrafted

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
2421	72	29	72	31	"Technologies exist to take all sub-sectors to very low or zero emissions, but require 5–15 years of intensive innovation, commercialization and policy to ensure uptake." This is a big vague and probably much too optimistic. There is a timeframe for developing a technology from lab-scale to medium scale, demonstration and piloting and then commercialization. But time from commercialization to 10% uptake to 90% uptake can take 5-10 yrs to 30-40 years, respectively. (See the work of Gross, Energy Policy 123 (2018) 682–699 ; A. Grubler, among others for example)	Max Wei	United States of America	Noted - innovation processed are addressed in detail in chapter 16
15363	72	32	72	37	In this paragraph, it is statement that emission reduction activities lead to the increase of producers' costs and the amount transmitted to intermediate manufacturers and final consumers is very small, but this may be inaccurate. The supporting examples are rather one-sided, considering only the part that emission reduction leads to the increase of steel production costs has little impact on the final increase of automobile production costs, but may ignore the fact that emission reduction activities do not only occur in the production process of steel raw materials required for automobile production. It will involve the production process of various input products, including organic and inorganic chemical products, petrochemical products, machinery, energy and other automobile production. The cost increase ratio of emission reduction costs transmitted to final products through various supply chains may not as low as 1-2%. The reference is as follows: [1] Karstensen and Peters. Distributions of carbon pricing on extraction, combustion and consumption of fossil fuels in the global supply-chain. Environ. Res. Lett. 13 (2018) 014005. https://doi.org/10.1088/1748-9326/aa94a3 . [2] Liu et al. Supply chain carbon emission reductions and coordination when consumers have a strong preference for low-carbon products. Environmental Science and Pollution Research 2021. https://doi.org/10.1007/s11356-020-09608-0	LEI HUANG	China	accepted , examples given have been made more specific
11393	72	34	72	35	The source of the statement "it will likely cost 20–40% more for virgin green steel, 5–10% for steel parts, but will add below 1–2% on the price for a new car or a new house, based on higher costs for steel and cement respectively" cannot be identified in the main text (Ch.11). Please check.	SAI MING LEE	China	text removed from final TS
2423	72	41	72	41	"private "buyer's clubs" in the auto sector linked to green branding": this sound exclusive and maybe not something that should be highlighted if folks with lower income are excluded.	Max Wei	United States of America	text removed from final TS
83789	73	3	73	12	CCU should be mentioned there as it is highly interconnected with the presence of renewable energy. Next to Hydrogen, CCU can foster the transition towards renewable energy via the power-to-X approach, i.e. with the production of synthetic fuels/e-fuels based on CO2 and renewable hydrogen to store energy (e.g. Sternberg and Bardow, 2015, Ram et al., 2019, Breyer et al., 2015, 2019, Fasihi et al., 2017, 2019, Anwar et al., 2020).•Sternberg and Bardow, 2015, Energy Environ. Sci. 8, 389–400. •Ram et al., 2020 DENA/LUT University report, Powerfuels in Renewable Energy Word. •Breyer et al., 2015, Energy Procedia, 73, 182-189. •Breyer et al., 2019, Joule, 3, 2053-2057. •Anwar et al., 2020, J. of Env. Manag., 260, 110059. •Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980. •Fasihi et al., 2019, Journal of Cleaner Productions, 224, 957-980.	Christian Breyer	Finland	CCU and CCS are treated in detail elsewhere in the TS
74323	73	3	73	12	The paragraph should be modified to incorporate the contribution that nuclear power could make to green hydrogen production. https://www.fchea.org/in-transition/2020/5/11/using-nuclear-power-to-produce-green-hydrogen	Jeffrey Merrifield	United States of America	Noted- this section has been drafted but also seeks to make a broader point
54491	73	3	73	12	It may be important to note the growing potential for supply-chain disruptions that have emerged in recent years as a result of COVID-19 and political conflicts. While the locational elements mentioned here are important, it will also be important to consider supply-chain reliability as a driver, potentially beneficial to decarbonization.	Government of United States of America	United States of America	Noted - addressed in part in the covid box

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66285	73	3	73	12	CCU should be mentioned there as it is highly interconnected with the renewable energy. Besides Hydrogen, CCU can foster the transition towards renewable energy via the power-to-X approach, i.e. with the production of synthetic fuels/e-fuels based on CO2 and renewable hydrogen to store energy (e.g. Sternberg and Bardow, 2015, Ram et al., 2019, Breyer et al., 2015, 2019, Fasihi et al., 2017, 2019, Anwar et al., 2020).•Sternberg and Bardow, 2015, Energy Environ. Sci. 8, 389–400. •Ram et al., 2020 DENA/LUT University report, Powerfuels in Renewable Energy Word. •Breyer et al., 2015, Energy Procedia, 73, 182-189. •Breyer et al., 2019, Joule, 3, 2053-2057. •Anwar et al., 2020, J. of Env. Manag., 260, 110059. •Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980. •Fasihi et al., 2019, Journal of Cleaner Productions, 224, 957-980	Deepak PANT	Belgium	CCU and CCS are treated in detail elsewhere in the TS
60403	73	3	73	12	CCU should be mentionned there as it is highly interconnected with the presence of renewable energy. Next to Hydrogen, CCU can foster the transition towards renewable energy via the power-to-X approach, i.e. with the production of synthetic fuels/e-fuels based on CO2 and renewable hydrogen to store energy (e.g. Sternberg and Bardow, 2015, Ram et al., 2019, Breyer et al., 2015, 2019, Fasihi et al., 2017, 2019, Anwar et al., 2020).•Sternberg and Bardow, 2015, Energy Environ. Sci. 8, 389–400. •Ram et al., 2020 DENA/LUT University report, Powerfuels in Renewable Energy Word. •Breyer et al., 2015, Energy Procedia, 73, 182-189. •Breyer et al., 2019, Joule, 3, 2053-2057. •Anwar et al., 2020, J. of Env. Manag., 260, 110059. •Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980. •Fasihi et al., 2019, Journal of Cleaner Productions, 224, 957-980	Célia Sapart	Belgium	CCU and CCS are treated in detail elsewhere in the TS
54493	73	13	73	15	While globally industry has a lot of experience with energy efficiency, energy efficiency is evolving to have a greater focus on temporal and locational considerations, as well as a shift to a systems-focus that seeks to optimize across individual technologies and supply chains. It will be important for modelers to capture this evolving and expanding nature of this important pathway that will continue to play an important role in industrial decarbonization.	Government of United States of America	United States of America	Noted
54495	73	24			The final paragraph helpfully includes a broader perspective beyond technical solutions. For successful industrial sector mitigation, suggest expanding this discussion to include voluntary programs such as the Science Based Targets initiative (which has numerous industrial company value chain GHG reduction targets published on its website) and links with financial institutions seeking to align their investment and lending portfolios with net-zero and the Paris Agreement.	Government of United States of America	United States of America	Noted
2425	73	24	73	33	The shift from fossil fuel industry to zero carbon supply and decarbonized industry is a huge shift. I think some comment should be made on the oil and gas industry (\$3 trillion revenues in 2019 for oil and gas drilling sector alone) vis-à-vis: potential for re-use/ reconfiguring existing infrastructure; training/retraining large segments of the energy industry; transition pathways for key industrial feedstocks from oil refining industry; role for oil and gas expertise in some key technologies: CCS, hydrogen handling/distribution, chemical handling/distribution.	Max Wei	United States of America	Noted

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
24489	73	25	73	25	Please mention that the risk of carbon leakage can increase in the context of divergent climate ambition (especially in the recovery packages) and policies (such as carbon pricing initiatives). See OECD, Climate Policy Leadership in an Interconnected World: What Role for Border Carbon Adjustments?, December 2020. https://www.oecd-ilibrary.org/docserver/8008e7f4-en.pdf?expires=1614165322&id=id&acname=guest&checksum=94A0517A7014F7E2C814363F05EBE13B Kuusi, T., Björklund, M., Kaitila, V., Kokko, K., Lehmus, M., Mehling, M. & Wang, M. (2020). Carbon Border Adjustment Mechanisms and Their Economic Impact on Finland and the EU. Publication of the Finnish Government's analysis, assessment and research activities. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/162510/VNTEAS_2020_48.pdf European Commission, communication COM(2019) 640 final on The European Green Deal, December 2019. https://ec.europa.eu/info/publications/communication-european-green-deal_en IMF, Fiscal Monitor, October 2020. https://www.imf.org/en/Publications/FM/Issues/2020/09/30/october-2020-fiscal-monitor#Full%20Report%20and%20Executive%20Summary Vivid Economics, Greenness of Stimulus Index, February 2021. https://www.vivideconomics.com/wp-content/uploads/2021/02/Greenness-of-Stimulus-Index-5th-Edition-FINAL-VERSION-09.02.21.pdf	Government of France	France	Thank you. Carbon leakage is also addressed in other sections of the TS, notably TS5.9 and TS6.1.
24509	73	29	73	31	It would be useful to mention the role of policy packages including R&D support, carbon pricing, etc.	Government of France	France	Accepted
87049	73	25	73	25	The risk of carbon leakage can increase in the context of divergent climate ambitions (especially in the recovery packages) and policies (such as carbon pricing initiatives)		France	Thank you. Carbon leakage is also addressed in other sections of the TS, notably TS5.9 and TS6.1.
87051	73	29	73	31	It would be useful to mention the role of policy packages including R&D support, carbon pricing, etc.		France	Thank you for your comment. These topics are also extensively covered in later sections of the TS, particularly in TS.6 Implementation and enabling conditions
64081	74	2	74	2	General comment for section TS 5.6.1: The narrative structure of this section is awkward Suggest the authors consider beginning with the conclusions about current emissions before presenting the conclusions about the potential scope for mitigation, including CDR, in this sector. The first two paragraphs here (TS-74 lines 3-25) seem out of place/context. The content of these lines on mitigation and CDR potential seems to link better to the text beginning on page TS-77 line 28 and continuing to page TS-78 which addresses the mitigation potential of this sector. Indeed there is currently some overlap of text, with some conclusions on page TS-74 repeated on page TS-78.	Government of Canada	Canada	accept, This part has been revised
48155	74	3	74	11	"The Agriculture, Forestry and Other Land Use (AFOLU) sector is the only sector for which it is currently feasible to enhance CO2 removals at scales that are significant in the context of 1.5 and 2°C scenarios with continued provision of renewable resources, facilitating the substitution of fossil fuels and other GHG-intensive products (high evidence, high agreement)."- This is very strong and may need more prominence further up in the TS and SPM	Aidan Farrell	Trinidad and Tobago	Accepted
77949	74	3	74	3	The statement AFOLU is "the only sector for which..." seems too strong. And it could represent that the major responsibility and effort of mitigating GHG should be from this sector, for instance, farmers.	Barrantes Olivia	Spain	Noted. Paragraph revised
31019	74	3	74	6	"... it is currently feasible to enhance CO2 removals ..." seems to be inconsistent with sentences of C9.3 in pages 24-25 of SPM. It would be better to make revisions.	Government of Japan	Japan	accepted text revised
51837	74	13	74	15	Unclear why AFOLU would be "required" to deliver 25% of the pledged mitigation. This is a theoretical technical potential value, as can be seen in chapter 7. In line with the Paris Agreement, Article 4.1, the bulk of the emission reductions would have to come from other sectors by 2030.	Florin Vladu	Germany	reject, this sfollows from the global mitigation pathways

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
67461	74	13	74	15	There is no requirement under the Paris Agreement for a specific share of emissions reductions to come from AFOLU. This sentences is presumably based on literature which analyses the pledges made by countries in their NDCs. This should be made clearer with a line of sight to the relevant section of the underlying report.	Philippe Tulkens	Belgium	reject, agree to the coment, but this follows from the global mitigation pathways
31021	74	15	74	15	It would be better to give a more detailed reference than "WGII." For instance, Grassi et al. 2017 or capter 7.1.2.	Government of Japan	Japan	accept, This part has been revised
53189	74	16	74	22	Ch7: This point about lack of spending in AFOLU mitigation should show up in the SPM document. In the SPM document (C9, SPM-24), the 400 billion estimate is mentioned but not the estimate of 0.7 billion.	Government of Saudi Arabia	Saudi Arabia	agree, spm is in development
24589	74	17	74	19	This sentence is erroneous: 0.7 billion yr-1 corresponds to the amount spent on carbon offsets from the AFOLU sector which is not representative of total spending (agricultural policies and their green measures, conservation policies, ...). The sentence should be deleted.	Government of France	France	reject, we ned to be clear what has realy been spend on mitigation offstes. many other policies may help, but may alos work in other direction. and greening of agri policies as currently very slow
64083	74	18	74	19	Unclear whether the estimated 400 billion/year is necessary to achieve 30% of the global AFOLU mitigation or for the full global AFOLU contribution to global emission mitigation, of which AFOLU can contribute up to 30%. We think the latter is intended, but the 30% differs from the estimate of a 25% contribution to mitigation from AFOLU in the para above (line 13).	Government of Canada	Canada	accept, This part has been revised
31023	74	19	74	19	For "global mitigation effort", it is necessary to add explanation about the mitigation scenario and time point.	Government of Japan	Japan	accept, This part has been revised
77951	74	19	74	19	Not clear if "30% of global mitigation effort" should be for all sectors or for AFOLU, only	Barrantes Olivia	Spain	accept, This part has been revised
24491	74	23	74	25	cultural practices and varietal innovation are key players here - {7.4} see references suggested in 7.4 Dingkuhn M, Luquet D, Fabre D, Muller M, Yin X, Paul M. 2020. The case for improving crop carbon sink strength or plasticity for a CO2-rich future. Curr. Op. Plant Biol., https://doi.org/10.1016/j.pbi.2020.05.012 Corbeels, M., Cardinael, R., Powlson, D., Chikowo, R., Gerard, B., 2020. Carbon sequestration potential through conservation agriculture in Africa has been largely overestimated: Comment on: "Meta-analysis on carbon sequestration through conservation agriculture in Africa." Soil Tillage Res. 196, 104300. doi:10.1016/j.still.2019.104300	Government of France	France	Agree with comments but still CA can contribute to climate change mitigation thorough carbon sequestration and to climate adaptation and resilience.
24511	74	25	74	25	Rather than taking the example of conservation practices, it might be good to refer here more broadly to climate smart agriculture as "an approach for developing actions needed to transform and reorient agricultural systems to effectively support development and ensure food security under climate change." FAO. Climate Smart Agriculture Sourcebook Food and Agriculture Organization of the United Nations. Available online: http://www.fao.org/climate-smart-agriculture-sourcebook/concept/module1-introducing-csa/chapter-a1-2/en/	Government of France	France	accept, we also align with the main text
31025	74	31	74	31	According to Table SPM.1 of SRCLL, the average period is "2007-2016" rather than "2006-2016".	Government of Japan	Japan	accept, This part has been revised
77953	74	31	74	32	The statement that "emissions of CO2 are predominantly due to LULUCF..." is not evident from Table TS.3, as they are missing values in some cells	Barrantes Olivia	Spain	accept, This part has been revised
77955	74	31	74	32	Table TS.3. The view of the figures is not complete, because there are some empty cells, for instance, column A and B for CO2 and for Totals.	Barrantes Olivia	Spain	accept, This part has been revised
81503	74	32	74	32	What does mean 'LULUCF'?	Luana Ferreira	Brazil	accept, This part has been revised
29693	74	35	75	2	Considerations of the land sink resulting from greening/forest expansion could be combined with considerations of other perturbations/implications resulting from greening/expansion. For instance, according to chapter 7, "A/R activities may change the surface albedo and evapotranspiration regimes, producing net cooling in the tropical and subtropical latitudes for local and global climate and net warming at high latitudes". Furthermore, this part of the technical summary could benefit from elaborating on regional differences e.g. in many regions the total forest area is expanding (even though local deforestation occurs), while total forest area is reduced in some tropical areas.	Government of Norway	Norway	accept, This part has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
8189	74	38	74	40	Please amend text: global CO2 fluxes are dominated by photosynthesis and respiration and do not result predominantly from the activities mentioned here. Did you want to point out the most important anthropogenic factors for net fluxes?	Joachim Rock	Germany	accept, This part has been revised
7443	74	39			Yes, "tropical deforestation" – or "in the tropics" on page 77 Line 14 is a priority, but without reading about forest degradation and loss in the enormous temperate and boreal forests, it does seem biased. If there is no literature on this, that too needs to be reported.	Debra Roberts	South Africa	accept, This part has been revised
85273	74		74		Does this section take into account the consequences of a changing climate related to the possibility to enhance removals (constraints due to water limitation, heat stress etc?).	Valérie Masson-Delmotte	France	This is noted as a cause of uncertainty, but there is limited treatment of this issue
24513	75	40	75	43	There is need to better evaluate the direct and indirect effects of livestock activities on climate change, whether negative or positive in sub-Saharan Africa. The multiplication of new quantified references on greenhouse gas Emissions (particularly enteric methane emissions) and carbon sequestration would reduce uncertainties and these findings could be integrated into the IPCC guidelines for extensive livestock systems. { 7.7} Assouma comment p 150	Government of France	France	accept, This part has been revised
1381	76	1	76	2	Many cells of the table are left blank which does not help to catch the information. Redesigning the table would be necessary. What about the values for CH4 and N2O from non AFOLU sector which account respectively for 56 % and 18 % of the total ?	Julien Demenois	France	accept, This part has been revised
50039	76	1	76	2	Superscripts for chemical symbols (e.g., CO 2^2 in the LaTeX notation) are very confusing.	Masahiro Sugiyama	Japan	accept, This part has been revised
24515	76		76		Many cells of the table are left blank which does not help to catch the information. Redesigning the table would be necessary. What about the values for CH4 and N2O from non AFOLU sector which account respectively for 56 % and 18 % of the total ?	Government of France	France	accept, This part has been revised
1383	77	9	77	10	This sentence seems contradictory : how can global agricultural area decrease if regional agricultural areas increase ?	Julien Demenois	France	accept, This part has been revised
77957	77	9	77	10	"Despite a reduction...and non-wood products". Insert a comma "," after "2000"	Barrantes Olivia	Spain	accepted
24583	77	10	77	10	We recommend to add "some" before "regional"	Government of France	France	accept, This part has been revised
1209	77	10	77	12	Due to the phrase after the comma, this sentence seems to imply that all of the forest area designated for wood production is practicing unsustainable forestry. To avoid this, you could rearrange the material, starting with the sentence describing global agricultural area, then inserting a separate sentence indicating that about one-third of the world forest area is designated for production of wood and non-wood products. The sentence following this could then say, "In addition to agriculture, localised unsustainable forest can directly impact forest resources. "	Reid Miner	United States of America	accept, This part has been revised
24517	77	14	77	14	This urban expansion can accelerate with socio-institutional instability, like observed in Egypt over the last decade. {7.3.1.2}	Government of France	France	accept, This part has been revised
7445	77	18			Livestock emissions are also a function of how the animals are grown and kept, what does the literature say about this?	Debra Roberts	South Africa	accept, This part has been revised
29695	77	18	77	20	This seems somewhat imprecise. Increased productivity is usually defined as increase output (i.e. milk) per unit of input (i.e. individual head), and will logically reduce emissions per unit of output. However, it would probably be valid to propose that emissions are a function of animal numbers and input intensity.	Government of Norway	Norway	accept, This part has been revised
24493	77	23	77	24	the livestock population increase can also be put in relation with the crop-livestock diversification strategy in land-fragmented and self-sufficiency households farms, most heavily concentrated in Asia and Africa (from the current estimations 80% of the poor population in rural areas depend on livestock activity. In these small-scale farming systems where land property become too small, livestock is often the only opportunity to build up a heritage. Moreover, animal products accounted for an average of 33% of the protein in a daily balanced diet of the 864 million people worldwide who are undernourished or malnourished (FAO 2006) {7.3.2.1}	Government of France	France	accept, This part has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
24497	77	23	77	24	There is an evidence that the ruminant population must be reduced at a global scale, but how can we maintain grasslands and pastoral lands –which represent half of the agricultural area in the world - with less animals as they represent a source of biodiversity to maintain and a carbon sink? And how could we transfer fertility from grasslands to crop areas without ruminants? As well, reducing quality nutrient from animals can result in a change of land use, with the cultivation of grasslands (and the corresponding GHG emissions). Social (btw, rather than "societal"), technological and institutional changes are instrumental to produce durable, persistent and sustainable transformation - including at an individual level. On the contrary, the literature on nudges stresses the issue of the long-term effects of nudging and shows there is mixed evidence of it. See for example, 1) Bergeron, H. et al. (2018), Le Biais comportementaliste. Presses de Sciences Po. 2) Dupas, P. (2012). Health behavior in developing countries, Annual Review of Economics, 3, 1–39; 3) Giné, X., Karlan, D., & Zinman, J. (2010). Put your money where your butt is: A commitment contract for smoking cessation. American Economic Journal: Applied Economics, 2, 213–235; 4) Gneezy, U., Meier, S., & Rey Biel, P. (2011). When and why incentives (don't) work to modify behavior. The Journal of Economic Perspectives, 25, 91–209. Therefore, building the entire strategy for changing behaviour on nudging hazardous at best. Indeed, this has to do with how demand-side mitigations are regarded: beyond technologies and infrastructures, the social domain is regarded as synonymous to (implicitly) individual behaviours, or even "lifestyle options". In this respect, preferences seem to be taken for granted, while it could be argued that a key driver to implement persistent transformations through the demand-side requires changing the very preferences through an action on social norms.	Government of France	France	accept, This part has been revised
1385	77	26	77	27	It could be useful to mention that the challenge is to bridge the yield gap in those regions and therefore enhance food security	Julien Demenois	France	accept, This part has been revised
24519	77	26	77	27	It could be useful to mention that the challenge is to bridge the yield gap in those regions and therefore enhance food security	Government of France	France	accept, This part has been revised
11395	77	29	77	31	The source of the text "AFOLU mitigation measures have an supply-side (up to USD100/tCO2 yr-1) mitigation potential of 9 (± 3) GtCO2-eq yr-1 between 2020 and 2050" cannot be found in the main text (Ch.7). Please check.	SAI MING LEE	China	accept, This part has been revised
28999	77	34	77	45	There could be more consistency between the Summary for Policymakers and the Technical Summary in terms of presenting the potentials for mitigation options. Several values and ranges are presented throughout the report and summaries, some ranges are found across the whole literature, some revised for use in models and scenarios taking into account several and different limitations, or split across different sectors. This could create confusion if not clearly distinguished.	Jasmin Kemper	United Kingdom (of Great Britain and Northern Ireland)	accept, This part has been revised
31027	77	43	77	43	For "side streams", "residues" may be reader-friendly as mentioned in line 16, page 6 of chapter 7 .	Government of Japan	Japan	accept, This part has been revised
31029	77	48	77	48	Is "Figure TS.26" correct?	Government of Japan	Japan	accept, This part has been revised
77959	77	48	77	48	In my opinion, the Figure TS.26 should be more commented in this Technical Summary, to be well understood	Barrantes Olivia	Spain	accept, This part has been revised
24521	78	1	78	7	The large difference between the IAM estimates and the National GHG inventories suggests that IAMs may overestimate the potential of forest carbon sequestration in the EU and UK. The question is therefore more about the reliability of IAMs projections - what influence can this have on the results? - rather than about the location of afforestation/reforestation activities.	Government of France	France	accept, This part has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
48157	78	1	78	8	Table TS.4 and "Land-based agricultural production offers a wide range of available or emerging options, including digital agriculture, gene technology, sustainable intensification or agro-ecological farming {12.4.3}. Emerging technologies such as cellular agriculture, plant-based analogues of animal products, and controlled environment agriculture promise substantial reduction in direct GHG emissions from food production." This list seems to give to attach too much importance to new (un-proven technologies). Why 'digital agriculture' specifically rather than precision farming or climate services; why gene technology specifically rather than crop improvement/plant breeding (including GMOs); why plant-based analogues specifically rather than low carbon protein in general (e.g. chicken).	Aidan Farrell	Trinidad and Tobago	accept, This part has been revised
46871	78	4	78	7	Adding concrete numbers for the two potentials in the tropics and in the temperate zone could visualize the scale of the difference, whereas the current formulation is rather vague and leaves room for interpretation for the reader. Please revise adding this information.	Government of Germany	Germany	accept, This part has been revised
77961	78	5	78	5	Not clear "lower cost", is this cost economic, social?	Barrantes Olivia	Spain	accept, This part has been revised
67463	78	8	78	11	This statement seems to contradict the balance of Section 7.4 which seems to state that for most mitigation measures the potential is similar to the SRCL estimates. The line of sight for this paragraph is 7.4.4 (the BECCS section), whereas these lines refer to 'large-scale afforestation or large-scale biomass'. Is this statement underpinned by a different part of Chapter 7? If so, different sections may be giving contradictory messages, and this will need to be addressed.	Philippe Tulkens	Belgium	accept, This part has been revised
24523	78	8	78	11	Importantly, considering A/R mitigations strategies alone leads to increased food prices, a consequence often overlooked in studies on A/R mitigation potentials, which calls for complementary options, such as diet change. {7.4.2.2}	Government of France	France	accept, This part has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
47991	78	8	78	12	<p>As it is made clear in Chapter 12, Section 12.5, p. 69, l.13-26, IAM's in general are limited in the assessment of the complex dynamics of bioenergy systems as is the case in integrated feed-food-fiber systems: "[...] Because IAMs do not include options of biomass production integrated with existing agricultural and forestry systems, they may over-estimate the total additional land area required for biomass production."</p> <p>Moreover, apparently this SOD may be downplaying the potential global expansion of land-based mitigation on abandoned, under-utilized and/or degraded croplands and pastures. The authors are invited to carefully consider the following papers that address the issue, adding up to the growing literature:</p> <p>Næss, Jan & Cavalett, Otavio & Cherubini, Francesco. (2021). The land–energy–water nexus of global bioenergy potentials from abandoned cropland. <i>Nature Sustainability</i>. 10.1038/s41893-020-00680-5.</p> <p>Kerdan, I.G., Giarola, S., Jalil-Vega, F. et al. Carbon Sequestration Potential from Large-Scale Reforestation and Sugarcane Expansion on Abandoned Agricultural Lands in Brazil. <i>Polytechnica</i> 2, 9–25 (2019). https://doi.org/10.1007/s41050-019-00012-3</p> <p>Cherubin, M.R.; Carvalho, J.L.N.; Cerri, C.E.P.; Nogueira, L.A.H.; Souza, G.M.; Cantarella, H. Land Use and Management Effects on Sustainable Sugarcane-Derived Bioenergy. <i>Land</i> 2021, 10, 72. https://doi.org/10.3390/land10010072</p> <p>Also, "large-scale" expansion in IAMs refers to projected expansion at the upper bound of the estimated potentials. Those extreme cases of severe and rapid expansion at the maximum technical potential should not be confused with a common use of the expression 'large-scale'. Therefore, statements such as this one in the Technical Summary, p. 78, l. 8-12, regarding projected impacts of large-scale expansion of bioenergy and BECCS should always be presented with caution, including the necessary qualifiers in the wording. A more nuanced language for instance is adopted in Chapter 7, Section 7.4.4, p. 95, l. 44-46 and p. 96, l 1-26.</p> <p>This excerpt should be adapted accordingly. We propose to update the text as follows: Very large increases (at the upper bound of IAM models) in the use of bioenergy and BECCS will put significant stresses on land use and ecosystems. At the same time, a number of management approaches in the agriculture and forestry sectors can enable biomass production and use for energy in conjunction with supply of food and other biobased products, reducing the pressure on</p>	Marcelo moreira	Brazil	accept, This part has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
50911	78	8	78	12	<p>As it is made clear in Chapter 12, Section 12.5, p. 69, 1.13-26, IAM's in general are limited in the assessment of the complex dynamics of bioenergy systems as is the case in integrated feed-food-fiber systems: " [...] Because IAMs do not include options of biomass production integrated with existing agricultural and forestry systems, they may over-estimate the total additional land area required for biomass production."</p> <p>Moreover, apparently this SOD may be downplaying the potential global expansion of land-based mitigation on abandoned, under-utilized and/or degraded croplands and pastures. The authors are invited to carefully consider the following papers that address the issue, adding up to the growing literature:</p> <p>Næss, Jan & Cavalett, Otavio & Cherubini, Francesco. (2021). The land–energy–water nexus of global bioenergy potentials from abandoned cropland. <i>Nature Sustainability</i>. 10.1038/s41893-020-00680-5.</p> <p>Kerdan, I.G., Giarola, S., Jalil-Vega, F. et al. Carbon Sequestration Potential from Large-Scale Reforestation and Sugarcane Expansion on Abandoned Agricultural Lands in Brazil. <i>Polytechnica</i> 2, 9–25 (2019). https://doi.org/10.1007/s41050-019-00012-3</p> <p>Cherubin, M.R.; Carvalho, J.L.N.; Cerri, C.E.P.; Nogueira, L.A.H.; Souza, G.M.; Cantarella, H. Land Use and Management Effects on Sustainable Sugarcane-Derived Bioenergy. <i>Land</i> 2021, 10, 72. https://doi.org/10.3390/land10010072</p> <p>Also, "large-scale" expansion in IAMs refers to projected expansion at the upper bound of the estimated potentials. Those extreme cases of severe and rapid expansion at the maximum technical potential should not be confused with a common use of the expression 'large-scale'. Therefore, statements such as this one in the Technical Summary, p. 78, l. 8-12, regarding projected impacts of large-scale expansion of bioenergy and BECCS should always be presented with caution, including the necessary qualifiers in the wording. A more nuanced language for instance is adopted in Chapter 7, Section 7.4.4, p. 95, l. 44-46 and p. 96, l 1-26.</p> <p>This excerpt should be adapted accordingly. We propose to update the text as follows: Very large increases (at the upper bound of IAM models) in the use of bioenergy and BECCS can put significant stresses on land use and ecosystems. At the same time, a number of management approaches in the agriculture and forestry sectors can enable biomass production and use for energy in conjunction with supply of food and other biobased products, reducing the pressure on</p>	Government of Brazil	Brazil	accept, This part has been revised
7447	78	12			What "other measures" are being referred to?	Debra Roberts	South Africa	accept, This part has been revised
1211	78	12	78	12	By saying "other measures show enhanced mitigation potential", the material indicates that large-scale afforestation and bioenergy do not have enhanced mitigation potential. The material in Chapter 7, however, makes it clear (as noted in the last sentence in this paragraph of the technical summary) that the benefits and impacts of AFOLU mitigation measures are highly context specific. The sentence beginning "However", therefore, should be changed to: "However, under appropriate conditions, a range of mitigation measures show enhanced mitigation potential, with many..."	Reid Miner	United States of America	accept, This part has been revised
29697	78	12	78	17	The proposal "other measures show enhanced mitigation potential" is vague, while there are a number of examples that should be provided to substantiate the proposal. Please consider including improved soil carbon sequestration, improved cropland management, improved livestock management, improved nutrient management, improved capacities to lead water that can be implemented within existing land uses and improve sustainability without increased demand for land. Please also consider to include 7.5.3.6 and other relevant parts of 7.4 in the paranthesis with references	Government of Norway	Norway	accept, This part has been revised
15425	78	14	78	14	"...buildings and industry The..." --> "...buildings and industry. The ..." A period should be added after "industry".	Hiroaki Kondo	Japan	accept, This part has been revised
77963	78	18	78	18	Not clear what type of "land requirement" is referred here, land area, inputs?	Barrantes Olivia	Spain	accept, This part has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
24525	78	18	78	18	chapter {17.3.2} Adam et al. 2020 and Falconnier et al 2020 showed, respectively, the relatively low impact of climate change (from 5 to 15%) on sorghum yield and maize yield in the current production systems in Sub-saharan Africa. However, they also highlighted the importance of intensification of systems to increase food productivity (more than double productivity), while stating that "impact of climate change in sub-Saharan Africa will increase with the amount of applied nitrogen fertilizer" to reach an impact of about 25%	Government of France	France	accept, This part has been revised
47993	78	18	78	19	This section seems to ignore the massive potential of expansion on degraded and/or abandoned cropland and pastures and of intelligent land use management, which is already promoted in national programs in different countries (e.g. ABC Plan, in Brazil). This has already been assessed in recent papers, some of which are cited in Chapter 7, and some of which were not included in the report, e.g.: Næss, Jan & Cavalett, Otavio & Cherubini, Francesco. (2021). The land–energy–water nexus of global bioenergy potentials from abandoned cropland. Nature Sustainability. 10.1038/s41893-020-00680-5. Kerdan, I.G., Giarola, S., Jaill-Vega, F. et al. Carbon Sequestration Potential from Large-Scale Reforestation and Sugarcane Expansion on Abandoned Agricultural Lands in Brazil. Polytechnica 2, 9–25 (2019). https://doi.org/10.1007/s41050-019-00012-3 Therefore, alternative wording is suggested, as follows: "It is possible to reduce agricultural land requirements through sustainable intensification, reduced food loss and wastes, dietary change (in high nutrition countries), intelligent land use management, and expansion in abandoned, underutilized or degraded croplands and pastures."	Marcelo moreira	Brazil	accept, This part has been revised
50913	78	18	78	19	This section seems to ignore the massive potential of expansion on degraded and/or abandoned cropland and pastures and of intelligent land use management, which is already promoted in national programs in different countries (e.g. ABC Plan, in Brazil). This has already been assessed in recent papers, some of which are cited in Chapter 7, and some of which were not included in the report, e.g.: Næss, Jan & Cavalett, Otavio & Cherubini, Francesco. (2021). The land–energy–water nexus of global bioenergy potentials from abandoned cropland. Nature Sustainability. 10.1038/s41893-020-00680-5. Kerdan, I.G., Giarola, S., Jaill-Vega, F. et al. Carbon Sequestration Potential from Large-Scale Reforestation and Sugarcane Expansion on Abandoned Agricultural Lands in Brazil. Polytechnica 2, 9–25 (2019). https://doi.org/10.1007/s41050-019-00012-3 Therefore, alternative wording is suggested, as follows: "It is possible to reduce agricultural land requirements through sustainable intensification, reduced food loss and wastes, dietary change (in high nutrition countries), intelligent land use management, and expansion in abandoned, underutilized or degraded croplands and pastures."	Government of Brazil	Brazil	accept, This part has been revised
7449	78	19			Suggest to add numbers and mention in order of mitigation potential. Might food loss and waste be the highest component? Followed by dietary change in societies with very high meat consumption? Intensification on the other hand needs caveats, because fertilizer is a major source of emissions, so intensification needs to be qualified.	Debra Roberts	South Africa	accept, This part has been revised
77965	78	20	78	20	"... making land available for other uses", please, add "and other resources" to "land" (for instance, water, Nitrogen, Phosphorous...	Barrantes Olivia	Spain	accept, This part has been revised
46873	78	20	78	23	Please reformulate: "[...] maintaining carbon stocks on the land while sufficiently producing food, feed, fuel and fibre is a NECESSARY approach, because without an active management of biotic resources from sustainable land use it will not be possible to gain the most possible mitigation potential from bioeconomy."	Government of Germany	Germany	accept, This part has been revised
24527	78	20	78	23	Such efforts have conducted to the developemnt of the HCS approach, a scientific methodology that makes it possible to distinguish forest plots known as HCS forests to preserve degraded areas that are therefore suitable for agricultural development. The approach combines carbon stock values with the protection of HCV areas (including peatlands and riparian zones) and areas important for the livelihoods of local communities, as well as the Free, Informed and Prior Informed Consent of populations { 2.8.3.3 }	Government of France	France	accept, This part has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
77967	78	21	78	21	Please, add "or increasing" to "maintaining"	Barrantes Olivia	Spain	accept, This part has been revised
29699	78	24	78	32	Please consider to substantiate the AFOLU mitigation measures in this paragraph with concrete examples.	Government of Norway	Norway	accept, This part has been revised
77969	78	26	78	26	Please, add "wild and domestic" before "biodiversity"	Barrantes Olivia	Spain	accept, This part has been revised
24595	78	35	78	43	Please consider this interrogation: This 0.65 GtCO ₂ yr ⁻¹ is the amount of carbon offsets from the AFOLU sector. This is by no means representative of what "policies" in general have delivered. Estimating what policies have delivered (in good or bad) at global level would be very challenging. At national level and/or on specific policies, such studies exists but they are not reviewed in this report. The 0.7 billion USD figure is problematic for the same reason. If relevant, please consider deleting this paragraph?	Government of France	France	accept, This part has been revised
31031	78	38	78	39	For "30%", it is necessary to put a more detailed reference or explanation. The meaning of "total mitigation necessary" is unclear. It would be better to add explanations about key assumptions and the period considered.	Government of Japan	Japan	accept, This part has been revised
29701	78	39	78	41	This sentence is repeted in technical summary page 74 line 17-20. The prognosis that AFOLU can provide 30 % of overall mitigation needs further clarification.	Government of Norway	Norway	accept, This part has been revised
30343	78	42	78	42	Should be (i.e., gradual)	Vanessa Lamers	United States of America	accept, This part has been revised
77971	78	42	78	42	"...current subsidies...". This can be true in the European Union through CAP subsidies, but does it work for other regions?	Barrantes Olivia	Spain	accept, This part has been revised
77973	78	46	78	46	"...of animal", instead of "or animal"	Barrantes Olivia	Spain	accept, This part has been revised
69999	79	12			What might be missing in this section Food Systems is the possible improvement in food preservation, an important dimension as 10-20% of agricultural products are destroyed by various pests or go rotten. Improvements in cold chains of distribution can have a significant effect. See e.g. a Nigerian example of 100% solar-powered walk-in cold rooms to eliminate food waste in IEA/ISA 2019. Solar Energy - Mapping the road ahead, p.42.	Cédric PHILIBERT	France	Noted - addressed in part in underlying chapter
15433	79	12	87	3	Are the Tables TS.4 and TS.5 referred in this subsection TS.5.6.2?	Hiroaki Kondo	Japan	Thank you for your comment. All tables and figures are referred in the text now
29703	79	12	92	1	In chapter 7, demand side measures in food systems are proposed to provide 1,9 Gt CO ₂ -eq. (chapter 7, page 5, line 20) or around 6 Gt CO ₂ -eq. (combined for diets and food waste, table 7.5, page 50). From this perspective, it seems unjustified to spend 14 pages of the Technical summary on food systems alone. It would be more helpful to discuss how producers and consumers alike can enable win-win-solutions in existing food systems, including incentivizing soil carbon sequestration, sustainable livestock system, integrated landscape management (as presented in chapter 7 and in pages 68-89 in chapter 12. Please consider to balance the text better when describing traditional agriculture compared to new practices	Government of Norway	Norway	accepted - final TS is more concise
81761	79	13	79	13	It would be useful to understand why the food system emission estimate given is different from that of the "Climate Change and Land" special report (32-36% versus 21-37%).	Government of New Zealand	New Zealand	This figure has been revised
11397	79	13	79	13	The figures "32-36%" are different from what is presented in the main text (25%-42%, Ch.12, P.41, line 21). Please check and revise as appropriate.	SAI MING LEE	China	Accepted. Numbers checked and harmonised
77975	79	13	79	13	Please explain why this number, "32-36%" is different and greater than 23.2% in table TS.3	Barrantes Olivia	Spain	Thank you. Corrected
7451	79	18			"share of global GHG emissions from the food systems has decreased" – this could just mean that other sources of emissions have risen more? Some food-emissions related statistics here in different regions of the world would be welcome. For example, tropical deforestation attributable to the meat industry directly (beef farming) and indirectly (e.g. planting soya for the livestock industry – sometimes in other parts of the world).	Debra Roberts	South Africa	accepted - text now gives absolute numbers
24495	79	18	79	19	It is important to note that the annual land use change emissions reported here correspond to the ongoing additional natural vegetation replacement for increasing food demand. This is not the GHG emissions footprint of food systems, which includes land use which changed in the past, but could revert to natural vegetation if the food demand decreased. Food systems GHG emissions footprint would allocate land use related GHG emissions to every area of land used for agriculture, including pastures based on the natural vegetation replaced	Government of France	France	Noted - this approach not used in chapter.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
15427	79	19	79	19	Is it OK that the absolute emission is from 16 to 18 TgCO ₂ eq/yr? As it seems that this value is 16 to 18GtCO ₂ eq/yr in Figure TS.26, isn't this value 16 to 17 PgCO ₂ eq/yr?	Hiroaki Kondo	Japan	figures now given in GtCO ₂ e
81505	79	20	79	20	What does mean 'ca'?	Luana Ferreira	Brazil	Accepted. Acronyms explained in first instance where appropriate
77977	79	22	79	22	Figure TS.26 should be cited here?	Barrantes Olivia	Spain	Noted. All cross-references have been cited in the text
8203	79	24	79	26	Figure TS.26: Please check and correct: If only emissions from "LUCF" are shown here, emissions from "LU" (land-use) are neglected. Either state which emissions have been neglected or correct the title of the sector to "LULUCF".	Joachim Rock	Germany	Thank you for your comment- the figure and figure caption has been revised
81507	79	25	79	25	What does mean 'LUCF'?	Luana Ferreira	Brazil	Accepted. Acronyms explained in first instance where appropriate
24529	80	2	80	2	In reference to {7.4} add agroforestry to the list (R Cardinael, CIRAD)	Government of France	France	text removed from final TS
24531	80	2	80	2	The concept of "Ecological intensification" is missing in this report, i.e. using ecological processes to intensify the provision of food and other ecosystem services. {box 7.2}	Government of France	France	Addressed in part in chapters 7 and 12, but this terminology is not used
24533	80	2	80	2	Rather than taking the example of conservation practices, it might be good to refer here more broadly to climate smart agriculture as "an approach for developing actions needed to transform and reorient agricultural systems to effectively support development and ensure food security under climate change." FAO. Climate Smart Agriculture Sourcebook Food and Agriculture Organization of the United Nations. Available online: http://www.fao.org/climate-smart-agriculture-sourcebook/concept/module1-introducing-csa/chapter-a1-2/en/	Government of France	France	There are a variety of terms used in this field. Chapter uses sustainable intensification and agro-ecological farming
24535	80	3	80	3	This is a point of view that should be more careful : fc comments p 12-4 of chapter 12 "I43: Emerging food technologies such as cellular agriculture or controlled environment agriculture promise substantial reduction in direct GHG emissions from food productio" this is in contradiction with the analysis in 12.4.3.3, p 12-55 35 ... show similar GHG intensities per unit of protein (mean values ranging 0.3-3.1 kg CO ₂ eq per 100 g of protein), comparable to milk, eggs, and tuna	Government of France	France	Text revised to reflect differences in production systems
81753	80	12	80	13	Suggest noting that red meat tends to have the highest "per animal" footprint i.e. as it can differ per hectare - in NZ our red meat sector tends to be lower intensity than our dairy sector so on a per ha basis dairy is actually higher footprint.	Government of New Zealand	New Zealand	Text revised to reflect differences in production systems
24537	80	12	80	13	this statement should be qualified with reference to the chapter {7.4.3}. A distinction should be done between cattle industrial agriculture system and grazing farming sytem or pastoral system that offers a lot of services including carbon sequestration. {7.4.3} and	Government of France	France	Text revised to reflect differences in production systems
77979	80	12	80	14	In my opinion, to mention here the red meat as having highest GHG footprints could be negative for the livelihood of millions of pastoralists who rely on ruminant systems based on rangelands. At least, it should be mentioned that important eocsystem services are delivered by such systems, such as transformation of non-edible products (celulose-rich feeds) into high-quality animal products, decrease of wildfires (in Mediterranean systems), biodiversity of rangelands, landscape,... and compatibility of this land use with land conservation (oposite to cropping systems, in general). White meat rely, in general, on edible concentrates, rather than on roughages rich in cellulose, and produces, many times, negative landuse changes, like deforestation to produce soya. Blaming cattle as responsible of climate change is being a constant in some media, so I think that scientific reports should be specially careful on this subject	Barrantes Olivia	Spain	Text revised to reflect differences in production systems
77981	80	13	80	13	"In many regions", seems too vague. Which regions? Number of persons affected by this question worldwide?	Barrantes Olivia	Spain	Text revised to reflect differences in production systems
24539	80	14	80	16	At the Europe level (but not true in a lot of developping countries), substituting ruminant products by legumes lead to -231 to -259 MtCO ₂ eq emissions reductions without and with reforestation, with more emissions reductions than a legumes substitution supply-side scenario (-10 MtCO ₂ eq), and that the associated reductions could happen substancially outside of Europe in the scenario without reforestation {7.4.5.1}	Government of France	France	Text revised to reflect differences in production systems

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
81755	80	14	80	17	Please clarify that the health benefits apply only in cases where there is overconsumption of animal products. You can reference the study by Payne et al. 2016 (https://doi.org/10.1017/S1368980016000495) which highlights that diets with lower GHG emissions can be highly heterogeneous with respect to nutrients, micronutrients and health outcomes and poor outcomes for sugar and micronutrient intakes	Government of New Zealand	New Zealand	Final TS includes revised paragraph on this
81763	80	19	80	20	It would be useful to qualify the "requirement" in this sentence. Presumably, "... is required in all countries [to make progress towards the associated SDGs]." is what was intended. If so, it would be useful to state this.	Government of New Zealand	New Zealand	Text deleted from final TS
7453	80	21	80	22	Re: deaths due to malnutrition in children / mothers versus deaths due to high calorie intake, it must be made clear that the former has major repercussions for an entire lifetime (sequelae of prenatal and early childhood malnutrition) while the latter is a problem of privilege and excess, with health impacts mainly later in life. The two are not really comparable. This should really be emphasised in the Figure too.	Debra Roberts	South Africa	Text deleted from final TS
86813	80	12	80	18	We suggest removing "with red meat having highest GHG footprints." and "in particular red meat", otherwise explain assumptions of the type of livestock production (for example, livestock diets and grazing pattern).		Argentina	Noted. This section has been revised, linking more closely to particular livestock
31033	81	1	81	1	For the unit shown in Figure TS. 27, (kg CO2 cap-1 year-1): Isn't it CO2eq instead of CO2?	Government of Japan	Japan	Accepted. This has now been corrected.
15429	81	1	81	1	Why is West Europe missing in the figure?	Hiroaki Kondo	Japan	Accepted. This has now been corrected.
81509	81	1	81	1	What does mean 'LUC' and 'BMI', in box of the figure TS.27? Does BMI mean Body-mass index?	Luana Ferreira	Brazil	Noted thank you. This has now been corrected.
8207	81	1	81	7	Figure TS.27: Please check and correct: Western Europe is missing, East Europe is given twice (with South and North).	Joachim Rock	Germany	Accepted. This has now been corrected.
77983	81	15	81	15	Table TS.4 and TS.5, should not be cited here?	Barrantes Olivia	Spain	Noted thank you. All cross-reference have been checked and confirmed
7455	81				This is a very interesting figure. This focuses on the industrialization / energy intensity of food. Another figure showing total emissions associated with food production would be valuable.	Debra Roberts	South Africa	Thank you for your positive comment.
24541	81		81		Figure TS.27 is relevant and informative but it is rather complex. The 5 boxes below the x-axis should be placed differently in order to avoid interpreting that the left boxes correspond to the regions with the highest "wholesale cost for food". West Europe is not mentioned while East Europe is mentioned twice, probably because of an error in the name of one of the European regions.	Government of France	France	Accepted. This has now been corrected. The boxes have been revised, and the regions have been checked
86815	81	8			We reiterate the comments on the non agreed term "sustainable diets". It should be removed.		Argentina	Thank you for your comment. This has been harmonised throughout the TS
80501	82	1	82	1	The use of gene technology in agricultural production and fisheries does not seem to have any adverse effects. This looks a bit odd and an explanation somewhere would help (or a discussion about the advantages and disadvantages)	Moritz Riede	United Kingdom (of Great Britain and Northern Ireland)	noted - discussed further in underlying chapter
77985	82	1	82	1	Table TS.4 and TS.5 are not cited in the text	Barrantes Olivia	Spain	Accepted. All tables and figures are now referred to in the text
15431	82	1	84	5	There are some indications to refer foot note in the column of 'system' in Table TS.4, but there are no such indications in original Table 12.9.	Hiroaki Kondo	Japan	Thank you for your comment. Rectified
66593	82	1	87	1	I learnt a lot from this section so hate to say it – but I really don't think the TS is appropriate for two Tables spanning so many pages. Anyway, I am afraid the result is that the vast majority of readers will simply tune out and skip it. Find a way to synthesis into one page that can then attract the specialists to hunt out the full thing.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted, thank you for your comment. This table has been revised and shortened to enhance readability
77987	82	3	82	3	The symbols "+" and "-" are confusing in this table: for instance, (+) indicates "increase", but in the table, the sense seems to be positive (i.e., decreasing emissions), instead of "increasing" emissions	Barrantes Olivia	Spain	Partially accepted. The symbols have been revised in the table to enhance readability, particularly by adding arrows to indicate change

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
7457	82				Table TS.4: it would be useful to see mention of literature about food surplus versus food deficit in different regions. Are there new answers to this old problem?	Debra Roberts	South Africa	Thank you for your comment- the table has been revised
18661	83	1	83	1	Table 12.9 -Cellular Agriculture is given the co-benefit of "increased food safety for consumption of animal food, potentially reduced risk from zoonotic diseases, pesticides and antibiotics". Could the authors please revise the sentence to reflect the number of concerns/challenges to food safety and product authorisation linked to the use of required growth promoters etc., with only one example authorised for consumer consumption at present. This same comment applies to Table TS.4. I would recommend removing the text "increased food safety for consumption of animal food"	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Sentence deleted
81765	83		99		It would be useful to know how the allocations given in the tables/figures (Table TS.4, Figure TS.30 and Table TS.10) were ranked/summarised.	Government of New Zealand	New Zealand	noted - discussed further in underlying chapter
24543	84		84		In order to avoid a potential misinterpretation of the data we suggest to replace "direction of effect on GHG emissions" with "direction of effect on GHG emissions mitigation".	Government of France	France	Thank you for your comment. Accepted- the table has been revised
81511	85	1	85	1	First line of the table TS.5 might be in landscape mode.	Luana Ferreira	Brazil	Thank you for your comment. Accepted- the table has been revised
7459	88	1			It would be quite helpful if this section started by listing and categorising various bioenergy options more clearly, with all their pros and cons, some being very promising, others highly problematic, perhaps in the form of a table – or added to table TS6. Some of this gets discussed in the text, but can this section put forth some clear guiding principles to help policy makers make wise decisions? Currently this section is still a little vague, considering how important bioenergy seems to be in 1.5 scenarios.	Debra Roberts	South Africa	accept, This part has been revised
53191	88	1	88	41	Ch5: the section differs from the previous sections with no bolded statements or a reflection what we have learned since AR5, or the emission potential	Government of Saudi Arabia	Saudi Arabia	Revised draft changed substantially.
1213	88	12	88	15	This sentence does not adequately capture the findings in Chapter 7. I suggest the following replacement for the sentence beginning "While not..." and ending "...with BECCS" "A number of recent studies have identified an apparent trade-off between the two principal objectives to store carbon on land and to harvest biomass for energy and other biobased products. Other studies have concluded that it, under the right circumstances, is possible to increase wood demand while also increasing forest carbon stocks. The range in findings highlights the context specific benefits and impacts of increased demand for biomass energy. Recent research has also highlighted the importance of timing when evaluating bioenergy. Bioenergy use releases carbon back to the atmosphere quickly, sometimes compared to long-lived biobased products, unless combined with BECCS."	Reid Miner	United States of America	Text substantially revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
47995	88	12	88	17	<p>This extract is unbalanced as it presents exclusively potential trade-offs, without mentioning the existing of synergies that could avoiding them and promoting positive outcomes. Appropriate land management practices can increase carbon stocks and soil organic carbon (in some cases even resulting in negative ILUC emissions – cf ICAO’s work on aviation biofuels, ICAO document "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels"). Besides ICAO’s documentation, based in extensive peer reviewed research, the authors are invited to consider the follow paper:</p> <p>Liu, X., Kwon, H., Northrup, D., & Wang, M. (2020). Shifting agricultural practices to produce sustainable, low carbon intensity feedstocks for biofuel production. Environmental Research Letters, 15(8), 084014.</p> <p>Another example of the highly positive effects of proper land management practices, in this case empirically observed in Brazil, is assessed in the following paper:</p> <p>Moreira, Marcelo & Seabra, Joaquim & Lynd, Lee & Arantes, Sofia & Cunha, Marcelo & Guilhoto, Joaquim. (2020). Socio-environmental and land-use impacts of double-cropped maize ethanol in Brazil. Nature Sustainability. 3. 1-8. 10.1038/s41893-019-0456-2.</p> <p>We invite the authors of to take these findings into account in the assessment of the issue (both in this Technical Summary as well as in Chapter 7 and others, when addressing trade-offs and synergies of bioenergy systems).</p> <p>A more balanced description of the potential trade-offs and co-benefits of bioenergy and BECCS as land-based mitigation options is presented in Section 12.5.2.1 of Chapter 12 (p. 71, l. 3-15). This extract should be adapted accordingly. We propose to update the text as follows:</p> <p>"While not mutually exclusive, there may be an apparent trade-off between the two principal objectives to store carbon on land and to harvest biomass for energy and other biobased products. However, impacts can vary significantly, since effects can be either positive or negative, depending on the character of the land use/biomass supply system, management practices, previous land/biomass use, the biomass conversion process, and how the bio-based products are used "</p>	Marcelo moreira	Brazil	Text substantially revised

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50915	88	12	88	17	<p>This extract is unbalanced as it presents exclusively potential trade-offs, without mentioning the existing of synergies that could avoiding them and promoting positive outcomes. Appropriate land management practices can increase carbon stocks and soil organic carbon (in some cases even resulting in negative ILUC emissions – cf ICAO’s work on aviation biofuels, ICAO document "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels"). Besides ICAO’s documentation, based in extensive peer reviewed research, the authors are invited to consider the follow paper:</p> <p>Liu, X., Kwon, H., Northrup, D., & Wang, M. (2020). Shifting agricultural practices to produce sustainable, low carbon intensity feedstocks for biofuel production. Environmental Research Letters, 15(8), 084014.</p> <p>Another example of the highly positive effects of proper land management practices, in this case empirically observed in Brazil, is assessed in the following paper:</p> <p>Moreira, Marcelo & Seabra, Joaquim & Lynd, Lee & Arantes, Sofia & Cunha, Marcelo & Guilhoto, Joaquim. (2020). Socio-environmental and land-use impacts of double-cropped maize ethanol in Brazil. Nature Sustainability. 3. 1-8. 10.1038/s41893-019-0456-2.</p> <p>We invite the authors of to take these findings into account in the assessment of the issue (both in this Technical Summary as well as in Chapter 7 and others, when addressing trade-offs and synergies of bioenergy systems).</p> <p>A more balanced description of the potential trade-offs and co-benefits of bioenergy and BECCS as land-based mitigation options is presented in Section 12.5.2.1 of Chapter 12 (p. 71, l. 3-15). This extract should be adapted accordingly. We propose to update the text as follows:</p> <p>"While not mutually exclusive, there may be an apparent trade-off between the two principal objectives to store carbon on land and to harvest biomass for energy and other biobased products. However, impacts can vary significantly, since effects can be either positive or negative, depending on the character of the land use/biomass supply system, management practices, previous land/biomass use, the biomass conversion process, and how the bio-based products are used"</p> <p>there are also a lot of xamples of bioenergy production that increase GHG emissions compared to fossil references. (cf Box 7.9 comment sfrom Th Brunelle)</p> <p>and also in biodiversity loss</p>	Government of Brazil	Brazil	Text substantially revised
24545	88	14	88	15		Government of France	France	accept, This part has been revised
64085	88	27	88	27		Government of Canada	Canada	accept, This part has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
47997	88	31	88	32	Reference should also be made to multiple cropping and expansion on unused land, which are also relevant land-saving technologies, as presented in the following papers that add up to the existing literature: Næss, Jan & Cavalett, Otavio & Cherubini, Francesco. (2021). The land–energy–water nexus of global bioenergy potentials from abandoned cropland. Nature Sustainability. 10.1038/s41893-020-00680-5. Moreira, Marcelo & Seabra, Joaquim & Lynd, Lee & Arantes, Sofia & Cunha, Marcelo & Guilhoto, Joaquim. (2020). Socio-environmental and land-use impacts of double-cropped maize ethanol in Brazil. Nature Sustainability. 3. 1-8. 10.1038/s41893-019-0456-2. Liu, X., Kwon, H., Northrup, D., & Wang, M. (2020). Shifting agricultural practices to produce sustainable, low carbon intensity feedstocks for biofuel production. Environmental Research Letters, 15(8), 084014. The following alternative wording is proposed: " [...] and improve resilience through maintenance of the productivity of the land resource base. Multiple cropping and expansion on unused land also help to reduce pressure for additional dedicated land "	Marcelo moreira	Brazil	accept, This part has been revised	
50917	88	31	88	32	Reference should also be made to multiple cropping and expansion on unused land, which are also relevant land-saving technologies, as presented in the following papers that add up to the existing literature: Næss, Jan & Cavalett, Otavio & Cherubini, Francesco. (2021). The land–energy–water nexus of global bioenergy potentials from abandoned cropland. Nature Sustainability. 10.1038/s41893-020-00680-5. Moreira, Marcelo & Seabra, Joaquim & Lynd, Lee & Arantes, Sofia & Cunha, Marcelo & Guilhoto, Joaquim. (2020). Socio-environmental and land-use impacts of double-cropped maize ethanol in Brazil. Nature Sustainability. 3. 1-8. 10.1038/s41893-019-0456-2. Liu, X., Kwon, H., Northrup, D., & Wang, M. (2020). Shifting agricultural practices to produce sustainable, low carbon intensity feedstocks for biofuel production. Environmental Research Letters, 15(8), 084014. The following alternative wording is proposed: " [...] and improve resilience through maintenance of the productivity of the land resource base. Multiple cropping and expansion on unused land also help to reduce pressure for additional dedicated land "	Government of Brazil	Brazil	accept, This part has been revised	
24547	88	32	88	33	It is possible, however, to systematically compare the GHG mitigation efficiency of bioenergy with other land uses, by separating supply from demand effects. In such a setting, dedicated bioenergy systematically increases overall GHG emissions compared to food crops, mostly because of indirect land use change based emissions . cf comments Dumas {7.4.4}	Government of France	France	accept, This part has been revised	
46875	88	32	88	35	It seems appropriate to hint to the possible effects of the large-scale adoption of bioenergy crop production: a displacement not only of food production areas, but also of natural ecosystems is possible. This might have direct or, through crowding-out effects, indirect impacts on biodiversity. The impacts on biodiversity might be mentioned here separately, as the intrinsic value of nature and biodiversity is only partially covered by the negative side effects on anthropocentric sustainability criteria as described in this paragraph	Government of Germany	Germany	accept, This part has been revised	
84751	88	33	88	35	Why would rapid and large-scale deployment of monoculture biomass plantations likely have adverse side-effects for sustainability only at the higher end of areas envisaged in AR6 scenarios? Given that the sustainable limit for BECCS could be as low as 0.5 Gt by 2050, one would assume that risks and adverse side-effects can materialise also in scenarios with lesser use of Gt (and not just the extremes).	Kaisa Kosonen	Finland	accept, This part has been revised	
46877	88	33	88	35	Is there a reason for the focus on "rapid" and large-scale deployment of monocultures having detrimental effects on sustainability criteria? Monocultures can also develop negative side-effects when they expand over longer time horizons and are subject to a slower deployment. The formulation of the sentence might therefore be misleading.	Government of Germany	Germany	accept, This part has been revised	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
64087	89	6	89	6	While it may be true that section TS.5.6 covered AFOLU contributions to CDR to some extent, there was no clear statement there about the total CO2 removal potential, as there is in this section for non-land based measures. It would be helpful to include/repeat summary conclusions about the potential for CDR through land-based measures to be able to compare the potentials across different <u>measures/approaches</u> .	Government of Canada	Canada	accepted - this is included in CDR section	
24549	89	9	89	9	Defining what "Enhanced Mineral Weathering" and "Ocean Alkalinity Enhancement" refer to is needed to better understand this section.	Government of France	France	Thank you for your comment. These are explained in the chapter	
11399	89	12	89	13	The first sentence tends to convey the message that DACCS, enhanced weathering and ocean-based (mainly ocean fertilisation and ocean alkalinity enhancement, etc) CDR methods are promising techniques to remove carbon from the atmosphere. However, according to the main text in Ch.12, (1) the current scale of DAC plants are designed to capture at most 4 ktCO ₂ yr ⁻¹ (P.25, line 27-28) while the order required in mitigation scenarios are GtCO ₂ yr ⁻¹ ; (2) enhanced weathering has been demonstrated in the laboratory and in small scale field trials but is yet to be demonstrated at scale (P.27, line 45-46); (3) efficiency of ocean fertilisation depends on the region and experimental conditions and downward carbon transport is less than those observed during natural iron fertilisation (P.30, line 13-15); (4) very few studies have explored the impact of elevated alkalinity on ocean ecosystems (P.30, line 24). It is suggested to revise this sentence in such a way to avoid painting an overly optimistic and promising picture of CDR technologies.	SAI MING LEE	China	accepted - text revised to include caveats	
46879	89	12	89	18	The evidence provided is not sufficient to support the supposedly moderate to large potential. The risks and environmental effects of ocean-based approaches are not mentioned. The environmental impact of these measures on the terrestrial environment is also not mentioned. The missing <u>information should be explicitly added in chapter 12.</u>	Government of Germany	Germany	accepted - text revised to include caveats	
46881	89	13	89	13	Please delete: "have moderate to large mitigation potential" replace with: "have small or uncertain potential" COMMENT: A moderate or even large potential of DAC is not supported by the literature <u>or the underlying report.</u>	Government of Germany	Germany	rejected - TS reflects chapter and literature. Additional caveats provided in <u>revised text</u>	
78731	89	13	89	15	this statement is not correct and not covered by the body of literature. There is NO lack of low-cost and low-carbon energy, as ALL energy requirement can be based on practically unlimitedly scalable solar PV (see Breyer et al. https://www.cell.com/joule/fulltext/S2542-4351(19)30413-1) where it is also shown that cost levels below the mentioned ones are achievable, if based on low-cost scalable <u>zero emission energy supply. Revision of this statement is required.</u>	Christian Breyer	Finland	rejected - TS reflects chapter and literature. Additional caveats provided in revised text	
29001	89	13	89	18	For a complete comparison, potentials for DACCS and potentials and costs for BECCS need to be given. Regarding costs given for DACCS, the lower end seems very optimistic and to be what is predicted could potentially be achieved until 2050. Numbers reported/claimed by DAC technology developers (Carbon Engineering, Climeworks, Global Thermostat) cover a range of 94-600\$/tCO ₂ .	Jasmin Kemper	United Kingdom (of Great Britain and Northern Ireland)	Provided in Table TS7	
46883	89	22	89	22	Please add: "and result in 'mitigation deterrence'. Therefore it is proposed that targets for negative emissions should be explicitly set and managed separately from existing and future targets for emissions reduction, to avoid mitigation deterrence". This would enhance transparency, and allow setting and managing separate targets and thus alleviate mitigation deterrence." See e.g. Geden O., Schenuit F, https://www.swp-berlin.org/en/publication/eu-climate-policy-unconventional-mitigation/ . Smith. https://www.nature.com/articles/s43247-021-00095-w?proof=t .	Government of Germany	Germany	Text substantially revised	
80173	89	22	89	25	This section should use the academic terms of art for each of these phenomena, namely; moral hazard, slippery-slope, technological lock-in, and polarization driving social and geopolitical conflict, which are used in each of the papers cited. Their omission both impedes understanding and policy relevance, <u>and threatens neutrality.</u>	Kelly Wanser	United States of America	Thank you for your comment. Noted	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
29003	89	26	89	30	Need to make the distinction more clear, the basic process steps described are very similar to conventional CCS. Important distinction is the CO2 concentration/source, as you mentioned this enables a certain degree of freedom for the location of DAC, which is not reliant on a point source but on an energy source (ideally zero-/low-carbon). Many point sources bring an energy source with them (although the use of CCS there results in a penalty of course). Regarding the CO2 concentration, point source capture is much more thermodynamically favourable, thus DAC has <u>higher energy requirements/costs</u>	Jasmin Kemper	United Kingdom (of Great Britain and Northern Ireland)	Accepted - Text substantially revised
46885	89	31	89	31	Please reformulate: "Geological reservoirs or mineralization have a potential for permanent removal". The percentage of leakage and the permanence is not completely certain (see 12.3.2.1).	Government of Germany	Germany	accepted - text revised to include caveats
74057	89	31	89	34	The utilisation of CO2 can also provide permanent storage via CO2 mineralisation in building material. Ostovari et al., have shown that all considered CCU technologies for mineralization could reduce climate impacts over the entire life cycle based on the current state-of-the-art and today's energy mix. Reductions range from 0.44 to 1.17 ton CO2e per ton CO2 stored. For all mineralisation pathways evaluated, the carbon footprint is mainly reduced due to the permanent storage of CO2 and the credit for substituting conventional products. Thus, developing suitable products is critical to realize the potential benefits in practice. Then, carbon capture and utilization by mineralization could provide a promising route for climate change mitigation. Current data suggests that up to 1 Gt per year of the cement market could be substituted by mineralization products. Di Maria et al., conducted an LCA of carbonated steel slag including CO2 capture and confirm that mineralization is a negative-carbon-footprint technology, since the amount of CO2 taken up and stored during the process is higher than the amount of CO2 emitted, considering the whole life cycle. While comparing the findings to Portland cement concrete blocks, they report GHG emission reductions of up to 77%. At endpoint, they report that concerning the damages to human health and ecosystems, the carbonated blocks have a lower impact compared to the traditional PC-based concrete, and an overall positive environmental impact. The manufacture of carbonated aggregates starts to be commercially established at global scale, and recent advances in technology include a mobile plant that directly utilizes flue-gas derived CO2 in the mineralisation process in the UK (Hills et al., 2020). At mid-term, direct air capture combined with CO2 mineralisation could allow creating negative emissions as CO2 will be removed from the atmosphere and store permanently in materials (Beuttler et al., 2019, Frontiers n Climate, 1 :10; SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2; Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496;Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93;Hills et al., 2020, frontiers in Energy Research, 8 :142.	Ana Machado	Portugal	Noted
29005	89	31	89	34	Not 'may not' but rather 'does not', except for some building materials which fall under the 'mineralisation' category mentioned in the previous sentence.	Jasmin Kemper	United Kingdom (of Great Britain and Northern Ireland)	Accepted - Text substantially revised

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If any fields are not readable, please ensure to expand relevant cells. If reading this in PDF format, please refer to the Excel format version of this document available on: https://www.ipcc.ch/report/ar6/wg3/downloads/drafts-and-reviews								
Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
83791	89	31	89	34	<p>The utilisation of CO2 can also provide permanent storage via CO2 mineralisation in building material (e.g. Ostavari et al., 2020, Di Maria et al., 2020) Ostovari et al., 2020 have shown that all considered CCU technologies for mineralization could reduce climate impacts over the entire life cycle based on the current state-of-the-art and today's energy mix. Reductions range from 0.44 to 1.17 ton CO2e per ton CO2 stored. For all mineralisation pathways evaluated, the carbon footprint is mainly reduced due to the permanent storage of CO2 and the credit for substituting conventional products. Thus, developing suitable products is critical to realize the potential benefits in practice. Then, carbon capture and utilization by mineralization could provide a promising route for climate change mitigation. Current data suggests that up to 1 Gt per year of the cement market could be substituted by mineralization products.</p> <p>Di Maria et al., 2020 conducted an LCA of carbonated steel slag including CO2 capture and confirm that mineralization is a negative-carbon-footprint technology, since the amount of CO2 taken up and stored during the process is higher than the amount of CO2 emitted, considering the whole life cycle. While comparing the findings to Portland cement concrete blocks, they report GHG emission reductions of up to 77%. At endpoint, they report that concerning the damages to human health and ecosystems, the carbonated blocks have a lower impact compared to the traditional PC-based concrete, and an overall positive environmental impact.</p> <p>The manufacture of carbonated aggregates starts to be commercially established at global scale, and recent advances in technology include a mobile plant that directly utilizes flue-gas derived CO2 in the mineralisation process in the UK (Hills et al., 2020). At mid-term, direct air capture combined with CO2 mineralisation could allow creating negative emissions as CO2 will be removed from the atmosphere and store permanently in materials (e.g. SAPEA, 2018, Beuttler et al., 2019).•Beuttler et al., 2019, Frontiers n Climate, 1 :10. •SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2. •Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496. •Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93. •Hills et al., 2020, frontiers in Energy</p>	Christian Breyer	Finland	Noted
66287	89	31	89	34	<p>CCU can also provide permanent storage via CO2 mineralisation in building material (e.g. Ostavari et al., 2020, Di Maria et al., 2020) Ostovari et al., 2020 showed that all considered CCU technologies for mineralization could reduce climate impacts over the entire life cycle based on the current state-of-the-art and today's energy mix. Reductions range from 0.44 to 1.17 ton CO2e per ton CO2 stored. Current data suggests that up to 1 Gt per year of the cement market could be substituted by mineralization products.</p> <p>Di Maria et al., 2020 conducted an LCA of carbonated steel slag including CO2 capture and confirm that mineralization is a negative-carbon-footprint technology, since the amount of CO2 taken up and stored during the process is higher than the amount of CO2 emitted, considering the whole life cycle. While comparing the findings to Portland cement concrete blocks, they report GHG emission reductions of up to 77%. At endpoint, they report that concerning the damages to human health and ecosystems, the carbonated blocks have a lower impact compared to the traditional PC-based concrete, and an overall positive environmental impact.</p> <p>The manufacture of carbonated aggregates starts to be commercially established at global scale, and recent advances in technology include a mobile plant that directly utilizes flue-gas derived CO2 in the mineralisation process in the UK (Hills et al., 2020). At mid-term, direct air capture combined with CO2 mineralisation could allow creating negative emissions as CO2 will be removed from the atmosphere and store permanently in materials (e.g. SAPEA, 2018, Beuttler et al., 2019).•Beuttler et al., 2019, Frontiers n Climate, 1 :10. •SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2. •Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496. •Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93. •Hills et al., 2020, frontiers in Energy</p>	Deepak PANT	Belgium	Noted

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
60405	89	31	89	34	<p>The utilisation of CO2 can also provide permanent storage via CO2 mineralisation in building material (e.g. Ostavari et al., 2020, Di Maria et al., 2020) Ostovari et al., 2020 have shown that all considered CCU technologies for mineralization could reduce climate impacts over the entire life cycle based on the current state-of-the-art and today's energy mix. Reductions range from 0.44 to 1.17 ton CO2e per ton CO2 stored. For all mineralisation pathways evaluated, the carbon footprint is mainly reduced due to the permanent storage of CO2 and the credit for substituting conventional products. Thus, developing suitable products is critical to realize the potential benefits in practice. Then, carbon capture and utilization by mineralization could provide a promising route for climate change mitigation. Current data suggests that up to 1 Gt per year of the cement market could be substituted by mineralization products.</p> <p>Di Maria et al., 2020 conducted an LCA of carbonated steel slag including CO2 capture and confirm that mineralization is a negative-carbon-footprint technology, since the amount of CO2 taken up and stored during the process is higher than the amount of CO2 emitted, considering the whole life cycle. While comparing the findings to Portland cement concrete blocks, they report GHG emission reductions of up to 77%. At endpoint, they report that concerning the damages to human health and ecosystems, the carbonated blocks have a lower impact compared to the traditional PC-based concrete, and an overall positive environmental impact.</p> <p>The manufacture of carbonated aggregates starts to be commercially established at global scale, and recent advances in technology include a mobile plant that directly utilizes flue-gas derived CO2 in the mineralisation process in the UK (Hills et al., 2020). At mid-term, direct air capture combined with CO2 mineralisation could allow creating negative emissions as CO2 will be removed from the atmosphere and store permanently in materials (e.g. SAPEA, 2018, Beuttler et al., 2019).•Beuttler et al., 2019, Frontiers n Climate, 1 :10. •SAPEA, 2018, Science Advice for Policy by EU Academies, Novel Carbon Capture and Utilisation Technologies-Research and Climate Aspects, Evidence Review Report, 2. •Ostovari et al., 2020, Sustainable Energy Fuels, 4, 4482-4496. •Di Maria et al, 2020, International Journal of Greenhouse Gas Control, 93. •Hills et al., 2020, frontiers in Energy</p>	Célia Sapart	Belgium	Noted
4615	89	35	89	42	<p>Row 37: Or used in CCUs, such as land reclamation projects, after enhanced weathering in a designated large greenhouse. (Myers and Nakagaki 2020. Direct mineralization of atmospheric CO2 using natural rocks in Japan. Environ.Res.Lett. 15:124018</p>	Glenn Bark	Sweden	Sections on CDR have be substantially revised
85277	89		91		<p>There is a potential to more closely build on the corresponding WGI assessment (linked to CDR) (asymetry of Earth system response to increasing / decreasing emissions ; level of knowledge on options and potentials). Missing link to the SROCC assessment of blue carbon potential.</p>	Valérie Masson-Delmotte	France	Sections on CDR have be substantially revised
64089	90	3	90	7	<p>This text on ocean fertilisation is purely descriptive. The key conclusion from the assessment seems to be buried in Table TS.6 where is states that there is a "likely decadal-scale return to the atmosphere of nearly all the extra carbon removed" (through ocean fertilization).</p>	Government of Canada	Canada	Sections on CDR have be substantially revised
81513	90	7	90	7	<p>Also is necessary understand other aspects (chemical, biological and physical) involved into ocean productivity process.</p>	Luana Ferreira	Brazil	Sections on CDR have be substantially revised
65585	90	8	90	10	<p>Should review the sentence about the definition of blue carbon. Suggestion "The term was used originally to refer to biological carbon sequestration in all marine ecosystems but it has also been currently (and increasingly) used to address carbon removal associated with rooted vegetation in the coastal zone, such as tidal marshes, mangroves and seagrasses."</p>	Mônica M. C. Muelbert	Brazil	Noted, corrected
64091	91	1	91	1	<p>Table TS.6: As per Canada's comment recommending the inclusion of summary information on AFOLU contributions to CDR to start section TS.5.7, we would also recommend information on AFOLU CDR be added to this table so that there is a single table providing information on the current suite of potential CDR approaches. Also, please clarify what the 'no data' in the last column means. If there are no data (on the role of these options in mitigation pathways), can it simply be stated that they are not incorporated in current IAMs? And thirdly, what does the "status (TRL)" column represent. Unclear.</p>	Government of Canada	Canada	Thank you for your comment. Accepted- the table has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
81515	91	2	91	2	What does mean 'TRL' into parentheses of status, Table TS.6	Luana Ferreira	Brazil	Thank you for your comment. Expanded form of TRL added in table caption	
78733	91	2	91	2	DACCS: the claim that DACCS would require water input is factually wrong and shall be corrected. Most DAC systems (all of the low-temperature solutions) can be run on zero water demand or even with water surplus. See details in Fasihi et al. (https://www.sciencedirect.com/science/article/pii/S0959652619307772). Such wrong claims shall be removed.	Christian Breyer	Finland	Sections on CDR have be substantially revised	
78735	91	2	91	2	DACCS: the cost range for DACCS is not fully inline with the full body of literature. See the cost results in Breyer et al. (https://www.cell.com/joule/fulltext/S2542-4351(19)30413-1), which would justify to set the lower limit to 50 USD/tCO ₂ .	Christian Breyer	Finland	Sections on CDR have be substantially revised	
78737	91	2	91	2	DACCS: this statement is not correct and not covered by the body of literature. There is NO lack of low-cost and low-carbon energy, as ALL energy requirement can be based on practically unlimitedly scalable solar PV (see Breyer et al. https://www.cell.com/joule/fulltext/S2542-4351(19)30413-1) where it is also shown that cost levels below the mentioned ones are achievable, if based on low-cost scalable zero emission energy supply. Revision of this statement is required.	Christian Breyer	Finland	Sections on CDR have be substantially revised	
29007	91	2	91	3	Interesting that DAC has a significantly higher potential than what is given for BECCS in other parts of this summary and some chapters. What are the conditions to achieve the higher end number? Unlimited access to low-carbon energy? This assumption might just be as questionable as unlimited access to sustainable biomass for BECCS. It is stated that DAC 'can be located anywhere'. This is not true, DAC has a certain degree and maybe a higher degree of freedom than other mitigation options such as CCS/BECCS but due to the high energy demand co-location with an (ideally low-carbon) energy source is required and for storage or utilisation of the captured CO ₂ further co-location might be favourable or required.	Jasmin Kemper	United Kingdom (of Great Britain and Northern Ireland)	Noted. Potentials have been checked and data confirmed based on the available underlying literature	
24597	91				This table TS6 does not include all CDR options which might be misleading by highlighting certain options among others: second part of this table found in chapter 12 is missing. Consequently title should be changed to reflect the addition. In addition, SR1.5 reported much detailed risks an impact, for instance concerning land use, which might be included in this table TS.6, citing SRCCCL, SPM B3.4.: "For projected socioeconomic pathways with low population, effective land-use regulation, food produced in low-GHG emission systems and lower food loss and waste (SSP1), the transition from low to moderate risk to food security, land degradation and water scarcity in dry lands occur between 1 and 4 million km ² of bioenergy or BECCS (medium confidence). By contrast, in pathways with high population, low income and slow rates of technological change (SSP3), the transition from low to moderate risk occurs between 0.1 and 1 million km ² (medium confidence)." {6.4; Cross-Chapter Box 7 in Chapter 6; Table SM7.6; Box SPM1}	Government of France	France	Thank you for your comment. Accepted- the table has been revised	
24551	91		91		Whatd does TRL mean in the first raw of Table TS.6 ?	Government of France	France	Thank you for your comment. Meaning of TRI added in table caption	
7461	93	1			This section is very well written, relevant and clear.	Debra Roberts	South Africa	Thank you for your positive comment.	
46887	93	1	93	26	Section 5.8: Gender should be included and addressed as cross-cutting issue in all demand-driven social aspects; gender aspects influence also structural conditions (institutions, technology, labour market etc.). Please also check in underlying chapter. (compare i.e.: EU Gendered Innovations report: https://ec.europa.eu/info/sites/info/files/research_and_innovation/strategy_on_research_and_innovation/documents/ki0320108enn_final.pdf)	Government of Germany	Germany	Noted, revised. Gender is included briefly in TS.6.3 (societal aspects of mitigation)	
53193	93	1	93	26	Ch12: The section does not highlight the potential challenges associated with achieving these demand side aspects, and only focuses on the positive side of the coin	Government of Saudi Arabia	Saudi Arabia	Accepted. The challenges facing mitigation options are addressed where appropriate	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
11401	93	8	93	8	The figures "50-80%" do not tally with the caption of Figure 5.7 in P.37 of Ch.5 (40-80%), Please check and revise as appropriate.	SAI MING LEE	China	Thank you for your comment. The data has been checked and updated accordingly.	
29469	93	8	93	9	To TS: We appreciate the quantification of demand side options.	Government of Norway	Norway	Thank you for your positive comment.	
29471	93	9	93	13	Please consider to elaborate the language about physical infrastructure similar to what is written in SPM C4.1 page 20, line 7-13.	Government of Norway	Norway	Accepted. Section revised. Language harmonised with the SPM	
7463	93	10			"Avoid" would also work in general consumerism, and by extension industry, which is not yet given prominence. The personal carbon footprint is largely determined by spending patterns – as indicated in Figure 28(a). Could the idea of "buying less stuff, especially things made of metal, plastic, chemicals, minerals – materials with a high carbon footprint" be included in Figure 28 (b)? This is part of the basic needs/sufficiency/demand side discussed so nicely in later paragraphs. It could also be included in Figure TS.30 perhaps?	Debra Roberts	South Africa	Thank you for your comment, this figure has been revised to ensure it is consistent with findings in the underlying report	
50041	93	14	93	15	The statement "Lifestyle changes can rapidly ..." needs qualification about conditions. For instance, a shift away from red meat could be controversial in some regions. The ES of Chapter 17 has a phrase "A rapid transition to sustainable development pathways is as desirable as it is difficult." This kind of qualification is desirable.	Masahiro Sugiyama	Japan	Noted. The phrase has been deleted	
85279	93		108		I am surprised that the enabling conditions for demand side shifts are not assessed. Key aspects are related to education, lifelong training (including for civil servants, teachers, policy makers etc), and information on carbon footprints.	Valérie Masson-Delmotte	France	Accepted, thank you. The section in the TS references enabling conditions for climate mitigation in general, including demand-side mitigation. This includes education, and the need to involve all actors	
50043	94	1	94	1	In panel (c) of Figure TS28, the leftmost "primary energy" bars do not match up, while others (final energy, etc.) do. Is this a small error?	Masahiro Sugiyama	Japan	Thank you for your comment. The data has been checked and updated accordingly.	
66595	94				Fascinating and comprehensive diagram, thanks. Somewhat confusing having darker and lighter blue for two different sectors, which then seem not consistent between c) and (d). Some classifications / attributions are puzzling (how is live car-free – Avoid – separate and additional to walking and cycling and use of public transit ?) And I am surprised EVs go into negative – I have not seen any recent evaluations which conclude that. Vehicle efficiency used to be a big deal.. Surprised if materials don't feature on the left, but then space is limited. Sorry not time or expertise to dig into detail though	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted.	
24499	94		94		The report should put a much stronger emphasis on the issue. Indeed, when dealing with behavioural change (sometimes called socio-behavioural change), nudging seems the main, if not the only driver considered. Social (btw, rather than "societal"), technological and institutional changes are instrumental to produce durable, persistent and sustainable transformation - including at an individual level. On the contrary, the literature on nudges stresses the issue of the long-term effects of nudging and shows there is mixed evidence of it. See for example, 1) Bergeron, H. et al. (2018), Le Bias comportementaliste. Presses de Sciences Po. 2) Dupas, P. (2012). Health behavior in developing countries, Annual Review of Economics, 3, 1–39; 3) Giné, X., Karlan, D., & Zinman, J. (2010). Put your money where your butt is: A commitment contract for smoking cessation. American Economic Journal: Applied Economics, 2, 213–235; 4) Gneezy, U., Meier, S., & Rey Biel, P. (2011). When and why incentives (don't) work to modify behavior. The Journal of Economic Perspectives, 25, 91–209. Therefore, building the entire strategy for changing behaviour on nudging hazardous at best. Indeed, this has to do with how demand-side mitigations are regarded: beyond technologies and infrastructures, the social domain is regarded as synonymous to (implicitly) individual behaviours, or even "lifestyle options". In this respect, preferences seem to be taken for granted, while it could be argued that a key driver to implement persistent transformations through the demand-side requires changing the very preferences through an action on social norms.	Government of France	France	Thank you for your comment. This section has been revised	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
24553	94		94		The meaning of the 3 blue arrows "Improve", "Shift - Shift" and "Avoid" in Panel c) of Figure TS.28 is not clear and we do not see how it applies to the blue horizontal and vertical arrows drawn in the upper part of Panel c).	Government of France	France	Thank you for your comment. A note behind an asterisk was added to highlight what the primary energy arrows relate to. The colours of the arrows have also been revised to <u>enhance contrast</u> .
66597	95				This in principle is useful diagram but I have one major reservation. Many options hinge on combination of technology and behaviour. Indeed the UK Climate Change Committee, Sixth Carbon Budget, has a great chart which indicated that something like 40% of net zero could arise from combinations which combine behaviour and technology choices, notably, EVs and heat pumps. And of course EVs to important degree hinge on infrastructure. So this may need rethinking ...	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. This figure has been revised to further highlight the interlinkages between behaviour and technology. The caption has also been updated <u>accordingly</u> .
24555	95		95		We recommend to clarify the meaning of the graphs related to electricity in Figure TS.29, in particular with regards to "sector coupling". We suggest to replace "Emissions 2050" with "Potential reduced emissions 2050" and to replace "Residual emissions" with "Non potentially reducible emissions 2050" in the top left caption.	Government of France	France	Accepted. The terms are clarified.
46889	96	1	96	35	The title of the box does not match its content. This box briefly touches upon the significance of social science but then addresses shifts in approaching decision making in the IPCC. It would be useful to revise the box and enhance focus by describing the evolution of "models of decision making" in more detail, including an explanation of the AR6 approach.	Government of Germany	Germany	Noted. We change the title of the Box. Now it includes the disciplines mostly covered in the chapter. The box has very limited space allocation. So, purpose of the Box is only to flag that a new chapter with supplementary material has allowed to include new emerging literature in the intersection of branches of social science and mitigation and how they have been reflected in underlying chapter 5. So, it is to flag where more details can be found. The assessment is reflected in presentation of mitigation potentials in Figure TS.29 with a different framing where socio-behavioral, structural and technological contributions from demand side are presented.
46891	96	1	96	35	BOX TS-11 on Social Science in this report should please include information on the added-value of gender research/gender perspectives in social science. Please also include this aspect in the underlying chapters. References: How Gender Can Transform the Social Sciences Innovation and Impact. By Marian Sawer/Fiona Jenkins/Karen Downing (eds.), Springer: https://link.springer.com/book/10.1007/978-3-030-43236-2#toc Woodward, K., Woodward, S. Gender studies and interdisciplinarity. Palgrave Commun 1, 15018 (2015). https://doi.org/10.1057/palcomms.2015.18 Gender and Environmental Studies, by Mary Buchanan/Phoebe Godfrey/Emily Kaufman in: Women's and Gender Studies, by (ed.) Nancy A. Naples (2020), https://doi.org/10.1007/978-1-4939-9414-9_14	Government of Germany	Germany	Noted. Gender perspective and mitigation implications have been included in the Underlying chapter in section 5.2). Limited space of the Box does not allow to include all the dimensions. Specific mention of gender studies mentioned now in revised version with other disciplinary approaches. Apologies about that. This box is only to flag that a new chapter has been added in AR6.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
20283	96	1	96	35	Box TS -11 Social science in WG-IIIAR6.... Very good idea to include the connection between the social science and the mitigation of climate change. Really it's an interesting new perspective to <u>review the increasing new peer literature on the topic.</u>	Avelino G. Suarez	Cuba	Thank you
66599	96	41	96	43	Is the general finding represented sufficiently in the SPM – should be	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted, checked for consistency between the two summary products
77301	96	46			Change "renewable" with "low-carbon".	Giacomo Grasso	Italy	Thank you for your comment on harmonisation of terms across the TS. This section has been substantially revised. 'Renewable' is used where appropriate, as is 'low-carbon'
84753	97	3	97	4	This is a key finding, and highly policy relevant, so it should be lifted to the SPM.	Kaisa Kosonen	Finland	Noted, thank you. Messages on demand-side mitigation have been strengthened in the SPM
46893	97	7			For which time period do these figures apply?	Government of Germany	Germany	Thank you for your comment. This section has been substantially revised, and data checked accordingly
66601	97	12		13	Surely, Can be more culturally-appropriate – not definite?. Also is there a risk of overlooking in this presentation of findings the contribution of traditional energy efficiency policies?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted, this section has been substantially revised
46895	97	12	97	15	We do not understand the first sentence, and its relation to the rest of the paragraph is unclear. Please revise.	Government of Germany	Germany	Noted. This paragraph has been revised
50045	97	17	97	18	Demand-side measures are heterogeneous and face different barriers. Does it make sense to lump them together? Is this useful for policymakers? At least, a little more qualification is desirable.	Masahiro Sugiyama	Japan	Noted, this section has been substantially revised and material better integrated with other findings in this TS section
46897	97	24	97	27	What is meant with "service levels", and what is the share of the additional energy demand in the total energy demand?	Government of Germany	Germany	Noted, this section has been substantially revised and material better integrated with other findings in this TS section
64093	97	27	97	27	Is this estimate of energy needs to provide decent living standards for all tied to specific population assumptions in 2050? If so, what are these?	Government of Canada	Canada	Thank you for your comment. This section has been substantially revised, and data checked accordingly
53195	98	6	98	15	Ch12: The concept of the circular carbon economy was endorsed during the G20 meeting (https://www.cceguide.org/guide/). Include.	Government of Saudi Arabia	Saudi Arabia	Thank you. The TS includes a Box on Circular Economy (Box TS.12). This highlights the increasingly important role that the circular economy is playing as a mitigation approach.
46899	99	1			Figure TS.30 seems to provide oversimplified information. We doubt that almost all options can be associated with high confidence (4 stars) for all regional, social and cultural contexts world wide. Please revise keeping in mind the high quality standards of the IPCC.	Government of Germany	Germany	Thank you for your comment. The data underpinning this figure have been checked and enhanced. Full details on the underlying literature can be found in Ch5
67465	99	1	99	2	Under co-benefits, a nuancing is needed and that is the period over which such co-benefits are possibly available. Presenting them as curretly done, for example for ocean alkalinity enhancement could lead the reader to think that it is a solution to ocean acidification. Or, that is not the case. The same for ocean fertilization with the co-benefit of reduced upper acidification.	Philippe Tulkens	Belgium	Noted thank you, this section has been substantially revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
67467	99	1	99	2	Very complex figure. NBSs are portrayed as neutral - why not positive?	Philippe Tulkens	Belgium	Noted. This figure has been revised to enhance visual design and the data <u>has been checked</u>
67469	99	1	99	2	Overconsumption is portrayed as neutral on water. Why not positive? Reducing overconsumption will have a positive impact on water as well.	Philippe Tulkens	Belgium	Noted. This figure has been revised to enhance visual design and the data <u>has been checked</u>
67471	99	1	99	2	SDG14 is not included in the table.	Philippe Tulkens	Belgium	Noted, thank you. The assessment is based on the underlying literature of linkages to the SDGs
14371	99	1	99	3	Figure TS.30, from chapter 5, is really complex, to the extent that I wonder how useful it is. Moreover, there is overlap with table TS.10. Both tables are so intricate, it's really difficult to cross-compare, but it would be good to make sure there are no contradictions between them. I would recommend that, for the TS, there be just one table focussing on the SDGs. Also, why is this a figure? It is clearly a table (with rows and columns).	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Noted. This figure has been substantially revised and linkages between the two figures have been checked and confirmed
50047	99	1	99	3	The caption (Figure TS30) is not inadequate and should provide enough information so that the readers can understand.	Masahiro Sugiyama	Japan	Noted, thank you. Additional linking material that refers to this figure has been added in the text to highlight <u>what the figure is showing</u>
66603	99				The co-benefits are largely cast in terms of SDGs, which I think is fine. But the huge overlap – and some inconsistencies – between “Figure TS.30” [why Figure?] and Table TS.10 is just confusing. This data really should form the core of evidence for net co-benefits in low carbon transitions and we don't want confusion. Somehow they need to synthesised into one, or one dropped from TS with a chapter cross-reference instead, or otherwise radically changed to relate to the other more sensibly.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. This figure has been substantially revised and linkages between the two figures have been checked and confirmed
66605	99				Note big questions in sharpening consistent understanding re co-benefits .. Important	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted, thank you
3463	99		99		Figure TS.30 Need a longer figure captions to explain. The text on p. 97, line 4-6 says “Decent Living Standards (DLS) is a benchmark of material conditions for human well-being and overlaps with many Sustainable Development Goals (SDGs) {Figure TS.30}.” The figure is trying to relate demand side mitigation options to “well-being dimensions”. The “wellbeing dimensions” can in turn be related the SDGs. Also, are you just addressing the energy demand in each sector? Figure TS.30 is not mentioned anywhere else. Is it necessary to include the Figure in the TS? What is a “social discount rate”? Please define.	Malcolm Ko	United States of America	Thank you for your comment. The caption has been revised
46901	100	12				Government of Germany	Germany	Noted. This section has been rewritten. Throughout the TS, efforts were made to ensure definitions are <u>provided where appropriate</u> .
46903	100	13			Please replace “response measures” by “response options” since the first has a very specific meaning in the UNFCCC. Please check throughout the report.	Government of Germany	Germany	Noted, corrected
66607	100	18			Sectoral assessments may also have far more potential policy relevance, since the large majority of practical policy decisions are taken at sector level, by sectoral ministries	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted, thank you
46905	101	1			Please add to the title of table TS.7 the wording on page 104-5 to 7 (“table o be interpreted with care”) since this guidance is essential to avoid misinterpretation of the results.	Government of Germany	Germany	Thank you for your comment. Table <u>has been deleted</u> .
29009	101	1	101	1	It is mentioned that the potentials presented for the energy sector are indicative and placeholders, this is somewhat concerning, information presented in the Technical Summary should be more reliable. The range given for 'Bioenergy with CCS' under AFOLU sector also seems different from the Summary for Policymakers, which also gave median 0.8 GtCO2/a but for a range of 0-6 and didn't mention an additional technical potential of 4 Gt but rather some additional mitigation of up to 7 Gt across bioenergy in general from substitution.	Jasmin Kemper	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Table <u>has been deleted</u> .

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
78739	101	1	101	1	cost for GHG emission reduction of PV is for sure wrong. This is rather in the category of <0 and higher. Bogdanov et al. (https://www.nature.com/articles/s41467-019-08855-1) found a substantial potential to reduce power system cost compared to the present, mainly driven by solar PV - that's completely missing. Even worse, results based on IAMs are massively biased against solar PV as clearly documented by Jaxa-Rozen (https://www.nature.com/articles/s41558-021-00998-8) compared to non-IAM scenarios. A major revision of this item has to be carried out for a proper assessment of the potential of solar energy. The GHG reduction potential by solar energy is MUCH higher and for less cost. See also the scenario results of Ram et al. (http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf ; scenario in AR6 scenario database), which finds high benefits for a stongly solar energy based energy system across sectors.	Christian Breyer	Finland	thank you for your comment. the data has been checked based on the available underlying literature
8193	101	1	103	1	Table TS.7.; "Land-based mitigation ..." (page 101): Please delete "s change" from "other land-uses change options", since the framework you refer to is called "other land use" and should not be confused with "LULUCF". Besides, the options mentioned (fire prevention, peatland restoration) do not require land-use change.	Joachim Rock	Germany	Thank you for your comment. Table has been deleted.
8191	101	1	103	1	Table TS.7.; "Land-based mitigation ..." (page 101): Please change the order to "afforestation, reforestation, reducing deforestation". The text as it is now could be misunderstood as e.g. "reducing reforestation".	Joachim Rock	Germany	Thank you for your comment. Table has been deleted.
77093	101	1	103	30	Comment #3 particularly applies on the real and unaffordable costs of mitigation.	Jim O'Brien	Ireland	Noted
7465	101				Table: it is not clear what are the units of the numbers? What does a value of 0.3 actually mean? What is the time frame? Per year? This looks like it could be very useful information but clear explanations would help.	Debra Roberts	South Africa	Thank you for your comment. Table has been deleted.
66609	101				AS flagged in my comment to the corresponding Figure in the SPM (SP<M.9), and TS.31: I confess I was quite sceptical about this effort, but I think focusing it on 2030, and cost ranges, has addressed many of my concerns – congratulations. I am not sure if table gives enough added value to take 3 pages in the TS – the Figure TS.31 may suffice? I wonder if the presentation could be clearer – more like sectoral cost-curves, so that one can see visually the relative costs rather than have to cross-refer to colour codling? This might also facilitate an indication that options at higher cost end may have scope for strategic investment to lower costs?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Table has been deleted.
77303	101				The GHG emission reduction potential for nuclear (0,44) seems to strongly underestimate the actual potential, which could be comparable if not superior to that of vRES depending on the policies (as in the case of France or Sweden). Also, the indicated cost categories do not account for the anticipated reductions in cost for NOAKs, stating instead (some of) the current experiences on FOAKs.	Giacomo Grasso	Italy	Thank you for your comment. Table has been deleted.
64095	101		101		Table TS.7: the title should reflect that these values are for the year 2030 (as per text on page TS-100 line 19).	Government of Canada	Canada	Noted. This table has been removed as the data is presented in a figure (Figure TS.23)
28657	101		101		Table heading should include 2030 to avoid confusion	Tim Dixon	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Table has been deleted.
15841	101		103		Table TS.7: "Detailed overview of GHG emission reduction potentials (GtCO ₂ -eq) in the various cost categories". This table and its interpretation is very misleading. See my detailed remarks on this Table in chapter 12 (Table 12.2).	Jean-Michel Trochet	France	Noted. This table has been removed as the data is presented in a figure (Figure TS.23)
29011	102	1	102	1	Does 'Biofuels' include biofuels with CCS, such as corn-based ethanol with CCS? This can be delivered at costs below \$50/tCO ₂ (McLaren, D., 2012. A comparative global assessment of potential negative emissions technologies. Process Safety Environ. Protect. 90, 489–500.)	Jasmin Kemper	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Table has been deleted.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
64097	102	1	102	1	There are duplicate lines with different information for "LDV - fuel efficiency" and "LDV - electric vehicles", please check	Government of Canada	Canada	Noted. This table has been removed as the data is presented in a figure (Figure TS.23)	
24557	102		102		The corresponding ter for "increased use" in chapter 7 is "enhanced use", which is more appropriate. Indeed, the is strong evidence that increased use would result in higher emissions, at least until 2050. The wording should therefore be changed to "Enhanced use of wood products (eg. shift from short-lived uses such as paperboard to long-lived uses such as construction).	Government of France	France	Thank you for your comment. Table has been deleted.	
29013	103	1	103	1	The note on DACCS is important and needs to be highlighted/mentioned in other parts of the summaries or chapters that discuss DACCS and cite large technical potentials.	Jasmin Kemper	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Table has been deleted.	
24559	103		103		Table TS.7: Please specify what TRL means in the bottom-right cell. It would be useful to explain in the legend the meaning of negative cost categories: it is clear when it is a reduction obtained through increased efficiency but it is less clear for wind energy. Explaining how there are negative cost data for wind and not for solar would be useful.	Government of France	France	Thank you for your comment. Table has been deleted.	
7467	104	1	104	6	Please could you give an example of where one option affects another, or where they are mutually exclusive, to help the reader understand.	Debra Roberts	South Africa	Noted thank you. The caption has been expanded, and further detail provided in the underlying report	
7685	104	10	104	10	Replace "HFC" to "CFC, HCHF and HFC"	MASAAKI OKABE	Japan	Noted. This section has been substantially revised and more information presented in figure format	
64099	105	2	105	2	Will empty rows be filled in the next version?	Government of Canada	Canada	Thank you for your comment. Table has been deleted.	
2439	105	2	105	3	It is necessary to fill in the blanks in the table for sectors other than the industrial sector.	Nyun-bae Park	Republic of Korea	Thank you for your comment. Table has been deleted.	
46907	105	3			It is unfortunate that the information in this table is too sparse to allow reviewing it.	Government of Germany	Germany	Thank you for your comment. Table has been deleted.	
66611	105	10		12	This stated gulf between sectoral and IAM assessments for AFOLU seems a rather important observation ! Deserves cross-chapter discussion / explanation	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted	
46909	105	10	105	12	Please explain this difference between IAM and sectoral analysis in more detail for uninformed readers.	Government of Germany	Germany	Text substantially revised	
7469	105				A landscape format would make the text easier to read.	Debra Roberts	South Africa	Noted, corrected	
28263	105		105		Table TS.8: information for all sectors to be added.	Eleni Kaditi	Austria	Thank you for your comment. Table has been deleted.	
46911	106	1			Do these emission reduction potentials reflect theoretical technological potentials or do they include other factors that would determine the real potential, including costs, infrastructure constrains and political acceptance?	Government of Germany	Germany	Text substantially revised	
64101	106	1	106	1	There is overlap between Table TS8 and Figure TS31, maybe there is a way to merge both	Government of Canada	Canada	Accepted. Figure TS.31 has been made more clear, and makes reference to the full data tables that are available in the underlying reports	
81517	106	1	106	1	Better display the charts from figure TS.31, using the entire page because the current visualization of the information is very small. Put aside only 2 charts per layer, e.g. energy and agriculture in the upper layer, buildings and transport in the intermediate, and industry and others in the lower.	Luana Ferreira	Brazil	Accepted. This figure has been revised substantially to enhance visual design.	
53197	106	1	106	5	Ch12: The figure font is too small to read.	Government of Saudi Arabia	Saudi Arabia	Accepted. This figure has been revised substantially to enhance visual design.	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
7471	106				Figure: consider including reduced general consumption of 'stuff' (especially items made of high-carbon footprint materials) by consumer society, ref TS 6.1.	Debra Roberts	South Africa	Thank you for this suggestion. The figure has been revised and the assessment in the figure is based on <u>the latest available literature</u> .
77305	106				The figure reflects the data of Table TS.7, so an adjustment is recommended according to the previous comment.	Giacomo Grasso	Italy	Noted, thank you. Figure TS.31 has been made more clear, and makes reference to the full data tables that <u>are available in the underlying reports</u>
24561	106		106		In order to clarify the messages conveyed in Figure TS.31 about the energy sector (top left graph), we recommend to specify where the quantified reductions expressed for wind energy, solar energy, nuclear energy, bio-energy, hydropower and geothermal energy are coming from: replacement of a part of the baseliien scenario fossil-fuel energy with these energy sources, increase in the share of <u>these sources with respect to the base-line scenario ... ?</u>	Government of France	France	Accepted, thank you for your comment. The caption of the figure now makes clear that the values are relative to a specified emission <u>baseline that reflects current policies</u>
46913	107	1	109	20	Section 6.1 on Enabling Conditions should please provide a reference to gender-gaps in behaviour/demand (i.e. carbon footprint or vegetarianism). Please also include this aspect in the underlying chapters. (References: - Thereza R.S. de Aguiar, Anne Fearfull & Maria V. Sanagustin Fons (2016) Calculating the carbon footprint: Implications for governing emissions and gender relations, Accounting Forum, 40:2, 63-77, DOI: 10.1016/j.accfor.2016.04.001 - UBA Texte 30/2020, p.67-68, https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2020-02-06_texte_30_2020_genderspekte_klimapolitik.pdf	Government of Germany	Germany	Thank you for your comment. These references have been passed to the relevant underlying chapters. Please note that the Technical Summary does not include references as it is a summary product, but includes line of sight to the underlying chapters where the relevant material is covered
53199	107	1	109	20	Ch5: There is little mention of how social aspects may differ in the context of least developed nations where having access to basic needs or the necessary governance/institutional capacity may be lacking. <u>Include.</u>	Government of Saudi Arabia	Saudi Arabia	Thank you for your comment. This section has been revised and context-specificity included
66617	107	2	109		Welcome to see confidence statements coming in, but what about evidence statements? And generally, I think a lot of people may find the language difficult and conceptual	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted thank you. This has been revised accordingly
72255	107	12	107	20	While the section is fine, it is not clear while other chapters covering the same topic are not cited here. For example 9.9 convey the same message and therefore shall be added in the citation in the {...}	bertoldi paolo	Italy	Noted thank you. Cross-references have been added where appropriate
67473	107	12	107	20	While the section is fine, it is not clear why other chapters covering the same topic are not cited here. For example 9.9 convey the same message and therefore should be added in the citation in the {...}	Philippe Tulkens	Belgium	Noted thank you. Cross-references have been added where appropriate
66619	107	21			The Avoid-Shift-Improve is very useful as a categorisation of service/demand-side options. But in general the language in this section may be hard for some readers to follow, and it risks being hard to get at the real substance behind the concepts. It is certainly very different from some of the language, and more empirical content. Might be worth testing some of the language against people not deeply into this kind of social science, and asking the "so what" question on what might a <u>decision-maker take from it?</u>	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. This section has been substantially revised to enhance accessibility
66621	107	21			what does the word domain mean here? It is a word used in various ways in different contexts (in relation to transitions, the Planetary Economics book uses it to describe different types and actors of decision-making in quite specific ways: the material covered in Chapter 5 illuminates hugely issues in "First Domain" (individual & localised) behavioural choices of small actors, as well to an important degree, large-scale "Third Domain" social process of systemic change - and its charts well their interdependencies, which I find really helpful. But I don't think that is how the word here is being <u>used?</u>	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. This section has been substantially revised to enhance accessibility
15435	107	32	107	33	"Error! Reference source not found." appeared.	Hiroaki Kondo	Japan	Thank you, corrected
33115	107	32	107	33	Missing sources.	Beibei Liu	China	Thank you, corrected

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
30345	107	32	107	33	Error where reference is not appearing	Vanessa Lamers	United States of America	Thank you, corrected
72257	107	34	107	42	It is very positive seeing also the sociological dimension mentioned here, in particular the role of social norms.	bertoldi paolo	Italy	Thank you for your positive comment.
67475	107	34	107	42	It is very positive to see also the sociological dimension mentioned here, in particular the role of social norms	Philippe Tulkens	Belgium	Thank you for your positive comment.
66613	107				<p>Section title: I would suggest to avoid this title for at least two reasons. First there are some inconsistencies, albeit mostly minor, between the 'lists' of what constitute enabling conditions – compare titles in this section to SPM para E1 and Chapter 4, Figure 4.7 (and the almost-corresponding Chapter 1, Fig 1.4). Second, I really struggle to think of some of these as “enabling”. What is “being enabled”? Surely policy is implementation; the enabling factors concern governance, capacity, etc.</p> <p>And, we’ve jst read a section called “demand-side aspects of mitigatin”, now we have one, now the first “Enabling condition” is a section called “demand, services and social aspects of mitigation”</p> <p>For simplicity, if the broad coverage is maintained, maybe call the overall section – if it is to be overall - Implementation and Enabling Factors?</p> <p>And at minimum I would think it needs a scene-setting para or two on the “high level” need for directional signals and shaping of transparency in economic-climate decision-making across multiple sectors, the value of learning from experience in a process which concerns shifting the evolution of multiple sectors and development pathways, etc = as well as the more specific governance issues?</p>	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. The section title has been updated to reflect the broad material covered in this section
66623	107				At present this section, partly from its language and concepts, seems very hard to relate to major themes in the Tech Sum, or the or the classification attempts eg. through Feasibility & Enabling Conditions / Dimensions of Assessment / Analytic Frameworks [see Ch.1 which tried to grapple with this]	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted, thank you. This section has been substantially revised. This includes harmonising concepts, and moving material to ensure a consistent narrative runs throughout the section and the entire TS.
66615	107		130		More radically: Having read the TS in full, I suggest to consider restructuring to bring key empirical material from section TS.6.2 (especially) forward to the suggested section “Where we are and how we got here”. I believe this would give the TS a much more solid and integrated grounding, much more useful for policymakers. Policymakers really want evidence, and some indication of what efforts over the past of decades have delivered, and taught us. The TS is the place to bring that together. At present, much of core evidence from experience, some of the richest and most convincing material for policymakers, appears intermittently from about page p.110 onwards – in the summary document! This risks being almost useless, and precludes any chance of an integrated, multi-disciplinary narrative that combines the earlier highly technical and modelling analysis with any sense of what we have learned about implementation and impacts. See also my cross-cutting comments on restructuring rest of TS.6 to enhance integration and relevance	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. The structure of the TS has been revised and streamlined. Material has been moved accordingly
72259	108	11	108	16	Again, this message is not only coming from Chapter 5. The role of One-stop and facilitators is also clearly described in 9.9.2, it is recommended to add it.	bertoldi paolo	Italy	Thank you for your comment. Material in this section mostly draws from the policy chapters and so line of sight is mainly back to those chapters. More cross-cutting findings have been added, especially in the form of boxes throughout the TS

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
67477	108	11	108	16	This message is not only coming from Chapter 5. The role of One-stop and facilitators shops is also clearly described in 9.9.2 please add it.	Philippe Tulkens	Belgium	Thank you for your comment. Material in this section mostly draws from the policy chapters and so line of sight is mainly back to those chapters. More cross-cutting findings have been added, especially in the form of boxes throughout the TS
28265	108	18	108	19	Delete "Lobby activism ('merchants of doubt'), protecting rent extracting business models, prevent political action."	Eleni Kaditi	Austria	Noted, thank you. This section has been substantially revised.
50049	108	38	108	39	COVID-19 is a short-term crisis, and that was the reason why we had a swift change. Climate change is different and a long-term issue. The wording should be changed to reflect the different nature of COVID-19.	Masahiro Sugiyama	Japan	Noted, thank you. This section has been substantially revised.
72261	108	38	109	2	This is partially correct, but also legislation played a big role in "forcing" people to stay home, closing social event, imposing face masks, etc. This is a very important lesson learnt for climate change, if information for behaviour change and other soft mechanisms are not enough, then mandatory policy measures are needed, and if well justified (e.g. climate emergency) would be accepted by citizens and business.	bertoldi paolo	Italy	Noted, thank you. This section has been substantially revised.
67479	108	38	109	2	This is partially correct, but also the key role of regulation played a big role in "forcing" people to stay home, closing social event, imposing face masks, etc. This is a very important lesson to be learnt for climate change, if behaviour in not enough, then mandatory policy measures are needed, and if well justified could be accepted by people.	Philippe Tulkens	Belgium	Noted, thank you. This section has been substantially revised.
15437	109	1	109	2	"...action is possible is possible." Isn't "is possible" duplicated?	Hiroaki Kondo	Japan	Accepted, thank you, this has been corrected
81519	109	1	109	2	The words 'is possible' are repeated x2.	Luana Ferreira	Brazil	Accepted, thank you, this has been corrected
72263	109	3	109	3	Again this very important points are also discussed in 9.9 and perhaps in other chapters, it is recommended to cite them.	bertoldi paolo	Italy	Thank you for your comment. Material in this section mostly draws from the policy chapters and so line of sight is mainly back to those chapters. More cross-cutting findings have been added, especially in the form of boxes throughout the TS
67481	109	3	109	6	Again this very important points are also discussed in 9.9 and perhaps in other chapters, it is recommended to cite them	Philippe Tulkens	Belgium	Thank you for your comment. Material in this section mostly draws from the policy chapters and so line of sight is mainly back to those chapters. More cross-cutting findings have been added, especially in the form of boxes throughout the TS
7473	110	1			Section: It would be great to see some more numerical evidence in this section, where possible. For example "Media coverage of climate change increased notably and influenced public discussion, but such increases were not evenly distributed among countries (high confidence)." Or "The majority of climate change litigation cases..." or "Citizens in developed nations report higher awareness of climate change than in developing nations..." or "substantial share" P112 – many other examples of words suggesting that there are numerical data available	Debra Roberts	South Africa	Accepted. Section thoroughly revised
7475	110	2			Section I: Is there evidence that, at a country (or sector) level, climate laws have reduced emissions more than in countries where there are no such laws? Is there an association? And then further, what kind of climate laws are associated with the biggest emissions reductions?	Debra Roberts	South Africa	Accepted. A box on Policy Attribution added A table on Signs of Progress and Continuing Challenges added

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66625	110				This - particularly the empirical material - is quite an abrupt transition; in my general remarks I suggest it would be great to move the empirical material much earlier, as part of analysing trends to date in ways which combine numbers and policy/legislation. Either way, given that AR5 had very little analysis on the trend or drivers of policies, it would be good to start this material with a sentence on likely drivers of policy coverage to 2007 (and whether this largely covered emissions coverage in Annex I, explaining why DEV coverage actually seems to go down - which could easily be misinterpreted). Also - maybe clarify how much of "RoW" is covered also in terms of % (or emissions or population?)	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Section restructured
72265	111	25	111	29	This is very important. Local authorities are also much closer to citizens and communities, therefore local policy making is more likely to include their views.	bertoldi paolo	Italy	Noted. Thank you.
67483	111	25	111	29	This is very important. Local authorities are also much closer to citizens and communities, therefore policy making is more likely to include their views.	Philippe Tulkens	Belgium	Noted. Thank you.
66627	111		114		The rest of the section has some overlap in concepts, if not in language, with the previous section derived from Ch.5. It would also help if the material could be better linked with some of the attempts to structure or identify common themes, eg. Feasibility & Enabling Conditions / Dimensions of Assessment / Analytic Frameworks [see Ch.1 which tried to grapple with this]	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Section restructured
29457	112	25	112	26	Please consider to add a sentence to elaborate about earmarking such as in the SPM page 33 line 37-38.	Government of Norway	Norway	Noted- paragraph revised
46915	112	37	112	44	Based on this paragraph and in addition to figure TS.32, a figure about the global coverage of GHG emissions subject to mitigation policies in different sectors might be a very valuable supplement here (similar to chapter 13: figure 13.3 on G20 emission coverage; here sources are cited as well for global data: e.g. Eskander and Fankhauser 2020).	Government of Germany	Germany	Noted. A box on Policy Attribution added. A table on Signs of Progress and Continuing Challenges added.
60157	112	41	112	44	Geothermal energy production or other groundwater abstraction activities (eg thermal water) may also have CH4/CO2 emissions, which could be reduced. Technology for degassing and recovery of accompanying gas is available but maybe not implemented everywhere.	Government of Hungary	Hungary	Thank you for your comment. Noted
72269	112	45	113	3	It is worth considering how this could be aligned with the feasibility assessment of the mitigation options.	bertoldi paolo	Italy	Noted. Section revised and restructured
67485	112	45	113	3	It is worth considering how this could be aligned with the feasibility assessment of the mitigation options.	Philippe Tulkens	Belgium	Noted. Section revised and restructured
85281	112		112		The role of educating is absent here. The statement lines 23 to 24 is challenged by a few international surveys that have been recently performed on awareness of climate change across countries (e.g. https://www.edf.fr/en/climate-international-observatory-results/ , or https://www.undp.org/content/undp/en/home/news-centre/news/2021/Worlds_largest_survey_of_public_opinion_on_climate_change_a_majority_of_people_call_for_wide_ranging_action.html)	Valérie Masson-Delmotte	France	Noted. Section revised and restructured
66629	112		113		Section III - good material, would be nice to tie it even tighter with links to existing frameworks, theories and rationales for policy diversity. Economics tend to present these as "second best", justified by market failures, but there are to my mind much better and more useful (no surprise, among these I am thinking of Three Domains / Three Pillars in the book Planetary Economics and the subsequent academic papers)	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. Section revised and restructured
29459	113	4	113	11	To TS: When the report is discussing carbon pricing it is relevant to also discuss fossil fuel subsidies due to its opposite effect on carbon pricing. Please insert text on fossil fuel subsidies based on findings in the report (see e.g. TS page 114, line 22-26 and TS page 125, line 14-21). We propose to include: Elimination of fossil-fuel subsidies would make a significant contribution to the temperature and mitigation goals. By keeping prices to consumers artificially low, fossil fuel subsidies encourage wasteful consumption, disadvantage renewable energy and drain scarce public resources that could be better spent on other sustainable developments goals	Government of Norway	Norway	Thank you for your comment. The text has been substantially revised to ensure a balanced assessment. Consideration of fossil fuel subsidies is given in Section TS6.1.

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
72267	113	4	113	11	The role of carbon tax and the recycling of revenues are described in details in 9.9.3, therefore it must be cited it in this sentence.	bertoldi paolo	Italy	Thank you for your comment. Material in this section mostly draws from the policy chapters and so line of sight is mainly back to those chapters. More cross-cutting findings have been added, especially in the form of boxes throughout the TS
67487	113	4	113	11	The role of carbon tax and the recycling of revenues are described in details in ch 9.9, please consider citing it.	Philippe Tulkens	Belgium	Thank you for your comment. Material in this section mostly draws from the policy chapters and so line of sight is mainly back to those chapters. More cross-cutting findings have been added, especially in the form of boxes throughout the TS
24563	113	4	113	4	It is 22% (Chap 15, World Bank 2020)	Government of France	France	Thank you for your comment. This has been updated where appropriate to ensure consistency across the report
28267	113	10	113	11	Delete "Countries with a lower carbon pricing gap (higher carbon price) tend to be more carbon efficient (medium confidence)."	Eleni Kaditi	Austria	Thank you for your comment. This section has been substantially revised
72271	113	12	113	16	Some of the most effective regulatory mechanisms are buildings, cars and appliances mandatory efficiency levels, see 9.9.3.	bertoldi paolo	Italy	Noted. Section revised and restructured
67489	113	12	113	16	Some of the most comment regulatory mechanisms are buildings, cars and appliances mandatory efficiency levels, see 9.9	Philippe Tulkens	Belgium	Noted. Section revised and restructured
66631	113	26	113	27	Whether lower primary fossil fuel prices are economically good or bad depends on whether exporter or importer! It seems to be a repeated narrative but high oil import costs have been a significant impediment to development in many of the poorest countries in the world – even India just stated that the recent rise in oil prices might threaten its recovery from Covid. point should be rebalanced.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. Paragraph revised
66633	113	30	113	35	Would be good to tie in more specifically with SDPS, and offer an assessment of the case for net co-benefits in well designed mitigation responses (see Chapter 1, section 6.6 - conclusions on language and implications of synergies and tradeoffs, risks and opportunities, and the potential to maximise the positives and minimise negatives in context of development and transition choices (might be good to work with Ch.13 on tightening and ligning the Ch.1 currently brief remark on this)	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. This section has been revised. SDPS is detailed throughout the SPM
84515	114	1	114	13	The mapping of the landscape of climate development actions covers a wide range of strategies while urban strategies is not visible in this landscape. It will be useful for the consistency of the report to represent urban planning oriented strategies in this context. The urban dimension is also relevant within this landscape.	Sir KILKIS	Turkey	Accepted. Included in the revised version
28269	114	24	114	26	Analysis should relate to inefficient fossil fuel subsidies that encourage wasteful consumption.	Eleni Kaditi	Austria	Noted - paragraph no longer included
7477	114				Figure TS 33 – what is the role of advertising as a social driver (ref previous section)?	Debra Roberts	South Africa	Included in Social Primer Box (Box TS.11: A New Chapter in WG III AR6 Focusing on the Social Science of Demand, and Social Aspects of Mitigation)
66635	114				Im sure the diagram is imperfect but its still the best I've seen attempting to make sense of these issues - and move them from conceptual to practical - congrats	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Figure revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
85283	114		114		I think that the statement on the adaptation deficit needs to be considered very carefully. A key aspect of the WGI assessment is that every region of the world will face changing profiles in "climatic impact drivers" (characteristics of a changing climate including means, trends, extremes, values above tolerance thresholds). it would be very misleading to suggest that the lack of adaptation to novel conditions is restricted to a specific group of countries - the WGII assessment also stresses the widespread lack of transformative adaptation and the lack of method to evaluate the efficacy of adaptation measures that are taken currently. It is striking to read that the WGIII TS is written as if there would be no constrain or limitation to mitigation by the fact that climate will be changing (implications for each sector, implications for governance and decision making of operating in a changing climate)	Valérie Masson-Delmotte	France	Accepted- paragraph no longer included
24565	114		114		Some of the acronyms used in Figure TS.33 should be expanded.	Government of France	France	Accepted
28271	115	11	115	11	Delete "parallel carbon pricing reform".	Eleni Kaditi	Austria	Accepted
66637	115	16	115	21	See my cross-cutting comment on TS.9 re the selection of case studies. The text suggests these are drawn from sectoral chapters which in general would be good, but they still seem a strange selection if we are trying to draw lessons from policies that have demonstrably made a big difference. What about the German Energiewende? Some the Japanese demand-side policies? UK Electricity Market Reform & offshore wind? Really the purpose and selection of case studies needs elaboration. Parts of the UK story appear in Chapter 2 and 13, but bizarrely not in Chapter 6. happy to help	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. Section revised and restructured
81521	116	6	116	6	What does mean 'LGP'? Does mean 'Liquefied Petroleum Gas'? See Table TS.9 (boxes 5.7 and 6.3)	Luana Ferreira	Brazil	Yes. Acronym expanded
81523	116	6	116	6	What does mean 'MNCs'? See table TS.9, box 7.14 (barriers column)	Luana Ferreira	Brazil	Noted thank you. Acronyms have spelled out and removed where possible
81525	116	6	116	6	What does mean 'RE'? See table TS.9, box 8.2 (barriers column) and box SM 9.1 (objective column)	Luana Ferreira	Brazil	Noted- lines revised
15439	117	1	117	1	At the row of Box 12.5 and column of C.Policy mix: What is abbreviated by 'SMDRC'?	Hiroaki Kondo	Japan	Noted- lines revised
81527	118		118		What does mean 'ETS'? See table TS.9, box SM 9.1 (enablers column)	Luana Ferreira	Brazil	Acronym expanded
72273	120	1	122	40	The summary of Chapter 14 as well as the Chapter 14 itself are extremely interesting and reach in material for policy makers taking decisions in national policies and in the future preparation of NDCs. However, a key topic is not included in the TS: i.e. the discussion on metrics to assess the adequacy of national current and future NDC targets with the overall 2.0C or 1.5 C targets. With metrics to assess adequacy of NDC, the application of these metrics can be used to evaluate NDC and disclose their level of ambition and adequacy based on scientific evidence and methodology. A similar exercise is carried out in the EU for assessing its member states national Energy and Climate Plans	bertoldi paolo	Italy	Thank you for your comment. Section has been revised
67491	120	1	122	40	This summary of chapter 14 is extremely interesting and reach in material for policy makers taking decision in national policies and future NDCs. However a key topic is not included in the TS: i.e. the discussion on metrics to assess the adequacy of national NDC targets with the overall 2.0C or 1.5 C goal and once a few metrics are established the application of these metrics to screen NDC and disclose their ambition and adequacy based on scientific evidence	Philippe Tulkens	Belgium	Thank you for your comment. Section has been revised
46917	120	4	120	4	Rather than achieving effective climate change mitigation goals in the context of sustainable development, section 14.2 (referring to chapter 4) suggests embedding climate change mitigation in a sustainable development approach. Hence, the suggestion is to replace "in the context of" with "embedded in".	Government of Germany	Germany	Thank you for your comment. Section has been revised
64103	120	9	120	9	We recommend changing the formulation to "when it directly and indirectly supports", or delete "directly": it doesn't matter whether the support is direct (e.g. providing) or indirect (e.g. mobilizing, incentivizing, etc).	Government of Canada	Canada	Thank you for your comment. Section has been revised
64105	120	15	120	15	Regarding "UNFCCC regime" it would be better to use "climate change regime" or "UN climate regime" used in Chapter 14, given that there are numerous treaties that contribute to fighting climate change and we wouldn't want to exclude them.	Government of Canada	Canada	Noted thank you. This has been updated to 'UN climate regime'

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
66641	120	17	120	18	But surely the point is that "... adopted a different architecture to achieve it..." - what is IT? The aim of the PA was completely different from that of the KP - that's the point, and that is the basic problem I have with the framing of these paras	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Paragraph revised
14355	120	22	120	24	In order to more accurately reflect the differences between the KP and the PA, which appears to be the purpose of this paragraph, I suggest altering the wording to: "...and tied to well-defined mechanisms for monitoring and enforcement. By contrast, the emission commitments under the Paris Agreement are procedural, extend to all parties, and allow considerable discretion for parties to define the type and scope of their contributions. The Paris Agreement includes mechanisms aimed at promoting iteratively rising levels of ambition across all countries in pursuit of its global goals". The point is that the KP, and indeed the UNFCCC before it, also aimed to "trigger domestic policies and measures, enhance transparency and stimulate climate investments, particularly in developing countries" (on domestic policies and measures, see UNFCCC Article 4.1 and KP Article 2; strong reporting and review provisions are integral to both; and both sought to promote financial transfers to DCs, through the CDM in the case of the PA) so suggesting that this is a "contrast" with the PA is not correct	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. This paragraph has been revised
66643	120	22	120	24	? Is this suggesting that the procedures of the PA are better ways of doing all these things than more specific commitments negotiated in a multilateral context? Is there evidence for this? It may well be that negotiating specific outcome commitments is not Possibly for global application, but that is an entirely different question.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. This paragraph has been revised
14357	120	25	120	46	Should read "common but differentiated responsibilities and respective capabilities"	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Accepted
66639	120				I found this an awkward section. Its main emphasis seems to be on the theme that everything changes with the Paris Agreement - which unquestionably was a really important achievement - but quite a bit is lost in this narrative. There is no theoretical foundation in terms of the core functions of international cooperation, nothing explicit on participation incentives, not much on what can sensibly be done at global versus other levels. There is no reference to learning from what went before, or explicit acknowledgement that the PA was a shift from a structure designed to implement the UNFCCC commitment of leadership by industrialised countries, to one of global involvement on the same legal basis, which necessitated emphasis on procedure not outcomes	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Section has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
14359	121	1	121	8	Figure TS.34 is flawed and I would recommend deletion for the following reasons (1) All four categories - decentralised, centralised, allocation of effort, enhancement of effort - are misleading and unhelpful. The use of the category "Allocation of effort", in particular, does not chime with the reality of the international regime. No attempt to formally "determine and allocate countries' relative mitigation efforts" (figure legend) has ever taken place. The UNFCCC establishes a carefully worded "aim" for Annex I Parties to return their GHG emission levels to 1990 by 2000, but this is "individually or jointly", not at country level. Annex I Parties took on emission targets under the KP, but these were tabled by the countries themselves, with limited negotiations around the margins, and explicitly no use of " 'Allocation of effort' instruments" If you mean the differentiation of roles and commitments between Annex I and non-Annex I Parties, then this should be clearer, and does not represent "allocation of effort" as commonly understood. (2) It is not clear to me what "the intermediate cumulative emissions target for Annex I countries" refers to. Is this a reference to the "at least 5%" in the KP? If so, then this reference is incorrect if framed in the context of "allocation" of effort. The 5% figure consists of the bottom-up *summation* of the individual emission targets, not a pre-determined top-down global goal, that was then used to allocate individual country targets. (3) It is not clear to me why accounting and reporting is categorised as centralised/allocation of effort for the UNFCCC/KP, but decentralised/enhancement of effort under the Paris Agreement. The PA system builds entirely upon the UNFCCC transparency system. It might be stronger, but I don't see a qualitative difference in terms of centralisation/enhancement/allocation of effort here. Same for the compliance mechanisms. Both the KP and PA systems are centralised, according to the definition supplied in the legend; one is stronger than the other, but I don't think that's the point the figure is trying to make. (4) I have the same issue with LULUCF and market-based mechanisms. Decentralised/centralised is not a useful distinction. Market-based mechanisms under the KP were not decentralised - they were founded on quite strong rules and procedures, including committees and centralised registration systems, based with the climate regime organs. LULUCF commitments were also subject to standardised rules and methodologies.	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Noted. Figure deleted
83521	121	1	121	9	I would have expected the Periodic Review of the Paris Agreement long term global goal also to feature in the Information&Review category.	Joeri Rogelj	United Kingdom (of Great Britain and Northern Ireland)	Noted. Figure deleted
14361	121	11	121	14	A major critique of the PA, in addition to NDC inconsistency with global goals is that the contents of NDCs are not legally binding. The review mechanism - the Global Stocktake - while not mandated to review "adequacy" as such, is generally seen as one of its strengths	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Noted
66645	121				IS this figure really explanatory, or merely a way to organise caricatures? I'm not aware than anything in 30 years of negotiations "allocated effort" - though the KP did formally codify the <u>outcome of negotiations on contributions</u>	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. Figure deleted
64107	121		121		Market-based mechanisms under the Kyoto Protocol ("the flexibility mechanisms") were actually quite centralized.	Government of Canada	Canada	Thank you for your comment. Noted
86269	122	11	122	11	SO2 has also been reduced to limit transboundary pollution which lead to a warmin. Maybe the sentence is a bit naive, there are co-benefits but also side effects wich can not be ignored.	Sophie Szopa	France	Thank you for your comment. This paragraph has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
14363	122	20	122	26	(1) I am not convinced that the evidence provided in chapter 14 supports the finding that international cooperation "is proving effective". Some nuance or caveat is needed, eg "is starting to prove effective", "shows signs of becoming effective", "is making progress towards effectiveness", or "has been effective in some ways". This should be coupled with an acknowledgement that international cooperation over the past 30 years has made insufficient progress (I have commented on this also for chapter 14, suggesting two references). (2) Some limited environmental effectiveness is demonstrated here by reference to the AFOLU and non-CO2 sectors. However, there are other, more significant, positive indicators. These include the important finding in SPM B2, to the effect that "a growing number of countries have entered a period of sustained GHG emission reductions in the absence of economic crisis", a point further elaborated in B2.4. Another important metric is the spread of climate legislation, targets and strategies, as documented in chapter 13. B5 finds that "there has been a substantial growth in climate policy and corresponding institutional arrangements at national and sub-national level". Chapter 13 provides evidence that this is linked to "international negotiation events" (KP entry into force, run-up to CPN, PA adoption). These provide important evidence of emerging environmental effectiveness of the climate regime.	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. This paragraph has been revised
46919	122	22			Please note that the Paris temperature target also refers to 1.5 °C - please add.	Government of Germany	Germany	Thank you for your comment. Section has been revised
14365	122	30	122	30	"nationally determined contributions", not "nationally determined commitments". Also this should refer to the first round of NDCs - so "Collectively, countries' first NDCs are inadequate etc..."	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Accepted. Thank you
14367	122	32	122	32	Best to use the accepted term "conditional" rather than "contingent".	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Accepted.
85413	122	34	122	34	This statement needs reference, but it still appears to be subjective and politically driven rather than data based. We suggest a proposed replacement as a statement of fact: In its 40th Session (2019), the ICAO Assembly requested the ICAO Council to continue to explore the feasibility of a long-term global aspirational goal for international aviation (LTAG), through conducting detailed studies assessing the attainability and impacts of any goals proposed, including the impact on growth as well as costs in all countries, especially developing countries, for the progress of the work to be presented to the 41st Session of the ICAO Assembly (2022)	Neil Dickson	Canada	Thank you for your comment. Section has been revised
14369	122	35	122	36	I would add "have adopted climate mitigation goals and strategies"	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Section has been revised
54497	122	35	122	36	Indicates that ICAO and IMO agreements are not sufficient. Can a bit more detail to explain why they do not reach the ambition of the Paris Agreement be included?	Government of United States of America	United States of America	Thank you for your comment. Section has been revised
66647	122				it would be useful to draw clear distinctions between what can be negotiated, and challenges of national implementation in relation to international agreement - whether multilateral or other	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Section has been revised
66649	122				Would be good to see more on sectoral agreements, good and bad .?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Section has been revised
31195	123	2	123	4	This statement is not correct. Vulnerable countries (what exactly do we mean by this?) mainly need support to adapt to climate change but commonly not to reduce greenhouse emissions which tend to be small. Language and logic should remain clear.	Jochen Harnisch	Germany	Thank you for your comment. This paragraph has been deleted and section has been revised completely
31199	123	14	123	15	Not sure whether this true. There is a lot of talk on this subject and opportunistic embracing, but can the wider financial sector really be a critical and effective driver of change? I tried to find the answer in chapter 15 but did not find robust, empirically based answers.	Jochen Harnisch	Germany	Noted- lines revised
31197	123	23	123	33	A very important result of chapter 15 which should not be lost or diluted. May be bring out the message even clearer?	Jochen Harnisch	Germany	Thank you for your comment. This paragraph has been revised

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
24501	123	37	123	37	It does not make much sense to talk about a variation in a single year	Government of France	France	Thank you for your comment. This paragraph has been deleted and section has been revised completely	
24503	123	38	123	39	This could be rephrased. International climate finance flows have grown from \$52bn in 2013 to \$79bn in 2018 but there is no evidence yet on whether the \$100bn goal has been met (OECD 2020)	Government of France	France	Thank you for your comment. This paragraph has been deleted and section has been revised completely	
87053	123	37	123	37	It does not make much sense to talk about a variation in a single year		France	Thank you for your comment. This paragraph has been deleted and section has been revised completely	
87055	123	38	123	39	This could be rephrased. International climate finance flows have grown from \$52bn in 2013 to \$79bn in 2018 but there is no evidence yet on whether the \$100bn goal has been met (OECD 2020).		France	Thank you for your comment. This paragraph has been deleted and section has been revised completely	
24505	124	1	124	1	Please consider providing a definition for the meaning of "climate finance"	Government of France	France	Thank you for your comment. Noted	
28273	124	12	124	13	Delete "Another barrier includes persistently high levels of fossil-fuel financing."	Eleni Kaditi	Austria	Thank you for your comment. This paragraph has been deleted and section has been revised completely	
66651	124				These finance paras have a lot - would be good to unpack a bit - but its not clear what is meant by commercial finance necessarily placing additional burden on developing countries, compared to what? Also I think important to note that public finance dominates new fossil fuel in ASia, whereas private is main vehicle for renewables finance and seems more likely to expand?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Section has been revised	
31201	125	1			Figure TS-35 including its caption are difficult to understand. What is its main message? How was it derived?	Jochen Harnisch	Germany	Figure revised	
50051	125	1	125	1	Figure TS35 doesn't indicate any uncertainty range and should provide uncertainty information.	Masahiro Sugiyama	Japan	Figure revised	
28275	125	18	125	18	Delete "particularly in fossil fuel subsidies.", as this should relate only to inefficient fossil fuel subsidies that encourage wasteful consumption.	Eleni Kaditi	Austria	Noted- lines revised	
24567	125		125		Could you mention that the flows considered in the left chart are average annual flows?	Government of France	France	Figure revised	
31203	126	1	126	16	These two paragraphs need serious rewriting. Currently this language seems ideological and is certainly not "policy neutral".	Jochen Harnisch	Germany	Thank you for your comment. This paragraph has been revised	
31035	126	4	126	6	In the main text (Chapter 15), there seems to be not enough literature supporting the role of central bank in supporting faster and more sustainable growth.	Government of Japan	Japan	Thank you for your comment. Noted	
15839	126	22	126	24	"Challenges remain in the green bond market, including the potential for 'greenwashing', and creditworthiness constraints in developing countries." To reduce these errors, qualification of green should emphasize more precise and rigorous criteria of what is "low carbon" or "decarbonised".	Jean-Michel Trochet	France	Thank you for your comment. This paragraph has been revised	
24569	126	40	126	40	Note that in Decision 1/CP.21 the COP "Agrees that Article 8 of the Agreement does not involve or provide a basis for any liability or compensation" for loss and damage	Government of France	France	Noted. Thank you	
66653	126				What does it mean to "shift inertia"?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. This paragraph has been revised	
87057	126	40	126	40	Note that in Decision 1/CP.21 the COP "Agrees that Article 8 of the Agreement does not involve or provide a basis for any liability or compensation" for loss and damage		France	Noted. Thank you	
54499	127	2	127	7	No support for "medium confidence" in {16.1, 16.2}.	Government of United States of America	United States of America	Noted and revised	
54501	127	2	127	7	Inconsistent citation: This exact paragraph in the Chapter 16 Executive Summary (page 4, lines 2-7) is cited as {16.1, 16.2, 16.6}.	Government of United States of America	United States of America	Thank you for your comment. Line of sight to underlying chapters have been checked and corrected where appropriate	

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
80175	127	8	127	9	Due to the immaturity and urgent need for research & development for assessment and uncertainty reduction, CDR and SRM should be explicitly mentioned in the context of innovation and technology development. While there are numerous risks and uncertainties, CDR will likely be necessary and SRM may become necessary to constrain warming over the next 10-30 years, while promoting safety and stability. The rapidity with which solar climate intervention could reduce heat in the Earth system makes SCI a vital component of a portfolio of possible climate responses." Suggested addition: "In addition, accelerating the rate of innovation in CDR and SRM technologies would provide vital and complementary options to ensure stability, alongside mitigation efforts and low-carbon transitions."	Kelly Wanser	United States of America	Noted. CDR is addressed in TS5.7. SRM is referred to in terms of international cooperation, as the material on SRM in the underlying report refers to governance aspects.
24571	127	8	127	9	Accelerating the rates of adoption of low carbon technologies is crucial for climate stabilisation (medium agreement). Adoption is indeed crucial, agreement should be strong not medium	Government of France	France	Thank you for your comment. Confidence language of all statements have been checked for consistency with the underlying chapters
66655	127				As it stands, the section TS6.5 contains quite a lot of repetition of material that appears earlier in the TS. It is focused maybe too much (though understandably) given title I guess), on the earlier stages of overall transition processes - rather than the wider processes of innovation and transformation which can be reasonably categorised as emergence, diffusion and culmination linked to S-curve dynamics. Delivering deep decarbonisation will obviously need multiple transition waves of this nature, the section only gives a very incomplete picture of the processes involved. See my Whole Report comments on this, and the lacuna it leaves. I will try to submit comments to Chapter 16 though fear they will be late	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Section has been revised
66657	127				See also Chapter 1 section 1.6.4, and my suggestions on TS restructuring, in which case an amended version of Innovation and Transformation analysis could help to introduce and structure the materials on policies, international, and finance linked to innovation and transformation	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted. This section has been substantially revised, and the narrative has been enhanced
28277	127		127		Figure TS.36 is not clear / readable.	Eleni Kaditi	Austria	Figure deleted
54503	128	5	128	12	Inconsistent citation: This exact paragraph in the Chapter 16 Executive Summary (page 4, lines 17-24) is cited as {16.3, 16.4.2, 16.4.4, 16.5}.	Government of United States of America	United States of America	Noted and edited.
72275	128	13	128	25	The following policy mechanisms "policy instruments such as feed-in tariffs, auctions, emissions trading schemes, taxes and renewable portfolio standards have generally been" are presented and discussed extensively in section 9.9.3 and therefore should be cited here.	bertoldi paolo	Italy	Thank you for your comment. This paragraph has been deleted and section has been revised completely
67493	128	13	128	25	The following policy mechanisms "policy instruments such as feed-in tariffs, auctions, emissions trading schemes, taxes and renewable portfolio standards" are presented and discussed extensively in section 9.9	Philippe Tulkens	Belgium	Thank you for your comment. This paragraph has been deleted and section has been revised completely
54505	128	13	128	25	Inconsistent citation: This exact paragraph in the Chapter 16 Executive Summary (page 4, lines 25-38) is cited as {16.3, 16.5.4}.	Government of United States of America	United States of America	Noted and edited.
24573	128	17	128	23	it seems important to acknowledge the role of energy prices inclusive of taxes to drive energy efficiency and low-carbon innovation. there is ample evidence on this as reviewed in the chapter.	Government of France	France	Thank you for your comment. Noted
18663	128	26	128	26	Fig TS.37: would the authors consider adding Technology Patents and Design Rights to the right most column? IPR may also be usefully included here, although discussion in Ch 16 indicates that IPR may not be beneficial, so perhaps that is why it has been excluded from the figure. The authors might also consider adding a node to the graph between "First gen" and "First commercial ..." to show "acquisition of IPR" on the interface between the Prototype and the Demonstration layers. "Licensing" perhaps fits in with "Knowledge Transfer" too.	Government of United Kingdom (of Great Britain and Northern Ireland)	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. IPR is addressed in the text instead of in the figure. The figure is an illustrative figure on technology innovation

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
24575	128		128		We recommend to focus Figure TS.37 more on climate specificities and examples, especially in the right columns.	Government of France	France	Noted, thank you for your comment. This figure is an illustrative figure of the roles of different public policy instruments and the technology innovation process. These are also relevant to climate change. Examples are briefly provided in the TS text and elaborated in detail in the underlying chapter.
54507	129	1	129	3	Confidence does not track: no robust evidence and/or high agreement claims regarding recent technologies in {16.4, 16.5}.	Government of United States of America	United States of America	Thank you for your comment. This paragraph has been deleted and section has been revised completely
54509	129	12	129	13	No support for "spending on energy RD&D in least-developed countries is a fraction of that in developed countries" in {16.5.4, Box 16.4}.	Government of United States of America	United States of America	Thank you for your comment. This paragraph has been deleted and section has been revised completely
54511	129	26	129	30	Inconsistent citation: This exact paragraph in the Chapter 16 Executive Summary (page 5, lines 15-20) is cited as {16.2, 16.3.2.2, Cross-Chapter Box 4 in Chapter 4}.	Government of United States of America	United States of America	Thank you for your comment. This paragraph has been deleted and section has been revised completely
54513	130	4	130	6	"Most models do not include detailed representations of innovation policies and practices" is not supported by {16.3.4, Box 16.1}.	Government of United States of America	United States of America	Thank you for your comment. This paragraph has been deleted and section has been revised completely
54515	130	7	130	16	Inconsistent citation: This exact paragraph in the Chapter 16 Executive Summary (page 5, lines 29-37) is cited as {16.6.3.1; Box 16.9}.	Government of United States of America	United States of America	Thank you for your comment. Line of sight to underlying chapters have been checked and corrected where appropriate
31037	130	17	130	19	There is no argument in the body text to support this sentence, which needs to be deleted. It would be necessary to define what level of financial support is needed, to quantitatively show how much technology is currently being transferred based on specific data, and to discuss the issue based on the peer-reviewed papers. The authors claim that there is "a gap remains, in the coverage of activities, the amount of committed funding, and the effectiveness." based on (Brook et al. 2016) , but this is a misunderstanding of the purpose of the paper. This paper was published online before Paris Agreement was adapted, and proposed a technology component as a part of the new agreement. They do not cover the efforts of the Technology Mechanism after the Paris Agreement at all. The technical mechanism provides technical assistance based on requests from developing countries. If the support were insufficient, the number of non-supported requests would pile up, but so far the support has been provided without delay.	Government of Japan	Japan	Thank you for your comment. This paragraph has been revised
64109	130	17	130	20	The authors state that current arrangements for technology development and transfers are insufficient and that enhancing financial support may contribute to improvements. These conclusions are based on research from 2016 (Brook et al. 2016) and 2015 (de Coninck and Puig 2015; Ockwell et al. 2015) which were both published prior to the complete negotiation and implementation of the Technology Framework and its additional measures. In addition, any discussion of gap of funding should also provide a more quantitative assessment of what the current situation is, studies pointing to what it should be, and what is not being supported as a result.	Government of Canada	Canada	Thank you for your comment. This paragraph has been deleted and section has been revised completely
67495	130	26	131	13	Consider mentioning the enormous energy footprint of cryptocurrency (blockchain and mining) in this box.	Philippe Tulkens	Belgium	Noted thank you. The box on digitalisation also includes considerations on how this might affect energy demand

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
28287	130		131		Discussion of digitalization anywhere in the report should include reference to this review article: Koomey, Jonathan G., H. Scott Matthews, and Eric Williams. 2013. "Smart Everything: Will Intelligent Systems Reduce Resource Use?" The Annual Review of Environment and Resources. vol. 38, October. pp. 311-343. [http://arjournals.annualreviews.org/eprint/wjniAGGzj2i9X7i3kqWx/full/10.1146/annurev-environ-021512-110549]. This is also an important reference: IEA. 2017. Digitalization and Energy. Paris, France: International Energy Agency, November 5. [https://www.iea.org/digital/]	Jonathan Koomey	Canada	Thank you for the suggested reference for the digitalization box
46921	132	1	135	27	We are concerned that section TS.7 does not provide a suitable summary of the report since it is entirely based on chapter 17. However, also the sectoral chapters have assessed the mitigation in the context of SD. In addition, please revise the section to avoid policy-prescriptive language, please see e.g. our comment on TS-132-2.	Government of Germany	Germany	Thank you for your comment. Section has been revised
46923	132	2	132	7	This first paragraph talks about "accelerating climate actions and the just energy transition" and the second paragraph states "A sustainable transition must also be socially equitable and just." Linking accelerated mitigation, sustainable transition and equity/ justice seems a normative approach that needs to be grounded in scientific evidence. Please revise both paragraphs accordingly.	Government of Germany	Germany	Thank you for your comment. This paragraph has been revised
64111	132	8	132	8	This is subjective language and not appropriate in an IPCC report. This sentence is not needed.	Government of Canada	Canada	Thank you for your comment. This paragraph has been revised
66661	132	11			When referring to "fundamental reframing of development" what does it mean, and is it same - or how does it relate - to SDPS on which many people spent a lot of effort?	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Section has been revised thoroughly
64113	132	17	132	17	This is subjective language and not appropriate in an IPCC report. This sentence is not needed.	Government of Canada	Canada	Thank you for your comment. Noted
54517	132	17	132	24	Inconsistent citation: This exact paragraph in the Chapter 17 Executive Summary (page 3, lines 17-24) is cited as {17.1.1.1}.	Government of United States of America	United States of America	Thank you for your comment. This paragraph has been deleted and section has been revised completely
66663	132	25			Again, to try and improve understanding and coherence with the rest of the report, this is basically a statement that IAMs reflect the fundamentals of Aggregate Efficiency Analytic Frameworks, but largely neglect the central importance of the Ethics and Equity Frameworks. This concluding section does a better job at integration, but still seems weaker in terms of the Transition, and the Psychology and Political Frameworks.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. Noted
66659	132				This concluding section struck me as analytically strong and interesting, but rather disconnected from the rest of report in terms of the language.	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Noted thank you.
66665	132				The co-benefits are largely cast in terms of SDGs, which I think is fine. But the huge overlap – and some inconsistencies – between "Figure TS.30" [why Figure?] and Table TS.10 is just confusing. This data really should form the core of evidence for net co-benefits in low carbon transitions and we don't want confusion. Somehow they need to be synthesised into one, or one (probably Ch.5?) radically changed to relate to the other more sensibly. Also note the TS version here doesn't seem to be quite the same as in the SPM and has a disturbing number of m.a.s particularly around transport and industry	Michael Grubb	United Kingdom (of Great Britain and Northern Ireland)	Figure revised
46925	133	1			It is unfortunate that the information in this table is too sparse to allow reviewing it, it seems premature to comment on the assessment which means that it will not be reviewed at all. However, even with the many n.a. replaced by information, the table does not indicate any uncertainties and therefore is not in line with the high quality standards of the IPCC. Please delete this table. (In addition, CCU is mentioned twice.)	Government of Germany	Germany	Figure revised
1387	133	1	133	3	For options in AFOLU, that would be necessary to specify if "enhance carbon in agricultural systems" includes soil carbon management	Julien Demenois	France	Noted. Thank you. "soil carbon management" is an option in the revised figure.
17163	133	1	133	4	See comment no. 5	Government of Poland	Poland	Thank you for your comment. Noted

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
74325	133	1	133	4	For the purpose of this comment, I am focusing on Table TS-10 (energy systems), specifically as it relates to nuclear. I believe this is a highly subjective chart and has no basis for the comparisons that are made. I note that Solar and Wind are placed first rather than in alphabetical order. As it relates to nuclear, it receives a +/- on SDG1 and a N/A for SDG2 while wind and solar received higher grades. I see no reason for the distinction. I am not going to comment on every SDG, but I would note that nuclear development requires significant training and nuclear units have a significant number of technical positions that are well paying and increase opportunities for women. For that reason, I believe that both SDG4 and 5 should be a + for nuclear. As for SDG6, nuclear contributes baseload power that provides a significant resource for water pollution control and sanitation, so for this reason it should also be a +. Like wind and solar, SDG 8 and 9 should be + for nuclear given the significant permanent jobs and infrastructure needed to produce nuclear energy. There is no basis for assigning a - to SDG10 as nuclear development is a positive contributor to economic growth and jobs. As nuclear currently provides 35% of the world's carbon free energy, to say that it is not applicable for SDG 13 (Climate Action) has no basis in fact. Overall, I believe this chart is flawed, based on subjective personal views and incorrect data carried over from other sections, and should be eliminated.	Jeffrey Merrifield	United States of America	Figure revised. Supplementary Material Table 17.1 in Chapter 17 provides the basis of the figure
18801	133	1	133	4	Please see the comment in line no. 1.	Tomáš Martanovič	Czech Republic	Thank you for your comment. Noted
67497	133	1	133	4	Enhanced weathering is shown as positive for SDG14. That is not the case. It has the side effect of altering the natural salinity of the seas.	Philippe Tulkens	Belgium	Noted- this has been revised. Supplementary Material Table 17.1 in Chapter 17 provides brief explanation behind each of the entries in this figure
67499	133	1	133	4	Under transport - waterborne transport has impact on SDG14. This should be reflected in all 4 cases. Currently, they show n.a. for SDG14.	Philippe Tulkens	Belgium	Noted- this has been revised. Supplementary Material Table 17.1 in Chapter 17 provides brief explanation behind each of the entries in this figure
67501	133	1	133	4	Reduce overconsumption has positive impact on SDG14 (fisheries for example) while in the table it is shown n.a.	Philippe Tulkens	Belgium	Noted- this has been revised. Supplementary Material Table 17.1 in Chapter 17 provides brief explanation behind each of the entries in this figure
67503	133	1	133	4	solar energy on small waterborne vessels and leisure boats positively impact SDG14.	Philippe Tulkens	Belgium	Noted- this has been revised. Supplementary Material Table 17.1 in Chapter 17 provides brief explanation behind each of the entries in this figure
67505	133	1	133	4	CDCUS if the storage is in the ocean, it negatively impacts SDG14	Philippe Tulkens	Belgium	Noted- this has been revised. Supplementary Material Table 17.1 in Chapter 17 provides brief explanation behind each of the entries in this figure
67507	133	1	133	4	As there is a section: agriculture, forestry and land use, a section of fisheries, aquaculture and marine use could be added. Parts of the blue economy sectors are missing in the report and should be included as these need decarbonising.	Philippe Tulkens	Belgium	Noted- this has been revised. Supplementary Material Table 17.1 in Chapter 17 provides brief explanation behind each of the entries in this figure

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response
14373	133	4	133	4	Table TS.10 is not consistent with the original table 17.7 in chapter 17, and with the equivalent table SPM.11 in the SPM (I think Tables 17.7 and SPM.11 are the same). All the entries for Industry under SDG 13 are missing in Table TS.10, and they are also inconsistent for some of the other SDGs.	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. This table has been substantially revised as a figure. The figure is consistent with the summary provided in chapter 17, and the sectoral assessments provided in Ch6-12
72949	133	8	133	8	"on" instead of "no" ?	Antoine BONDUELLE	France	Noted, this has been corrected
24581	133	12	133	13	There are also options which can create synergies like soil carbon sequestration (biodiversity, food, desertification) according to SRCCCL	Government of France	France	Noted- this has been revised. Supplementary Material Table 17.1 in Chapter 17 provides brief explanation behind each of the entries in this figure
1389	133	12	133	13	There are also options which can create synergies like soil carbon sequestration (biodiversity, food, desertification) according to SRCCCL	Julien Demenois	France	Noted- this has been revised. Supplementary Material Table 17.1 in Chapter 17 provides brief explanation behind each of the entries in this figure
77307	133				A revised table is recommended as per the same in chapter 17, according to comment 50.	Giacomo Grasso	Italy	Noted- this has been revised. Supplementary Material Table 17.1 in Chapter 17 provides brief explanation behind each of the entries in this figure
24577	133		133		Is it "Cross sectional" or "Cross sectoral?". It would be fine to find a way to remind the definition of the different SDGs, for example by inserting their official icons.	Government of France	France	Noted- this has been revised. Supplementary Material Table 17.1 in Chapter 17 provides brief explanation behind each of the entries in this figure
24579	133		133		For options in AFOLU, that would be necessary to specify if "enhance carbon in agricultural systems" includes soil carbon management	Government of France	France	Noted. Thank you. "soil carbon management" is an option in the revised figure.
24585	133		133		This table appears problematic. Most rating regarding nuclear energy are impossible to understand. For example, for the nuclear energy, it seems disputable that a negative impact is reported on SGD9 (industry, innovation and infrastructure). It is surprising that Nuclear energy is the only mitigation option (among the 40 listed) with a negative impact on SDG10 (Reduce inequalities). What is the justification for solar and wind to be positive for SDG5 (Gender Equality), and not nuclear? The word "gender" is not present in Chapter 6. The evaluation of several SDG (for example: SDG13 Climate action) raises questions considering that only mitigation options are in this table but some are evaluated as "non applicable". Chapter 6 clearly states that nuclear generates more low carbon electricity than both wind and solar, and that the LCA CO2 emission of solar is significantly larger than that of nuclear. Comparing the energy sector options' ratings, there seem to be a lot of evaluation of SDG goals which seems rather objectively "non applicable" ; and it raises questions why some SDG are "non applicable" for some mitigation options and not for others. Thus, we suggest that this table be revised and specifically documented for each case with link to the exact references used to justify the rating (the reference given here is to several chapters of hundreds of pages is insufficient, and could be further specified and targetted). This comment is all the most important since it is also in the TS and SPM.	Government of France	France	Noted- this has been revised. Supplementary Material Table 17.1 in Chapter 17 provides brief explanation behind each of the entries in this figure
72945	133		133		This table (TS.10) is the best way to account for chapter 17. Maybe use the example of solar electrification in the text page 132 line 43 ?	Antoine BONDUELLE	France	Noted. This table has been revised (Figure TS.29)
67509	134	1	134	2	Instead of 'water tress' write 'water stress'.	Philippe Tulkens	Belgium	Noted, this has been corrected
15441	134	2	134	2	"tress" --> stress?	Hiroaki Kondo	Japan	Noted, this has been corrected

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Comment ID	From Page	From Line	To Page	To Line	Comment	Reviewer	Country	Response	
31039	135	1	135	6	Conditions such as "impede the transition", "strong shocks such as climate-change impacts", and "economic crises and political change" are not preferable, but they are treated as the desirable ones that may accelerate sustainable development. Revised expression may be better, such as "these conditions may create opportunity for accelerating sustainable development".	Government of Japan	Japan	Thank you for your comment. Section has been revised	
14375	135	7	135	10	I'm afraid this long sentence is rather vacuous and generic. What is a "social field"? What is meant by "allow sustainability to happen"? What is "thinking and behaviour consistent with the 1.5 degree goal"? These are nice slogans, but what do they mean in concrete terms?	Joanna Depledge	United Kingdom (of Great Britain and Northern Ireland)	Thank you for your comment. This paragraph has been deleted and section has been revised completely	
77309	135	18			Change "renewable" with "low-carbon".	Giacomo Grasso	Italy	Thank you for your comment. This paragraph has been deleted and section has been revised completely	
31217	137	1			Figure TS-36 is overly complex and difficult to understand. It needs serious simplification.	Jochen Harnisch	Germany	Thank you for your comment. This figure has been deleted	
85271					It is difficult to find information related to non CO2 GHG in many sections (incl. For instance energy and CH4 emissions) apart from the AFOLU section. There is a potential for enhanced disaggregation.	Valérie Masson-Delmotte	France	Accepted, gasses have been disaggregated where the information was available	
85275					The gender dimension is absent in the TS despite the availability of literature related to the gender dimension of just transitions and mitigation.	Valérie Masson-Delmotte	France	Noted, revised. Gender is included briefly in TS.6.3 (societal aspects of mitigation)	
66875					Context: The summary and mitigation chapters make the point that, as time continues to go by since COP 25 in Paris, an acceleration and broadening of mitigation measures is needed to achieve targets of 2 C or 1.5 C limits to temperature rise.	Jerry Hopwood	Canada	Thank you for your comment. The need for acceleration and scaled-up action is addressed in the TS	
66877					Chapters 3 and 4 provide a broad and wide-ranging review of what mitigation measures are being considered. The review is based on compiling and noting a lengthy set of studies that have been documented elsewhere. Perhaps of necessity, there is little assessment of the strength, balance, and impact of the studies. This means that the direction of the report is often driven by the choice of studies to include. Given the enormous level of research into mitigation measures, this involves individual judgement and will reflect the political view as well as the evidence-based scientific view.	Jerry Hopwood	Canada	The report is written according to IPCC practice	
33109					This report is very much informative, and the figures and graphs are very well organized. Especially, Fig TS 4, 7, 11, 12, 17,25, 27, 29, 30 are very much impressive.	Beibei Liu	China	Thank you for your positive comment.	
33111					Fig TS 6 is not clear.	Beibei Liu	China	Thank you for your comment. This figure has been substantially revised to make it more readable	
33113					Table TS 8 contains too little information.	Beibei Liu	China	Noted, this table has been removed from the TS and enhanced in the underlying chapter	