Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
12937	0	0	0	0	Well written chapter. Readability can be improved by reformatting tables like Table 10.3 and figures like 10.3 (blow-up can be used for the part 0-500 on the x-axis) and 10.9	Accepted. Thanks have reformated Table 10.3	Prashant Goswami	Institute of Frontier Science and Application	India
2849	0				Overall, I think the role of powertrain hybridisation is under-emphasised in this report as a carbon mitigation option for light-duty vehicles. This is especially the case if you consider the following points:	Take into account. Hybrids will be added/expanded upon. However, flex-fuel options are fairly niche and unlikely to be deployed on a large scale, according to current forecasts. We will Expand/add hybrids and review more flex-fuel option for possible consideration	Nicholas Surawski	University of Technology Sydney	Australia
2851	0				-hybrids could be coupled with existing carbon mitigation options such as biofuels. As a case in point, in 2018 Toyota have released a flex-fuel hybrid (at the time a world first) in the Brazillian market:	Take into account.Hybrids will be added/expanded upon. However, flex-fuel options are fairly niche and unlikely to be deployed on a large scale, according to current forecasts	Nicholas Surawski	University of Technology Sydney	Australia
2853	0				Flex-Fuel Hybrid (Toyota): https://global.toyota/en/newsroom/corporate/21633112.html	Noted. Comment Unclear	Nicholas Surawski	University of Technology Sydney	Australia
2855	0				With this technology, there is the possibility to operate this hybrid vehicle with E100 in place of gasoline. Provided the biomass is sustainably sourced (in Brazil sugarcane would be the feedstock) and the production process is sufficiently decarbonised, I believe deep decarbonisation outcomes could be achieved.	Yes in Brazil but globally not seen as feasible. Biofuels remain potentially able.	Nicholas Surawski	University of Technology Sydney	Australia
2857	0				-another point to consider is global variability in supplies of biomass and electricity. Take for example, the Middle-East North Africa (MENA) region. Here, supplies of biomass are limited which prevents development of biofuels. In addition, the inability of the grid to provide sufficient low-carbon energy limits the prospects for vehicle electrification and water splitting for hydrogen fuel cell vehicles through electrolysis. As a result, vehicle hybridisation could be a first viable step in decarbonising the transport sector in this region while the electricity grid is shifted towards decarbonisation.	Yes but EV's are now looking better in GHG and costs	Nicholas Surawski	University of Technology Sydney	Australia
2859	0				The mild hybrid conversion undertaken at UTS (see below) is an example of technology that could be deployed until the grid is ready for vehicle electrification:	Taken into account.	Nicholas Surawski	University of Technology Sydney	Australia
2861	0				https://www.createdigital.org.au/engineers-are-building-a-hybrid-vehicle-that-doesnt-cost-the-world/	Taken into account.	Nicholas Surawski	University of Technology Sydney	Australia
2863	0				Overall, this suggests that a fifth decarbonisation option in the report may be required, which would involve Vehicle Hybridisation and potentially coupling this solution with biofuels. This could be achieved by adding a sub-section 10.3.5 to the report.	Taken into account.	Nicholas Surawski	University of Technology Sydney	Australia
2879	0				I'm interesting to know where off-road vehicles sit within the context of the IPCC? I didn't see them mentioned in this chapter but presumably these technologies are placed somewhere else within the general framework.	Accepted. We had not considered Off-road vehicles. We will need to think about this a bit more.	Nicholas Surawski	University of Technology Sydney	Australia
3019	0				1- No assesment provided on costs and distributional implications of the transport system transition to low carbon. 2- No proper assessment of scalability of options or discussion of barriers provided.	Accept. Not yet	Mustafa Babiker	Aramco	Saudi Arabia
11069	0				The inclusion of aviation and shipping as explicit sections is very welcome and reflects the developments in the climate change debate in these fields. However, in both areas, there is insufficient consideration of possible or feasible rates of deployment of low carbon technologies/operations. Also, there is an inadequate discussion of the implications of the mulitlevel perspective. This is a literature which has considered the paths of diffusion of new technologies and transport systems in detail, but this literature is not mentioned here.	Accepted. Agree, check	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
16329	0				Absent from Chapter 10 is a cogent treatment of transport to space, both for satellites and missions for scientific and other purposes, and the contributions to GHG from this sector. Space transport is a growing field, and economic costs have been lowered considerably recently by the presence of private companies in the sector. The possibilities of space development and space tourism are also drivers of growth in this sector. The chapter would be improved by including a treatment of emissions from the space transport sector, as these emissions can be significant.	Accept. Not yet on the outline for IPCC.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
16331	0				Absent from Chapter 10 is a cogent treatment of transport use by militaries globally and their GHG emissions. If data are not extant, the chapter might include a range of uncertainties to help with estimating possible scenarios. Including military emissions in the transport sector will also help to motivate governments to make changes to military transport in line with the climate emergency. In some cases, militaries can pilot new technologies or strategies in transport modalities and fuels, and this can help to be a driver for change. Global GHG emissions from military transport are significant, and the chapter would be improved by including a description of them.	Accept. Will try and add military issues.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
22825	0				While the chapter mentions the ASI framework, it is heavily oriented towards supply-side / technology measures, with little discussion of the more demand / social aspects. On the other hand, transport is discussed in detail in Chapter 5 on "Demand, services, and social aspects of mitigation". I am not sure if this division of labour is deliberate. In any case, it would be good to warn the reader of this - sectoral specialists who plan to read the transport chapter only should be pointed to Chapter 5 for a more thorough discussion of demand-side measures. This disclaimer could appear in the executive summary and the introduction. Some important, and much discussed measures such as carbon/fuel pricing are barely discussed at all within Chapter 10.	Accept. These issues are there but clear. They will be highlighted.	Giulio Mattioli	TU Dortmund University	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
22827	0				The chapter devotes considerable attention to what are defined as "disruptions in transport", including AVs and shared mobility. However, Chapter 5 does a much better job of discussing these in a critical way, i.e. highlighting the potentialof these innovations for climate change mitigation, as well as their limitations and possible unanticipated counterproductive effets. The discussion in Chapter 10 is not critical enough in my opinion and misses some key references in the literature. It is important to counter the 'hype' that surrounds these innovations in the political, public and media discourse. I have provided some examples of this problem in more specific comments to Chapter 10 sections. Note that one of the key ponts in the executive summary of Chapter 5 is "Current energy and GHG emission trends related to digitalization, the shared economy, and the circular economy contribute little, if at all climate change mitigation". It seems important for the IPCC report to send a somewhat consistent message on this point. I believe more coordination with the authors of Chapter 5 is warranted.	Accepted. We will better harmonize with chapter 5	Giulio Mattioli	TU Dortmund University	Germany
28235	0				Section 10.2 Systemic Changes in Transport deals exclusively with Passenger Transport. Why no freight transport relevance	Take into account. To be discussed	Cornie Huizenga	CESG	Germany
28249	0				Section 10.2.3 is to a large extent wishful thinking about what could be but is not backed up by recent developments	Noted - text revised to provide broader views on potential negatives and positives of these different transport technologies/services	Cornie Huizenga	CESG	Germany
28251	0				Section 10.3 focuses on battery technology but ignores the application in transport. One would expect that chapter also deals with transformation of the auto industry. There are large differences between the auto industry and ist orientation towards electric mobility. It is important to indicate this - to back up the statement in beginning of chapter that electric vehicles are moving from meso to macro.	Thanks. The section is dealing with four different set of vehicle and fuel technologies relevant for transport. The application of these are covered in sections 10.4 (land transport), 10.5 (aviation) and 10.6 (shipping), Transformation of these technologies for future is covered in Section 10.7	Cornie Huizenga	CESG	Germany
28255	0				Structure of chapter is not balanced. The section on biofuels has a sub-section on mitigation potential, other parts of the chapter not?	Taken into account: Section on mitigation potential within biofuels will be taken out	Cornie Huizenga	CESG	Germany
28257	0				The chapter is biased towards technological solutions of decarbonization of transport. While other chapters e.g. urban chapter talks extensively about modal shift chapter 10 does not talk about this in any form of detail. The chapter also does not link up in any form or shape with the chapters (3-4) on policy.	Accept. This is clearly there in 10.2 but will be more highlighted.	Cornie Huizenga	CESG	Germany
28259	0				Although there is a section on potential linkages with sustainable development, the overall tone and direction of the chapter - electrification and other technological solutions make indicate that these potential co-benefits are not likely to be realized.	Accepted.	Cornie Huizenga	CESG	Germany
28277	0				This chapter ignores a key part of electrified transport: 2-3 wheelers with sales surpassing electric LDVs manyfold - see China https://www.sciencedirect.com/science/article/pii/S2210422417300503, India https://rmi.org/wp-content/uploads/2019/04/rmi-niti-ev-report.pdf Netherlands https://www.bike-eu.com/sales-trends/nieuws/2019/07/dutch-bike-market-turning-exclusively-electric-10136158?_ga=2.219642203.395692234.1584011712-1349060126.1584011712	Accepted. We are included 2-3 wheelers in the review and will include them in the SOD	Cornie Huizenga	CESG	Germany
29311	0				Please improve on the quality of the Tables and Figures throughout the chapter - some like Table 10.3, Fig. 10.1, 10.9, 10.14 etc are too blurred for the reader to properly crosscheck on the discussion referenced to them.	Accept. All diagrams are to be improved for SOD.	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
29329	0				Even though professional editing will be conducted, some sentence structures throughout the entire chapter need will ned to be keenly be looked at e.g page 6, line 7-9 & 19-22; page 10, line 1-2; page 55, line 6; Page 58, line 20 - and many others.	Accept. All English will be improved SOD.	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
29333	0				Please harmonise the in text referencing style throughout the chapter.	Noted	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
29335	0				Would it be possible for the authors to include a comparative figure that highlights the trends of CO2 emisisons for the different transport options such as the one presented in Figure 10.15?	Accept. Yes we are hoping to do that.	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
29337	0				General comment: Overall, I find chapter 10 to highlight all of the important aspects related to transportation with regard to GHG emissions and reduction options/strategies. The completion of the 'place holder sections and information' will make the chapter even much better. Great work by the authors.	Accept. Much appreciated.	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
30357	0				Complementarity of BEV and FCEV for road transport (LDV, MDV, HDV), in terms of optimizing infrastructure costs as well as in their ability to serve the different use-cases retaining user convenience (hence accelerating user adoption). Sources: https://juser.fz-juelich.de/record/842477/files/Energie_Umwelt_408_NEU.pdf See also H2 Council, 2019 https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf especially Exhibit 22 p.42)	Literature suggests BEV doing much better now	Guillaume DE SMEDT	Hydrogen Council	France
37529	0				The chapter focuses on the transport sector's relevance to the SDGs as an entry point an their relative contribution to climate change and GHGs secondarily. The focus of the IPCC is on the climate change context, and while of course SDG cobenefits should be highlighted and assessed, the chapter as written subverts the two relative to each other.	Accepted.	Michiel Schaeffer	Climate Analytics	Netherlands
37531	0				Across the chapter, scenarios are categorized by temperature that do not correspond with categorizations in other WG3 chapters. Most notably, the lowest temperature category is "below 1.6C", where all other chapters identify, correctly, 1.5C as a cutoff. These categorizations should be harmonized across assessments in WG3.	Finalized with harmonised text	Michiel Schaeffer	Climate Analytics	Netherlands

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
37533	0				See comment above. In light of this, I find the current draft of several chapters to be highly prescriptive in its pathway classification towards the Paris Agreement temperature goal by classifying what 'below' or 'well below' 2°C is in terms of probabilities. Obviously, policy makers did not make explicit reference to a probability level of concept. However, this does not mean it is unknown. Here are some indications that could guide an assessment on this crucial policy relevant question. Some background on this: • Pre-Paris, the 2010 Cancun language was 'below 2°C'. In response to that, the IPCC AR5 presented the likely (66%) below 2°C category. This has in turn been taken up by the UNFCCC. Both the preambles of the Doha and Lima decisions (COP 19 and COP20) refer to pathways with 'a likely chance' and Paragraph 17 1/CP.21 explicitly mentions a 40 Gt limit in 2030 that is linked to 66% 2°C pathways. • The introduction of 'well below 2°C' in the Paris Agreement represents a clear strengthening of previous language (e.g. Schleussner et al. 2016) and is a reaction to the outcome of the 2013-2015 Review that established in its Structured Expert Dialogue that 2°C 'cannot be considered safe' (compare also decision 10/CP.21).	Later versions clarified this.	Michiel Schaeffer	Climate Analytics	Netherlands
37535	0				(continued) This WG3 draft is now shifting the goalpost on 2°C. A 50% 2°C pathway becomes 'below 2°C' (which is at odds with what is commonly understood by the word 'below') and a 66% chance suddenly becomes 'well below' 2°C (compare table 3.3) but without changing anything in the IAM modeling protocols that determine the pathways that previously were used to inform the 'below' 2°C goal of the Cancun Agreements. This is highly policy prescriptive and arguably in contradiction with the evidence available on how to interpret the PA goal. Rather than interpret the PA, the IPCC should provide different 2°C pathways and label this factually, not normative (in terms of wrong- interpretations of PA language).The IPCC has calibrated likelihood language that can be deployed here. I would suggest to also add an additional 'very likely 2°C' pathway (compare e.g. SR1.5 Ch 3 Table SM2.12). See also Schleussner, C.-F., Lissner, T. K., Rogelj, J., Fischer, E. M., Knutti, R., Licker, R., Levermann, A., Frieler, K., Schaeffer, M. and Hare, W. (2016) "Science and policy characteristics of the Paris Agreement temperature goal", Nature Climate Change 6, 827–835, doi:10.1038/nclimate3096.	Later versions clarified this	Michiel Schaeffer	Climate Analytics	Netherlands
37537	0				(continued) and the following fragment from Wachsmuth et al (2019) "The EU long-term strategy to reduce GHG emissions in light of the Paris Agreement and the IPCC Special Report on 1.5°C", Fraunhofer ISI Working Paper Sustainability and Innovation No. S 22/2018: "The core scientific basis for mitigation pathways that underpinned the Cancun Agreements and subsequent literature, and the work of the SED on the 2013-2015 Review of the adequacy of the long-term goal (all preceding the Paris Agreement) systematically characterized the Cancun "hold below 2°C" global goal using pathways that limited warming to below 2°C with a chance of at least 66%, or "likely" in IPCC terms [15]. The decision to strengthen the long-term goal therefore has to be seen with reference to this context, which frames the negotiations over the ambition elements of the Paris Agreement. The Paris Agreement LTTG strengthens the former Cancun temperature goal by referring to holding warming "well below 2°C" and, in this context, pursuing efforts to limit warming to 1.5°C. It therefore signals that warming needs to be held to a lower level than in the former (Cancun) goal, and hence increase both margin and likelihood by which warming is to be kept below 2°C compared to merely "hold below 2°C" [4]."	Later versions clarified this	Michiel Schaeffer	Climate Analytics	Netherlands
41267	0				The transport sector emits a broad group of components with very different characteristics; long -lived, short lived, warming and cooling, gases and aerosols. Thus I suggest that early in the chapter you explain this as a basis for the rest of the chapter. And that you throughout the sections are very careful to be precise and clear what components or group of components you consider. Especially when you use the agregate CO2eq. WGI has a searate chaper on SLCF, and coordination with this chapter can be very useful. Please contact TSUs or bureau memebrs for help with finding relevant authors in WGI	Accept and revised.	Jan Fuglestvedt	CICERO	Norway
41279	0				Many carbon footprint (or climate footprint) calculators use a multiplier for aviation in order to account for non-CO2 impacts. These impacts operate on a very different timescale compared to CO2, and the uncertainties for many of these effects are very uncertain. It would be very useful if the chapter could include an assessment of the multiplier and the way they are used in development of mitigation and in communication of impacts of aviation to the civil society. (Some multipliers are based on the backward looking RFI from IPCC 1999, while other mulipliers may be forward looking based on GWP)	Accepted. Agree and add point	Jan Fuglestvedt	CICERO	Norway
28651	1	1	1	1	I missed to note the correct line of text and as I need to stop revieweing I just note this as a comment: in past studies (I think also IPCC) the transport sector is seen as one of the most difficult to decarbonize. I think this still holds for air and ship, but this assessment should be modified for cars, trucks and busses. Their life time is shorter (lets say between 5 to 20 years) while air, ships are in the range of 30 years, and power plants or buildings are in the range of 50 years. Thus the transformation of the capital stock can be much faster in the road sector - and the technologies exist (electrification of cars) or will soon be available (for trucks) to decarbonize them. So, I would emphasize that transport decarbonization can provide a faster contribution then thought in the past (and of course modal-shift by incentives can also occur faster then decarbonizing the stock of buildings).	Accepted and revised.	Wolfgang Schade	M-Five GmbH Mobility, Futures, Innovation, Economics	Germany
36157	1	23	1	23	"the"should be removed before "better decarbonization scenarios"	Accept. Done.	Arvind Gangoli Rao	Delft University of Technology	Netherlands

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31187	1	1	75	17	This is a very important comment: This whole chapter would benefit strongly from using a seamles quantitative link to IP1..IP5. It is very important to use IP1 .. IP5 as examples to show how the decarbonization is actually reached in these scenarios, i.e. show how transport activity changes, how modal split changes, how drive trains change, how fuels change and so on. All this data must be available in the scenarios IP1 .. IP5 and should be presented here. All important transport KPIs (Key Performance Indicators, including transport activity for passenger and freight, vehicle efficiency etc.) from IP1 .. IP5 should be discussed in this chapter. If such data is not available from IP1..IP5, then scenarios should be created and presented here in Chapter 10 which are consistent with the transport systems in IP1..IP5. [BTW: The same is true for the chapters on buildings, industry, energy systems, agriculture etc.. Also there the quantifications of IP1 .. IP5 should be presented. Discussing the quantifications of IP1..IP5 should be a general theme in AR6.]	Accept. This will be done more in SOD but depends having the transport elements provided.	Urs Ruth	Robert Bosch GmbH	Germany
31513	1	1	75	17	Thank you for providing this comprehensive manuscript. I highly enjoyed its reading! It is much better than other Chapters, but I still could find typos and other editorial things (e.g. figures) which I didn't mention below.	Accept. Appreciated.	Patrick Jochem	German Aerospace Center (DLR)	Germany
31517	1	1	75	17	I would introduce each abbreviation in each chapter when it is mentioned first and use it TROUGHOUT the chapter without introducing it again (e.g. SLR).	Accept. Agreed	Patrick Jochem	German Aerospace Center (DLR)	Germany
34057	1		75		As far as I can see this chapter fails to explicitly acknowledge a series of critical challenges around low-carbon mobility transitions; namely those of unequal technological diffusion, social justice and reinforced social vulnerabilities. This may include a lack of access to electric vehicles due to pricing or a lack of access to charging points, for example, which has been linked to issues rural peripheralisation (though the chapter does mention "affordability" and "access" the justice link is underemphasised, as is the empirical reality of its existence). Likewise, there are justice issus embedded within the development of the technologies themselves, including those involved with the so-called Artisinal mining of cobalt, for instance. I would expect at least a brief mention of "justice" or "vulnerability" ideas as a reflection of the socio-technical nature of such issues. The authors may wish to refer here to observations from a special issue by Simock and Mullen here (https://www.sciencedirect.com/journal/energy-research-and-social-science/vol/18) or to Sovacool's work on supply-chain injustices (https://www.sciencedirect.com/science/article/pii/S2214790X1930084X).	Accept. Justice issues are being more focussed into this and other issues. Both references will be used.	Kirsten Jenkins	University of Edinburgh	United Kingdom (of Great Britain and Northern Ireland)
11147	1	1	101	17	This is a well written chapter. However, it is mainly a technological review and not so much an assessment. It lacks a larger focus on behavioral aspects, i.e., social science studies in this field. For instance, what is needed for people to choose low-emissions vehicles when travelling? Will a technological change to low emissions vehicles change poeple's traveling habits? What will the social aspects be of self-driving cars? I will turn to some of this in my other commenbts.	Accept.	Snorre Kverndokk	Frisch Centre	Norway
11471	1	1	101	17	The chapter including flg 10.10 completely neglects urban freight and informal transport modes	Take into account. We did not exclude urban freight as we included medium-duty trucks, which are part of the urban freight. We need to think how to include fleet vehicles (like USPS trucks), but we can include that. I am not sure how we include informal transport (I am not sure what does that mean).	Sudhir Gota	Independent Consultant/Researcher	India
11481	1	1	101	17	The chapter discussion on mitigation is entirely "Technology oriented" (about 90% of mitigation discussion could be sourced to technologies) with some discussion of shifts and active transport. It does not describe the behavioral changes and the avoid strategy. No discussion on stagnation of BRTs, No discussion on Co-benefits (except couple of mentions of air pollution). see Chapterv 3 -41 for further discussion in Chapter 10. Bike share discussion in chapter 5 is not reflected in chapter 10.	Accept. Understand the reaction there are many sections on these issues. They will be clearer and more obviously highlighted in SOD.	Sudhir Gota	Independent Consultant/Researcher	India
11493	1	1	101	17	No discussion of current transport targets developed by cities, companies, countries/non-state actors. The historical performance shows that transport sector has grown as per the BAU predictions of the past!. The growth in activity levels outpaced energy efficiency and fuel economy improvements. This is important with reference to discussion in 10-75	Accept. This will be added in some case studies if space is available.	Sudhir Gota	Independent Consultant/Researcher	India
6005	1	1	101	48	My opinion is the chapter should be differentiate between river transport and sea transport because each category has specific characters and consumers, then the mitigation efforts maybe more effective, and economically justified.	Accept. We are mainly focused on international shipping, as that is where the major emissions are coming from, and where the major mitigation challenges are. Inland waterways will be briefly covered.	Ayman Batisha	International Sustainability Institute (ISI)	Egypt
6007	1	1	101	48	Similarly, the chapter should be differentiate between road and rail transport because each category has specific characters and consumers, then the mitigation efforts maybe more effective, and economically justified.	Take into account. The section on land-based transportation (10.4) provides separate information for light-duty passenger transport, truck-based freight transport, buses, passenger rail, and freight rail. We need to confirm with the scenarios section what level of dissagregation the IAM and up-bottom models provide	Ayman Batisha	International Sustainability Institute (ISI)	Egypt
6009	1	1	101	48	Correspondingly, the chapter should offer some sort of recommendations about the best fit transport from mitigation point of view, if more than one option is available.	Accept. That is how we are re-organising 10.8.	Ayman Batisha	International Sustainability Institute (ISI)	Egypt
6011	1	1	101	48	Analogously, the chapter should offer some sort of classifications concerning most important consumers for Transport, urban transport, rural transport … etc. It will be very useful in addressing the mitigation options.	Accept. Will try to see where it can fit.	Ayman Batisha	International Sustainability Institute (ISI)	Egypt
6013	1	1	101	48	In the same way, the chapter should offer some sort of classifications concerning most important factors such as the distribution of Transport GHG in geographic locations in the World. It will be very useful in addressing the mitigation options.	Accept and revised.	Ayman Batisha	International Sustainability Institute (ISI)	Egypt

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34983	3	7			Focusing the chapter on decarbonizuingaviation and shipping falls short; transport emissions are direct and indirect related to mobility and traffic, so that measures have to be set in various transport-related sectors. First of all: reduce dependencies on motorized transport facilities - cars as well as aviation, (high speed) trains, ships etc. > srengthening of local and regional mobility, active forms of mobility such as walking and cycling	Accept. These other elements are there but will be highlighted more.	Stephan Tischler	University of Innsbruck	Austria
11799	4	0	4	0	This executive summary does not yet include any major findings from the chapter, for instance no mention of the mitigation potential for the transport sector. Please consider to include more information about what can be achieved and how.	Accept. ES is low on numbers as we don't have data from IEA and IAM's yet. Main messages are there but will be refined in SOD.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
11633	4	1	4	12	please work on the language in abstract - it doesn't look clear at the moment	Accept. SOD will be better.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
3249	4	1	4	30	Given the relevance of the transport sector for global emissions and the richness of the literature on mitigation of GHG emissions of this sector the current executive summary is much too short and high level. It should be as informative as e.g. the executive summary of chapter 9 (buildings). A good starting point might be sub-chapter 10.8. However, this need to be shortened by about 50%.	Accept. Will make a bigger version in SOD.	Klaus Radunsky	retired from Umweltbundesamt	Austria
3253	4	1	4	30	A proposal for a story line of the executive summary could be to describe the barriers for transport to become carbon neutral and how the various stakeholders would have to contribute to move at some speed to meet such goal, e.g. by 2050. The chapter could also link to the alternative - if such goal would be missed - that would be carbon dioxide removal in the long term and SRM in the short and medium term.	Accept. We are going to do this in 10.8 to make the focus more obvious and will bring into ES.	Klaus Radunsky	retired from Umweltbundesamt	Austria
11131	4	1	4	30	Promotion of electrification is the key to achieve the Paris goals, and thus, promotion of electrification in transportation should be clearly written in the Executive Summary, with an exaple of targeted electrification ratio based on IPCC SR15 scenarios or IEA scenario.	Accept.It is there in the bold section of ES but we are seeking to make it clearer in SOD.	Midori Sasaki	industrial organization	Japan
25193	4	1	4	30	Executive Summary to have summarise takeaway messages similarly to the other chapters	Accept. It needs to be written more clearly.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
41263	4	1	4	30	The ES needs to be written in a format constent with the rest of the report	Accept. The SOD will be a more formal document.	Jan Fuglestvedt	CICERO	Norway
47265	4	1	4	30	The executive summary should be formatted and consisting of a summary of facts and needed actions, measures and policies, like in other chapters, e.g. chapters 5, 6, 11, instead of an introduction-like formatting.	Accept. Good advice and we can now see that is a better style.	Beat Brunner	Lightning MultiCom SA	Switzerland
35795	4	1	4	31	Executive summary does not highlight key findings in the report	Accept. It does but not clearly.	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
3179	4	2	4	2	The statement is inconsistent with line 13-14 of page 6: "Transport sector carbon dioxide (CO2) direct emissions increased 29% (from 5.8 Gt to 7.5 gigatonnes (Gt)) between 2000 and 2016". Please clarify whether the period considered should be 2000-2016 or 2010-2016.	Accept. Will ensure consistency.	Sai Ming LEE	Hong Kong Observatory	China
41265	4	2	4	2	Re "GHG": I suggest you insert a footnote saying which components that are inlcuded here. This is very important for the Transport sector due to the broad group of components emitted.	Accept and revised.	Jan Fuglestvedt	CICERO	Norway
28529	4	2	4	3	the second sentence is not obvious after having only growth numbers in the first sentence --> what is the total amount of transport GHG emissions? What percentage of the total?	Accept and revised.	Paul Wolfram	Yale University	United States of America
31191	4	2	4	3	for a better understanding, the increase in transport activity in the corresponding periods should also be stated here	Accept. Yes will try to do that. Data still coming.	Urs Ruth	Robert Bosch GmbH	Germany
47889	4	2	4	12	The first paragraph is bold - suggesting it is especially important, like an abstract. If so, it needs to contain more bottom line findings, like policy recommendations and the best low CO2 technologies, something along these lines. Or else maybe not bold it?	Accept. Not sure who put it in bold. Will be removed.	Lewis Fulton	University of California, Davis	United States of America
3181	4	2	4	30	Please indicate the Section(s) referenced for each of the paragraphs.	Accept. Added.	Sai Ming LEE	Hong Kong Observatory	China
47891	4	2	4	30	More generally, the entire executive summary says very little about hard findings and recommendataions at this point. The introdcution is where to tell readers what the report will cover, organization, etc. - the Exec Sum is to put the top level findings. These are currently missing.	Accept. These are there but obviously need to be clearer using dot points.	Lewis Fulton	University of California, Davis	United States of America
11625	4	3	4	3	"climate mitigation" goals not "climate change goals"	Accept. Big error.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
47883	4	3	4	3	"this is now needing" is awkward. I just mention it because it suggests a copy edit scrub will be needed at some point, presumably near the end - but hopefully it will happen.	Accept. Not yet done for this FOD but we will get better for SOD. No copy edit until the very end.	Lewis Fulton	University of California, Davis	United States of America
11627	4	5	4	5	"came from road transport" not "came from on road"	Accept.Will change.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
11801	4	5	4	5	unnessessary to write "the developed and developing world"	Accept. Changed	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
47885	4	5	4	5	"75% of transport emissions came from on road" - in 2016? Is 2016 the base year (most recent data year) of the analysis? Please be clear on this.	Accept. New data will come for SOD.	Lewis Fulton	University of California, Davis	United States of America
14055	4	5	4	6	Based on IEA data, it seems that those figures are taking into account direct and indirect emissions but it is not clear from the sentence (based on the 3% of emission in rail which matches the data from the IEA for 2016 taking into account indirect CO2 emissions). Please clarify if only direct emissions are accounted here.	Accept.	Victor Garcia Tapia	International Energy Agency (IEA)	France

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14057	4	5	4	6	Regarding the emissions' shares in these lines, from my point of view it is not clear the source, the year and if those emissions' shares are referring to GHG or CO2 only.	Accept and revised.	Victor Garcia Tapia	International Energy Agency (IEA)	France
14059	4	5	4	6	Are pipeline transport emission taken into account for this chapter or only road, rail, aviation and navigation ? Based on IEA data pipeline transportation accounted for around 2 % of the CO2 emissions with emissions from electricity reallocated.	Accept and revised.	Victor Garcia Tapia	International Energy Agency (IEA)	France
47281	4	5	4	6	"this need to shift the load further" I don't understand what is meant here. I suppose something positive about rail?	Accept. Will use 'shift mode'	Auke Hoekstra	Eindhoven University of Technology	Netherlands
11457	4	6	4	6	It is quoted - "But 22% of emissions come from aviation and shipping (split evenly), and are the fastest growth areas". However, they are not split evenly now. research indicates that aviation emissions are slightly higher than shipping. See https://www.climate-chance.org/wp-content/uploads/2019/12/en_c1_complet_def.pdf, https://theicct.org/sites/default/files/publications/ICCT_CO2-commercl-aviation-2018_20190918.pdf, https://www.iea.org/reports/tracking-transport-2019	Accept and revised.	Sudhir Gota	Independent Consultant/Researcher	India
11629	4	6	4	6	"this needs to shift the load further remains a theme - unclear sentence	Accept. Fixed.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
11803	4	6	4	6	strange sentence "this need to shift the load"	Accept. Fixed	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
47887	4	6	4	6	"this need to shift the load further" - informal, and it does not automatically follow that a low share on rail means we should shift the load futher - it depends on carbon intensity, which you haven't mentioned yet.	Accept. Fixed.	Lewis Fulton	University of California, Davis	United States of America
42851	4	6	4	8	The focus on aviation and shipping is necessary and welcome - but this section must mention that the climate impact of the aviation is 2-4 times the impact of the CO2 emissions alone due to indirect effects (IPCC AR 4). The CO2 emission figures alone give a misleading impression of the climate impacts.	Accept.	Mark MAJOR	Partnership on Sustainable Low Carbon Transport	Spain
28531	4	8	4	9	"Since AR5 there has been a developing split … " --> what does this mean?	Accept. Will be clarified.	Paul Wolfram	Yale University	United States of America
27015	4	8	4	12	This sentence is a bit unclear. Are you trying to say that there is a case for optimisim due to the electrification of light/medium transport, but that further R&D breakthroughs are needed for heavy vehicles? Also, are buses and trains light duty systems - because thats how this sentance seems to read.	Accept. Poorly written though essentially this is a main conclusion.	Thomas Longden	Australian National University	Australia
28227	4	8	4	12	Lumping Trucks with Shipping and Aviation is not correct. The viability of ewlectric trucks is much better developed than electric ships and planes. https://www.transportenvironment.org/sites/te/files/publications/20180725_T%26E_Battery_Electric_Trucks_EU_FINAL.pdf https://www.sciencedirect.com/science/article/pii/S0306261918318361	Accept. Trucks now in Light/Medium.	Cornie Huizenga	CESG	Germany
11635	4	9	4	9	decarbonisation *options* aren't solely about elelctrification. Modal shift (people cycling and walking instead of high-CO2 modes of transport) is a serious measure that ought to receive its due consideration in abstract	Accept. This is in later sections but have been added higher up to give greater emphasis.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
20689	4	10	4	10	There is a general complain that in decarbonization practices, much more focus is given to electrification of vehicle, public transport, which also makes projects more expensive, rather than on non-motorized transport such as walking and cycling, while those options can be delivered at a much lower cost. Consideing the fact that IPCC documents will be taken way more seriousely, even by the government officials, in order to prove their decision is right, how much focus is given on the non-motorised transport in your report?	Accept. We have added active transport higher up.	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
47283	4	10	4	12	I have found no basis in science for the claim that heavy trucks are somehow impossible to electrify while I did find their business case will be better than diesel after 2025. I have had 6 master students do their thesis on it (e.g. reverse engineerding the Tesla Semi truck and using real driving patterns from fleets that where given to us) and have written a report, multiple blogs and a converence publication about it. This will be a recurring theme in my feedback below and in order to make it stick I will also write a peer reviewed English article with leading authors in the coming 6 months.	Accept. Trucks accepted as part of electro-mobility.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
20705	4	11	4	11	There is a debate about (lack of) integration between spatial planning and transportation planning. Also, mitigation and adaptation strategies are inter-dependent/ inter-related. Transportation planning is being treated so much in separation from spatial planning, so that I heard a faculty at MIT explaining Transportation planning is a subject, and NOT a discipline. How much do you bring in the spatial planning or land use planning aspects	Accept. It's a big part of the chapter and of the author's research backgrounds. WE have made it more prominent in SOD.	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
11631	4	11	4	12	"..and planes which decarbonization options are more complext and require further RandD" instead of "..planes that have only complex options that all require RandD"	Accept. Re-did whole para.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
42215	4	13	4	15	The chapter is heavy on the improve strategies, but the same level of attention was not given to avoid and shift discussions.	Accept. It has grown in SOD.	Alvin Mejia	Wuppertal Institute	Germany
11149	4	13	4	30	The words "review" and "survey" is used here in the Executive summary, but this report is supposed to be an assessment, not a survey of the literature.	Accept. Agreed and changes made.	Snorre Kverndokk	Frisch Centre	Norway
11637	4	14	4	15	framing social/human aspect of transport use as 'behaviour' is limiting as it assumes the prevalence of "individual choice" as the main factor. There's been a debate on that for the last c. 10 years in social sciences. Shove's (201) is one of the key papers https://journals.sagepub.com/doi/10.1068/a42282 Please consider using the word "practice" instead. One of the key exmaples from transport is Spurling et al 2013 https://eprints.lancs.ac.uk/id/eprint/85608/ or Watson 2012 https://www.sciencedirect.com/science/article/pii/S0966692312000889	Accept. We will try to be more inclusive of this idea. Linda Steg to respond.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
3251	4	17	4	17	It is strongly suggested to avoid in the executiuve summary abreviations such as ICE (Internal combustion engine) which are likely well known to specialists in the field but authors should recognize that they are writing the excrecutiuve summary (and the report) not for the specialists but for lay persons and mainly policy makers that are usually not familiar with any such sector specific specific acronyms.	Accept. Agreed. Changed.	Klaus Radunsky	retired from Umweltbundesamt	Austria

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11805	4	17	4	17	add "in no direct order" after "followed"	Accept.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
11807	4	17	4	17	Please consider to delete "advanced ICE", all other pathways mentioned is ENERGY source/carrier.	Accept. Changed.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
13717	4	17	4	17	Please explain "ICE" (Internal combustion engines comes on page 34)	Accept. Changed.	volker Grewe	DLR-Oberpfaffenhofen	Germany
27995	4	17	4	17	IPCC includes "biofuels, synthetic hydrocarbons and advanced ICE" as options for decarbonization yet says nothing of the air pollution associated with these fuels. Whether any solution is used must be based on a social cost analysis that accounts for carbon and air pollution, not just an assumption that if carbon is reduced, that is sufficient or okay. Given that the worldwide cost of air pollution mortality today (7 million deaths/year, $30 trillion per year) is higher than that of global warming Jacobson, M.Z., Review of solutions to global warming, air pollution, and energy security, Energy & Environmental Science, 2, 148-173, doi:10.1039/b809990c, 2009; Jacobson, M.Z., M.A. Delucchi, M.A. Cameron, S.J. Coughlin, C. Hay, I.P. Manogaran, Y. Shu, and A.-K. von Krauland, Impacts of Green New Deal energy plans on grid stability, costs, jobs, health, and climate in 143 countries, One Earth, 1, 449-463, doi:10.1016/j.oneear.2019.12.003, 2019, the ignoring of air pollution impacts of solutions is not okay. For transportation, the only technologies that eliminate air pollution and their social costs are battery electric vehicles and hydrogen fuel cell vehicles, where the electricity is produced from clean, renewable energy and the hydrogen is produced from clean, renewable electricity. Combustion fuels are not okay. Please clarify this in the main conclusions and throughout the chapter.	Accept. Added to co-benefits.	Mark Jacobson	Stanford University	United States of America
47285	4	19	4	20	"complexity of options for sea and air" I think it would be could to specify this is the "complexity of options for long distance travel for sea and air" since multiple short distance vehicles are already there (e.g. large ferries) or being researched (e.g. aircraft up to 1600km) and their business case will be much imporved once battery prices come down further.	Accept. We have clarified in Feasibility section. Hard to put short enough.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
2651	4	21	4	28	One is impressed by the clarity of this chapter and the sharpness of conclusions, as illustrated incidentally by the concision of the summary. Major examples of course are the split between incremental and transformative, and the heavy versus light vehicle cases. Such qualities increase the influence of statements throughout the text. Then let us hope that the authors are completely sure whenever they are affirmative, because they will be listened to carefully by SPM readers.	Accept. Much appreciated.	Philippe Waldteufel	CNRS/IPSL/LATMOS	France
47287	4	22	4	26	I really like the use of the multi level perspective. I hope it can be further implemented in the rest of the chapter. I have also written on the usefulness of MLP for mitigation pathways. (Hoekstra, A.E., Steinbuch, M., Verbong, G.P.J., 2017. Creating Agent-Based Energy Transition Management Models That Can Uncover Profitable Pathways to Climate Change Mitigation. Complexity. https://doi.org/10.1155/2017/1967645). MLP will also be a central part of the NEON research project I'll be heading the coming 5 years.	Accept. Added to references.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
20707	4	23	4	23	If this is about Multi-level Governance, then this requires more detailing out of various levels of government and private sector invovlement and coordination between them.	Accept. Developed further in 10.8 in SOD	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
28533	4	23	4	24	Poorly written sentence. What is the Multi-Level Perspective? It needs a brief introduction	Accept. Changed sentence.	Paul Wolfram	Yale University	United States of America
28643	4	24	4	24	In some countries the targets for heavy trucks decarbonisation by electrification are mid-term already. Germany in the recent climate package (Klimaschutzgesetz) set the target of 30% electrified heavy truck transport by 2030. It let the technology open, but in ongoing trials all three options (BEV, catenary, fuel cell) are tested. By 2021 Hyundai will run 1600 fuel cell trucks in Switzerland. Four major drivers of the German strategy can be identified: the European CO2 standards for new heavy trucks for 2030 (-30% CO2 compared to 2020, which implies a substantial share of electrified trucks), the national decarbonisation target for the transport sector (-42% compared to 1990), a modification of the heavy goods vehicles road charge (charge reduction for CO2-free trucks, charge mark-up for fossil fueled trucks), and several billions of support for the new technologies (for R&D but also as subsidy for purchasing carbon free trucks). As far as I remember, Sweden set the target by 2030 to reduce CO2 from truck transport by at least 75% (though they want to make use of their biomass potentials, which is not at all feasible for other countries). Thus I would disagree with the statement that "heavy vehicle systems remain at the micro level". Actually, in developed / industrialized countries the transformation of heavy trucks towards a decarbonized fleet can be faster than for cars: (1) the turnover of the fleet is faster then for cars (average lifetime of heavy truck: 5-8 years, of car: 15-20 years), and (2) truck purchasers are fully cost sensitive to TCO i.e. if the package of lower truck cost (through learning), differentiated road charge, subsidy, lower maintenance cost changes the TCO ranking the transformation will happen quickly from diesel to ZE trucks. The second IMPORTANT point is: the speed of transformation will differ strongly between frontrunners, other industrialized and developing countries. While frontrunners switch to ZE trucks, they will continue to sell their used diesel trucks to the other countries, as well as manufacturers will continue to sell their diesel trucks to the laggards.	Accept. Trucks moved into first category.	Wolfgang Schade	M-Five GmbH Mobility, Futures, Innovation, Economics	Germany
28535	4	25	4	26	Why is it that light vehicles move from meso to macro level? Needs a brief explanation.	Accept. Tried to add more but the sentence is reasonably clear about facilitating markets and recharge facilities.	Paul Wolfram	Yale University	United States of America
18381	4	27	4	28	Emissions of transportation are growing rapidly in the world, so we should make an in-depth analysis on the emission distribution of international transport emissions between regions, especially shipping , aviation and railway transport.	Accept. We are seeking such data but hard to get.	Jie Guo	China Academy of Transportation Sciences	China
22829	4	1			The executive summary is a very short and not very well structured - I am not sure if it does justice to the Chapter	Accept. It doesn't do justice but hopefully would in the SOD	Giulio Mattioli	TU Dortmund University	Germany

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43659	4	1			A very well written chapter. The executive summary may also point to non-motorized transport, e.g. to bicycle transitions, especially as those are associated with high quality of life, not only motorized transport. https://www.fastcompany.com/90456075/here-are-11-more-neighborhoods-that-have-joined-the-car-free-revolution Digitalization and shared mobility may also deserve more attention. A key issue that is missing in this chapter is some sort of economics, especially urban economics. While there shouldn't be any abstract formalisms, some intuition is very important. Especially the relevance and interaction of fuel prices with urban form and modal shares.	Accept. Added more on this	Felix Creutzig	MCC Berlin	Germany
43663	4	1			A few words on novelty of this transport chapter would help. What is new compared to Kahn Ribero GEA 2012 and Sims et al 2014 AR5? Consider also summary publications: Figueroa, Maria, Oliver Lah, Lewis M. Fulton, Alan McKinnon, and Geetam Tiwari. "Energy for transport." Annual Review of Environment and Resources 39 (2014). Lah, Oliver, Santhosh Kodukula, and Shritu Shrestha. "Transition to sustainable mobility: Pathways, Policies, Co-benefits and Opportunities of low carbon transport future." (2019). Creutzig, Felix. "Evolving narratives of low-carbon futures in transportation." Transport reviews 36, no. 3 (2016): 341-360.	Accept and revised.	Felix Creutzig	MCC Berlin	Germany
43665	4	1			There are two key overlaps with Chapter 5: emphasis on demand-side options and A-S-I framework. Opportunity to cross-over more in detail. A third area: shared mobility and digitalization?	Accept. We will do more on both.	Felix Creutzig	MCC Berlin	Germany
11639	5	11	5	11	this is somehow techno-centric look on what 'disruptions' are. please consider trends which are re-shaping cities and social norms, e.g. car restrictions (parking restrictions, congestion charges) and pedestrianisation of cities. In terms of what's shaping the present and the future, there is far more evidence of the above mentioned policies having an impact rather than quite niche autonomous vehicles. "transport options" is not only about the vehicles, but also about the roads, cycle lanes, pavements, bus stops etc - infrastructure as a whole	Accepted. The chapter is more focused in tech options. Other alternatives as different spacial structures are dealt in chapter 5 (5.3.2.1/ 5.3.3.1)	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
47289	5	11	5	11	Agree electrification, sharing and autonomy are the big three. Even more so in most government planning I'm involved in. I think this could become even more prominent in the rest of the chapter. What I'm missing is that autonomy is an important driver for sharing since every vehicle becomes a taxi but minus the cost and space usually associated with the taxi-driver. Sharing autonomous vehicles would logically speaking also lead to smaller vehicles and thus a big reduction in energy use. Also, since you lead less vehicles if you share, manufacturing emissions would be much reduced which I don't think I see mentioned. We have two papers about this that are submitted but not yet accepted. E.g. https://www.dropbox.com/s/45d7i8qmhvnbn9a/EVS32%20-%20Hogeveen%20-%20Hoekstra%20-%20Shared.pdf?dl=0	Accepted. We will address this consideration, and if possible we will include the reference cited.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
11641	5	29	5	29	in SDG no 3: links between active transport and good health, e.g. Smith et al https://ijbnpa.biomedcentral.com/articles/10.1186/s12966-017-0613-9 also *improving road accessibility to disabled users (king et al https://www.tandfonline.com/doi/full/10.1080/16549716.2018.1538658)	Accepted. If possible we will include the reference cited.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
11643	5	29	5	29	in SDG 8: could be more precise, e.g. * role of transport provision in accessing work, reconfiguration of social norms, e.g. working from home (Hampton, 2017 https://www.sciencedirect.com/science/article/pii/S2214629617300828) *transport manufacturers as key employers *changing role of transport-related labour due to platform economy (taxi drivers) and innovations in autonomous vehicles (lorry drivers) (Henscher 2017 https://www.sciencedirect.com/science/article/pii/S0965856416303949)	Accepted. If possible we will include the reference cited.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
20709	5	29	5	29	Could the table be converted into cost benefit analysis?	Accepted. We can try to consider a qualitative analysis: actions/benefits/ benefit impact (high = 3; medium=2; low = 1)/ Costs/ Costs impact (high = 3; medium=2; low = 1).	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
20711	5	29	5	29	The following categories would make sense too: SDG 1: No poverty Transport poverty SDG5. Gender equality In transport SDG17. Partnership for the goals SDG 10. Reduced inequalities	Accepted. We will include	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
20713	5	29	5	29	For SDG 3: An dditional point would be reduced stress level from driving.	Accepted. We will include	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
20715	5	29	5	29	For SDG 8: The additional point is: Faster economic development contributed by decarbonised public transport rather than private vehicle use.	Taken into account.	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
20717	5	29	5	29	For SDG 9: Example of innovation at the informal scale would be: E-rickshaw.	Accepted	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
20719	5	29	5	29	For SDG 11: -Accessibility vs mobility -Not only access to transport, but mobility to opportunities. -Transport equity -Development as freedom	Accepted. We will include	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India

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20721	5	29	5	29	For SDG 12: Considering while life cycle analysis	Accepted. We can include based on literature review.	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
23759	5	29	5	29	"for cities": but also more rural areas	Accepted. We can include based on literature review.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23761	5	29	5	29	"Material consumption during production of vehicles and their operations": Not only production of vehicles/power trains, also including entire value chains Close carbon / nutrient cycles >> link to circular economy	Accepted. We can consider. Check if we have literature to support.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23763	5	29	5	29	"Reduction of GHG emissions": Along the entire value chain (WTW). Further development adressing minor GHG emissions	Accepted. We can consider	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
34895	5	29	5	29	Table-10.1, SDG 8, typos, inverted comma to be typed correctly.	Accepted. We will review.	ANUPAM DEBSARKAR	University	India
42217	5	29	5	29	For SDG 3, transport related topics - time spent on transport/mobility is also very important	Accepted. We can include based on literature review.	Alvin Mejia	Wuppertal Institute	Germany
42219	5	29	5	29	For SDG 8, transpot related topics - affordability of mobility services, this can also be covered under "universal access"	Accepted. We can include based on literature review.	Alvin Mejia	Wuppertal Institute	Germany
1677	5	12	6	9	This section on SDGs is not good start of this chapter. As other end-use sectors, It is easy to read if you start from the trends and drivers.	Noted	Shigeki KOBAYASHI	TICJ	Japan
11703	5	29	6	1	The higher personal income, the higher use of transport services, which are quite basic. Therefore, transport is also indirectly related to SDG1 target 1.4 "By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance".	Accepted. We totally agree. We will consider.	Andrey Kolpakov	Institute of Economic Forecasting of the Russian Academy of Sciences	Russian Federation
29103	5	29	6	1	There are a couple of recent papers on transportation and the gender SDG, especially how safe public transport enables the greater participation of women in the workforce	Accepted. We can include based on literature review.	Minal Pathak	Ahmedabad University	India
47291	5	29	6	1	Under SDG 3 one could add "Noise pollution" since this is an important driver for stress, learning problems and shorter lifespan in cities. I've understood this leads to the loss of more DALYs (disability adjusted life years) than particulate matter which in turn causes much more DALYs lost than traffic accidents.	Accepted. We will address based on literature review.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47293	5	29	6	1	Under SDG 12 one could add "GHG emissions during manufacturing" since the reduction potential here is often largely forgotten (also in this chapter). But although GHG emission reductions during the use phase are important, we also need GHG emission reductions during the manufacturing phase when we want to stay below 2C. This is one of the reasons I'm very interested in electric vehicles (mostly BEV but also FCEV): when we drive AND MANUFACTURE them using renewable electricity the emissions can become really low. See e.g. Hoekstra, A., 2019. The Underestimated Potential of Battery Electric Vehicles to Reduce Emissions. Joule 3, 1412–1414. https://doi.org/10.1016/j.joule.2019.06.002	Accepted. We will address this consideration, and include the reference cited.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
11151	5	1	8	29	In the Introduction and overview section, it would be nice to have a figure showing emissions from transport, how it has evolved divided into different vehicles, and compared to total emisions.	Noted	Snorre Kverndokk	Frisch Centre	Norway
14061	5	23	24	4	The text says that transport is particularly linked to SDGs 3, 7, 8, 9, 11, 12, and 13 but then it also gives examples of direct effects concerning SDGs 2,4,6 related with transport that indirectly affect SDG 1 not listed before (access to education (SDG Targets 4.2, 4.3), safe drinking water (6.1.), and by increasing agricultural productivity (2.3))	Accepted. We can include	Victor Garcia Tapia	International Energy Agency (IEA)	France
23757	5	21			For the general understanding of the reader and the connection to the SDG topic, it might make sense to add a rough definition on the concept of sustainable transport.	Accepted. We can include	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
34985	5	29			SDG 3: what about the positive effects of walking and cycling?	Accepted. We can include based on literature review.	Stephan Tischler	University of Innsbruck	Austria
42211	6	1	6	1	The direct effects can also be mentioned, particularly in relation to % household incomes dedicated to transport expenses.	Accepted.	Alvin Mejia	Wuppertal Institute	Germany
47847	6	5	6	9	This paragraph highlights an important challenge of transport and gender equality, and potential issues of climate justice. Could expand and qualify the assertions here i.e. provide data on trips for women vs men, gendered dependence on public transit; clarify why access to EVs or V2G is gendered? i.e. due to preferences, income, targeted marketing?	Take into account. If there is space to expand we will do it	Martino Tran	University of British Columbia	Canada
23765	6	6	6	6	"as women and girls make more trips and change more frequently than men": What is the key message related to SDG 5; that female are more affin regarding mobility as a service and thus different transport modes?	Accepted. We will clarify that	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
28537	6	6	6	6	What does this sentence refer to? What exactly changes?	Accepted. We will clarify that	Paul Wolfram	Yale University	United States of America
34765	6	6	6	6	Second half of the inverted comma in wrong order	Accepted. We will correct this	Rudra Shrestha	Tyndall center for climate change research, The University of Manchester	United Kingdom (of Great Britain and Northern Ireland)
42213	6	6	6	6	May need rephrasing, regardless of the frequency of trips (regardless of gender), equity in access should be provided.	Accepted. We will clarify that	Alvin Mejia	Wuppertal Institute	Germany
11645	6	7	6	7	again, quite a "high tech"-centric view on what 'green technologies' in transport are. Bicycles are quite green and they're also 'technology'!	Accepted	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
25195	6	7	6	7	Do not use terms such as "green transport" as there is no agreed definition, and for example, electricity used for electric vehicle may be from coal-based	Accepted	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
31193	6	7	6	7	only valid when renewable energy is used -> Access to green transport technologies such as electric vehicles operated with green electricity or vehicle-to-grid is gendered	Accepted	Urs Ruth	Robert Bosch GmbH	Germany
28229	6	11	6	13	It would be good to add that According to 2012 IEA data, transport was the largest energy consuming sector in 40% of countries worldwide, and in most remaining countries, transport is the second largest energy consuming sector. http://www.ppmc-transport.org/wp-content/uploads/2015/08/Analysis-on-National-Transport-Sector-Emissions-1990-2012.pdf	Accepted	Cornie Huizenga	CESG	Germany
11455	6	11	6	18	Kindly include 2018 figure - quoted in chapter 2 - 8.3 Gt CO 2eq from transport (direct). Direct and Indirect is estimated to be about 9.7 Gt https://www.climate-chance.org/wp-content/uploads/2019/12/en_c1_complet_def.pdf. In page 60 you quote 8 Gt	Take into account. If there is space to include a new figure we will do it	Sudhir Gota	Independent Consultant/Researcher	India
14063	6	11	6	22	Which is the data source for those numbers ? According to the IEA, CO2 direct emissions from transport in 2016 were 7.7 Gt not taking into account pipeline transport. Could you please clarify the data source and what it is included ?	Accepted. we will clarify that	Victor Garcia Tapia	International Energy Agency (IEA)	France
30961	6	12	6	12	CO2 used before definition on Line 13	Accepted. We will change	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
1679	6	12	6	13	Please add "direct"; third-largest source of CO2 direct emissions.	Accepted	Shigeki KOBAYASHI	TICJ	Japan
28539	6	12	6	13	… and has now for the first time surpassed power sector emissions in the US (see US EIA, p. 196, https://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf)	Take into account. If we have enough space we will expand the sentence	Paul Wolfram	Yale University	United States of America
47295	6	12	6	13	I would avoid using CO2 and CO2eq/GHG interchangably but would convert everything to CO2eq.	Accepted. This will be aligned units used in Chap.2 and rest of AR6	Auke Hoekstra	Eindhoven University of Technology	Netherlands
31195	6	13	6	13	for a better understanding, the increase in transport capacity between 2000 and 2016 should also be stated here	Accepted. It can be considered.	Urs Ruth	Robert Bosch GmbH	Germany
11461	6	13	6	14	"Transport sector carbon dioxide (CO2) direct emissions increased 29% (from 5.8 Gt to 7.5 gigatonnes (Gt)) between 2000 and 2016" - This needs revision.	Take into account. we will check	Sudhir Gota	Independent Consultant/Researcher	India
1681	6	13	6	18	Please check newest data; IEA has 2017 data.	Take into account. We will check	Shigeki KOBAYASHI	TICJ	Japan
30963	6	14	6	14	Gt used before definition	Accepted. We will change it	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
30965	6	14	6	14	There must be newer data available – this report will be published no earlier than 2021, five years after the value of '7.5 Gt in 2016'	Accepted. we will check it	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
30967	6	19	6	19	Which year?	Accepted. We will clarify that	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
30979	6	19	6	19	The same statistic as in lines 28-29	Accepted. We will change	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
1683	6	19	6	20	Need year of data, and also check the newest data.	Accepted. We wil check it	Shigeki KOBAYASHI	TICJ	Japan
11463	6	19	6	20	"75% of transport emissions came from on road, 3% from rail and this need to shift the load further remains a theme from AR5." - This statement is not clear. Mode shift discussion should be in terms of demand and not emissions.	Accepted. This is going to be changed	Sudhir Gota	Independent Consultant/Researcher	India
34901	6	19	6	20	Reference missing, GHG or CO2 emission- to be specified	Accepted.	ANUPAM DEBSARKAR	University	India
47851	6	19	6	20	Please clarify what "shift the load" mean in this context i.e. shift ridership from road to rail, shift emissions from carbon intensive modes (personal vehicles) to less carbon intensive (public transit)? Or is this saying need to reduce aggregate emissions from the transport sector?	Accepted. We will clarify that	Martino Tran	University of British Columbia	Canada
2655	6	19	6	21	Trains Rail is mentioned ocasionally a dozen times in this chapter.This alinea explains that due to the high percentage of emissions due to aviation and shipping the focus will however be on those ways of transportation. Let us note that on page 41 line 45+ the lack of data for freight trains is mentioned, and again on page 45 line 25. This situation is worth some attention. The authors of chapter 10 prefer to focus on shipping and aviation, as indicated above, rather than discussing acceleration of changeover from aviation to train; as just seen, a further difficulty when analysing train issues seems to be the lack of data and literature.	Take into account. This issue is going to be dealt in the following items	Philippe Waldteufel	CNRS/IPSL/LATMOS	France
31515	6	19	6	22	You may provide a reference for this section.	Accepted. This is going to be changed	Patrick Jochem	German Aerospace Center (DLR)	Germany
30969	6	21	6	21	What rate of growth, relative to other modes or overall transport?	Accepted. This is going to be changed	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
14065	6	23	6	23	Could you please clarify the data source and the definition of passenger and freight transport (e.g. is international transport included) ? In case of interest, consider that the IEA has a database containing energy and activity data for passenger and freight transport for IEA member countries and beyond (IEA (2019), "Energy Efficiency Indicators 2019", IEA, Paris https://www.iea.org/reports/energy-efficiency-indicators-2019).	Accepted. We will consider that	Victor Garcia Tapia	International Energy Agency (IEA)	France
11465	6	23	6	24	"Passenger and freight transport emissions increased by 36% and 75%, respectively, between 2000 and 24 2015" - This quote is from SLoCaT (2018). Transport and Climate Change Global Status Report 2018.	Accepted. We will check	Sudhir Gota	Independent Consultant/Researcher	India
31197	6	23	6	24	for a better understanding, the increase of "person km travelled" and "tonnes km" should also be stated here	Noted	Urs Ruth	Robert Bosch GmbH	Germany
35797	6	23	6	29	Is it possible to get figures more recent than 2015	Take into account. We will check	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
23767	6	24	6	24	"2015": Are there also values for 2016 to make data comparable with the values given for CO2/GHG in the section above (or vice versa).	Take into account. We will check	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
30971	6	24	6	24	Should use a common baseline or set of years for comparison. Earlier, our most recent data point was 2016.	Take into account. We will check if it's possible	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
30973	6	24	6	24	Is this statement an average or proportion across all industries? An example or two here might be useful. Additionally, an example or two showing where the statement does not hold.	Take into account. We will check if it's possible	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
11459	6	24	6	25	"Freight transport industries are the major causes for increasing the CO2 emissions within the supply chain (Makan & Heyns, 2018)." - Why are the freight transport industries emissions are being quoted - are we talking about entire logistics emissions including storage and handling?	Noted. Freight Transport emissions are counted on a Tonne-Km basis and do not include storage and Handling	Sudhir Gota	Independent Consultant/Researcher	India
25591	6	24	6	27	Are the results based on the number of t.km? If possible, specify the increase in quantity (tonnes); and the increase in terms of distances (t.km).	Accepted. When possible the information can be made explicit	Sabine Limbourg	HEC-Uliege	Belgium
30975	6	25	6	25	Quantify 'much faster' and the time period	Accepted	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
47893	6	27	6	28	You reference Yeh et al for a very basic percentage number of global CO2. That's a great paper but such a number should come from one of the agreed authoritative sources, such as the IPCC itself, or IEA. In general, key indicators, especially CO2 estimates,should have an agreed upon database that you draw on, rather than random papers.	Accepted	Lewis Fulton	University of California, Davis	United States of America
30977	6	28	6	29	These are stating the same statistic	Accepted. This will be changed	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
29113	6	10	7	16	Since the approved outline includes a bullet on 'Mobility trends and drivers (regional specifies)', might be worth elaborating this section. There are scattered trends in different sections. Could be brought here	Accepted. this will be changed	Minal Pathak	Ahmedabad University	India
45201	6	10	7	16	An overall framework for GHG emissions in transport is given by Schipper (2000), the ASIF model: Activity (pkm/tkm) * modal Split * energy Intensity (MJ/vkm) * Fuel carbon (gCO2/MJ). this would set the stage for the entire chapter, and corresponds quite elegantly to the mitigation domains Avoid - Shift - Improve (and Fuel), see also Bongardt et al 2013 Low-carbon land transport, policy handbook (and other publications). Then figure 10.10 could be move to this section also	Accepted. This session will be changed	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
45203	6	10	7	16	This section should state the GHG (land) transport emission split between urban and non-urban (ITF transport outlook has this)	Accepted. This can be considered	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
957	6	11	7	2	The percentages of emmisions mentioned for the transport sector in the text are not easy to follow. Have one paragraph explaining the difrefernces, another expaling the increase from 2000-2016 etc. Otherwise mixing it up is disturbing the flow.	Accepted. Language simplification and editing for clarity will be considered	Stella Kabiri-Marial	National Agricultural Research Organisation	Uganda
43587	6	11	7	8	All forms of transport have a most payload-fuel-efficient speed somewhere between zero and the maximum practical speed and in unrestricted space such as motorways most vehicles travel faster than this - a serious assessment is needed of the potetial reduction in GHG emissions by the introduction of regulation to limit speeds to the most payload-fuel-efficient - for road transport, which accounts for 75% of transport GHG, this could be done by law; the more difficult case of air transport is discussed later	Noted. This report assesses existing literature. This area will be searched if literature exist it will be assessed.	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)
47297	6	11	7	8	I would add a graph showing this long list of percentages and how they develop through time in a more easy to digest manner. If this graph uses Gt of CO2eq it could also make line 4-8 more readily understandable. Now I'm left to juggle percentages and gigatons. And even I have no idea how many gigatons transport emits currently and how that compares to other sectors without looking it up.	Accepted. The units will be aligned and discussed in the same manner as Chap.2 for clarification	Auke Hoekstra	Eindhoven University of Technology	Netherlands
6399	6	4			Really interesting linkage between transport sector and SDGs; I would highlight the role of transportation to lever the whole economy. For example, in the land locked African countries access to mobility is a crucial factor for enabling the economic activity.	Accepted.	Apostolos Petropoulos	International Energy Agency	France
47849	6	10			For section 10.1.2 suggest include updated summary plots and data for changing transport trends and contributions to GHG emissions since AR5.	Accepted. This willl be coordinated with Chap 2.	Martino Tran	University of British Columbia	Canada

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37539	7	5	7	5	The IEA B2DS scenario is not a 1.5C scenario. As stated in their report (IEA, 2017): " The B2DS approach has the potential to achieve carbon neutrality of the energy system by 2060 and limit temperature increases to 1.75°C by 2100. "	Accepted. this will be changed	Michiel Schaeffer	Climate Analytics	Netherlands
29107	7	6	7	8	Sentence on mitigation potential not clear	Accepted. It will be revised for clarity	Minal Pathak	Ahmedabad University	India
42221	7	9	7	9	Suggestion to change "balanced" to "balanced and context-appropriate"	Accepted	Alvin Mejia	Wuppertal Institute	Germany
28231	7	9	7	16	Suggest to add refrebnce to the http://www.ppmc-transport.org/actionable-vision-of-decarbonization-of-transport/ which mentions 8 components to scale up decarbonization of transport	Accepted. Thanks for reference	Cornie Huizenga	CESG	Germany
29181	7	9	7	16	This part is insisting on the need for a consistent articulation between the different levers of decarbonization. Regarding this topic, I would like to let you know about a specific publication focus on freight (which is most of the time less analyzed than passenger). https://www.iddri.org/sites/default/files/PDF/Publications/Catalogue%20Iddri/D%C3%A9cryptage/201911-IB1419-fret%20NDCs.pdf	Accepted. We accepted your reference. Thank you.	Yann BRIAND	Iddri, Sciences Po	France
298	7	9	7	40	A small discussion about inland waterways shipping would be helpful. Inland shipping can help minimize overland (heavy truck or railroad) transportation by being more efficient both in terms of energy and costs. However, inland waterways shipping can be impacted by climate change by the waterways occasionally inaccessible due to high flows in the rivers. The main climate chagne threats to port operations in lines 39 and 40 only apply to marine port operations, not inland waterways ports.	Take into account. Inland shipping mitigation contributions would be assessed if sufficient literature exist.	Rebecca Harjo	NOAA/National Weather Service	United States of America
11647	7	11	7	11	add: policies to incentivise sharing trips (including improving pulbic transpor)	Accepted. Sharing topic will be expanded toward SOD.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
30981	7	12	7	12	Part of the 'shift' should be towards active and sustainable modes, such as walking, cycling (both could be considered within the 'avoid' category re motorised trips) and public transport. A focus on shifting from a petrol car to a diesel or electric car meets addresses vehicle technology and less carbon intensive fuels. However, public transport should be where trips are shifted to as a priority.	Accepted. Active sustainable modes will be expanded as part of shift policies toward SOD.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
47299	7	13	7	13	"improving the carbon intensity" for me gives the association that transport should become more carbon intensive, not less. I would simply use "reducing carbon emissions of modes of transport". You could even leave it out since "increasing the performance of vehicles" amounts to the same thing (unless I misunderstood of course).	Accepted. Language and terminology will be reviewed for clarity. Carbon intensity is a term derived from KAYA identity in the literature.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
17941	7	14	7	14	The reference (Lutsey and Speling, 2018) is not reported in the bibliography	Accepted. It will be reported in SOD	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
28541	7	15	7	15	Again, not sure what this "split" refers to	Accepted. This split refers to freight and passenger transport. However it will be modified for clarity	Paul Wolfram	Yale University	United States of America
47301	7	15	7	16	"though the Chapter has found a growing split between options for heavy vehicle and light vehicle systems." I have not found arguments to support this split in this Chapter. I haven't found them in Industry in the many years I've been researching this now either. It reminds me of the difference promoted with regard to electric passenger vehicles 10 years ago when the dominant thinking was that it was only suited for intracity vehicles while it is clear now that adoption is fastest in the long range (diesel) segment since those cars (Tesla's mainly at first) became available. I think the real difference is between vehicles travel limited ranges of up to about 800 km for which the battery usually has the best business case and those that need to cover even longer ranges. This makes electric problematic for about 20% of heavy electric trucks, many planes and most intercontinental ships. But for over 80% of trucks electric is a great from 2021 onwards. More on that below.	Accepted. Good points split need not being emphasised. It will be reconsidereed.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
20723	7	16	7	16	1. Issue of transport justice: How to invest at the bottom of the pyramid first, i.e., E-rickshaw. 2. How to avoid spatial mismatch: (Lack of) integration between transportation planning and spatial planning. 3. Reflection on Robin Hyckman's TC-SIM model.	Accepted. Unclear what is the reviewer suggestion. The topics are included later in conection with SDGs.	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
12789	7	18	7	26	The paper of Forzieri et al. (2018) shows the impact of 7 climate change driven natural hazards on critical infrastructures (including transports) in Europe. Those impacts are quantified and valued by sector, and period until 2100. Such estimations may be useful to discuss the general question of impacts on the transport sector. GEC Article: "Escalating impacts of climate extremes on critical infrastructures in Europe" https://www.sciencedirect.com/science/article/pii/S0959378017304077	Accepted. We will address this recommendation and consider the paper suggested toward SOD.	antoine leblois	INRA	France
11705	7	23	7	24	If roads are environmentally sensitive infrastructure, more attention should be paid to the adaptation to climate change.	Accepted. This is the idea. We can consider expand more focused on adaptation.	Andrey Kolpakov	Institute of Economic Forecasting of the Russian Academy of Sciences	Russian Federation
28645	7	23	7	25	I agree that roads are vulnerable to high temperatures (we have seen this on German motorways as well in the last tow summers). However, the increasing intensity of storms in the last two years have shown that the railway system is even more vulnerable. That is unfortunate as is contradicts the objective of climate mitigation by modal-shift but we need to be aware of the problems: (1) the catenary lines are cut by falling trees during storms (also flooding destroyed some tracks), (2) high speed trains have to slow down or are completely stopped due to heavy winds, and (3) when the whole rail system collapsed (or some lines only) it (I) takes days to re-organize the system back into a stable situation, and (II) the network is less dense then for roads, such that often no alternative routes exist when a line gets blocked (so lower resilience then roads).	Accepted. The idea is brings the concept of resilience for each infrastructure mode. We can consider railway system and other examples supported by available literature.	Wolfgang Schade	M-Five GmbH Mobility, Futures, Innovation, Economics	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
30983	7	24	7	24	all transport infrastructure is broadly exposed to environment (albeit different): roads, rail, ports.	Accepted. We can improve paragraph supported by available literature.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
23769	7	27	7	27	"for example the UK": Please add some more examoles - otherwise link to "most countries..." and then just mentioning one example does not fit.	Accepted.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
46943	7	27	7	29	It is not clear what point the first sentence is making, particularly given the examples given in the second sentence. This paragraph can be much sharper, as it could be a potentially very important point. The point about reducing emissions as another basis for adaptation is critical. There are an increasing number of peer reviewed publications that have looked at the costs and benefits of adapting infrastructure (and in the UK also extensive work not only for the highways sector but also rail, led by Network Rail and RSSB). These may now become subject to cost-benefit analysis as authorities seek to mitigate climate change impacts. But they could be compared to the literature regarding the costs-benefits of curbing emissions now. This would show how our understanding of the impacts of climate change have developed in recent years, and our understanding of the costs-benefits of adaptation versus reducing emissions now have developed since the Stern Report. The risk otherwise is that transport remains in the 'too difficult or costly to address now' category.	Accepted. We can consider the recommendations supported by available literature.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
46945	7	27	7	29	The reference to Wang et al (2019) is presumably to Wang, T. et al and not to Wang, G. et al (2019).	Accepted. We will check the reference.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
20725	7	27	7	31	Three forms of adaptation: Structural adaptation (densification of urban form). Dependency between mitigation and adaptation.	Accepted	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
17943	7	29	7	29	The reference (Thornbush et al 2013) is not reported in the bibliography	Accepted. We will check the reference.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
22311	7	29	7	29	remove "also "	Accepted. Agreed.	Kym Lennox	climate change equity	Australia
30985	7	29	7	29	This is true, but the ability to shift road activity to rail is not universal. Two key points: the barriers to implementing road infrastructure are low, relative to other modes; and the barriers to use of the road infrastructure are low, relative to other modes. Roads permit a level of access and flexibility which other modes cannot compete with.	Accepted. We can improve paragraph supported by available literature.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
18383	7	29	7	31	A case study can be added here. The rapid development of high-speed railway has led to many passenger trips replacing aviation and long-distance bus transportation, it made emission reductions.	Accepted. We can consider to include "a case study" if we have enough space.	Jie Guo	China Academy of Transportation Sciences	China
11649	7	30	7	30	you mention urban sprawl as an example of interdepencencies between mitigation and adaptation - this is fine and correct, but you need to introduce earlier (between lines 18-26) how urban sprawl worsens potential to adapt and is likely to increase emissions (e.g. Congedo and Munafo 2014 https://link.springer.com/chapter/10.1007/978-3-319-00672-7_5)	Accepted. We can improve paragraph. Thanks for reference.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
30987	7	32	7	32	Forecasts of SLR, mean temperature rise and so on should reference the WG1 report.	Accepted	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
47895	7	32	7	37	this paragraph seems to go beyond the remit of the transport chapter, discussing sea level rise. Unless you want to say that rising sea levels give us another reason to densify, besides the CO2 benefit. This isn't clear in the current wording.	Accepted. We can review paragraph.	Lewis Fulton	University of California, Davis	United States of America
17945	7	33	7	34	The reference (Noland et al 2019) is either reported twice, or it's not differentiated in two items in the bibliography	Accepted. We will check the reference.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
29307	7	38	7	39	The statement "Shipping and aviation are being impacted through coastal flooding" need to be corrected since there is no direct connection between aviation industrty and coastal flooding.	Accepted. We will review the text toward SOD.	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
32535	7	38	7	47	More traffic within the Arctic and global climate because increased tourism or shipping will lead to increased pollution, including that of GHGs and SLCPs including black carbon that can further enhance warming in the region that is already warming twice the global average. Declining sea ice is already increasing shipping and tourism within the delicate Arctic region, where increased pollutants—including emissions of black carbon that can decrease the reflectivity of the surface in the region when it lands on snow and ice, which allows greater warming—could further endanger the Arctic, and as such, policies should be developed that will limit and minimize climate impacts in the Arctic. Given the current climate emergency, continued warming in the Arctic will continue to deplete sea ice—to which, if all of the sea ice is lost, it would be like adding an additional trillion tons of CO2 to the atmosphere—and thaw permafrost, which will also amplify warming through its release of stored carbon dioxide and methane; all together, these and other feedbacks will lead to a hothouse Earth. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 ("Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 ("Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region's ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area."); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists' Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595.	Accepted. We can improve paragraph and consider references recommended. Thanks for the references.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32537	7	38	7	47	The Eastern Pacific Emitted Aerosol Cloud Experiment (E-PEACE) studied the cooling effect of smoke from ships due to their emission's effect on brightening clouds, and found that brighter clouds from smoke produce a cooling effect 2 to 50 times greater than warming effect from carbon emissions from ships. See Russell et al., Eastern Pacific Emitted Aerosol Cloud Experiment, Bulletin of the American Meteorological Society (May 2013): "We use the 15% cloud brightening measured for the smoke on 16 July (Fig. 5) for both tracks to find 2-nK cooling for the cargo ship and 0.4-nK cooling for the smoke—that gives us ratios of cooling to warming (i.e., a cooling efficiency) of ~2 for the cargo ship and ~50 for the smoke generator. Although this is a very simplified calculation, we find that, if half of the open-ocean transit days of a cargo ship result in tracks that are on average 15% brighter than the surrounding clouds and cover 2,500 km2, then cargo ship transit (for consumables only) could be considered "carbon neutral" (in the sense of having no net warming effect) transportation. Further, we find that smoke generators on board smaller ships (that require less than 2% of the fuel per transit mile) could provide a net cooling effect, which could be used to offset some of the warming caused by ship CO2 emissions."	Accepted. We can improve paragraph and consider references recommended. Thanks for the references.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32539	7	38	7	47	The impact on the climate from aviation can be further managed by adjusting timing, altitudes, and routes of flights. Flights that occur over night lead to more climate forcing than in the day because the contrails that the planes form at night trap more infrared energy without being offset by sunlight like in the day. Winter flights also have a bigger overall warming effect than those during the rest of the year because contrails are more likely to form when it is cold. Stuber N., et al. (2006) The importance of the diurnal and annual cycle of air traffic for contrail radiative forcing, Nature 441:865–867. Lowering the altitude of aircraft by a little over 600 meters could reduce radiative forcing from nitrogen oxides by two-fifths. Sovde O. A., et al. (2014) Aircraft emission mitigation by changing route altitude: A multi-model estimate of aircraft NOx emission impact on O3 photochemistry, Atmospheric Environment 95:468–479. Further, re-routing flights to avoid regions that are more sensitive to changes in CO2 emissions could lower climate impact by 25% with a cost increase of 0.5%. Grewe V., et al. (2014) Reduction of the air traffic's contribution to climate change: A REACT4C case study, Atmospheric Environment 94:616–625.	Accepted. We can improve paragraph and consider references recommended. Thanks for the references.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America

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32831	7	38	7	47	More traffic within the Arctic and global climate because increased tourism or shipping will lead to increased pollution, including that of GHGs that can further enhance warming in the region that is already warming twice the global average. Declining sea ice may tempt people to increase shipping and tourism within the delicate Arctic region, where increased pollutants—including emissions of black carbon that can decrease the reflectivity of the surface in the region when it lands on snow and ice, which allows greater warming—could further endanger the Arctic, and as such, policies should be developed that will limit and minimize climate impacts in the Arctic. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 ("Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 ("Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region's ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area."); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Richter-Menge J., et al. (eds.) (2019) ARCTIC REPORT CARD 2019; Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists' Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595.	Accepted. We can improve paragraph and consider references recommended. Thanks for the references.	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
30989	7	41	7	41	have any of these heat wave impacts on aviation been experienced? If so, an example might be useful here. Or are they predicted?	Accepted. We will check.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
34903	7	42	7	43	Reference (Manioudi et al. 2018) not clear	Accepted. We will check the reference.	ANUPAM DEBSARKAR	University	India
22313	7	44	7	44	insert "it" between "and suggests that" and "is important to"	Accepted. We will review.	Kym Lennox	climate change equity	Australia
11707	7	46	7	47	Is building a new low-emissions infrastructure really an adaptation measure? It looks more like a mititgation measure.	Accepted. It could be consider as a co benefit. We will check. The idea is to promote synergies between mitigation and adaptation measures.	Andrey Kolpakov	Institute of Economic Forecasting of the Russian Academy of Sciences	Russian Federation
13715	7	4	8	29	Another disruptive transport developmet is urban air mobility. I think a statement on this would be required since it is a large area of research. I cannot judge how large ist contribution to transportation volume will be in the future, but it may have a substantial emission, both for passangers as well as for freight. Drones are mentioned in 10.2.3, however, I think the sentence "likely to limit this application" is too vague giving the importance in research.	Take into account. We will analyse it	volker Grewe	DLR-Oberpfaffenhofen	Germany
1685	7	17	8	3	Why is this section here? Please consider other place.	Rejected. We decided not to change the structure	Shigeki KOBAYASHI	TICJ	Japan
13713	7	17	8	3	There are more impacts on traffic from climate change. So I am not quite sure where to limit the overview. What about changes in turbulence (Williams 2017)?	Accepted. We can improve paragraph and consider reference recommended. Thanks for reference.	volker Grewe	DLR-Oberpfaffenhofen	Germany
6401	7	2			Please explain that the decoupling is linked to the higher occupancy factor of public transportation	Accepted	Apostolos Petropoulos	International Energy Agency	France
34987	7	27			just reducing emissions might not help to mitigate climate change; reduce the energy consumption of the transport sector must have highest priority, regardless of type and production of energy; electrified cars consume in total at least the same amount of energy than fossil drive cars	Noted.	Stephan Tischler	University of Innsbruck	Austria
47853	7	27			Not clear why UK is singled out here for mitigating transport sector? Europe, US, etc. all have active transport decarbonization strategies in place.	Accepted. We will review the text and try to address this comment. We can improve literature review and consider other examples worldwide.	Martino Tran	University of British Columbia	Canada
47855	7	36			Please clarify what "Where retreat is attempted..." means in this context.	Accepted. We will review and clarify.	Martino Tran	University of British Columbia	Canada
34989	7	41			aviation: changes in global jetstreams, extreme weather conditions etc.	Noted. We will try to find literature to support.	Stephan Tischler	University of Innsbruck	Austria
11651	8	3	8	3	Since the next paragraphs talks about digital innovation, it'd be timely to incorporate "cascading risk to infrastructure" as one of the impacts (e.g. more storms - more disruptions to the grid- blackouts - limited access to electric transport) e.g. Chang 2016 https://oxfordre.com/naturalhazardscience/view/10.1093/acrefore/9780199389407.001.0001/acrefore-9780199389407-e-66	Accepted. We will address recommendations toward SOD and consider referece suggested.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
11653	8	4	8	4	title could be misleading as 'disruption' in transport often means i.e. pausing public transport due to extreme weather. Suggest renaming to "disruptive innovations in transport"	Accepted.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
17955	8	4	8	29	Section 10.1.4 could be better informed by a UC Davis and ITDP 2017 report, synthesis in [Fulton, 2018] Fulton, L. M. (2018). Three revolutions in urban passenger travel. Joule, 2(4):575–578.	Accepted. we can include this reference	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy

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20465	8	4	8	29	more disruption can be observed: electrification of transport can be practically based on electricity: directly as described, but also indirectly with power-based fuels. This is not yet described well. Khalili et al. (https://www.mdpi.com/1996-1073/12/20/3870), Breyer et al. (https://onlinelibrary.wiley.com/doi/full/10.1002/pip.3114) and Horvath et al. (https://www.sciencedirect.com/science/article/pii/S0196890418302152) provide much evidence on that. This is also well affordable, as shown in much detail by Ram et al. (http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf).	Accepted. this will be dealt with in another session	Christian Breyer	LUT University	Finland
23771	8	4	8	29	The general description of the three disruptive technologies considered is quite helpful in this section. However, i was wondering, how potential combinations of these technologies can be, or have been considered	Noted. We did not find literature on that, but is worth mentioning.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
17947	8	5	8	5	The reference (Sprei, 2018) is not reported in the bibliography	Accepted. This will be changed	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
30991	8	5	8	5	Part of the challenge with focusing on these disruptions is they are almost certainly restricted to the private car and are not compliant with the 'avoid-shift-improve' hierarchy mentioned on p10-7	Accepted.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
47303	8	5	8	7	As I said above: electrification, sharing and autonomy are three useful pillars but you should mention that autonomy is an enabler for sharing since it turns every vehicle into a taxi, minus the costly and place/energy consuming human driver.	Accepted.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
28233	8	5	8	8	Misleading to put electrification at same scale as shared and autonomous. Shared mobility is still in "niche" phase, while autonomous is not yet even there. Electrification is going from meso to macro	Accepted. We aknowledge they are not at the same scale. We will clarify that	Cornie Huizenga	CESG	Germany
47857	8	5	8	8	Suggest provide data that support the assertion of rapid adoption of these disruptive technologies. Is it rapid adoption compared to conventional transport modes?	Accepted. We will include this consideration	Martino Tran	University of British Columbia	Canada
42223	8	5	8	29	There is a need to put more attention/emphasis to the situations in the developing (particuarly the rapidly emerging) countries and cities due to the significance in terms of making a difference now and changing future trajectories in these areas.	Accepted.	Alvin Mejia	Wuppertal Institute	Germany
31519	8	10	8	10	You may also include Creutzig et al. 2015 here as a second reference? 2. Creutzig, F.; Jochem, P.; Edelenbosch, O.Y.; Mattauch, L.; Vuuren D.P.v.; McCollum, D.; Minx, J. (2015), Transport – a roadblock to climate change mitigation?, Science (Policy Forum) 350 (6263), 911-912, doi: 10.1126/science.aac8033.	Accepted. We might include	Patrick Jochem	German Aerospace Center (DLR)	Germany
17949	8	11	8	11	The reference IEA 2017b is related to bioenergy, how is this relevant to the transport electrification?	Noted. It is related as a renewable source of electricity	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
30993	8	12	8	12	How many EVs are being produced annually and what's been the recent average growth rate?	Accepted. This is gong to be dealt in another session	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
30995	8	13	8	13	Is this pure exponential or is the term being used figuratively? How long is the exponential growth forecast to continue – it cannot be indefinite.	Accepted. we will clarify	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
17951	8	14	8	15	The four references are tangential to the discussed topic	Accepted	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
30997	8	15	8	15	Ambitious statement – how many EVs are in circulation compared to conventional combustion or hybrids?	Accepted	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
28647	8	15	8	17	I agree: electrification of passenger road transport is well underway. But does this hold for developing world as well, looking at their electricity grids? Here I can clearly see the need for a two steps approach: first develop and stabilize the grid and second transfor to electrified transport (and of course shared mobility will play a much larger role).	Accepted. This is going to be dealt in another section	Wolfgang Schade	M-Five GmbH Mobility, Futures, Innovation, Economics	Germany
11655	8	17	8	17	Here is essential to add how governments are supporting/hindering this innovation, e.g. by grants like this one: https://www.gov.uk/plug-in-car-van-grants Can you give some exmaples?	Accepted. This is the subject of another section	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
30999	8	17	8	17	Shifting fuels is only one side of it – we will not have delivered a low carbon transport system if every conventional combustion car is replaced with an EV. Instead, we need to shift trips onto public transport and reduce significantly the number of private vehicles in circulation.	Accepted	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
11657	8	18	8	18	Need to specify how platformisation is enabling that (e.g. Casprini et al 2019 https://www.sciencedirect.com/science/article/pii/S0040162518300829)	Noted. Thanks for reference	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
31001	8	18	8	18	Shared mobility is a fashionable topic. However, this is what public transport tries to accomplish. Moving from single occupancy trips to shared trips is the aim, with buses, trains and other mass transit options being the natural end point.	Accepted	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
45177	8	18	8	18	"Shared mobility" needs a definition	Accepted. We will include	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
28543	8	18	8	19	This should be more nuanced. There can be cannibalisation effects through Uber and Lyft, etc. … But maybe there will be more on that later on.	Accepted	Paul Wolfram	Yale University	United States of America
17953	8	20	8	20	There is no ITF 2018 in the bibliografy, what ITF report are you thinking of?	Accepted. We will fix it	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy

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31521	8	22	8	22	You may include another sentence to this section: "The reduction of the urban car fleet might be especially reduced if adequate alternative modes, such as public transport systems, are provided (Fromm et al., 2019). 181. Fromm, H.; Ewald, L.; Frankenhauser, D.; Ensslen, A.; Jochem, P. (2019), A Study on Free-floating Carsharing in Europe: Impacts of car2go and DriveNow on modal shift, vehicle owner-ship, vehicle kilometers travelled, and CO2 emissions in 11 European cities, Working Paper Series in Production and Energy 36, https://publikationen.bibliothek.kit.edu/1000104216/51584214. [WE CURRENTLY SUBMIT A MORE SCIENTIFIC PAPER TO A JOURNAL]	Accepted	Patrick Jochem	German Aerospace Center (DLR)	Germany
31003	8	26	8	26	This is a key point – it is difficult to argue how cities will embrace smart technologies, shift to shared autonomous electric vehicles at scale and achieve net zero emissions within 30 years. The promise of technology 'to come' or 'not yet here' distracts us from the options which we have access to now and the evidence of their effectiveness.	Accepted.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
28241	8	34	8	37	argument that electric charging shapes roll-out of electric vehicles is too simplistic. Regulatory forces and incentives have at least as much a role as elctric charging.	Accepted. Redoing the Section 10.2.4. new section as Transport Energy Nexus.	Cornie Huizenga	CESG	Germany
28545	8	34	8	37	Aging of vehicle fleets, travel demand and vehicle mix should all be considered as systemic variables. What are the reasons for including the mentioned factors but not others?	Accepted. Redoing the Section 10.2.4. new section as Transport Energy Nexus.	Paul Wolfram	Yale University	United States of America
31199	8	35	8	37	infrastructure is limited to electric recharging, what about hydrogen refuelling infrastructure?	Accepted. Redoing the Section 10.2.4. new section as Transport Energy Nexus.	Urs Ruth	Robert Bosch GmbH	Germany
47305	8	39	8	39	Great to see this framework mentioned in this context. One could say that BEV passenger vehicles are no approaching meso scale an electric trucks and autonomous/shared vehicles are still niches on the micro scale that need pilots, protection, launching customers etc. I describe how to quantify this MLP transition management framework in 'Hoekstra, A.E., Steinbuch, M., Verbong, G.P.J., 2017. Creating Agent-Based Energy Transition Management Models That Can Uncover Profitable Pathways to Climate Change Mitigation. Complexity. https://doi.org/10.1155/2017/1967645'. It will also be part of our journal paper 2 and 3 as mentioned at the start of this chapter.	Accepted. Reference to be added.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
34897	8	42	8	42	Sentence construction erroneous	Accepted. Sentence to be revised.	ANUPAM DEBSARKAR	University	India
45209	8	41	9	30	Discussion on urban sprawl and its impact on trip length and mode choices should be expanded. See e.g. Barrington-Lee (2019(Global trends toward urban street-network sprawl www.pnas.org/cgi/doi/10.1073/pnas.1905232116	Accepted. Reference to be added.	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
39551	8	30	10	17	low carbon fossil fuel and oil recoverey is one of trends here. As written in https://carnegieendowment.org/2015/03/11/know-your-oil-creating-global-oil-climate-index-pub-59285	Noted.	Shunsuke Kawagishi	Mitsubishi Research Institute	Japan
27017	8	41	10	6	Has there been large scale changes in the area of physical geography and urban form? This section doesn't really highlight anything new and it seems a strange way to start a discussion of 'systemic changes in the transport sector'.	Noted. Appears to be referring to Section 10.2.1, hard to see as line number is wrong.	Thomas Longden	Australian National University	Australia
42231	8	41	10	6	This section does not account for other movement types (e.g. aside from intercity and intracity)	Noted. Appears to be referring to Section 10.2.1, hard to see as line number is wrong.	Alvin Mejia	Wuppertal Institute	Germany
1687	8	30	16	26	Please consider to put this section 10.2 after discussing the technology matters, maybe after 10.3.	Accepted. Redoing the Section 10.2.4. new section as Transport Energy Nexus but not switching sections.	Shigeki KOBAYASHI	TICJ	Japan
43657	8	1			SIDS may also be excellent test beds for low-carbon transitions in the tranport sector, due to 3 reasons: 1) smaller networks require less investment into new infrastructures, 2) high benefits from replacing costly fossil fuel imports; and 3) tourism as opportunity for experimental shared mobility offers, electric. See the recent study by Soomauroo et al: https://www.mdpi.com/2071-1050/12/4/1435	Accepted. Reference to be added.	Felix Creutzig	MCC Berlin	Germany
22831	8	5			More arguments should be provided for the argument that these are 'disruptions' and to justify why these three (and not others) were selected. Currently there is a single reference to Sprei (2018), which does not even appear in the reference list.	Accepted. Heavily cited work and used by others to show why these three are major disruptions in transport. Reference to be added.	Giulio Mattioli	TU Dortmund University	Germany
22833	8	7			"can be labelled as disruptive due to their rapid adoption" - autonomous vvehicles have not had "rapid adoption" - in fact they are mostly still in a test phase, and when/whether Level 5 AVs will reach the market, or reach mass adoption, is very much the subject of debate. Many sharing services have very limited levels of adoption, being limited to the most central parts of large cities - see e.g. Marsden, G., Anable, J., Bray, J., Seagriff L., and Spurling, N. (2019). Shared mobility – where now, where next? Second report of the Commission on Travel Demand. https://www.creds.ac.uk/publications/where-now-where-next/	Accepted. Disruptions by definition are rapidly growing in their early phase. This is the case with autonomous technology in cars and adoption in large trucks where they are almost completely the norm now in Australia. Reference to be added.	Giulio Mattioli	TU Dortmund University	Germany
6403	8	10			Regulating the battery carbon footprint is also essential	Accepted. This is examined in detail in this chapter.	Apostolos Petropoulos	International Energy Agency	France
6405	8	26			You could give also examples of sustainable transportation systems in developing African countries (i.e. BRT)	Accepted. Case studies are being written if space allows.	Apostolos Petropoulos	International Energy Agency	France
22835	8	30			The structure of Section 10.2 appears a bit haphazardous as of the four "systemic drivers", two are very broad factors that would apply in any historical phase (urban form and "behaviour and modal choice"), while two points to the same current "disruptions" (smart mobility and EVs) that are discussed elsewhere in the report. I believe the section would benefit from being more clearly focused on (the full set of) systemic drivers of transport emissions. Also, the section is very short as compared to Section 10.3, which contributes to the impresssion that the focus of the whole chapter is skewed towards technological / supply-side interventions	Accepted. Redoing the Section 10.2.4. new section as Transport Energy Nexus.	Giulio Mattioli	TU Dortmund University	Germany
22837	8	41			The section on "physical geography and urban form", especially if compared to the importance of this factor. It would benefit from being expanded.	Accepted. Other literature to be added.	Giulio Mattioli	TU Dortmund University	Germany
42229	9	8	0	9	Aviation : for time sensitive and high value items.	Accepted and revised.	Alvin Mejia	Wuppertal Institute	Germany
42225	9	2	9	3	the sentence must also recognize generalized costs which is a function of different factors, the relevance of which are context dependence	Accepted. Added 'context dependence'. Generalized cost is metioned in line 6 page 9.	Alvin Mejia	Wuppertal Institute	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
17957	9	5	9	6	The four references in these two rows are missing in the bibliography. At this point I've counted 9 missing references, plus 4 tangential. This is frustating, even for a first draft	Accepted. Referencing to be fixed.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
42227	9	5	9	7	Access to modes is also a prerequisite	Rejected. No action needed. It is obvious from the section.	Alvin Mejia	Wuppertal Institute	Germany
31005	9	6	9	6	Check spelling of Scafer 2009	Accepted. To be corrected.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
29183	9	6	9	7	Another source on cost and time constraint integration into a climate modelling framework (IMACLIM): https://www.tandfonline.com/doi/abs/10.1080/14693062.2012.735916	Accepted. Reference to be added.	Yann BRIAND	Iddri, Sciences Po	France
25593	9	8	9	8	Air transport is also suitable for time-sensitive products such as perishable goods, and high-value products (significant reduction of inventory costs).	Accepted and revised.	Sabine Limbourg	HEC-Uliege	Belgium
31007	9	8	9	8	The choice of expensive modes (aviation, road and high speed rail) compared with low cost, slow modes (shipping, slow rail) is more about the value of the product, less about the mass. For example, aircraft parts are flown from factory to assembly plant because they are high value, and short lead times are important. The same thing exists for race horses or race cars.	Accepted and revised.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
17959	9	10	9	10	Missing reference, (Ertrac, 2019)	Accepted. Reference to be corrected.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
31009	9	10	9	10	The other point is that every trip requires multiple transport modes, either at the start or at the end.	Noted	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
17961	9	12	9	12	The reference (Newman and Kenworthy, 2015) is reported twice, a&b, in the bibliography. I'm not checking the remaining of Section 10.2.1, the author made too many linking mistakes that should have been cathced before the first draft.	Accepted. Referencing to be fixed.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
27019	9	13	9	15	A fixed travel time budget is a contested concept. And is it necessary to mention it in this context, especially when section 10.2.2 focuses on demand factors? Arent other issues (such as electrification, demand factors and mode shift) more important?	Accepted. More references to be added. This section covers the application to land use and transport which is generally accepted and was part of AR5 and 1.5 reports.	Thomas Longden	Australian National University	Australia
28237	9	16	9	17	where is cycling	Accepted. Cycling is part of active transport.	Cornie Huizenga	CESG	Germany
28239	9	18	9	19	what about busses	Take into account. Buses came later in history as part of car system.	Cornie Huizenga	CESG	Germany
29189	9	22	9	24	This paragraph highlights that the built environment transformations could have other co-benefits. We have seen this year in many countries that passenger transport transformation was really sensitive and hard when it is related to fuel costs: Chile, Ecuador, France... Some learnings highlighted by the Deep Decarbonization Pathways initiative on transport in Japan, UK, Mexico and France show also how urban transformations could have an impact on mobilty demand and modal choices and bring co-benefits for people's budget and time without reducing the activity access. https://www.iddri.org/sites/default/files/import/publications/ib0717_ddpp-transport.pdf	Accepted. Reference added.	Yann BRIAND	Iddri, Sciences Po	France
23773	9	25	9	25	"Economics": What means economics in that context?	Take into account. Explained further in references and section 10.8.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
42233	9	25	9	25	Having separate discussions on freight and passenger transport may be useful as well	Accepted and revised.	Alvin Mejia	Wuppertal Institute	Germany
31011	9	27	9	27	Absolutely, and this point is critical to the avoid-shift-hierarchy. Integrated planning (urban, land, transport and so on) is essential to close the gap between where we live, work and play to avoid motorised trips at scale.	Accepted.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
22841	9	27	9	30	There are also important limits to what urban design policies can achieve with regard to climate mitigation - for a review see: Holz-Rau, C., & Scheiner, J. (2019). Land-use and transport planning–A field of complex cause-impact relationships. Thoughts on transport growth, greenhouse gas emissions and the built environment. Transport Policy, 74, 127-137.	Accepted. Added reference	Giulio Mattioli	TU Dortmund University	Germany
29185	9	27	9	30	Another relevant source of information on the impact of the "built environment" and the concept of the 5D defined by Ewing and Cervero: https://www.tandfonline.com/doi/abs/10.1080/01944361003766766	Accepted. Added reference	Yann BRIAND	Iddri, Sciences Po	France
27021	9	31	10	3	Peak car has been contested for a while, not just since AR5. For example, this paper notes: "But it is worth making one point very strongly. As Stokes argues, the aggregate trends discussed do not allow us to forecast with any certainty the levels of car use that we can expect in the future. In fact they make it clear that a number of different future possibilities are plausible, which could lead to a rise, a fall, or stability in levels of car travel.". Phil Goodwin & Kurt Van Dender (2013) 'Peak Car' — Themes and Issues, Transport Reviews, 33:3, 243-254, DOI: 10.1080/01441647.2013.804133	Accepted. Added reference	Thomas Longden	Australian National University	Australia
18843	9		29		Biofuel powered vehicles will in the long run, be beneficial to the fight against climate change and will create jobs via value chain.	Accepted and revised.	Michael Ugom	University of Nigeria, Nsukka	Nigeria
22839	9	1			Non-urban travel accounts for 60% of global passenger transportation volume, and for two-thirds of projected growth to 2030: see UNWTO & ITF, 2019. Transport-related CO2 emissions of the tourism sector – Modelling results. Word Tourism Organisation. Madrid, Spain; ITF (2019) Transport Outlook 2019, International Transport Forum. It would be important to state this as research and policy on transport & climate mitigation tends to have an urban bias	Accepted, have added some lines to include this.	Giulio Mattioli	TU Dortmund University	Germany
31013	10	3	10	3	This is important – examples of cities which have implemented smart systems, but seen an increase in vehicle ownership/use should be presented here. Echoes the comment I made earlier	Accepted. Agreed.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
42235	10	3	10	6	Certain biases still exist in project selection which favors automobile fabrics (e.g. valuation of time travel savings for car users)	Accepted.Agreed.	Alvin Mejia	Wuppertal Institute	Germany
46947	10	3	10	6	This covers two important points, covering both urban (landuse) planning and the outcomes prioritised. Transport-landuse integration is not covered in much detail in this chapter. Although it may be covered elsewhere it deserves more specific treatment here, particularly in light of population increase, the need to build more homes, and deliver more jobs: landuse planning provides a powerful mechanism to influence transport supply and demand, behaviour and technology used. This also relates to the 'outcomes prioritized' statement. Agreeing on desired outcomes and a vision of the future will determine the pathways chosen - this is picked up briefly later in the chapter (pg. 64 lines 11 - 12; pg. 73, lines 12 to 18) - but none of the solutions, technologies or options addressed in this chapter address why we need to travel using the modes we do for the distances we do (pg. 36 lines 18 - 19 simply state that demand will continue to grow). Again, land use planning and the vision for how we want our towns and cities to look and operate (and rural areas) will have a significant impact.	Accepted.Agreed. Added extra statement.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
2379	10	11	10	41	What appears to be missing in Section 10.2.2.1 is the discussion of the most recent research in the field of social interaction or spillover effects and social learning in automobile ownership and mode choice decision making. Relevant articles, among others, would be: Abou-Zeid, Schmöcker, Belgiawan & Fujii (2013); Dugundji, Scott, Carrasco & Páez (2012); Dugundji, Páez, Arentze, Walker, Carrasco, Marchal & Nakanishi (2011); Goetzke, Gerike, Páez & Dugundji (2015); Goetzke & Rave (2011); Goetzke & Weinberger (2010); Maness, Cirillo & Dugundji (2015); Wang, Akar & Guldmann (2015); Walker, Ehlers, Banerjee & Dugundji (2011) and Weinberger & Goetzke (2019).	Accepted.	Frank Goetzke	University of Louisville	United States of America
39881	10	15	10	15	general comment on Transport Chapter : I see no mention of rebound effect linked with IoT, autonomous cars… although there are mentions of transport rebound effects in Chapter 9.9.2.	Accepted.Added rebound effect in line 30 page 10/9.	Bianka SHOAI-TEHRANI	RTE, CentraleSupelec	France
22843	10	15	10	16	The extent to which environmental values influence these choices vary much depending on the travel sector. There is a vast literature showing that the 'attitude-behaviour gap' is particularly large for long-distance, holiday and air travel REFERENCES: Hares, A., Dickinson, J., & Wilkes, K. (2010). Climate change and the air travel decisions of UK tourists. Journal of Transport Geography, 18(3), 466-473; Hibbert, J. F., Dickinson, J. E., Gössling, S., & Curtin, S. (2013). Identity and tourism mobility: an exploration of the attitude–behaviour gap. Journal of Sustainable Tourism, 21(7), 999-1016; Higham, J., Reis, A., & Cohen, S. (2015). Climate change, aviation and the attitude-behaviour chasm. In: Wilson, E., Witsel, M. (Eds.). CAUTHE 2015: Rising Tides and Sea Changes: Adaptation and Innovation in Tourism and Hospitality. Gold Coast, QLD: School of Business and Tourism, Southern Cross University,: 510-513.Holden, E., & Linnerud, K. (2011). Troublesome leisure travel: The contradictions of three sustainable transport policies. Urban Studies, 48(14), 3087-3106; Kroesen, M. (2013). Exploring people's viewpoints on air travel and climate change: understanding inconsistencies. Journal of Sustainable Tourism, 21(2), 271-290; Barr, S., Shaw, G., Coles, T., & Prillwitz, J. (2010). 'A holiday is a holiday': practicing sustainability, home and away. Journal of Transport Geography, 18, 474-481; Becken, S. (2007). Tourists' perception of international air travel's impact on the global climate and potential climate change policies. Journal of Sustainable Tourism, 15(4), 351-368; Czepkiewicz, M., Árnadóttir, Á., & Heinonen, J. (2019). Flights Dominate Travel Emissions of Young Urbanites. Sustainability, 11(22), 6340; Alcock, I., White, M. P., Taylor, T., Coldwell, D. F., Gribble, M. O., Evans, K. L., ... & Fleming, L. E. (2017). 'Green'on the ground but not in the air: Pro-environmental attitudes are related to household behaviours but not discretionary air travel. Global environmental change, 42, 136-147.	Accepted.	Giulio Mattioli	TU Dortmund University	Germany
31015	10	17	10	17	Does this assume an alternative transport mode exists for people who care about the environment?	Later versions clarified this.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
42241	10	17	10	42	The wider implications on vehicle ownership should be discussed in this section.	Later versions clarified this.	Alvin Mejia	Wuppertal Institute	Germany
31017	10	20	10	20	Also, the cost of driving and parking a vehicle in an urban environment may be sufficient to move people to public transport, independent of their views on the environment.	Yes this is clear in literature and in later text	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
46949	10	21	10	22	It may be better to provide context to the statement that women are more sensitive to parking pricing than men, on the assumption the cited reference is based on a particular geographic area, and what drives these differences. It is also important for all such statements to focus on what this means in the context of this chapter and this report. Parking management and pricing comes up again at the end of the chapter (pg. 74, line 1 onwards).	Later versions clarified this.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
42237	10	24	10	26	It may be more important to discuss "shifting" in terms of modes, rather than vehicles	Agreed. Later versions clarified this.	Alvin Mejia	Wuppertal Institute	Germany
28547	10	26	10	26	It would probably not hurt to mention somewehere here that behavioral factors are not well captured in current models.	Later versions clarified this.	Paul Wolfram	Yale University	United States of America
31523	10	26	10	26	These references are rather old for this very recent subject. I can provide further references, if requested.	Accepted. We will add more recent references	Patrick Jochem	German Aerospace Center (DLR)	Germany
11659	10	27	10	27	In "urban design" add urban sprawl and expectation of parking space provision in front of new builts	Accepted.Agreed but we cannot see where they referred to in the text.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
42239	10	28	10	31	This would also be dependent on the initial conditions of the urban area, and access to different modes.	Later versions clarified this.	Alvin Mejia	Wuppertal Institute	Germany
18197	10	28	10	41	We see a transformational change if cities introduce new convincing tramway systems so that inhabitants can live in their city nearly without passenger cars (high modal split for public transport) [not an option for rural areas]. Example: Look at the transformation in Montpellier (France) after the introduction of a tramway system in 2000. In short time (after the introduction of a further tramway line we expext that 3/4 of the population and 3/4 of working places will have access to attractive public transport. See described in Naumann, T. (2019): Mobilität als Gesamtkunstwerk. Montpellier und seine Straßenbahn. stadtverkehr, 6/2019, p.29 - 37. You may find similar examples in Strasbourg or Bordeaux, France. I suggest to make a case study on such a transformation e.g. for the case of Montpellier.	Partially Accepted. We will add recent references on transformed change if cities introduce new and alternative modes of transport	Manfred Treber	Germanwatch	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
23775	10	30	10	30	"elasticities": What is the definition of elasticities in this context resulting in 1.2 etc.?	This refers to the price elasticities of demand	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
28549	10	31	10	31	What dexactly does the value 1.2 mean or refer to?	This refers to long-term own price elasticities	Paul Wolfram	Yale University	United States of America
11153	10	31	10	33	Income elasticities?	Accepted. This is own price elasticity. Please also see Salvucci et al., 2019	Snorre Kverndokk	Frisch Centre	Norway
31019	10	33	10	33	This is important – these factors may have as much influence over the mode chosen to satisfy a specific trip as household income. The point is not to assume that because a car is owned, it will be used to satisfy every trip.	Thank you. Agree	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
11155	10	34	10	34	What is transit elasticities?	Noted, thank you. % Change in transit ridership as a result of change in price. Other factors could also influence as the statement suggests. In resposne to comment, sentence is revised	Snorre Kverndokk	Frisch Centre	Norway
18195	10	34	10	36	Please mention also the "schienenbonus", i.e.the fact that the passengers prefer to use public transport on rail - 20% higher demand than for a bus	Accepted	Manfred Treber	Germanwatch	Germany
31021	10	39	10	39	How many people?	This refers to a paper in Nature communications. The paper talks about global SSPs. This is an assumption for the transport sector and refers to car users only	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31525	10	41	10	41	You may include here: "ICT based services on smartphones may facilitate inter-modal behaviour in urban areas and might, therefore, decrease car usages (Jochem et al, in preparation)" 1. Jochem, P.; Lisson, C.; Khanna, A. (in preparation): The significance of coordination costs in modelling future mode choice decisions, Transport Research Part A: Policy and Practice	Accepted. We can add this. Please also see the section on digitalisation	Patrick Jochem	German Aerospace Center (DLR)	Germany
47307	10	42	10	42	Just want to say I really like that the competition between HSR and aircraft for intercity travel is made so clear.	Thank you	Auke Hoekstra	Eindhoven University of Technology	Netherlands
11157	10	43	10	44	Why is it a significant interest in understanding this?	This interest is evident from the large body of literature on this. This is of relevance to increase respective shares on routes where these modes compete as well as planning new routes. This is of interest to the HSR industry, Aviation industry and	Snorre Kverndokk	Frisch Centre	Norway
29309	10	28	11	21	There is a need to include a statement to highlight what the varying income elasticity values mean.	Accepted. We will include in the revised draft	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
29187	10	42	11	21	Additional litteratures for this section: http://downloads.hindawi.com/journals/jat/2018/6205714.pdf https://link.springer.com/content/pdf/10.1007/s12544-017-0233-0.pdf https://transweb.sjsu.edu/sites/default/files/1223-modal-shift-high-speed-rail-literature-review.pdf https://doi.org/10.3141/2289-02	Thank you	Yann BRIAND	Iddri, Sciences Po	France
11661	10	7	13	7	Similar to one of the comments above, framing this chapter as 'behaviour' issue is really problematic. Please read extensive literature on practices instead. Practice framing takes into account cultural norms, systemic enablers (or constraints) and shifts away from 'blaming the individual" to advocating for adequate infrastructure provision. Please add a 200 word paragraphs on transpor practices or rename this sub-chapter.	Partially accepted. Yes cultral norms, systematic enablers are important in shaping human behaviour. Yet, there is also literature on how individual behaviour (despite all its influences) can be a catalyst for change. We will revise this section to incorporate some of the suggestions.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
39319	10	11			information / communication and its influence on mobility behaviour (e.g. provoding real-time, user-specific and location based feedback), see e.g. https://link.springer.com/article/10.1007/s10707-015-0242-x	Accepted.	Stephan Tischler	University of Innsbruck	Austria
42057	10	29			A strong penetration of Lithium-ion batteries would entail geopolitical impact. The three countries accumulating the biggest reserves of lithium are Argentina, Bolivia and Chile.	Rejected. Disagree, Australian hard rock Lithium mines are now the biggest reserves abd biggest production.	Francisco Javier Hurtado Albir	European Patent Office	Germany
31023	11	4	11	4	How much does the price of a rail ticket need to fall to draw mode share from flights? Is there evidence of this phenomenon? This will be for a subset of flight connections, particularly because new flight connections can be established faster than high speed rail infrastructure installed.	Partially accepted. Thank you for the comment. Yes price is an important factor but other factors include the speed and frequency on the routes where these two modes compete. Revised in response to comment	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31025	11	8	11	8	Quantify 'significantly' – if aviation and HSR tickets are down, what is causing a shift in mode used? Price cannot be the main driver now. Related, with flights cheaper than before, has that taken some mode share from HSR?	Accepted. Exactly. It is not only the price but as mentioned in the response to the previous comment, the choice also relates to speed, frequency, time and comfort of travel. We have edited the section in the SOD to provide clarification	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
18199	11	11	11	11	Please also mention the case of HSR Madrid - Barcelona which had been in Europe the flight connection with highest demand. HSR was introduced and has won a significant market share (63 %), see https://www.globalrailwayreview.com/news/66620/barcelona-madrid-85-million-passengers/.	Accepted.	Manfred Treber	Germanwatch	Germany
31027	11	13	11	13	Define 'safer'	Accepted. Revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31029	11	14	11	14	Quantify 'sizeably'	Accepted. Revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31031	11	15	11	15	Does this mean you can verify bus and car traffic being down along routes between HSR stations, while road traffic volumes largely unchanged on other routes?	Need to check	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
18201	11	17	11	21	Please also mention the success of HSR in China (now more that 30,000 km length after the first line in 2008) and the passenger demand.	Accepted. Included in the revised version	Manfred Treber	Germanwatch	Germany
22315	11	20	11	21	The point is also made that integrated traffic and transport planning to support intermodal functionality and utility is essential to achieving potential benefits from transport infrastructure, but materially the conclusion as covered is not reflected in the policy discussion later in the chapter (moreover, this is not the only 'conclusion' not carried through).	Later versions clarified this.	Kym Lennox	climate change equity	Australia
23777	11	22	11	22	"10.2.2.2 New demand concepts" No Numbering necessary	Accepted.Agreed, no numbering is necessary.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
28243	11	27	11	30	Remote working is certainly a new factor that has shaped transport demand since AR5	Accepted.Agreed and discussed in 10.2.2.3	Cornie Huizenga	CESG	Germany
11663	11	29	11	30	"all of which lead to decoupling " - this is a strong and unsuported claim. Please remove or state "Could potentially lead to.."	Accepted.Agreed added text.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
22317	11	29	11	30	Why does the text assume that transport choices default to a suffering of economic activity?	Rejected. Not assumed it is a definition of decoupling for transport	Kym Lennox	climate change equity	Australia
25595	11	31	11	43	And using returnable transport items	Noted. No action needed.	Sabine Limbourg	HEC-Uliege	Belgium
28551	11	33	11	34	Caerful! Reusing engines does not improve fuel economies (Sutherland et al., https://doi.org/10.1016/j.cirp.2008.03.004) and extending conventional vehicle lifetimes with low fuel economies will probably increase net emissions so there are always trade-off effects and that has to be mentioned. Whether a net reduction in emissions can be achieved will depend on the type of the original vehicle, the type of replacement vehicle, the timing of the replacementm the duration of the lifetie extension and so on. Kagawa found that lifetime extension can yield to net reduced emissions but only under certain conditions (dx.doi.org/10.1021/es1034552). In a UN report the authors also find a net reduction from vehicle lifetime extension but they did not extend lifetimes of gasoline-powered cars, only of electric cars (https://www.resourcepanel.org/sites/default/files/documents/document/media/resource_efficiency_and_climate_change_summary_for_policymakers_final_0.pdf).	Accept & will be added in new line (34-35)	Paul Wolfram	Yale University	United States of America
31033	11	37	11	37	LCA not defined	Accept will be defined in the text	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
28553	11	37	11	38	This sentence is unclear	Accept, by adding the definition of LCA in the text to make sentence clear	Paul Wolfram	Yale University	United States of America
31035	11	38	11	38	'Greenhouse' should be GHG	Accept	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31037	11	41	11	41	Define transport efficiency here – are you referring to energy, time, cost? Also, best to use economy or 'normalised use', rather than efficiency which is purely a ratio of like quantities	Accept, transport 'economy' will be used	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31039	11	42	11	42	Case studies throughout would be useful – many of the examples have been attempted and may have failed. In terms of mitigation, the important lessons to communicate are what worked and why, what did not work and why and the scale of the emissions saving.	Accept. Case studies will be considered as long as the space is available	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
11665	11	44	11	47	"Dematerialization is where technology is created that incorporates a range of 45 functions previously taken up by several different products. The best example is a smart phone. This 46 process is also enabled by the move to declutter lifestyles instead of consuming more and more 47 (Kondo, 2016) (Whitmarsh, Capstick, & Nash, 2017)." - unclear and too assertive, please rewrite	Accept, sentence will edit the sentence to be soften, explained and illustrated.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
31041	11	46	11	46	I'm not sure the smart phone has delivered the 'declutter lifestyles instead of consuming more and more.' Some evidence should be presented here for this.	Accept, The smart phone dematerialised 22 other devices but doesn't do anything about consuming other things; we made that clearer and the reference will be added (https://doi.org/10.1080/17530350.2019.1570962)to to replace Kondo.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
47309	11	44	12	16	Don't forget virtual travel under dematerialisation. As the reaction to Covid-19 proves, we can do more virtually and many even like that. It may sound like science fiction but science fiction often becomes reality and this was already being described in great detail in the 1992 novel "Snowcrash" by hard SF author Neil Stephenson. We already see that online games provide increasingly realistic immersive collaborative spaces. Realistically seeing each other will be made possible by the technology already employed to digitize movie actors. Travelling to joint virtual places will emit very little GHG, especially when the comuters are running on low carbon electricity. And it will make it easier to work together on computer files. I'm not an expert on this so don't take my word for it but it seems pretty clear to me that this is where we are heading.	Accept. The section 10.2.3 will be expanded and also will be included in section 10.8	Auke Hoekstra	Eindhoven University of Technology	Netherlands
22845	11	22			I was not convinced by Section 10.2.2.2. The concept of 'new demand values' was not clearly defined. The section on the circular economy focuses on supply, rather than demand factors.	Take into account. The first sentence on the paragraph discuss demand side. We will add some more sentences on demand side in this section and other sections.	Giulio Mattioli	TU Dortmund University	Germany
6407	11	36			Circular economy has to include also the re-use of batteries; I know that you mention this later in the text but I find it important to be mentioned here.	Accept. Found extra literatures on re-use of batteries: https://www.sciencedirect.com/science/article/pii/S0301479719307236?via%3Dihub; https://www.nature.com/articles/s41467-018-04826-0.pdf;	Apostolos Petropoulos	International Energy Agency	France
22847	11	47			Kondo (2016) is cited here in relation to 'decluttering' but does not appear in the reference list. I am not sure if this is Marie Kondo? I would avoid this reference as it's not a good look for an IPCC report. Also, it's not clear how 'decluttering' links to transport.	Accept, will the literatures will be added. Beside M Kondo, (https://doi.org/10.1080/17530350.2019.1570962)	Giulio Mattioli	TU Dortmund University	Germany
23779	12	1	12	2	"followed by a reversing trend with higher dematerialization between 2008 to 2010 (Ziolkowska & Ziolkowski, 2015)": Do you see a link to the world economic crisis that time?	Take into account. Link to comment 100	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
31043	12	2	12	2	What has happened since 2010?	Take into account.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
11667	12	3	12	5	"In the UK, transition to a 3 service economy resulted in dematerializing some freight transport (Alises, Vassallo, & Guzmán, 4 2014) but new evidence is showing that freight can increase due to on-line shopping deliveries (Fix 5 2019; Laghaei et al. 2016); Visser et al. 2014))." -> there is an issue with this argument b/c it doesn't take into account that if you transform UK into into service-based economy, UK's emissions won't disappear but be transferred abroad (e.g. to countries which are now major manufacturers)	Accept. Additional Reference from Mc Kinnon: McKinnon, A. (2018). Decarbonizing Logistics: Distributing Goods in a Low Carbon World. First edition. London: KoganPage.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
31045	12	4	12	4	The role of home delivery is important – how does that align with the point on the previous page re not consuming more and more.	Accept, the phrase “consuming more and more” has been revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31047	12	13	12	13	Where does e-commerce save energy in the LCA and what are the boundaries? How does this align with line 4 re increased freight deliveries (more vehicles, more fuel, more congestion and so on)	Accept, will add some sentences to clarify	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31049	12	15	12	15	forecast	Accept spelling error	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31051	12	15	12	15	Some more details is needed on the range because it is so broad, especially as those at 8t/cap/yr appear to be using global resources sustainably already	Accept. Revised to show 2t on mobility; added literature (Resources 2014, 3(3), 488-515; https://doi.org/10.3390/resources3030488)	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
11669	12	17	12	19	"The values of creating a more shared economy are related to both of the above 18 values as well as the notion of community well-being associated with the act of sharing instead of 19 simply owning for oneself ->" that's not what MaaS is, car clubs, on-demand bikes and ride hailing services are not owned by the 'community'. they are owned by the companies which market these services, the community can 'rent' them. there is no evidence that 'renting economy' contributes to wellbeing	Accept, sentence will be changed to include MaaS	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
18385	12	17	12	29	A case study can be added here. In China, the electric vehicle, sharing bike, sharing taxi, sharing public bus, unmanned delivery and so on, are all bring emission reduction. Emission reduction potential of these technologies should be evaluated.	Accept will be add in an extraline	Jie Guo	China Academy of Transportation Sciences	China
47311	12	17	12	42	Agree with this paragraph but would like to add vehicle size. We recently submitting an article (to be accepted in the coming months) making the point that a fleet of shared autonomous vehicles (SAEVs) will lead to more vkm but also to lighter vehicles requiring much less energy/materials/money to build/drive/buy. The energy/GHG aspect will be made explicit in an article to be submitted next month. This aspect that a fleet of SAEVs should be optimized per trip and that this could lead to mostly small 1 person vehicles (if one optimizes on cost/emissions/resources) is often overlooked. This is important in reducing GHGs and financial costs but also adds to many of the other SDGs. Submitted article here: https://www.dropbox.com/s/45d7i8qmhvnbn9a/EVS32%20-%20Hogeveen%20-%20Hoekstra%20-%20Shared.pdf?dl=0	Accept will be added in the reference	Auke Hoekstra	Eindhoven University of Technology	Netherlands
14067	12	20	12	23	If I understand correctly, after the reference in line 22 there should be a comma instead of a point. If not, the sentence does not have sense.	Accept, comma after the bracket	Victor Garcia Tapia	International Energy Agency (IEA)	France

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
28555	12	20	12	23	The authors should talk more about potential unintended consequences from services such as carsharing, Uber or Lyft (cannibalisaztion effects). Some numbers would be important to complement this valuable contextuial information. But maybe more is coming later?	Rejected. Already discussed in the next paragraph	Paul Wolfram	Yale University	United States of America
31053	12	26	12	26	A sustainable, decarbonised transport system cannot have the one to one competition of taxis and car sharing. That translates to many more vehicles in circulation and attendant impacts socio, environmental and economic impacts	Accept, no additional action needed	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31527	12	29	12	29	You may include at the end of this paragraph: "A study for 11 European cities has proven that one free-floating car sharing car may replace up to 11 private cars in a city (Fromm et al., 2019) Fromm, H.; Ewald, L.; Frankenhauser, D.; Ensslen, A.; Jochem, P. (2019), A Study on Free-floating Carsharing in Europe: Impacts of car2go and DriveNow on modal shift, vehicle owner-ship, vehicle kilometers travelled, and CO2 emissions in 11 European cities, Working Paper Series in Production and Energy 36, https://publikationen.bibliothek.kit.edu/1000104216/51584214	Accept add the reference	Patrick Jochem	German Aerospace Center (DLR)	Germany
28245	12	30	12	33	There is increasing evidence that ride sharing and hailing services increase congestion see https://link.springer.com/article/10.1007/s11116-018-9923-2. https://www.tandfonline.com/doi/abs/10.1080/01944363.2019.1637770?journalCode=rjpa20 https://archive.sfcta.org/sites/default/files/content/Planning/TNCs/TNCs_Congestion_Report_181015_Final.pdf	Accept add the reference	Cornie Huizenga	CESG	Germany
31055	12	31	12	31	Quantify 'higher' and what you are comparing it to.	Take into account. See the section 10.2.2.1	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31057	12	34	12	34	This is the key point to be stressed – the discussion up to this point has not been balanced, in terms of the possible downsides of introducing another option to compete with public transport.	Take into account. Added literature: https://journals.sagepub.com/doi/pdf/10.1177/0361198118790842	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
22849	12	36	12	37	There is research questioning whether car and bike sharing are inclusive modes of travel - see e.g. Clark, J., & Curl, A. (2016). Bicycle and car share schemes as inclusive modes of travel? A socio-spatial analysis in Glasgow. Social Inclusion, 4(3), 83-99; Tyndall, J. (2017). Where no cars go: Free-floating carshare and inequality of access. International journal of sustainable transportation, 11(6), 433-442.	Accept. It was discussed in MaaS and this reference added.	Giulio Mattioli	TU Dortmund University	Germany
31059	12	38	12	38	The issue of accessibility and inclusion is important here, across age, ability and socio-economic class	Accept. It was discussed in MaaS and this reference added as in 114	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
22319	12	39	12	39	Demand responsive transport systems are a rapidly evolving service offering, is there not a more recent reference than 2014 to inform on financial viability?	Accept. Added, in comment 113	Kym Lennox	climate change equity	Australia
22851	12	40	12	42	See also Docherty, I., Marsden, G., & Anable, J. (2018). The governance of smart mobility. Transportation Research Part A: Policy and Practice, 115, 114-12; Marsden, G., & Reardon, L. (Eds.). (2018). Governance of the smart mobility transition. Emerald Group Publishing.	Accept, will be added in the reference	Giulio Mattioli	TU Dortmund University	Germany
31061	12	44	12	44	We should be challenging the notion that economies have to grow to be considered successful – not all growth is good, or necessary, regardless of whether it can be decoupled from environmental harm.	Accept, no action needed	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31063	12	44	12	44	From a climate perspective, emissions need to be reduced in absolute terms. The fact that economic activity is growing faster than GHG emissions such that we have an improving emissions intensity is no consolation.	Accept. Data shows a plateau in absolute terms which should be some consolation especially when followed by a decline which is now happening.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
11467	12	43	13	7	The decoupling discussion could be transport specific.	Accept. Final sentence does refer to transport but added more based on further comments below.	Sudhir Gota	Independent Consultant/Researcher	India
47313	12	43	13	7	I think Peter Newman makes an important point regarding decoupling (and does so in a more thoughtful and nuanced way than McAffee in 'More from less') and I'm really glad the IPCC puts everyone on the trail of looking for maximum decoupling. I think it helps us to depolitisize by decoupling the problems (e.g. GHG emissions and biodiversity) from the solutions. Now the solutions are often equated with politics (e.g. conservatism or capitalism) and while there may be a correlation, it's good for the discussion and for broad support to not jump to that point prematurely. That's what I think at least.	Accept. Agreed!	Auke Hoekstra	Eindhoven University of Technology	Netherlands
17419	12	43	48		It should be explained the prosses decoupling for Key Indicators. Refer to figure 10.1.	Noted. Unsure what 'prosses' means.	Zeyaeyan Sadegh	Islamic Republic of Iran Meteorological Organization (IRIMO)	Iran
22853	12	43			I don't see how 'decoupling' can be considered a 'new demand value', the section is extremely short, and includes a figure where transport is not reported (I doubt we would see similar rates of decoupling for transport). I suggest removing this sub-section entirely	Rejected. Disagree. Decoupling is about a human value that integrates the value of economic activity with value of reducing GHG showing that they are not inevitably competing. This is extremely important to include. See comment 122.	Giulio Mattioli	TU Dortmund University	Germany
14069	13	2	13	2	Is the GDP in the figure at current or constant prices (real GDP) ?	Later versions clarified this.	Victor Garcia Tapia	International Energy Agency (IEA)	France
28247	13	4	13	7	The decoupling argument should not be limited to cities. See also http://www.ppmc-transport.org/wp-content/uploads/2015/08/Analysis-on-National-Transport-Sector-Emissions-1990-2012.pdf	Accept. Important reference added.	Cornie Huizenga	CESG	Germany
45179	13	5	13	7	Unclear why decoupling is only related to cities and "urban" here. Decoupling is a key notion for decarbonisation and deservers more attention (though potentially lack of evidence)	Accept. More text and references added.	Stefan Bakker	GFA Consulting Group GmbH	Netherlands

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
42059	13	9	13	15	ICT brings very positive aspects that mitigate climate change. However the assessment must consider that ICT equipment manufactruing is energy intensive and tha both, manufacturing and disposal, have an environmental impact.	Accept. Text and reference added.	Francisco Javier Hurtado Albir	European Patent Office	Germany
31065	13	10	13	10	Which cities? What is their growth in emissions? Global emissions need to peak in 2020 and fall every year afterwards to deliver AR5's RCP2.6 pathway.	Accept. It was discussed in references provided	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
17963	13	24	13	26	As an example of IoT, the concept of the Trackless Tram is introduced as per the reference (Newman et al 2019). This reviewer find it inappropriate, as explained in the following comment.	Rejected. Disagree. Trackless Trams are a very good example of smart technology that enables transit to be zero carbon and compete with cars.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
11675	13	8	15	17	The whole chapter is framed in terms of modes of transport - what about the adequate road provision (for walking, cycling, trains, cars?) and how the upcoming innovations might direct how future roads would look like? Similarly, the chapter lacks a perspective on transport as "infraststucture", e.g. governance of public transport, frequency and prices. I think we need to recognise somewhere i nthe beginning of the chapter that 'transport' includes a range of things: vehicles, practices (e.g. commuting), roads, bus/rail etc stations, prices, ownership, platforms.... please reconsider reframing	Accept. NMT is discussed in various places and certainly the perspective that transport is a system is fully adopted in the chapter. Added some words to clarify this.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
47315	13	9	15	17	Here there is fleeting mention of booking a single-passenger ride but without explaining the consequences. I would like to repeat the comment I made under 12-17 to 12-42: We recently submitting an article (to be accepted in the coming months) making the point that a fleet of shared autonomous vehicles (SAEVs) will lead to more vkm but also to lighter vehicles requiring much less energy/materials/money to build/drive/buy. The energy/GHG aspect will be made explicit in an article to be submitted next month. This aspect that a fleet of SAEVs should be optimized per trip and that this could lead to mostly small 1 person vehicles (if one optimizes on cost/emissions/resources) is often overlooked. This is important in reducing GHGs and financial costs but also adds to many of the other SDGs. Submitted article here: https://www.dropbox.com/s/45d7i8qmhvnbn9a/EVS32%20-%20Hogeveen%20-%20Hoekstra%20-%20Shared.pdf?dl=0	Accept. Reference added.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
31185	13	2			This figure appears to be obsolete in this chapter (should be discussed in the chapter on energy systems). Instead, the discussion of chapter 10 should start with a sound analysis of how global passenger transport demand and global freight transport demand evolve until 2100 in scenarios IP1 .. IP5, and in a reference (business as usual) scenario. These parameters are the key ones for deriving total energy demand or CO2 emissions from transport, and w/o presenting the transport demand inthe scenarios the remaining quantifications are meaningless. Also the modal splits (and changes thereof) need to be shown for IP1 .. IP5. Maybe Figure 10.20 should be moved to the beginning of this chapter!	Accept.	Urs Ruth	Robert Bosch GmbH	Germany
22855	13	8			A key missing reference for Section 10.2.3 is Docherty, I., Marsden, G., & Anable, J. (2018). The governance of smart mobility. Transportation Research Part A: Policy and Practice, 115, 114-12;	Accept. Reference added.	Giulio Mattioli	TU Dortmund University	Germany
6409	13	17			I would phrase that how we could build smart cities. Taking into account the huge urbanisation trend in Africa, plenty of new megacities will be located there it is a great opportunity to great a sustainable system from the start.	Accepted - text revised	Apostolos Petropoulos	International Energy Agency	France
22857	14	1	14	10	The discussion of MaaS is to one-sided. There is a growing literature casting doubt on claims that MaaS is positive for climate mitigation. See: Pangbourne, K., Mladenović, M. N., Stead, D., & Milakis, D. (2020). Questioning mobility as a service: unanticipated implications for society and governance. Transportation research part A: policy and practice, 131, 35-49. Wells et al. (2020) find that "Mobility as a Service" schemes are "more friends than foes" of the incumbent automotive industry (Wells, P., Wang, X., Wang, L., Liu, H., & Orsato, R. (2020). More friends than foes? The impact of automobility-as-a-service on the incumbent automotive industry. Technological Forecasting and Social Change, 154, 119975). Storme et al. empirical study finds limited car use / ownership reduction effects of MaaS pilots (Storme, T., De Vos, J., De Paepe, L., & Witlox, F. (2020). Limitations to the car-substitution effect of MaaS. Findings from a Belgian pilot study. Transportation Research Part A: Policy and Practice, 131, 196-205.)Noy and Givoni (cited earlier in the section) are actually rather critical of the extent to which smart mobility is inherently sustainable. Suatmadi et al. (2019) find negligible GHG reductions from shift to on-demand motorcycle taxies (Suatmadi, A. Y., Creutzig, F., & Otto, I. M. (2019). On-demand motorcycle taxis improve mobility, not sustainability. Case Studies on Transport Policy, 7(2), 218-229.) More broadly, the aim of MaaS initiatives is to encourage multimodality, but Heinen & Mattioli (2019) show that multimodality has a weak (or even positive) relationship with CO2 emissions, as multimodal individuals and trips tend to be associated with longer travel distances. (Heinen, E., & Mattioli, G. (2019). Multimodality and CO2 emissions: A relationship moderated by distance. Transportation Research Part D: Transport and Environment, 75, 179-196.)	Accepted - text revised	Giulio Mattioli	TU Dortmund University	Germany
42243	14	1	14	10	MaaS, I think, should be discussed outside of this box, right after the sharing economy section.	Accepted - text revised	Alvin Mejia	Wuppertal Institute	Germany
42245	14	7	14	10	These are sharing schemes, and not MaaS per se. MaaS would entail integration of the modes, trip planning, payment schemes, and changes in institutional roles (e.g. brokerage, regulation).	Accepted - text revised to differentiate between MaaS and vehicle-sharing	Alvin Mejia	Wuppertal Institute	Germany
14071	14	14	14	14	Missing parentheses in the reference	Accepted - text revised	Victor Garcia Tapia	International Energy Agency (IEA)	France
17965	14	16	14	22	Please avoid mentions to unconfirmed and over-hyped technologies. This is particularly relevant for the so-called "blockchain", which has significant negative externalities in terms of wasteful electricity consumption. Technology hype is a serious public policy problem [Funk, 2017]. [Funk, 2017] Funk, J. (2017). Assessing public forecasts to encourage accountability: The case of MIT's technology review. PLOS ONE, 12(8):e0183038–.	Take into account.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
22321	14	17	14	17	How does blockchain as a technology facilitate shared activity? A trusted transaction between parties otherwise unknown and without a third party as blockchain can facilitate is not an essential form for shared activity for transport. The technolgy has a role in transport and even as a facilitator of MaaS but not for the reason noted.	Take into account.	Kym Lennox	climate change equity	Australia

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
22323	14	17	14	18	Every 'future city' is going to have distributed solar energy? I seriously doubt Sapporo, Japan and many other challenged locations for solar resources will. This should be reworded if it is to stay, however, what does this commentary have to do with the application of blockchain to transport?	Accepted - text revised	Kym Lennox	climate change equity	Australia
11671	14	23	14	24	"smart technologies can improve.." - too assertive, there is not enough evidence to claim this. Say ' smart technologies are dubbed to improve…"	Accepted - text revised	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
31067	14	23	14	28	Lines 23-28: There should be specific examples quantifying the emissions savings from deploying smart technologies. We have talked for some time, both in these reports and in the literature about the potential of technology – here, we should be presenting the evidence of what works, what does not work so decision makers make the correct decisions	Accepted - text revised - need to find additional sources to provide this evidence (if available)	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
42247	14	23	14	28	It might be good to discuss 3d printing as well as it it does have the potential to be an innovative disruptor transport, particularly for goods transport (ITF, 2019 - ITF Transport Outlook).	Accepted - text revised	Alvin Mejia	Wuppertal Institute	Germany
23781	14	27	14	28	"Evaluations of actual GHG savings from such applications include Palsson et al (2017)": Some more information on applied method and reference system might be interesting.	Accepted - text revised - reference included	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
29313	14	27	14	28	The statement starting "Evaluations of actual GHG…." is not complete.	Accepted - text revised	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
17969	14	28	14	28	Missing reference, (Palsson et al, 2017)	Take into account.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
11709	14	29	14	35	Planes and trains may be autonomous, but they have a clearly defined route. This is their huge difference from a private vehicles in a big city. It makes sence to draw analogies with fixed-route road trancport (buses for instance). In addition, there are objective reasons related to security and terrorist threats, why man is present even on routes which can be completely autonomous.	Take into account.	Andrey Kolpakov	Institute of Economic Forecasting of the Russian Academy of Sciences	Russian Federation
22859	14	29	14	35	A key missing reference here on the possible impacts of autonomous vehicles on GHG emissions is Wadud, Z., MacKenzie, D., & Leiby, P. (2016). Help or hindrance? The travel, energy and carbon impacts of highly automated vehicles. Transportation Research Part A: Policy and Practice, 86, 1-18.	Accepted - text revised - reference included	Giulio Mattioli	TU Dortmund University	Germany
31069	14	29	14	35	What is the expected emissions savings from autonomous vehicles?	Take into account.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31529	14	29	14	35	You may include here the five levels of autonomous driving	Accepted - text revised	Patrick Jochem	German Aerospace Center (DLR)	Germany
42061	14	29	14	35	A complete assesment of autonomous vehicles must consider the ethical considerations of autonomous vehicles, also the safety issues. Ethically alligned desing is an issue	Accepted - text revised	Francisco Javier Hurtado Albir	European Patent Office	Germany
11677	14	30	14	32	"Planes and high-speed trains are already 31 largely autonomous" - as per above comment, this is incorrect (you meant perhaps "remotelly operated", "Remotely controlled" or "automated" (https://en.wikipedia.org/wiki/Automatic_train_operation)	Accepted - text revised	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
11673	14	31	14	32	"Planes and high-speed trains are already 31 largely autonomous as they are guided in all their movements, especially coming into stations and 32 airports, however that does not mean they are driverless. "- that's not what "autonomous" means. Do you mean they're already "remotely controlled"? they're definitely far from autonomous at the moment	Accepted - text revised	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
17967	14	33	14	33	As an example of AV, the concept of the Trackless Tram is introduced as per the reference (Newman et al 2019). I read the reference and the related bibliography and this reviewer is skeptical of the claims contained in that literature thread based on the following three main arguments. First, that reference indicates cost reductions that are not yet seen in practice. The first commercial example of this technology is in Yibin, China, on a 16,7 km route. The capital cost of this project ($164.4 million U.S.) is in line with BRT projects in China, and we do not have yet reliable figures on operational costs and performances. Second, this technology is in fact incremental with respect to a technology, so-called rubber-tired tram, or enhanced bus, with optical guidance, that in the past decades has not proved the high expectations similar to those claimed now. One example, among several, is the Caen, France, TVR that operated between 2002 and 2017, and experienced various failures. That system was scrapped and replaced by standard trams in 2019. The Achille heel of this technology has been the mechanical stress posed on the road pavement, particularly at the stations. This limitation requires costly pavement reinforcements such that it is not clear when this technology is cheaper than standard rail, which also has the benefit of avoiding customer lock-in with proprietary systems. Third, capital cost comparisons between urban transit technologies are misleading because are not adequately mapped with performances, operational expenses, and qualitative attributes (Vuchic et al., 2012; Bruun et al., 2018; Moccia et al., 2018). In view of this, I suggest removing this technology as an example in this IPCC report. References [Bruun et al., 2018] Bruun, E. C., Allen, D. W., and Givoni, M. (2018). Choosing the right public transport solution based on performance of components. Transport, 33(4):1017–1029. [Moccia et al., 2018] Moccia, L., Allen, D. W., and Bruun, E. C. (2018). A technology selection and design model of a semi-rapid transit line. Public Transport, 10:455–497. [Vuchic et al., 2012] Vuchic, V. R., Stanger, R. M., and Bruun, E. C. (2012). Bus rapid transit (BRT) versus light rail transit (LRT): Service quality, economic, environmental and planning aspects. In Transportation Technologies for Sustainability, pages 256–291. Springer, Berlin.	Accepted - text revised	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
20727	14	33	14	35	However, research shows that new model of cars emit higher than old model of cars.	Reject.	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
28557	14	33	14	35	The authors should make sure that there will be some mentioning about potential environemtal impacts of AVs; some are positive and some are negative (e.g. Gawron etal., https://pubs.acs.org/doi/10.1021/acs.est.7b04576). In general, this entire section seems to miss the connection to environmental problems; is that still coming?	Accepted - text revised - as mentioned, need to cover both sides	Paul Wolfram	Yale University	United States of America
11679	14	36	14	37	"There is a growing body of literature about the effect of smart city technology (including sensors 37 guiding vehicles) on demand for transport services as it is unclear what is the direction of the effect" - please state why the direction is unclear, what are the remaining questions, debates, controversies and gaps	Accepted - text revised	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
11681	14	36	14	37	"Some work suggests that shared vehicles such as Uber and Lyft.." - these are not shared vehicles, but ride hailing platforms. Examples of shared vehicles are car clubs	Reject - commonly referred to as ride-sharing, which is a form of a shared vehicle. Text to be revised to clarify	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
11683	14	36	14	37	you mention that it's unclear whether innovations in automotive sector will mitigate climate as they might instead lead to an increased vehicle kms travelled. This is a crucial point and needs to be emphasised - this is the right place to allude to the need to aforementioned 'modal shift' - that is, even with more efficient and electrified fleet we need to get people out of cars to buses, bicycles and on foot	Accepted - text revised	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
31071	14	36	14	42	This appears to contradict the points made in lines 23-28	Reject - unclear what this refers to	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
47897	14	36	14	42	Use of "smart city technologies" to describe automated vehicles is unclear and possibly confusing. The main automated vehicle technologies are sensors, Lidar and such. You should mention these. Also, this paragraph suggests that autonomous vehicles could improve competitiveness of either transit or private vehicles. It WILL do this for both - i.e. reduce operating costs. Overall it will tend to spur increases in travel, which is the key point and you do mention this - however, the current increases in travel from Uber and Lyft are not due to automation, obviously - they are due to subsidized taxi prices that draw people away from transit, walking and cycling and increase the number of trips, as Schaller says. Overall you should emphasize the risks of automation on induced travel and increased reliance on single-occupant vehicles. It's a major concern. The only real CO2 benefit of these vehicles will be from being electric, if they are.	Accepted - text revised - clarification of technology components vs smart mobility	Lewis Fulton	University of California, Davis	United States of America
22325	14	40	14	42	And what is the point being made as to the suggestions that shared vehicles services are increasing vehicle kms travelled? If this is due to improved outcomes in SDGs, then it is a good outcome. If the shared vehicle fleet has a very low emissions level per km, then it still means there is lower emissions from the sector. Why is this noted without context?	Accepted - text revised	Kym Lennox	climate change equity	Australia
31073	14	41	14	41	I raised this point in my comments on line 26 on p11, suggesting some contradiction in the text	Take into account.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31075	14	43	14	43	Automated mining vehicles, trains and aircraft confuses the issue with passenger cars. The issue is not whether the technology exists – that much is clear. It is the unique nature of the road network and street scape, with many more actors in close proximity, and how vehicles can circulate both autonomously and safely.	Accepted - text revised - challenges highlighted further	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
47317	14	45	14	45	Cities "will be an imprenetrable barrier". It is now stated as fact while many in the literature see the city as simply the next step that will just take 3-10 years longer.	Accept - can change langauge easily to "cities may under some contexts be an ..."	Auke Hoekstra	Eindhoven University of Technology	Netherlands
25597	14	46	14	46	Significant role of drones in healthcare	Reject - not a clear comment	Sabine Limbourg	HEC-Uliege	Belgium
47319	14	46	15	2	Glad the disturbance of drones to neighborhoods is pointed out. This is often missing.	Noted	Auke Hoekstra	Eindhoven University of Technology	Netherlands
31077	15	1	15	1	The key question should be how much CO2 is saved by switching to drones and what are the unintended consequences? Now, we have van delivering a number of online purchases, compared to one drone per parcel of given dimensions and mass. That implies many drones to do the same task as a single van, but not avoiding the need for vans completely because of the technological limitations of drones. Therefore, we still have many vans and many drones.	Reject - outside the scope of the chapter	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
22327	15	1	15	2	This appears preemptively conclusive. Even if Stolaroff et al are correct, this report should not promote such a position. The attritude taken here if applied to the early days of the automobile would have meant we would still be moving around at the same pace as horses. History shows that utility always trumps disturbance, if the drone services offer utility and are available to the majority of people, then they may not be limited in their application. There remains uncertainty and the report should reflect this.	Accept - we can make our writing slightly more nuanced here	Kym Lennox	climate change equity	Australia
47899	15	3	15	7	"The impact of these new technologies will be determined by how they are managed in terms of demand", yes this is true and this helps start to address my comments in the last comment. However the next sentence ("It is likely that different parts of the city...") does not follow this thought well, and it is confusing - why will automated vehicles be a better fit for cars than for transit? That is not true prema facie. (I also don't understand what you mean by "fabric" if you refer to transit, cars and active transport as separte fabrics - the "fabric" is how all these fit together isn't it?). Anyway you do not get to the point - driving and ride hailing may become so cheap (both monetarily and hedonically) that transit loses even if it is automated. You need to say this very clearly.	Accepted - text revised - elaborate further/clarify	Lewis Fulton	University of California, Davis	United States of America
11159	15	3	15	17	What do we know from research about behavioral impacts of AVs? Will emissions go down for a given transport demand? Will the new technology increase or reduce the demand for transport?	Accepted - text revised - update with further references/discussion	Snorre Kverndokk	Frisch Centre	Norway
11685	15	4	15	7	"It is likely that different parts of the city will be enabled to use autonomous vehicles more 5 than others – automobile city fabric for example will be more able to accommodate AV's than in 6 transit city fabric and walking city fabric where fast-moving autonomous vehicles would not be 7 economically and socially acceptable due to pedestrian priority."- this is a profound point and needs further attention. what else could happen - price of AVs priviliging only those who could afford it? de-prioritising cycle lanes and tram tracks (or any other users?)? there are so many anticipated consequences, see https://driverless-futures.com/	Accepted - text revised - elaborate further/clarify	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
22329	15	4	15	7	Where is the reference for this forecast as to the application of autonomous vehicles. Why can't the differing urban fabrics have a saturation of different types of vehicles? Why must autonomous vehicles be fast moving?	Accepted - text revised - include reference	Kym Lennox	climate change equity	Australia
47321	15	4	15	7	It is clear that fast moving vehicles are not welcome in spaces reserved for pedestrians and bicycles. However, this has nothing to do with them being autonomous or not. We already allow motorized wheel chairs and electric bikes. I think it would only be logical that slow moving autonomous vehicles are part of the mix and in many respects they are easier to integrate since slow moving vehicles cause less damage when they make an error. They can be lighter (which means they emit less energy in an accident) and their lower speed makes them less dangerous (energy increases by speed squared). So city centers with slow moving autonomous vehicles that make banning cars easier is not an unlogical future perspective.	Accepted - text revised - add further detail to address issue around AVs in dense areas	Auke Hoekstra	Eindhoven University of Technology	Netherlands
31079	15	7	15	7	Agreed – and we should be moving away from automobile cities to public transport and walkable cities, as part of the 'avoid-shift-improve' hierarchy introduced earlier	Noted	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
22331	15	10	15	10	I would suggest that some of the groups referenced would not appreciated being labelled 'marginal'	Accepted - text revised	Kym Lennox	climate change equity	Australia
25599	15	12	15	12	They can also reduce the demand for public transport.	Accepted - text revised - further discussion on potential negative impacts of AVs.. Reduced PT can be positive/negative depending on whether they are outer routes or trunk routes	Sabine Limbourg	HEC-Uliege	Belgium
17971	15	14	15	17	This Section has some overlap with Section 10.1.4. Both could be better informed on the potentially negative sides of AVs by a UC Davis and ITDP 2017 report, synthesis in [Fulton, 2018] Fulton, L. M. (2018). Three revolutions in urban passenger travel. Joule, 2(4):575–578.	Accepted - text revised - potential negatives of AVs included; discuss with 10.1.4	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
47323	15	14	15	17	In lectures and talks I often say "autonomous vehicles can be heaven and they can be hell". Municipalities really have to make sure they are integrated optimally in city life or we will get busier roads, more dangers to pedestrians and far more GHG emissions. But if we make them integrate with public transit optimally and make sure that small, light and slow vehicles are given preference we have a very powerful alternative for private cars. See also the article submitted mentioned above that will be followed by an article specifically about the GHG emissions and energy use of small shared autonomous vehicles. I'm sure there will be better articles about this soon by the way. https://www.dropbox.com/s/45d7i8qmhvnbn9a/EVS32%20-%20Hogeveen%20-%20Hoekstra%20-%20Shared.pdf?dl=0	Accepted - text revised - potential negatives of AVs included	Auke Hoekstra	Eindhoven University of Technology	Netherlands
2653	15	15	15	15	One wonders about this sentence. Do you mean "more sanguine"? From previous lines one would rather expect "less sanguine".	Accepted - text revised	Philippe Waldteufel	CNRS/IPSL/LATMOS	France

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11687	15	16	15	17	I think you didn't mean to use "sanguine" (this also means "optimistic" like the previous reference). Perhaps you meant the opposite? "others are more concerend whether policy interventions can enable..." also Hancock et al 2019 is not featured in the bibliography - please add	Accepted - text revised	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
40421	15	18	15	31	It is not apparent to me how V2G can help with range anxiety. The introduction to the 10.2.4 does not match its content. Wouldn't the usage of teh battery for other purpose even increase anxiety?	Accepted - text revised - this section has been shifted to 10.3, and broadened to discuss Smart Charging, where there is potential to reduce range anxiety by providing certainty on charge by particular time of day	Maya Strautmann	RWTH University, Chair of Electrochemical Energy Conversion and Storage Systems	Germany
28559	15	19	15	20	Sentence is poorly written	Accepted - text revised	Paul Wolfram	Yale University	United States of America
28561	15	21	15	21	There are many technological and systemic factors that are being discussed in more detail in Wolfram et al. (https://doi.org/10.1016/j.trd.2019.06.006). The authors also prvide a hierarchy of systemic and technological factors which ciuld help structure this chapter. How did the authors of this chapter decide what factors fall into the category 'technological' and which ones fall into the category 'systemic'?	Accepted - 10.2 has been revised to focus on systemic factors; moving technological issues to 10.3	Paul Wolfram	Yale University	United States of America
31531	15	23	15	23	After this sentence you may include: "The load flexibility of EV is tremendous and will sxceed other storages by far when market penetration of EV gains momentum (Babrowski et al., 2014) 49. Babrowski, S.; Heinrichs, H.; Jochem, P.; Fichtner, W. (2014): Load shift potential of electric vehicles in Europe: chances and limits, Journal of Power Sources 255, 283-293, doi: 10.1016/j.jpowsour.2014.01.019	Accepted - text revised	Patrick Jochem	German Aerospace Center (DLR)	Germany
28563	15	23	15	26	As a pioneer of V2G there should probably a reference to Kempton et al. here (https://doi.org/10.1016/j.jpowsour.2007.03.010)	Accepted - text revised	Paul Wolfram	Yale University	United States of America
31081	15	24	15	24	I don't see how V2G, GIV or VGI relate to range anxiety. Yes, they describe how EVs can provide grid support, but the vehicle range (and associated driver anxiety) will be the same regardless of the grid interaction.	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31533	15	28	15	31	I would replace these sentences "V2G and VGI ..." by "From the electricity system's perspective it is already sufficient to postpone the charging in order to avoid harmful impacts. Therefore, "smart charging" or "controlled uni-directional charging" is sufficient. Hence, V2G or VGI (Sovacool, Axsen and Kempton, 2017) or even V2X or vehicle-to-everything (Wang, 2019) is more a special case for decentral application or for the far future.	Accepted - text revised - section broadened to smart charging	Patrick Jochem	German Aerospace Center (DLR)	Germany
39883	15	32	15	32	French Electricity TSO conducted a thorough study of integration of electric vehicles in the French electricity system, the flexibility they can provide, the CO2 emission reduction they could provide. The penetration of about 15 millions EVs in the French fleet could reduce the total carbon footprint of road transport by 20% (FIgure 31). Relocating battery manufacturing in countries where electricity is low-carbon (e.g. France instead of China or Poland could divde the carbon footprint of one electric vehicle by half (Figue 33). The results are soon to be published at the IAEE 2020 conference (De Lauretis et al, 2020) English report here : https://www.rte-france.com/sites/default/files/rte_-_electromobility_report_-_eng_2.pdf	Accepted - text revised - reference included	Bianka SHOAI-TEHRANI	RTE, CentraleSupelec	France
31083	15	39	15	39	PEV not defined. If it means plug in electric vehicle, what other types of electric vehicles are there?	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31085	15	40	15	40	Useful to mention how many EVs need to be connected simultaneously to address demand peaks or provide other grid services, compared to the number of EVs in service. The other important component is how drivers are compensated for the additional battery wear.	Accepted - text revised - elaborate on potential challenges, but also scope/scale	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31087	15	41	15	41	What makes a PEV V2G capable? Are you suggesting it is a function of the vehicle itself, the charger or both?	Accepted - text revised - clarified requirements for vehicles to be smart charging capable with/without V2G	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
22335	15	44	15	45	Peak shaving of high-carbon electricity sources as an outcome assumes a merit order and market mechanism to apply that merit order in the wholesale supply of electricity. In practice this is not how such markets work and as such peak shaving will not lower the production of high-carbon electricity generation in the associated grid.	Accepted - text partially revised, some markets do indeed use merit order pricing but others do not, we can note this	Kym Lennox	climate change equity	Australia
29109	15	44	15	47	Penetration rate of 75% for V2G service by 2030 seems high- might be helpful to add other references	Accepted - text revised	Minal Pathak	Ahmedabad University	India
34899	15	45	15	45	Year of the reference is missing	Accepted - text revised	ANUPAM DEBSARKAR	University	India
47329	15	45	15	46	I would replace the word 'optimal' by the word 'theoretical'. I'm often considered an optimist on the adoption of EVs (although my predictions have been too low for the past 10 years) but 75% penetration rate in 2030 is almost impossible since cars last about 20 years. So even if you ramp up exponentially to 100% sales in 2030 (an optimistic but not impossible scenario in the literature) you would end up with something like 25% electric vehicles. (I thought Tony Seba was the only one thinking he could make things faster than that in a way that is never really explained.)	Accepted - text revised	Auke Hoekstra	Eindhoven University of Technology	Netherlands
20467	15	18	16	21	V2G can even reduce seasonal storage in highly renewable energy systems are found by Child et al. (https://www.mdpi.com/1996-1073/11/9/2206), this effect is missing in the section.	Accepted - text revised - include reference	Christian Breyer	LUT University	Finland
22333	15	18	16	26	The absence of an equivalent chapter on hydrogen implies a policy bias to electric mobility as the only solution. All the Intelligent Transport Systems details apply regardless of the energy vector and both electricity and H2 are short on infrastructure. Moreover, different urban and topographical factors of cities and countries coupled with their renewable energy resources will predetermine a bias between electric and H2. This policy detail is absent from the report.	Accepted - text revised - Smart Charging discussion has been shifted to 10.3, while this section has been revised to more broadly cover the Transport-Energy Nexus	Kym Lennox	climate change equity	Australia

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
40423	15	18	16	26	10.2.4 only focuses on V2G. You should mention political measures to help seting up the charging infrastructure in general. With respect to range anxiety, you can also mention statistics about the distances traveled with personal vehicles (the large part of trips is very short). Maybe this publication can be useful: https://doi.org/10.1016/j.trb.2017.04.008	Noted - these issues are discussed further in section 10.3	Maya Strautmann	RWTH University, Chair of Electrochemical Energy Conversion and Storage Systems	Germany
42249	15	18	16	26	The V2G section is allotted substantial space as compared to the others. Isn't this more of a supply factor (maybe under 10.3.1.3) rather than a demand factor? Also, should a section on electrification be added instead of V2G?	Accepted - text revised - Smart Charging discussion has been shifted to 10.3, while this section has been revised to more broadly cover the Transport-Energy Nexus	Alvin Mejia	Wuppertal Institute	Germany
47325	15	19	16	26	I'm completely missing the first step toward demand-response, often called 'smart charging'. By now it is part of most standards (like OCPP) and I have 121 peer reviewed sources on demand-response and smart charging in my Zotero library so I assume you know this. I would strongly advise adding smart charging to the paragraph on integrating electric mobility and grid management. From the simulations I have done for grid operators I conclude that V2G is about 5x more useful as a balancing mechanism than simply smart charging (so I am really glad it gets prominence in AR6) but I can say that in most countries, regulation enabling smart charging will be the first step before V2G regulation is considered. So it is really important to drive this point home to policy makers in 2022 in AR6.	Accepted - text revised - Smart Charging discussion has been shifted to 10.3, while this section has been revised to more broadly cover the Transport-Energy Nexus	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47327	15	19	16	26	I'm missing the increasing longevity (in terms of cycles) that makes this a possibility. V2G was rightfully objectionable to car manufacturers in the past when the battery had problems outlasting the car. But battery longevety is quickly increasing. See e.g. Harlow, J.E., Ma, X., Li, J., Logan, E., Liu, Y., Zhang, N., Ma, L., Glazier, S.L., Cormier, M.M.E., Genovese, M., Buteau, S., Cameron, A., Stark, J.E., Dahn, J.R., 2019. A Wide Range of Testing Results on an Excellent Lithium-Ion Cell Chemistry to be used as Benchmarks for New Battery Technologies. J. Electrochem. Soc. 166, A3031–A3044. https://doi.org/10.1149/2.0981913jes and much other work in the lab of Jeff Dahn.	Accepted - text revised - further discussion included on potential costs/impacts of V2G	Auke Hoekstra	Eindhoven University of Technology	Netherlands
40427	15	32	16	5	The text describes the advantages of V2G for the grid. Additionally, V2G can lead to a more efficient usage of the batteries. Battery degradation does not only take place during operation but also generally over time ("calendar ageing"). This means that sparing the battery from usage will lead to a long battery lifetime, but will not make the most of the battery. It might be economically beneficial to use the battery of PEVs during the long standing times. I don't know if V2G is also the best strategy to reduce greenhouse emissions. I guess it depends on the available alternatives for energy storage. There are many articles on the effect of V2G on batteries, maybe this one includes a wide perspective. https://doi.org/10.1016/j.enpol.2017.11.015	Accepted - text revised - this point has been incorporated into discussion	Maya Strautmann	RWTH University, Chair of Electrochemical Energy Conversion and Storage Systems	Germany
47331	15	47	16	5	[I] think this has to be qualified further. GHG emissions of V2G depend on a slew of assumptions regarding battery manufacturing (assuming an LCA approach was used here), merit order of energy sources and carbon intensity of the mix and how it evolves over the lifetime of the car that are all not made explicit here.	Accepted - text revised - deeper discussion on conditions required to deliver emission reductions	Auke Hoekstra	Eindhoven University of Technology	Netherlands
6411	15	18			I do see the benefit of V2G but I feel that the smart charging is the key technology. Then the V2G is going to unlock some marginal additional potential. It matters a lot what time are you charging, given the huge variability of the renewables and this is going to devide the carbon intensity of your electricity. The average carbon intentisty is not a representative index.	Accepted - text revised - Smart Charging discussion has been shifted to 10.3, while this section has been revised to more broadly cover the Transport-Energy Nexus	Apostolos Petropoulos	International Energy Agency	France
42063	15	18			The analysis in this section (10.2.4) should consider as well that the integration of EV/HEV in the management of power networks will encompass an strong technological effort (to the interaction with the netwrok, the third-party interaction with fleets or with vehicles in the same commercial initiative must be added). The impact of a growing number of EV/HEV on the electrical infrastructure must be also considered.	Noted - this issue is discussed further in section 10.3	Francisco Javier Hurtado Albir	European Patent Office	Germany
17973	16	6	16	10	I suggest for this discussion - V2G scenarios for Europe - the reference [Victoria et al., 2019]. Figure 3 of that paper is very informative not only on the potential of V2G but also on the postponing effect of BEVs with respect to other costlier grid storage technologies. [Victoria et al., 2019] Victoria, M., Zhu, K., Brown, T., Andresen, G. B., and Greiner, M. (2019). The role of storage technologies throughout the decarbonisation of the sector-coupled european energy system. Energy Conversion and Management, 201:111977.	Accepted - text revised - reference included	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
40425	16	6	16	26	The diffulties of implementing V2G should also be included. There are technological challenges regarding the "2-way plug". The high number of energy sources constitute a complex optimization problem. Network operators, energy suppliers and vehicle owners must agree on usage strategies and compensation.	Accepted - text revised	Maya Strautmann	RWTH University, Chair of Electrochemical Energy Conversion and Storage Systems	Germany
31089	16	8	16	8	Is this current storage capacity or forecast? What are the assumptions supporting this statement?	Take into account.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31091	16	13	16	13	How many EVs are expected to assist the transmission operators in the US? A number of these studies assume very large EV fleets, far exceeding what exists today. Therefore, the assistance forecast presents a future scenario.	Accepted - text revised - further clarification provided	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31093	16	16	16	16	How many V2I systems exist now, compared to the TRB forecast?	Reject - there is no data on this and the TRB forecast, although a bit older, is the most recent one we were able to find	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)

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23783	16	16	16	19	"could be utilized by about 460 million vehicles globally by 2030; vehicle-to-retail (V2R) systems, where cars communicate directly with fuel or automotive parts retailers, by another 406 million vehicles by 2030 globally; and another 50 million vehicles globally offering active V2G services by 2030 (Mohaddes & Sweatman, 2016)": Information about the current status might be helpful.	Accepted - text revised	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
31095	16	17	16	17	Likewise, how many V2R systems exist?	Noted - and addressed above	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31097	16	18	16	18	What growth rate is needed to yield 50 million EVs in circulation within 10 years (to 2030)?	Accepted - text revised - review this figure/provide additonal evidence?	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
23785	16	23	16	23	Why curves are decreasing until 2070/80 and increasing again by 2100?	Accepted -will revise text and how it describes the figure	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
1427	16	27	16	27	Zhang et al. (2020) discusses the importance of the renewable energy penetration along with the EV expansion in terms of GHG emissions. https://iopscience.iop.org/article/10.1088/1748-9326/ab6658/meta	Accepted - text revised	Shinichiro Fujimori	Kyoto University	Japan
34439	16	27	16	27	In this section, the innovative findings of Sharma and Maréchal, (2019) should be discussed. They propose a brilliant alternative to reduce CO2 emissions from the transport sector in capturing CO2, directly on board vehicles. Their CO2 capture system for engine exhaust stream (car, truck, bus, ship, or train) can capture 90% of the emitted CO2, without any energy penalty. This system can be integrated into overall mobility systems (fuel-engine- CO2 -fuel), where captured CO2 can be recycled as conventional liquid or gaseous fuels produced from renewable energy sources. (Sharma and Maréchal, 2019, Front. Energy Res. 7, 143)	Reject? Is this relevant to this section? Better addressed in Advanced ICE in 10.3?	Célia Sapart	Université Libre de Bruxelles et Co2 Value Europe	Belgium
34441	16	27	16	27	A section with a discussion on alternative fuels (next to biofuels and H2) is missing. A lot of research is published on alternative fuels for aviation and shipping. To reduce the negative impacts of the transportation sector, synthetic fuels are currently being developed, which are produced from renewable energy stored via catalytic conversion of hydrogen (H2) and carbon dioxide (CO2) captured from the air. A promising class of synthetic fuels are oxymethylene ethers (OMEs (Byrnolf et al., 2018). By driving out the use of fossil kerosene fuel in aviation through carbon pricing and requiring aircraft to switch to synthetic fuels, and advanced biofuels to a very limited extent, the climate impact of flying can be reduced dramatically. Zero emission CO2-based synthetic fuels and very low carbon advanced sustainable biofuels can be produced today and deployed immediately using existing engines and infrastructure. Estimates on the additional cost of synthetic kerosene vary with some studies claiming cost parity in 2050 but this would require very cheap electricity (Schemme et al, 2017, Byrnolf et al., 2018, Transport and Environment). At short-term, the role of hydrogen would first be to form CO2 based fuels, e.g. (Gumber and Gurumoorthy, 2018). These fuels can provide climate benefits, but the use of low carbon energy for their production is critical. CO2 emissions can be reduced by 74% to 93% for methanol and 54% to 87% for e-methane as compared to conventional production routes (IEAGHG, 2019a) (Transport and Environment, 2018: How to decarbonize European transport by 2050, Transport and Environment./IEAGHG, 2019a: Putting CO2 to Use – Creating value from emissions, International Energy Agency./Gumber and Gurumoorthy, 2018, Methanol, Chap. 25, 661-675./ Byrnolf et al., 2018, Renewable and Sustainable Energy Reviews, 81/2, 1887-1905./ Schemme et al., 2017, Fuel, 205, 198-221)	Thanks. We have now added a write on Synthetic Fuels within Section 10.3.4	Célia Sapart	Université Libre de Bruxelles et Co2 Value Europe	Belgium
31201	16	28	16	29	why four technologies only? In the executive summary there were mentioned 5: battery, hydrogen, biofuels, synthetic hydrocarbons and advanced ICE. Synthetic hydrocarbons should also be mentioned; also the use of hydrogen should not just be limited to the use within fuel cells but extended to ICE using hydrogen.	Accepted: Synthetic hydrocarbons can be covered in 10.3.4	Urs Ruth	Robert Bosch GmbH	Germany
22861	16	27			There is no discussion in this section of policies that have successfully promoted the diffusion of EVs as e.g. in Norway - see e.g. the International Council for Cleaner Transportation report on financial policies for EV diffusion, comparing Norway with other countries: https://theicct.org/publications/using-vehicle-taxation-policy-lower-transport-emissions	Take into account.	Giulio Mattioli	TU Dortmund University	Germany
23787	17	3	17	3	Did you also discussed to consider Plugin-Hybrids incl. range extender applications?	Take into account. Plug-in hybrids are included in section 10.4. I am not sure what they mean by range extender applications, but we will consider a range of driving conditions reported in the LCA literature	Stefan Majer	German Biomass Research Centre - DBFZ	Germany

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47335	17	3	17	45	I propose to add paragraph 10.3.1.5. on the business case of BEVs. This is important so people understand BEVs will take off after they will become cheaper on all fronts, irrespective of subsidies. This is especially true for heavy trucks. On page 17 line 44 the term "Price parity" is used. This is the first (and last?) time the business case was mentioned. In reality, "price parity" (assuming only sticker price is meant) not only depends on the battery price but also on the size of the battery (e.g. 25 kWh for the first Leaf and up to 100 kWh for Tesla), drivetrain cost (electric drivetrains, especially powerful ones for bigger cars, are increasingly cheaper); design (dis)advantages; and taxes. Furthermore, reactions of Dutch buyers to tax incentives that lower montly costs show consumers are also interested in the TCO (total cost of ownership). This strongly depends on: the cost of fossil fuel (different between countries: e.g. $7/gallon in the EU and $3/gallon in the US); the cost of electricity (different between countries and segments of the population: in the Netherlands between 3 and 20 cents); the energy use of the car (bigger energy use means more savings per km.); maintenance costs (~60-70% lower for electric vehicles but different per type of conventional or electric car); travel needs (people that travel more have a bigger TCO advantage); car segment (the advantage of EVs increases with size/price of the vehicle); and ownership period (due to depreciation the BEV becomes more attractive if you keep it longer). I published some simple prelimenary work in the past on this. Hoekstra, A.E., Vijayashankar, A., Sundrani, V.L., 2017b. Modelling the Total Cost of Ownership of Electric Vehicles in the Netherlands. Presented at the EVS30, Stuttgart. But as mentioned at the start of this review we will produce a new publication in time for the AR6 deadline to adress this paragraph in more depth. The publication will also tackle the business case of electric trucks vs conventional trucks. This is extremely important because based on this analysis, EVs be adopted at an increasingly rapid pace, irrespective of subsidies. This in turn is good imput for e.g. the big mitigation potential table in chapter 12 that Kornelis Blok must produce. Kornelis has indicated he would appreciate the effort. Conference article: Verbruggen, F., Hoekstra, A.E., Hofman, T., 2018. Evaluation of the state-of-the-art of full-electric medium and heavy-duty trucks. Presented at the EVS 31, Kobe, Japan. Whitepaper: Hoekstra, A., 2017. Electric trucks: economically and environmentally desirable but misunderstood, https://www.elaad.nl/news/auke-hoekstra-electric-trucks-economically-and-environmentally-desirable-but-misunderstood/ (accessed 3.15.20). Report (Dutch): Van Sloten, R., Hoekstra, A., de Kerf, D., Hoogeveen, P., Aldenkamp, M., 2019, eTrucks from the Port of Rotterdam - roadmap for electric container transport, https://www.portofrotterdam.com/sites/default/files/e-trucks-elektrisch-containervervoer-vanuit-de-rotterdamse-haven.pdf.	Take into account.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47859	17	8	17	14	This first paragraph seems repetitive wit Li-ion battery subsection below. Suggest remove mention of Li-ion and keep remarks more general on battery technology - opportunities and limitations.	Accepted. Agree. The overlapping text has been taken out	Martino Tran	University of British Columbia	Canada
31101	17	15	17	28	The history of batteries is not relevant to the emissions mitigation potential of EVs	Noted. The idea is to give an overview of all battery technologies however we have reduced text in the pre-LIB section	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31099	17	18	17	18	I don’t believe redox flow batteries were used in any mobile applications	Noted: Will be checked	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31203	17	29	17	45	in this chapter there is a mix between cost and price for LIBs. Please use "cost" consequently, as price is rather related to end customer.	Taken into account: Instead of prices now only costs will be used in the chapter	Urs Ruth	Robert Bosch GmbH	Germany
47901	17	29	17	45	I'm running out of time so just hitting some high points now - this paragraph on LIBs, and the associated table, need to address the issue of what the cost/price means. Is this a cell or pack price? Is this a cost to OEMs, or does it reflect the price impact on the vehicle (there will be some markup, there has to be, they have to recover a range of costs associated with putting that battery in the car, R&D, and general return on fixed investment. Also, what about the fact that no one will allow batteries to go below 20% state of charge. We need 1.25 kWh of batteries to provide 1 kWh of service. Should we penalize battery costs for that?	Take into account.We are going to have to figure out how to talk about costs of specific vehicle components. Section 10.4 will include a discussion of life cycle costs and we may try to harmonize LCC based on the data we receive about assumption. However, we will not be focused on the costs of batteries individually.	Lewis Fulton	University of California, Davis	United States of America
14073	17	36	17	38	It seems that there is an extra parentheses at the end of line 38 and that the text after Table 10.3 does not match the rest of the sentence	Editorial: Corrected	Victor Garcia Tapia	International Energy Agency (IEA)	France
31103	17	38	17	38	Check ‘see LIB energy optimised’	Editorial: Corrected	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
1689	17	7	20	15	One of important barriers for EV is short of driving range. The battery weight of Leaf and Tesla 3 is around 400kg, compared with the vehicle weight of around 1700kg. To compete with the driving range of more than 600km for conventional ICE vehicles, further battery packs should be installed, leading to more weight and higher cost. This important hurdle of current EV should be mentioned and discuss the need of new type of battery with higher energy density somewhere in this section.	Thanks. You rightly raise this issue of battery weight and we have therefore included battergy enerergy density and specific energy in Table 10.3 and here we compare alternative battery technologies for this.	Shigeki KOBAYASHI	TICJ	Japan
25837	17	3	22	44	I don't know if this is necessarily the right place to put this, but it needs to be mentioned somewhere that the carbon neutrality of this technology is entirely dependent on what you're charging from. If EVs are charged from coal, that might be even worse than petroleum.	Take into account.We will address this concern in section 10.4. The plan is to report the life cycle GHG emissions of EVs charged from different electricity sources	Jonathan Buonocore	Harvard University	United States of America
31105	18	1	18	1	How much further is the chemistry expected to improve? In other words, where does the learning curve begin to flatten?	Noted: Will be checked	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31107	18	2	18	2	Quantify ‘medium term’	Taken into account: Has been defined more specifically	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)

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2865	18	3	18	7	Would be good to review the work done by Prof. Mark Jacobson at Stanford. Mark has undertaken global assessments of renewable energy policy and has considered the economic and material demands on electrical energy conversion. The following papers are certainly relevant and could be of interest in a redrafted chapter:	Taken into account : Will be covered in revision	Nicholas Surawski	University of Technology Sydney	Australia
2867	18	3	18	7	Providing all global energy with wind, water, and solar power, Part I: Technologies, energy resources, quantities and areas of infrastructure, and materials	Taken into account.	Nicholas Surawski	University of Technology Sydney	Australia
2869	18	3	18	7	By: Jacobson, Mark Z.; Delucchi, Mark A.	Taken into account.	Nicholas Surawski	University of Technology Sydney	Australia
2871	18	3	18	7	ENERGY POLICY Volume: 39 Issue: 3 Pages: 1154-1169 Published: MAR 2011	Taken into account.	Nicholas Surawski	University of Technology Sydney	Australia
2873	18	3	18	7	Providing all global energy with wind, water, and solar power, Part II: Reliability, system and transmission costs, and policies	Taken into account.	Nicholas Surawski	University of Technology Sydney	Australia
2875	18	3	18	7	By: Delucchi, Mark A.; Jacobson, Mark Z.	Taken into account.	Nicholas Surawski	University of Technology Sydney	Australia
2877	18	3	18	7	ENERGY POLICY Volume: 39 Issue: 3 Pages: 1170-1190 Published: MAR 2011	Taken into account.	Nicholas Surawski	University of Technology Sydney	Australia
42251	18	3	18	7	The water footprint of such should also be discussed as there maybe significant implications to local climate ecosystems due to unchecked production practices (e.g. Jursova et al, 2019) https://www.mdpi.com/2076-3298/6/3/38/pdf ; Maeva, et al. 2019 https://cris.vub.be/files/49452020/EVS32_FullPaper_V1.pdf	Noted: Will expand more on water implications	Alvin Mejia	Wuppertal Institute	Germany
39691	18	8	18	13	While NMC batteries dominate, not all EV makers use NMC cathodes. For instance, Tesla uses NCA and LFP are still used, and most already use lower cobalt batteries than NMC111. Still, the fact that other chemistries can be used is not adequate to rule out limitations in supply of metals such as cobalt, as most auto makers are in fact making themselves dependent on these metals, with potential problems in the supply chains. Potential issues include the fact that cobalt is mainly produced as a by-product, the primary production is highly concentrated to few countries, and the processing into cobalt chemicals used for battery production is highly dominated by one single country. See eg. Schmidt, T., Buchert, M., Schebek, L., 2016. Investigation of the primary production routes of nickel and cobalt products used for Li-ion batteries. Resources, Conservation and Recycling 112, 107–122. https://doi.org/10.1016/j.resconrec.2016.04.017	Taken into account: This is a good comment. However, some of issues surounding the supply chains are addressed in line 19 to 30 of page 18. However, for completenes, we have inserted "Though the current lithium demand for EV is much lower than the reserves globally, issues about supply chains (upstream to downstream) have been expressed, since few countries control the materials for the production of LIBs (Simon, Ziemann, & Weil, 2015; Schmidt, Buchert, & Schebek, 2016). However, externalities regarding supply chains may be attenuated by transparent resource extraction and management, and circular economy (Simon, Ziemann, & Weil, 2015)" into line 18, of page 18, after the last sentence. Reference Simon, B., Ziemann, M., $ Weil, M. (2015). Potential metal requirement of active materials in lithium-ion battery cells of electric vehicles and its impact on reserves: Focus on Europe. Resources, Conservation and Recycling, 104, 300-310. http://dx.doi.org/10.1016/j.resconrec.2015.07.011 Schmidt, T., Buchert, M., & Schebek, L. (2016). Investigation of the primary production routes of nickel and cobalt products used for Li-ion batteries, Resources, Conservation and Recycling, 112, 107-202. http://dx.doi.org/10.1016/j.resconrec.2016.04.017	Simon Davidsson Kurland	Chalmers University of Technology	Sweden
11161	18	8	18	18	I lack some description of social problems of being dependent on minerals from mines in developing countries, for instance cobalt from Congo.	Taken into account: Have expanded discussion on resource constraints	Snorre Kverndokk	Frisch Centre	Norway
39693	18	14	18	14	Comparing the present use to reserves is not adequate to rule out resourse constraints. See eg. Vikström, H., Davidsson, S., Höök, M., 2013. Lithium availability and future production outlooks. Applied Energy 110, 252–266. https://doi.org/10.1016/j.apenergy.2013.04.005	Accepted: Will look at future demand as well.	Simon Davidsson Kurland	Chalmers University of Technology	Sweden
13307	18	14	18	18	Repetition of values of Li extraction from page 18 line 3. Grammar is also not quite correct here.	Noted: Instead of demand in 2018 demand in future (2030) has been put to relate to the reserves	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
28565	18	15	18	18	An emerging concern though is the additional resources needed for the buildup of infrastructure needed for the lithium economy.	Accepted :Have expanded discussion on resource constraints	Paul Wolfram	Yale University	United States of America
25601	18	18	18	18	Even if there is no geological resource problem, they may be economic, industrial, geopolitical, or environmental problems. Besides, lithium is not always recovered page 40 line 12.	Accepted: Have expanded discussion on resource constraints	Sabine Limbourg	HEC-Uliege	Belgium
31109	18	18	18	18	There is competition for lithium for transportation and mobile electronics. This chapter has already described the move to autonomous electric vehicles and a number of countries have pledged the phase out of conventional vehicles within the next 20-30 years. Therefore, what is the forecast lithium demand associated with the growth in EV production?	Accepted: Instead of demand in 2018 demand in future (2030) has been put to relate to the reserves	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11163	18	19	18	30	An intersting new study that may be considred when it comes to recycling of Lihium is: Rosendahl, K. E., and D. R. Rubiano, 2019: How Effective is Lithium Recycling as a Remedy for Resource Scarcity? Environ. Resour. Econ., 74, 985–1010, https://doi.org/10.1007/s10640-019-00356-5.	Editorial: Thanks. It has been included	Snorre Kverndokk	Frisch Centre	Norway
13309	18	19	18	30	I don't understand what is meant by 'externalities'. There are several grammatical mistakes in this paragraph.	Editorial: Will define externalities	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
14075	18	22	18	22	I believe that the dot should be a comma instead	Editorial: Thanks. It has been included	Victor Garcia Tapia	International Energy Agency (IEA)	France
20729	18	22	18	22	What implication would this have on SDGs?	Accepted: Have expanded discussion on resource constraints	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
31111	18	23	18	23	The phrase 'many fold in future' supports my earlier point and contrasts somewhat with the suggestion that resource constraints may be overstated	Accepted: Have expanded discussion on resource constraints	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
20731	18	23	18	25	What implication would this have on whole life cycle analysis?	Accepted: Have expanded discussion on resource constraints	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
16447	18	28	18	30	"No focus on recyclability" is not rigorous. Perhasp using "insufficient focus". In fact, recent studies start to consider the recycling of LIBs. Please investigate the literature, for instance, Tang et al. (2018; Recycling mechanisms and policy suggestions for spent electric vehicles' power battery -A case of Beijing; doi: https://doi.org/10.1016/j.jclepro.2018.03.043)	Accepted : Thanks have looked at more literature on recyclability and included the suggested papers	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
1691	18	33	18	34	All-Solid-StateBatteries (ASSB) is mentioned here, but no discussion on it is included in the following sections. ASSBs are one of very promising candidates for the next-generation batteries of EVs.	Taken into account in 10.3.1	Shigeki KOBAYASHI	TICJ	Japan
31113	18	34	18	34	Lithium is the most electropositive element, so difficult to see how non-lithium battery chemistries could be better.	Noted: Agree and that is what we conclude	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31115	18	39	18	39	How much higher?	Taken into account: Provided in Table 10.3	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31117	18	41	18	41	How much cheaper?	Taken into account: Provided in Table 10.3	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31119	19	1	19	1	Table entries are too small	Accepted : Revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
11689	19	11	19	11	poor resolution- change file extension	Accepted : Revised	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
23789	19	11	19	11	Hard to read due to figures pixel quality.	Accepted : Revised	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
28567	19	11	19	11	The meaning of the colors should be described in the table caption.	Accepted : Revised	Paul Wolfram	Yale University	United States of America
13311	19	12	19	12	Resolution is poor on this table - it is hard to read the text	Accepted : Revised	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
29315	19	21	19	21	Table 1.3 should be "Table 10.3".	Editorial: Corrected	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
14077	19	22	19	22	I think it should be referred to table 10.3 and not 1.3	Editorial: Corrected	Victor Garcia Tapia	International Energy Agency (IEA)	France
31121	19	22	19	22	Check table reference	Editorial: Corrected	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
34905	19	22	19	22	Table-1.3 may not be right.	Editorial: Corrected	ANUPAM DEBSARKAR	University	India
31123	20	1	20	1	There are manufacturers releasing heavy goods vehicles with batteries and some aircraft manufacturers are researching electric aircraft.	Taken into account: The para is related to technology readiness of batteries and needs to be checked	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
11769	20	1	20	3	Please consider to rephrase to make this statement less prescriptive on how the futire replacement of lead acid batteries will develop.	Accepted: Has been rephrased to make it less prescriptive	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
14079	20	7	20	7	I think it should be referred to table 10.3 and not 1.3	Editorial: Corrected	Victor Garcia Tapia	International Energy Agency (IEA)	France
11809	20	14	20	15	strange sentence "for vehicles that are normally used for in the city driving". Please consider to rephrase or delete.	Editorial: Corrected	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
31535	20	17	20	17	this start is not smooth in my eyes. You may include one sentence such as "Most charging may occur at home or at work or during shoping (see below). However, not every body may have suitable access to these options."	Accepted - text revised - sentence to be reworded	Patrick Jochem	German Aerospace Center (DLR)	Germany
11165	20	17	20	25	"Range anxiety" is mentioned. However, you should distinguish between “range anxiety” and “charging anxiety” (Hidrue et al., 2011). The first is due to the limited range for the batteries, and the concern for not reaching the charging station (on long trips) before the battery is empty. The other type of anxiety, charging anxiety, is related to the concern for long queues in front of the fast chargers. The range anxiety is higher the less charging stations in total (and the geographical distributions), whereas the charging anxiety is higher the more EVs per charging station. Reference: Hidrue et al. (20111): Willingness to pay for electric vehicles and their attributes, Resource and Energy Economics Volume 33, Issue 3, September 2011, Pages 686-70	Accepted - text revised - will distinguish between range anxety and charging anxiety; confirm term	Snorre Kverndokk	Frisch Centre	Norway
31537	20	20	20	20	you may add at the end of this sentence: "even though approx. 90% of daily mileage is below 100km and therefore well within the range of current EV (about 300 km).	Accepted - text revised - add in context for average mileage	Patrick Jochem	German Aerospace Center (DLR)	Germany
11811	20	25	20	26	must make clear if "eletric vehicle" include both plug in hybrid AND battery electric or not.	Accepted - text revised - clearly outline that EV includes both BEVs and PHEVs. Figure is from ICCT and will update this figure	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
11691	20	16	21	12	You need to mention potential concerns: e.g. security and privacy of data; fair distribution of transport budgets in cities, design of the charging stations not interfering with pavements	Accepted - text revised - other potential concerns regarding charging infrastructure design incorporated	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
45205	20	16	22	44	The section on charging infrastructure seems to have an implicit focus on cars, however buses, two-wheelers and three-wheelers also need infrastructure, but have different (and sometimes lesser) demands. This needs to be addressed	Accepted - text revised - focus broadened beyond just only light vehicles	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
31125	21	8	21	8	Policy makers also have a duty to enact the ‘avoid-shift-improve’ hierarchy which seeks to maximise the number of trips which can be satisfied using active transport modes before falling back into the old ‘predict and provide’ ways of thinking.	Accept. Agree with the sentiment and it needs to be better highlighted in the chapter. This is not the best place to make this point but the chapter will make sure it is in either 10.2 or 10.8 or both. It is well expressed and important.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
13313	21	13	21	13	Typo: 'charing'	Accepted - text revised	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
35799	21	13	21	13	charing (charging)	Accepted - text revised	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
42253	21	14	21	45	This section was largely written for the perspective of E-cars. It would be great to include discussions from the perspective of e-bus, e-2 and 3wheelers charging as well	Accepted - text revised - focus broadened beyond just only light vehicles	Alvin Mejia	Wuppertal Institute	Germany
13315	21	16	21	16	Typo: 'infrstructures'	Accepted - text revised	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
31127	21	16	21	16	infrstructures	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31129	21	17	21	17	connenctor	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
13317	21	18	21	18	Typo: 'cooomunication'	Accepted - text revised	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
31131	21	18	21	18	cooomunication	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
34907	21	18	21	18	communication - spelling mistake	Accepted - text revised	ANUPAM DEBSARKAR	University	India
31133	21	20	21	20	double space for ‘…a power…’	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31135	21	22	21	22	check ‘…and till now…’	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31539	21	28	21	28	You may include after this sentence: "(obviously a higher load does have an higer impact on the electricity grid, but decreases the probability of simultaneity of charging processes; consequently, the gross impact on the electricity grid is not linear dependent on the charging rate)"	Accepted - text revised - clarified differing impact of EV charging on grid	Patrick Jochem	German Aerospace Center (DLR)	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31541	21	30	21	30	You may add after this sentence: "Level 1 charging is used e.g. at home or work where parking times are long and charging time does not matter."	Accepted - text revised	Patrick Jochem	German Aerospace Center (DLR)	Germany
13319	21	33	21	34	Sentence doesn't make sense	Editorial: Revise sentence : Other forms of road electrification also may	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
31543	21	37	21	37	You may add a refernce here such as (Plötz et al., 2019). Plötz, P.; Gnann, T.; Jochem, P.; Kaschub, T.; Yilmaz, Ü. (2019): Impact of Trolley Trucks on the European Electricity System and CO2 Emissions, Energy Policy 130, 32-40, doi: 10.1016/j.enpol.2019.03.042.	have potentially, particularly for heavy freight where load demand is higher.	Patrick Jochem	German Aerospace Center (DLR)	Germany
42255	21	38	21	45	It would be worthwhile to mention that Japan and China are working on a common standard	Accepted - text revised - ChaoJi standard added	Alvin Mejia	Wuppertal Institute	Germany
31545	21	45	21	45	You may add the ChaoJi standard for China here. This is a powerfull 900 kW socket system, which can be used also for electric buses and trucks.	Accepted - text revised - ChaoJi standard added	Patrick Jochem	German Aerospace Center (DLR)	Germany
35801	21	18		18	1st word cooomunucation	Accepted - text revised	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
47861	22	1	22	15	Sufficient residential EV charging especially for apartments and strata housing is particulary important for adoption of EVs as a decarbonization strategy, since many cities are also pursuing densification policies increasing strata and multi-unit housing to meet increasing housing needs. This involves multiple interactions with new stakeholders and business models to finance, operate and maintaing apartment based charging infrastructure. See recent refs discussing these challenges include: Lopez-Behar D, Tran M, Froese T, Mayaud JR, Herrera O, Merida W. (2019) Charging infrastructure for electric vehicles in Multi-Unit Residential Buildings: Mapping feedbacks and policy recommendations. Energy Policy, 126, 144 – 451. Lopez-Behar D., Tran, M., Froese, T., Herrera, O., Merida, W. (2019) Putting electric vehicles on the map: A policy agenda for residential charging infrastructure in Canada. Energy Research & Social Science 50, 29 – 37.	Accepted - text revised - additional challenges for strata housing incorporated	Martino Tran	University of British Columbia	Canada
42257	22	1	22	44	Similar with the previous section, this section on charging locations is primarily written from the perspective of private e-car mobility. The implications, for example, of charging locations to bus operations, and how these decisions might affect costs, and ultimately service provision and level of service improvements should have been included.	Accepted - text revised - focus broadened beyond just only light vehicles	Alvin Mejia	Wuppertal Institute	Germany
27023	22	7	22	8	If current recharging is mainly at home (>75%) then why is there so much attention to the issue of charging points in this chapter? Arent at-home options important? Solar PV and batteries are changing how people view decentralised electricity use and storage.	Accepted - text revised - additional discussion added in terms of importance of charging in context of maximising renewable energy use; workplace preferred due to long periods parked during the day; home charging only ideal if significant hydro/wind generation overnight	Thomas Longden	Australian National University	Australia
31137	22	9	22	9	Quantify 'significant'	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31139	22	10	22	10	Does this hold universally? A number of urban homes do not have off-street parking for dedicated home charging. Or are you drawing a distinction between charging infrastructure near the home compared with off street parking with a dedicated charger per household?	Accepted - text revised - additional challenges for strata housing incorporated	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
22863	22	13	22	15	This is an important point and different countries are differently placed there - depending on the share of people living in apartment dwellings, which is extremely variable even within Europe - see https://ec.europa.eu/eurostat/statistics-explained/index.php/Housing_statistics#Type_of_dwelling	Accepted - text revised - additional challenges for strata housing incorporated	Giulio Mattioli	TU Dortmund University	Germany
13321	22	24	22	24	Typo:'spil'	Accepted - text revised	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
31141	22	24	22	24	'spil'	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
34909	22	24	22	24	probably the word 'spil' is to be replaced by 'split'	Accepted - text revised	ANUPAM DEBSARKAR	University	India
31547	22	30	22	30	Again I'm missing refernces here. After this sentence you may use Jochem et al. 2019. Jochem, P.; Szimba, E.; Reuter-Oppermann, M. (2019): How many fast charging stations do we need for European highways?, Transportation Research Part D 73, 120-129, doi: 10.1016/j.trd.2019.06.005	Accepted - text revised - reference added	Patrick Jochem	German Aerospace Center (DLR)	Germany
11693	22	36	22	43	you need to state that these are not purely 'market' processes - at the moment this is the impression this paragraph gives. There are multiple govt shcemes financing EV infrastructure which helps with the uptake - see one of my prev comments with a link to UK govt website	Accepted - text revised - mentioned impact of policy on encouraging charging infastructure rollout	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
22865	22	36	22	43	The siting of charging infrastructure also raises important issues for the allocation of road and curbside space - see Marsden, G., Docherty, I., & Dowling, R. (2020). Parking futures: Curbside management in the era of 'new mobility'services in British and Australian cities. Land Use Policy, 91, 104012.	Accepted - text revised - other potential concerns regarding charging infrastructure design incorporated	Giulio Mattioli	TU Dortmund University	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31143	22	40	22	40	Line 40: Another point is that, as vehicle battery capacity (and range) increases, higher charging rates will be required to return EVs to full charge in a reasonable time before the next trip.	Accepted - text revised - this point has been added; granted that fast charging is expected to remain a small proportion of overall charging. 350-500 kW chargers being installed today in Europe, North America, Asia-Pacific, deliver 350-500 km in 10 mins. Unlikely to see BEVs with driving range >750 km, and therefore expect charging infrastructure to also remain below 750 kW for light vehicles; potentially at 500 kW maximum.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31285	22	44	22	44	Electrification is an important technology in the decarbonization of transportation. Currently, batteries and power supply devices are being used in electric vehicles such as EVs and PHVs. As described in section 10.3.1.2, the main issue of electrification is to achieve a long cruise distance and reduce cost, thus to improve the durability. In recent years, as shown in Table 10.3, Lithium-ion batteries (LIBs) have been innovating in terms of energy density, specific energy, cost and life-cycle. It has been as one of the major power source in the electric automobiles. Since Fifth Assessment Report, batteries are mainly applied to small passenger cars and then later expanded to buses and trucks. However, applications for aviation, marine and heavy-duty land transportation has not been progressed much. In the heavy-duty vehicles, improving the acceptability of instantaneous regenerative energy with associated to the increase of vehicle weight is an important issue. Currently, the breakthroughs in electrification based on batteries are being explored in the power trains using hydrogen, biofuels, and synthetic hydrocarbons as a fuel option. On the other hand, capacitors are also have been evolving in terms of size and energy density as well as power density due to the recent technology innovation. Several cases for the application of capacitors to railways, industrial heavy equipment, etc. have been reported in terms of achieving better effects on regenerative power recovery and CO2 reduction (Reference 2, 4) . However, capacitor still has problems in the energy density and self-discharges. To overcome this problem, a power supply system that combining the capacitor and battery has been reported (Reference 1, 3) . This system can rapidly recover the regenerative electric power, and also can exchange the electric power between the capacitor and battery in order to improve the utilization rate of regenerative electric power. It is expected that this power supply system along with the control can provide a better solution to electric vehicles, heavy-duty vehicles and railways. In the future, capacitors will show an important role in the electrification of transportation. There is an additional description (Placeholder-Para on capacitors will be added in SOD.) at the end of 10.3.1.3.2. A description of the application of capacitors is expected. Reference 1: Hannan, M.A., Hoque, M.M., Mohamed, A. & Ayob, A. (2017). Review of energy storage systems for electric vehicle applications: Issues and challenges. Renewable and Sustainable Energy Reviews, 69, 771-789. http://dx.doi.org/10.1016/j.rser.2016.11.171 Reference 2: Kamdar, A. (2017). Ultracapacitor kinetic energy recovery system in road transport vehicles. Is it a viable retrofit option for reducing fuel consumption and CO2 emissions? 36th Southern African Transport Conference, South Africa, ISBN Number: 978-1-920017-73-6. Reference 3: Noumi, Y., Saito, T. & Kondo, K. A study on energy management controller of EDLC for batteries and capacitors hybrid electric vehicles. IECON 2014 - 40th Annual Conference of the IEEE Industrial Electronics Society, Dallas, TX, 2014, 2952-2957. Reference 4: Uno, M. & Kukita, A.(2016). Cycle Life Evaluation Based on Accelerated Aging Testing for Lithium-Ion Capacitors as Alternative to Rechargeable Batteries. IEEE Transactions on Industrial Electronics, 63(3), 1607-1617.	Taken into account - text revised - further response required to this statement	Eiichi Ono	Toyota Technological Institute	Japan
13721	22	45	22	45	I was wondering, why LH2 or LNG combustion was not mentioned here. The reason might be that this more refers to aviation and shipping, which are addressed separately further below? This might be clarified by one sentence, or so?	Accepted - text revised - LNG to be mentioned in Advanced ICE. LH2 to be briefly incorporated in context of shipping use potential	volker Grewe	DLR-Oberpfaffenhofen	Germany
23791	22	45	22	45	There are some paper/presentation form IAV that might be interesting in terms of TTW/WTW CO2 emissions of IEC, BEV and FCV and fleet production costs; i cannot add attachments. Please mail to stefan.majer@dbfz.de and i am happy to forward the documents	Take into account.I have added his contact information to the list of experts to whom we will send the request for LCA data. Hopefully he will submit the data.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23793	22	46	22	46	"Low carbon hydrogen": Low carbon hydrogen seems to be a bit misleading term. Just hydrogen or hydrogen derived synthetic fuels is more valid.	Accepted - text revised	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23797	22	46	22	46	does "synthetic fuels" include/mean Power-to-X fuels? If yes, than please see the next comment to page 23	Noted	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
11813	22	48	22	48	NO, hydrogen cannot be used DIRECTLY as substitute for diesel. Please consider to delete.	Taken into account : To be Checked	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
23795	22	48	22	48	"Hydrogen can also directly be used as a substitute for diesel": Why hydrogen is considered to be a diesel substitute, not as gasoline? As far as I remember, e.g. the BMW Hydrogen7 considers also gasoline.	Rejected - need to check but don't believe h2 can be used in gasoline ICE	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
13719	22	45	23	3	Fuel Cells are also discussed for aviation, e.g. for short-haul flights. However, the impact on non-CO2 effects, especially contrails is not clear. I think it should be mentioned here, since it might be an alternative for fast short-range kerosine driven aircraft?	Take into account. I'll check but I have no knowledge of any literature on non-CO2 impacts of fuel cells	volker Grewe	DLR-Oberpfaffenhofen	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
42975	22	45	29	27	I think that all the paragraph “10.3.2 Hydrogen fuel cell-electric technologies” need to be revised and updated for SOD-Draft taking in consideration also the new and more updated sources, like: US DOE “Hydrogen Production Cost From PEM Electrolysis – 2019” [February 3, 2020; available at <https://www.hydrogen.energy.gov/pdfs/19009_h2_production_cost_pem_electrolysis_2019.pdf>], IEA “The Future of Hydrogen Seizing today’s opportunities” [June 2019; available at <https://www.iea.org/hydrogen2019/> and <https://webstore.iea.org/download/direct/2803>], IRENA “Hydrogen: A renewable energy perspective” [September 2019, available at <https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Hydrogen_2019.pdf>], Hydrogen Council: “Path to Hydrogen Competitiveness: A Cost Perspective” [January 2020; available at <https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf >].	Accepted - text revised - references added	MARIO VALENTINO ROMERI	Independent consultant	Italy
6413	22	7			What about the densed cities?	Taken into account	Apostolos Petropoulos	International Energy Agency	France
31259	22	45			Headline and chapter to reflect H2 Fuel Cell and H2 ICE	Taken into account	Urs Ruth	Robert Bosch GmbH	Germany
28253	23	1	23	3	Suggest to add https://hydrogencouncil.com/en/path-to-hydrogen-competitiveness-a-cost-perspective/	Rejected - industry report/biased.	Cornie Huizenga	CESG	Germany
31205	23	2	23	3	this sentence does not reflect the current "state of play" - as fuel cell trucks are on the market (Switzerland, China) or clos to market (Nikola Truck, etc.)	Accepted - text revised - noted that some proof of concept deployments	Urs Ruth	Robert Bosch GmbH	Germany
27025	23	4	23	25	You mention the European Roadmap and the IEA report, but what about the other developments in hydrogen - such as the Japanese and South Korean strategies/roadmaps? These mention fuel cell vehciles in detail with target numbers of vehicles and refuelling stations. There are some big claims for 2030/2040 in these roadmaps.	Accepted - text revised - references added	Thomas Longden	Australian National University	Australia
42259	23	4	23	25	Water extraction is also an issue. Hydrogen tech would be more useful for storing RE from the perspective of transport, and not as a direct technology infusion to vehicles.	Accepted - text revised - water issue discussed	Alvin Mejia	Wuppertal Institute	Germany
14081	23	6	23	8	Could you please clarify the reference and data source ?	Accepted -to clarify the ref and data source	Victor Garcia Tapia	International Energy Agency (IEA)	France
31145	23	7	23	7	Is this correct? 5000 hours is less than a calendar year. How many calendar years is the equivalent of 5000 operational hours? Likewise, for commercial vehicles at 20000 hours	Taken into account	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
47903	23	9	23	10	Vehicle fuel cell system engines cost 80 to 95 percent less than they did in the early 2000s and cost $49 per kW. Is that right, they have reached that cost level at high volume production TODAY? I really doubt it, I think it's a future number. In any case what we really need is a comparison of the up front and TCO costs of fuel cell LDVs and Li-ion BEVs. Can fuel cells compete? When?	Taken into account	Lewis Fulton	University of California, Davis	United States of America
11167	23	9	23	12	Be more specific about what these costs refer to.	Take into account: Will Check.	Snorre Kverndokk	Frisch Centre	Norway
28569	23	9	23	12	It HAS TO BE mentioned that current fuel cell vehicle production numbers are WAY, WAY below the mentioned 500,000. Current costs are probably closer to 100$/kW. This means that FCVs are still prohibitively expensive and will probably remain to be so in the near to medium-term future. Many studies, especially integrated assessment models, have used cost figures of fully learned out fuel cell vehicles for present day cost assessments -- this assumption is obviously not realisitc. The numbers came from a popular National Research Council report (https://www.nap.edu/catalog/18264/transitions-to-alternative-vehicles-and-fuels), but modelers did not apply them correctly. An ICCT report (https://theicct.org/lit-review-ev-tech-costs-co2-emissions-2016) provided more realistic numbers.	Accepted - text revised - references added, figures corrected	Paul Wolfram	Yale University	United States of America
28571	23	14	23	16	Fuel stations and fuel cell vehicle sales numbers can vary a lot depending on the source. Numbers are also quite uncertain. Therefore, ranges would be more appropriate. The authors should also consult additional sources.	Accepted - text revised - references added, figures adjusted	Paul Wolfram	Yale University	United States of America
11815	23	18	23	18	Is it correct to write "2022 Winter Olympics"? Has not happened yet. Will it be better to write "in preperation for the 2022 Winter Olympics" or similar?	Accepted - text revised	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
1693	23	27	23	27	This is wrong, since fuel cell vehicle stock exceeded 12,900 vehicles as of end 2018(IEA), and over 30,000 fuel cell forklifts are now in daily operation in the US (E4tech). Also cumulative number of fuel cell units for the residence in Japan is more than 340,000.	Rejected - don't believe this is relevant as text is not including forklifts as vehicles..	Shigeki KOBAYASHI	TICJ	Japan
30359	23	27	23	28	Fuel cell technology is said to be "immature" which is an incorrect statement, a minima too strong a word. The technology is recognized as mature (several thousands of vehicles deployed worldwide), although not commercially mature due to the need to bring the ecosystems to scale (inc. infrastructure). For example there is a fleet of 100 taxis already in (intensive) operation in Paris, driven by "standard" drivers - showing the technology itself is sufficiently mature for commercial usages. Objective is to scale to 600 taxis in Paris in 2020. (source: https://www.toyota.fr/world-of-toyota/articles-news-events/2019/taxis-hydrogene-hype)	Rejected - technology is still largely proof of concept and therefore not yet mature OR simply change wording to say it is not yet commercially mature, and further R&D is required.. Refer to TOI link outlining technology maturity 2025	Guillaume DE SMEDT	Hydrogen Council	France
31207	23	27	23	28	this sentence does not reflect "state of the art" - as fuel cell trucks are on the market (Switzerland, China) or clos to market (Nikola Truck, etc.) and 2nd Generation Toyota Mirai, Hyundai, etc.	Accepted - text revised - noted that some proof of concept deployments	Urs Ruth	Robert Bosch GmbH	Germany
12939	23	27	23	38	Clear definition of performance level with normalization is required for Table 10.4. Is performance being used as synonymous with efficiency defined in the table?	Take into account: Will Check.	Prashant Goswami	Institute of Frontier Science and Application	India
47905	23	27	23	38	This paragraph and table 10.4 suggest that FCVs are not technology ready, based upon a 2014 pulication. This is not acceptable. You need really current sources to make statements like this. As far as I know, FCVs are now highly technically ready, and have performed excellently in applications like buses and LDVs (e.g. Toyota Mirai). This report really needs to be current and accurate on these types of technology readiness questions.	Taken into account	Lewis Fulton	University of California, Davis	United States of America

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31147	23	31	23	31	Some electric ships exist, but what electric aircraft are you referring to? There are some retrofits in service, but no electric aircraft manufactured at scale and certified for commercial application.	Rejected - provide reference; electric aircraft in EU, US and Australia; refer to 10.4.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
47337	23	31	23	36	"While battery electric alternatives are starting to emerge in the short-haul shipping and aviation sectors" ... "fuel cell heavy-duty trucks" might have "comparable costs to diesel vehicles by 2030". I love FCEVs driving on green hydrogen but I think it's only fair to also mention that the first short-haul (100 km) heavy eTruck went into production in 2017. And that Tesla promises is already road testing and has already sold hundreds if not thousands of heavy eTruck with a 800km range that they will start to deliver to customers in 2020. That would have a payback time of 2-3 years in a typical European fleet. The industry seems to want to deny this, but when AR6 is published, heavy electric trucks will be driving around by the hundreds if not thousands and will have an excellent payback time. I think it would be unwise to exclude them while mentioning FCEVs could achieve cost parity in 2030.	Accepted - text revised	Auke Hoekstra	Eindhoven University of Technology	Netherlands
30361	23	37	23	37	Change word "issue" with "challenge'	Accepted - text revised	Guillaume DE SMEDT	Hydrogen Council	France
30363	23	37	23	37	Add "hydrogen and" before hydrogen-based"	Accepted - text revised	Guillaume DE SMEDT	Hydrogen Council	France
31209	23	37	23	38	hydrogen-based synthetic fuels do "not just hold some promise" they are and will be - unless the potential of biofuels would be unlimited (which of course it is not) - crucially important. This should be emphasized more. Say: "... will be crucially needed..."	Taken into account : synthetic fuel to be in 10.3.4	Urs Ruth	Robert Bosch GmbH	Germany
36485	23	37	23	38	What is the basement that "longer time horizon" means "beyond 2030"? ICAO CORSIA which covers by 2035 consider bio fuel and perto-base lower carbon fuel in addtion to offset credits but synthetic fuel is not on the table. For achieving IMO's target in 2050 hydrogen is an option but with condition taht it is economically feasible. Synthetic fuel may be an option but it is misleding when it is described as an an option of "beyond 2030". It seems to be reasonable to say an option in 2050.	Taken into account: Will Check.	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
23799	23	38	23	38	hydrogen based synthetic fuels >> These section is about hydrogen fuel not hydrogen-based synthetic fuels, which differ in their technical, ecocnomic and environmental performance (not only due to the demand on CO2 from power plants, direct air acpture ...) from hydrogen fuel, this should made clearer in this section. A clearer differentiation or a separate chapter on hydrogen-based synthetic fuels seems necessary	Accepted - text revised - need to move in 10.3.4 elsewhere	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
28573	23	39	23	39	Maybe a 150,000-250,000 km range is more appropriate in column 5 ("Lifetime"), line "Fuel cell vehicles"	Taken into account: Will Check the Reference.	Paul Wolfram	Yale University	United States of America
31149	23	39	23	39	Table 10.4 Acronyms in first column need to be declared.	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
30365	23	39	24		Table 10.4 3rd row, PEMFC mobil: initial investment cost is put at c. 500$/kW whereas in-depth analysis by the DOE in 2017 show that for manufacturing capacity of few thousands per year, a FC cost is c230 $/kW : see https://www.hydrogen.energy.gov/pdfs/17007_fuel_cell_system_cost_2017.pdf p.10 : "The estimated cost to manufacture a fuel cell vehicle commercially available in 2017 at 1,000 systems per year is ~$230/kWnet" Lifetime (same row) shall be aligned with guarantees provided today by OEM	Taken into account	Guillaume DE SMEDT	Hydrogen Council	France
1695	23	39	25	21	This chapter deals with transport, so fuel cells for applications other than vehicles should be omitted from this table for simplification.	Accepted - text revised - other applications removed	Shigeki KOBAYASHI	TICJ	Japan
42973	23	39	25	21	I think that we made a mistake with regard to the title of Table 10.4. The correct title is not “Table 10.4 Current performance of key technologies of H2” but “Table 10.4 Performance of key technologies of H2 at ‘AR5 Time’”. In fact all sources used for the part I and II are dated 2014 or oldest. Only one source is dated 2015! I’m very surprised of this because, as I said in my first comment, I appreciated very much all the work done in this FOD. But no problem! Table 10.4 need to be completely re-wrote for SOD-Draft. New suggested sources: US DOE “Program Records” [various date, accessible at < https://www.hydrogen.energy.gov/program_records.html>] among others “Hydrogen Production Cost From PEM Electrolysis – 2019” [February 3, 2020; available at <https://www.hydrogen.energy.gov/pdfs/19009_h2_production_cost_pem_electrolysis_2019.pdf>], IEA “The Future of Hydrogen Seizing today’s opportunities” [June 2019; available at <https://www.iea.org/hydrogen2019/> and <https://webstore.iea.org/download/direct/2803>], IRENA “Hydrogen: A renewable energy perspective” [September 2019, available at <https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Hydrogen_2019.pdf>], Hydrogen Council: “Path to Hydrogen Competitiveness: A Cost Perspective” [January 2020; available at <https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf >].	Accepted - text revised - references/figures updated	MARIO VALENTINO ROMERI	Independent consultant	Italy
31211	23	39	40	1	data seems to be outdated! For example the cost of "PEMFC mobile" is stated with 500 USD/kW, this would result in 50.000 USD for a 100 kW application. Please compare for example power and cost of current FCEV vehicles with this value !	Accepted - text revised - references/figures updated	Urs Ruth	Robert Bosch GmbH	Germany
6415	23	26			I need you need to restructure the whole sub-chapter of hydrogen. You jump from the power sector to the FCEVs. Please give a schematic approach about the supply chain and then explain the potential improvements for each step.	Accepted - text revised - structure revised	Apostolos Petropoulos	International Energy Agency	France
31261	23	39			SOFC: change from "demonstration" to "early market" (reason: theere are several products available for unrestricted purchase)	Taken into account: Will Check.	Urs Ruth	Robert Bosch GmbH	Germany
14083	24		24		Acronyms for the different types of fuel cells in table 10.4 not explained in the chapter	Accepted - text revised	Victor Garcia Tapia	International Energy Agency (IEA)	France
30367	24		24		Table 10.4 Last line. Boil off figure seems high	Taken into account: Will Check.	Guillaume DE SMEDT	Hydrogen Council	France

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31151	25	23	25	23	FCV acronym defined on p23, line 5	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
23801	26	3	26	3	Add source to reference list.	Accepted - text revised	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
31153	26	8	26	12	Explain the order of magnitude increase in price from USD 1.8m to Euro 16m when moving from a 600kg/day to a 1000kg/day HRS	Taken into account: Will Check.	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31213	26	10	26	12	whilst for FCEV there is a detailed break-down of costs for infrastructure, the costs for battery electric vehicle infrastructure is not provided in the report. This needs to be added in the previous sections.	Accepted - text revised	Urs Ruth	Robert Bosch GmbH	Germany
30369	26	11	26	12	The example taken is very misleading as it mixes the refueling infrastructure and the production infrastructure, giving an impression of very high cost, where in practice this is likely to come from the high cost of decentralized electrolysis. This example shall be removed.	Taken into account	Guillaume DE SMEDT	Hydrogen Council	France
23803	26	12	26	12	"EUR 16 million": Comparable units like EUR or USD	Taken into account: Will Check.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
30371	26	14	26	15	Add a reference to H2council "Path to competitiveness" study highlighting industry views on potential for cost decrease https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf	Accepted, with criticism on optimistic figures	Guillaume DE SMEDT	Hydrogen Council	France
29317	26		26		I hope that abbreviations LP, MP, HP in Figure 10.4 will be defined in in the glossary section, for those readers who might not find them obvious.	Accepted - text revised	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
35803	27	1	27	2	What's the meaning of the different colours in fig 10.5	Accepted - to add more information.	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
47339	27	1	27	7	What I'm missing are the emissions of hydrogen. The chapter states elsewhere that the emissions of EVs can be up to 355 g/vkm when driving on coal but in that scenario hydrogen would emit twice that. Why is hydrogen always spared the honest comparison to electricity?	Take into account.The life cycle GHG emissions and LCC of hydrogen FCEV will be included in section 10.4 based on data availability and a harmonization process we hope to perfrom	Auke Hoekstra	Eindhoven University of Technology	Netherlands
31215	28	1	28	3	whilst for FCEV there is a detailed break-down of the hydrogen costs (at the refuelling station) , the electricity costs for battery electric vehicles is not provided in the report. This needs to be added in the previous sections in a similar way.	Take into account.We will include information about life cycle costs of fuel/vehicle technologies. If we get sufficient data we can provide LCC with diffferetn assumptions about hydrogen/electricity/fuel costs but we will see what we can find	Urs Ruth	Robert Bosch GmbH	Germany
47341	28	8	28	8	"Future perspectives including key batteries". This is about hydrogen. I think the term 'batteries' might be a small mistake here.	Taken into account: Will Check and Fix if mistake	Auke Hoekstra	Eindhoven University of Technology	Netherlands
31217	28	9	28	11	many of the arguments given here are also still valid for battery electric vehicles. The tonality of this sentence might be changed to reflect the current market introduction of fuel cell technologies in various markets.	Taken into account: Will Check	Urs Ruth	Robert Bosch GmbH	Germany
23807	29	10	29	10	Due to the high electricity consumption required for compression, distribution of biohydrogen is the main driver fof the overall GHG emissions of the entire provision chain [Zech et al: Technical, economic and environmental assessment of technologies for the production of biohydrogen and its distribution: Results of the Hy-NOW study]	Accepted - to add reference.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
30373	29	12	29	18	This section has to be removed or re-written completely. It mixes very different topics. The production pathways, be it reforming of natural gas with carbon capture and storage (CCS), are not directly related to safety of using H2 as an energy storage on-board for mobile applications	Taken into account: Will Check	Guillaume DE SMEDT	Hydrogen Council	France
37541	29	12	29	18	This paragraph highlights only a perspective of hydrogen generated by fossil fuel electrical supply (i.e., requiring CCS), and does not consider deployment of hydrogen infrastructure via carbon-neutral sources (e.g., renewables).	Taken into account : Will Check if covered elsewhere.	Michiel Schaeffer	Climate Analytics	Netherlands
30375	29	15	29	15	The sentence tends to question the safety isseus of hydrogen, relying on out-dated references (2012, 2015), whereas in the meantime FCEV have been homologued in several regions accross the globe. Similarly, refuleing station and logistics have to undergo usual regulatory review by the relevant authority before they are apporced	Rejected : We can reference the refuelling station explosions that occurred in 2019; safety considerations cannot be minimised	Guillaume DE SMEDT	Hydrogen Council	France
20733	29	19	29	27	Whole-life cycle analysis would be important here.	Accepted and revised.	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
27027	29	19	29	27	There are other issues - such as the lack of large-scale storage and transport carriers for liquefied hydrogen. These are very important hurdles.	Accepted - text revised	Thomas Longden	Australian National University	Australia
30377	29	19	29	27	The section lists a serie of topics that are very relevant to the uptake of hydrogen applications in a low carbon trajectory. Anyhow it does not provide any informed view on the topic and is rather a list "à la Prévert" of anti-H2 arguments that are not discussed as they shall be, taking into account technical and economical aspects of decarbonization option, sound comparison with alternatives (re-the point on water scarcity for electrolysis)	Taken into account. To check on this point.	Guillaume DE SMEDT	Hydrogen Council	France

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31155	29	19	29	27	This is the most important part of the hydrogen section: the environmental impacts of producing, transporting and using hydrogen in transport applications. The well-to-wheel energy and emissions penalties of hydrogen by different pathways should be laid out clearly for the reader. Additionally, comment is needed on the scalability of low emissions hydrogen technologies, taking due account of unintended consequences and problem shifting.	Accepted - text revised	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
31219	29	19	29	27	missing a chapter about the chances and potential of hydrogen. Whilst for battery electric the grid integration was highlighted, in the hydrogen section the additional benefits are completely missing. Please mention: - potential to produce green hydrogen in regions with excess renewable energy and without "energy conflicts" - potential to store energy seasonal, - potential to use excess energy in energy systems with hight share of PV/wind and thereofre high volatility - cross-link to the demand for hydrogen in the industrial sector (e.g. fertilizer production, steel, etc.)	Accepted - text revised - may be referred to 10.2	Urs Ruth	Robert Bosch GmbH	Germany
27997	29	33	29	35	IPCC states, "There is broad agreement in the literature that the most important factors in determining the mitigation potential of biofuels are the land use and land use change characteristics associated with biofuel deployment scenarios, in addition to the life-cycle greenhouse gases emissions." However, this is incomplete. Even more important is the death rate due to biofuel vehicle air pollution versus the zero operational death rate from electric, hydrogen fuel cell, and other vehicle types: Jacobson, M.Z., Review of solutions to global warming, air pollution, and energy security, Energy & Environmental Science, 2, 148-173, doi:10.1039/b809990c, 2009;; Jacobson, M.Z., Effects of ethanol (E85) versus gasoline vehicles on cancer and mortality in the United States, Environ. Sci. Technol., 41 (11), 4150-4157, doi:10.1021/es062085v, 2007; Ginnebaugh, D.L., J. Liang, and M.Z. Jacobson, Examining the temperature dependence of ethanol (E85) versus gasoline emissions on air pollution with a largely-explicit chemical mechanism, Atmos. Environ., 44, 1192-1199, doi:10.1016/j.atmosenv.2009.12.024, 2010. Please clarify that this is a serious problem with biofuels and a reason why biofuels should not be used if electric vehicle and hydrogen fuel cell vehicle options are available.	Accepted	Mark Jacobson	Stanford University	United States of America
46201	29	33	29	35	You did not consider the equivalent upstream resource use for the hydrogen section.	Accepted. Text totally revised and restructured, considering this point	Justin Bishop	Arup	United Kingdom (of Great Britain and Northern Ireland)
9589	29	33	29	36	The statement only applies to biofuels from purpose-grown feedstocks. Advanced types of biofuels can be produced from waste and residues that do not have a net land footprint. This should be specified.	Rejected. Addressed in other chapters	Jesper Kløverpris	Novozymes	Denmark
23805	29	30	30	47	The paragraph on climate mitigation potentials of biofuels is very important in order to highlight the general differences to other technological options such as hydrogen and electricity. The general description of impacts from land use change is clear and helpful. However, most of the mentioned models which can be used to clacluate the GHG impact from Bioenergy are based on scenarios regarding a specific demand for biofuels and biomass. Thus, it is quite hard to discuss the potential climate effects of biofuels without a reflection of sustainable biomass and biofuel potentials. This debate is currently missing in the chapter. I feel that this can be quite misleading, especially when you mention the high demand for biofuels in several of the scenarios analysed ((i.e. in line 42, page 30).	Accepted. Text totally revised and restructured, considering this point and updated in the Second draft HS number XXX.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
39547	29	28	32	22	CHJ has become another conversion technologies which is authorized in jet fuel standard https://www.astm.org/Standards/D7566.htm	Accepted. Text totally revised and restructured, considering this point and updated in the Second draft HS number XXX.	Shunsuke Kawagishi	Mitsubishi Research Institute	Japan
1697	29	28	34	3	Algae are very promising resources for biofuel, so somewhere in this section, the potential and challenges of algae should be discussed. Also this should be included in Table 10.6.	Take into account.	Shigeki KOBAYASHI	TICJ	Japan
31549	29	30	36	10	What I'm missing here is a stronger emphasis on energy efficiency and also the introduction of synthetic e-fuels (mainly coming from renewables such as wind and solar power generation (which would be curtailed otherwise). You may even start this Chapter 10.3.3.1 with energy efficiency (which is very low compared to other options).	Accepted. Text totally revised and restructured, considering this point	Patrick Jochem	German Aerospace Center (DLR)	Germany
27999	30	3	30	6	IPCC states, "From the Earth system model and regional climate modelling literature, we know that in order to understand the climate impacts of land use and land use change, we need models that encompass the full suite of biogeophysical and biogeochemical feedbacks associated with the land use and land use change as an interactive part of the climate system." More importantly, we need to use models that account for the full impacts of particles and gases and heat and moisture fluxes on climate, which none of the models cited do. For example, BC, BrC, heat, and moisture from biomass burning may be responsible for 40% of the warming due to biomass burning Jacobson, M.Z., Effects of biomass burning on climate, accounting for heat and moisture fluxes, black and brown carbon, and cloud absorption effects, J. Geophys. Res., 119, 8980-9002, doi:10.1002/2014JD021861, 2014, but this is discussed nowhere throughout the IPCC report. Please discuss this issue with reference.	Noted, we see no problem here but we will include additional literature	Mark Jacobson	Stanford University	United States of America
29111	30	37	30	38	Non-negible amounts of biofuels is a little general	Editorial-taken into account	Minal Pathak	Ahmedabad University	India
11817	31	2	31	2	It seems a bit strange to rely on "Projections from the oil industry" for assessing biofuels, is this the correct sector to use? If so, why?	Editorial-taken into account	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
13323	31	2	31	2	Typo: 'grow'	Editorial-taken into account	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
22337	31	2	31	2	correct spelling of 'from' and 'growth'	Editorial-taken into account	Kym Lennox	climate change equity	Australia
23809	31	2	31	2	Typo; form instead of from	Editorial-taken into account	Stefan Majer	German Biomass Research Centre - DBFZ	Germany

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34911	31	2	31	2	Sentence construction erroneous	Rejected, these issues are to be addressed in AFOLU chapter	ANUPAM DEBSARKAR	University	India
36159	31	2	31	2	"Projects from" and not "Projections form"	Rejected : We see no problem to cite BP, we will include additional literature. The other points are quite broad.	Arvind Gangoli Rao	Delft University of Technology	Netherlands
47343	31	2	31	3	"(about 90%) of the growth in biofuel use at the global level in the period up to 2040 will be used for road transport". I think it is practically very hard to achieve this while protecting tropical forests (you can make treaties but markets are flexible) thereby risking even more GHG emissions, while food supplies and biodiversity would suffer, not to mention that we need all the arable land we can get for an increasing population that is increasingly eating meat.	Editorial-taken into account	Auke Hoekstra	Eindhoven University of Technology	Netherlands
28649	31	2	31	18	I fully disagree with this paragraph and you should not quote BP here in an IPCC report, and not as sole source!!!! At least in the German policy perspective it is common sense that biofuels in mid to long-term will not go at all into passenger road transport and most probably not into freight road transport. Reasons: (1) limited availability of biofuels, (2) questionable decarbonization potential, and (3) you have much better options i.e. electrification. You may put biofuels into ships and planes. But also their is a much better option (which is nearly not mentioned in the whole chapter: Power-to-Liquid (PtL) and Power-to-Gas (PtG)). In my opinion the chapter neglects the PtL & PtG potentials, and the need for these in particular for air transport. This latter comment on PtG/PtL also holds for many other sections in the transport chapter.	Editorial-taken into account	Wolfgang Schade	M-Five GmbH Mobility, Futures, Innovation, Economics	Germany
13325	31	3	31	3	Typo: 'an'	Editorial-taken into account	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
34913	31	16	31	18	Sentence construction erroneous	Accepted. Text totally revised and restructured, considering this point and updated	ANUPAM DEBSARKAR	University	India
23811	31	18	31	18	please specifiy, to which economic sectors you are reffering to. Do you mean, sectors for the final application and use of the biomass/bioenergy?	Taken into account. Discuss these aspects is respect to costs and enabling conditions	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
9591	31	19	31	20	It is not clear what ‘lows levels’ mean?	Accepetd	Jesper Kløverpris	Novozymes	Denmark
47345	31	25	31	27	"Electrification in shorter haul transport applications" is underestimating electric vehicles. It is certainly true that bio and fossil fuels have a higher energy density and it is also true that electrifying vehicles that must be able to drive extremely long distances is economically unatractive. But those who have made detailed business case calculations for BEVs know that payback time depends on how often you use the battery. You pay the battery up front but everytime you use it, you earn a part of that cost back because the electric motor is more efficient and thus uses less energy. (In Europe, the cost of energy and tax is comparable for diesel and most electricity if you look per Joule.) Long distances are no problem as long as you travel them often and as long as the payload is not affected too much (although must cargo is volume contrained, not weight constrained). So a heavy electric truck that uses most of it's battery capacity every day is an ideal way to quickly pay back the battery, irrespective of distance. Of course you need a newly designed truck (motors close to the wheels) to reduce weight and create space for the batteries if you want to be able to go 800 km or so but much is possible there. Tesla claims to be able to prove that (an 800km range truck) this year and I had a student reverse engineer the Tesla truck for his master thesis and it might be a litle bit optimistic but it is mostly legit. This is another example why we need a paragraph on the business case of battery electric vehicles.	Accepted. Text totally revised and restructured, considering this point and updated	Auke Hoekstra	Eindhoven University of Technology	Netherlands
11071	31	29	31	30	This statement is false. Especially for aviation, there are biofuels standards in place such that biokerosene have already been used in commercial flights. As is mentioned later, the problem is one of cost and development of a large scale supply chain for biokerosene.	Noted, question about include literature? No point in discussing it here the carbon neutrality of biofuels	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
36487	31	29	31	30	ICAO has Carbon Neutral Growth (CNG) as reduction strategy which covers by 2035 and now there are considering technology option for setting 2050 target. IMO has 2050 target and they are considering its feasibility and technology option. Both are neutral toward technology option and they have target and these are actually similar effect of regulatory framework. Bio fuel is an option but not only the option. L29 to 30 is misleading. Two points should be described, the first is target/regulation and the second is technology neutral approach.	Editorial.revised	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
39143	31	29	31	30	More detail on biofuels in aviation While there are debates about the actual carbon neutrality of biofuels, the literature finds a considerable technical potential for CO2 mitigation through global production of biofuels in the medium to long term from 2030 to 2050 (Köhler et al 2014, Kieckhäfer et al. 2018). Köhler J., Waltz R., Marscheider-Weidemann F., Thedieck B. (2014) Lead markets in 2nd generation biofuels for aviation: A comparison of Germany, Brazil and the USA, Environmental Innovation and Societal Transitions 10 (2014) 59–76 Karsten Kieckhäfer, Gunnar Quante, Christoph Müller, Thomas Stefan Spengler, Matthias Lossau and Wolfgang Jonas (2018) Simulation-Based Analysis of the potential of Alternative Fuels towards Reducing CO2 Emissions from Aviation, Energies 2018, 11, 186; doi:10.3390/en11010186 Wei-Cheng Wang, Ling Tao, 2016 Bio-jet fuel conversion technologies, Renewable and Sustainable Energy Reviews,53,801-822, "Jet fuel blended with up to 50% bio-jet fuel from an F–T process was certified in August2009. Bio-jet fuels from hydro-processing technologies,such as hydro-treated esters and fatty acids (HEFA) or hydro-processed renewable jet(HRJ), were also studied extensivel. Conversion of alcohol to jet fuel, called alcohol-to-jet(ATJ), has also been developed at commercial scale and was flight-tested by the U.S. Air Force in July2012. Fuel produced by two recently proposed sugar-to-jet (STJ)fuel processes, fermentation of sugars to hydrocarbons [39] and catalytic conversion of sugars to fuels, have been developed in joint ventures by biofuel and oil companies [41–48]. Two recently proposed processes, CH and hydro-treated depolymerized cellulosic jet(HDCJ), also called pyrolysis,have not yet been approved by ASTM, but several companies and research institutes are working on this technology [49–52]. Currently bio-jet fuels from ATJ, HRJ, and F–T synthesis have been used for commercial and military flights." De Jong et al 2017 compare the GHG emission performance of six RJF conversion technologies: hydroprocessed Esters and Fatty Acids (HEFA), Fischer–Tropsch (FT), Hydrothermal Liquefaction (HTL), pyrolysis, Alcohol-to-Jet (ATJ) and Direct Sugars to Hydrocarbons (DSHC; also commonly referred to as Synthetic Iso-paraffinic fuel, SIP). Abstract: Fischer–Tropsch pathways yield the highest GHG emission reduction compared to fossil jet fuel (86–104%) of the pathways in scope, followed by Hydrothermal Liquefaction (77–80%) and sugarcane- (71–75%) and corn stover-based Alcohol-to-Jet (60–75%). Feedstock cultivation, hydrogen and conversion inputs were shown to be major contributors to the overall WtWa GHG emission performance. The choice of allocation method mainly affects pathways yielding high shares of co-products or producing co-products which effectively displace carbon intensive products (e.g., electricity). de Jong Sierk Kay Antonissen, Ric Hoefnagels, Laura Lonza, Michael Wang, André Faaij and Martin Junginger 2017 Life-cycle analysis of greenhouse gas emissions from renewable jet fuel production, Biotechnology for Biofuels, 10:64 IRENA (2017) also reviews bio-jet fuels. The ASTM has certified HEFA, Fischer-Tropsch through municipal solid waste or woody biomass, SIP and ATJ based on isobutanol. IRENA (2017), Biofuels for aviation: Technology brief, International Renewable Energy Agency, Abu Dhabi. Aviation biofuels have been manufactured from crops (1st generation biofuels), but since the environmental impacts of these fuels is highly controversial, attention has moved to 2nd and 3rd generation fuels (de Jong et al 2017). Processes for production of 3rd generation fuels are however, still at the laboratory stage (Köhler et al, 2014). Therefore, airlines and airports are concentrating on 2nd generation biofuels. There have been numerous demonstrations flights by most of the major airlines and some airports are organising the supply of second generation biofuels.	Noted, aditional literature to be included	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
11073	31	38	31	38	The potential of wind propulsion in shipping should be addressed e.g. CE Delft report, Köhler 2019, 2020. This technology has the potential to significantly reduce fuel demand in the freight markets in shipping.	Noted. Thank you. Peer reviewed publications on wind assisted propulsion is included in Section 10.6	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
11075	31	38	31	38	Köhler J., Nelissen Dagmar, Traut, Michael (2017) Fighting the windbreak, The Naval Architect, May, 26-32.	Take into account. Thank you, I cannot get hold of this paper anywhere. Wind sails are in any case covered in Section 10.6	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
11077	31	38	31	38	Nelissen Dagmar, Michael Traut, Jonathan Köhler, Wengang Mao, Jasper Faber, Saliha Ahdour (2016) Study on the analysis of market potential and market barriers for wind propulsion technologies for ships, CE Delft, Delft	Noted. Thank you. Peer reviewed publications on wind assisted propulsion is included in Section 10.6	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
11079	31	38	31	38	https://www.cedelft.eu/publicatie/study_on_the_analysis_of_market_potentials_and_market_barriers_for_wind_propulsion_technologies_for_ships/1891	Noted. Thank you. Peer reviewed publications on wind assisted propulsion is included in Section 10.6	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
11081	31	38	31	38	The potential of wind propulsion in shipping should be addressed e.g. CE Delft report, Köhler 2019, 2020. This technology has the potential to significantly reduce fuel demand in the freight markets in shipping. see also Köhler et al (2017) Nelissen et al (2016) references in the rows above, also: Köhler J. (2019) Transitions pathways to very low emissions shipping: the Matisse-Ship model, in The Royal Institution of Naval Architects, International Conference on Wind Propulsion pp. 83-90, RINA, London. ISBN 978-1-909024-97-7; Köhler J. (2020a) Zero carbon propulsion in shipping - scenarios for the development of hydrogen and wind technologies with the MATISSE-SHIP model Accepted for publication in International Shipbuilding Progress, Hydrogen Special Issue; Köhler J. (2020b): Modelling the multi-level perspective: The MATISSE agent-based model. In Enayat Moallemi, F. de Haan (Eds.): Modelling Transitions – Virtues, Vices visions of the future: Routledge: Oxon; New York pp.77-101. ISBN 978-0-367-17406-4	Taken into account. Wind assisted propulsion is included in Section 10.6. According to cited literature most suitable for smaller ship sizes, with little agreement on the size of CO2 reduction potential. Hence the discussion on this remains limited.	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
13327	31	39	31	39	Typo: 'o'	Accepted, we need to improve cost methods and include additional literature.	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
23813	31	41	31	42	"The projection for the transport system in the SSP scenarios shows a dominant position of electric and hydrogen-fuelled drive-trains in SSP1 in road transport": Maybe following IEA/EC study with dedicated case studies is an interesting source: https://iea-amf.org/content/news/TD-WS	Accepted, we need to clarify about the method and boundaries used for GHG mitigation	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
13329	31	42	31	43	Grammar - fuel option. Should be 'options'. I don't think the sentence needs a comma.	Editorial-taken into account	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
13331	31	47	31	47	Typo: 'support' should be 'supports'	Editorial-taken into account	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
37543	31	1	32	8	This section highlights the role of biofuel use in IAMs, citing heavily the SSP1 marker scenario (van Vuuren et al, 2017). However, the various mitigation options provided in the transport sector across IAMs is not discussed, but is highly relevant for the conclusions developed here. For example, in the IMAGE model (SSP1 marker), shipping can only be fueled by oil-based products, and no fuel-switching is allowed. Hence, the ability for the shipping sector to decarbonize is apriori limited by a modelling assumption. A full treatment of the mitigation options in IAMs is thus needed in order to draw robust conclusions from these studies.	Editorial-taken into account	Michiel Schaeffer	Climate Analytics	Netherlands
43601	31	27	50	2	The apparently wide difference between these two statements calls for some overall editorial intervention to enable the reader to understand whether the statements can be reconciled and, if not, to understand the root of the divergence.	Take into account.	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)
28001	32	14	32	15	IPCC states, "there has been slow technology development to produce biofuels derived from lignocellulosic feedstocks." Please provide evidence of even a single commercial lignocellulosic ethanol factory in the world that is running today or correct this statement to state "there is no operating lignocellulosic plant in the world today and efforts to date to commercialize this technology have failed."	Take into account.	Mark Jacobson	Stanford University	United States of America
23815	32	16	32	16	Having reasonable ranges might be more appropriate. For GHG and costs the method need to be briefly addressed cf. e.g. https://www.ieabioenergy.com/publications/new-publication-advanced-biofuels-potential-for-cost-reduction/ https://link.springer.com/article/10.1186/s13705-014-0020-x https://www.dbfz.de/fileadmin/user_upload/Referenzen/DBFZ_Reports/DBFZ_Report_11_4.pdf (unfortunately in DE but Figures should be easily readable) >> extract cf. presentation RID xxx	Noted, clarify system boundaries	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23817	32	16	32	16	The values for GHG emissions of the different pathways in table 10.6 reflect only a very small portion of the available literature. Especially for Biomethane from residues, lignocellulosic EtOH and FT Diesel, various additional literature does exist, which allows for a way more representative description of the status quo. Furthermore, the references cited here are not always comparable with regards to the methodology and for example the system boundaries used. For additional information and numbers, you might want to refer to: https://energsustainsoc.biomedcentral.com/articles/10.1186/s13705-014-0020-x http://www.biosurf.eu/wordpress/wp-content/uploads/2015/07/BIOSURF-D5.3.pdf https://onlinelibrary.wiley.com/doi/abs/10.1002/ejlt.200900045	Accepted. Text totally revised and restructured, considering this point and updated	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
9593	32	16	32	22	The energy efficiency (calculated as liquid fuels output divided by energy in feedstock entering the conversion plant) is misleading. It needs to consider the overall energy output (including co-products).	Accepted. Text totally revised and restructured, considering this point and updated	Jesper Kløverpris	Novozymes	Denmark
31551	32	17	32	17	I would add two other columns here. (1) on overal efficiency (WTW in %, i.e. which energy can I use for propulsion compared to the energy in the plant (considering the efficiency of the ICE)) and (2) on GHG per vehicle kilometer	Accepted. Text totally revised and restructured, considering this point and updated	Patrick Jochem	German Aerospace Center (DLR)	Germany
13333	32	17	32	18	Table row 4, 'form' should be 'from'	Accepted. Text totally revised and restructured, considering this point and updated	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
29319	32	17	32	18	In Table 10.6, Please ensure that the scale for the relative cost of conversion is defined.	Accepted. Text totally revised and restructured, considering this point and updated	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
18449	32		32		It is suggested to use the absolute cost value rather than the relative cost	Accepted. Text totally revised and restructured, considering this point and updated	Chang Shiyan	Tsinghua University	China
23819	32		32		Table 10.6 table heading row 4: GHG emissions of conversion >> Does it consider the entire provision chain, including cultivation, transport e.g.? If yes, better: GHG emissions; Background: In particular cultivation of dedicated crops has a strong influence on the overall GHG emissions	Accepted. Text totally revised and restructured, considering this point and updated	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23821	32		32		Table 10.6; row 2 column 2 Lignocellulosic ethanol: Can be based on residues and dedicted crops. This results in a range of GHG emissions.	Accepted. Text totally revised and restructured, considering this point and updated	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23823	32		32		Table 10.6; row 2 column 4 GHG emissions:11gCO2-eq/MJ (based on wheat straw) - 40 gCO2.-eq/MJ (based on miscanthus [Zech et al. 2016: Environmental and economic assessment of the Inbicon lignocellulosic ethanol technology. In: Applied Energy (171), S.347-356. DOI: 10.1016/j.apenergy.2016.03.057]	Accepted. Text totally revised and restructured, considering this point and updated	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23825	32		32		Table 10.6; row 3 column 2 Gasifiactio and Fischer-Tropsch synthesis: Is it also based on lignocellulosic crops? Pleas e specify.	Accepted. Text totally revised and restructured, considering this point and updated	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23827	32		32		Table 10.6; row 6 column 2 Upgraded pyrolysis oil: What is it based on? Waste, residues, dedicated crop? GHG emissions depend on the biomasse source.	Accepted. Text totally revised and restructured, considering this point and updated	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23829	32		32		Table 10.6; row 7 column 2 Hydroprocessed esters and fatty acids? What is ist based on? Waste (UCO), dedicated crop? GHG emissions depend on the biomasse source.	Take into account	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23831	32		32		Table 10.6; row 7 column 4 GHG emissions: More figures and bandwith: [Müller-Langer et al. PTG-HEFA Hybrid Refinery as Example of a SynBioPTx Concept - Results of a Feasibility Analysis. In: Applied Science 9 (19) DOI: dx.doi.org/10.3390/app9194047]	Noted, additional literature To be added	Stefan Majer	German Biomass Research Centre - DBFZ	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
23833	32		32		Table 10.6 row 8 column 2 Alcohol to jet: What is it based on ? Pls. see previous comments	Rejected. It would be discussed in AFOLU	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23835	32		32		Table 10.6 row 9 column 2 Biomethane from residues: Biomethane is also often based on waste, animal manure and dedicated crops	Editorial	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23837	32		32		Table 10.6 row 9 column 4 GHG emissions: 9,19 gCO2/MJ (Biomethane based on waste/residues) [Federal Office for Agriculture and Food (Germany). Evaluation and Progress Report 2018 (Extract)Background data (Chapter 10)]; <1 - 14gCO2-eq/MJ (Biomethane based on animal manure); 11.8-17.7gCO2-eq./MJ (Biomethane based on straw) [Majer, S., Oehmichen, K.: D5.3| Calculation of GHGemission caused by biomethane. 2016 www.biosurf.eu]	Noted	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23839	32		32		Table 10.6 row 10 column 2 Hydrothermal liquefication: What is it based on ? Pls. see previous comments	Accepted	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23841	32		32		Table 10.6 row 11 column 2 Sugars hydrocarbons: What is it based on ? Pls. see previous comments	Noted, additional literature to be added	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
28003	33	1	33	2	IPCC states, "Within the aviation sector there is optimism that jet fuels produced from 1 biomass resources could offer a viable means to reduce emissions under the right policy circumstances." IPCC is ignoring the impacts of combustion fuels used for aviation on surface air quality and health: Cameron, M.A., M.Z. Jacobson, S. R. H. Barrett, H. Bian, C.-C. Chen, S. D. Eastham, A. Gettelman, A. Khodayari, Q. Liang, H. B. Selkirk, N. Unger, D. J. Wuebbles, and X. Yue, An inter-comparative study of the effects of aircraft emissions on surface air quality, J. Geophys. Res. Atmos., 122, 8325-8344, doi:10.1002/2016JD025594, 2017 as well as the effects of soot from combustion fuels on global climate: Jacobson, M.Z., J.T. Wilkerson, A.D. Naiman, and S.K. Lele, The effects of aircraft on climate and pollution. Part II: 20-year impacts of exhaust from all commercial aircraft worldwide treated individually at the subgrid scale, Faraday Discussions, 165, 369-382, doi:10.1039/C3FD00034F, 2013.	Later versions clarified this.	Mark Jacobson	Stanford University	United States of America
23845	33	4	33	5	"Nearly all flights powered by biofuels have been using fuels derived from vegetable oils and fats": Maybe interesting here as well: DEMO-SPK project on Multiblend JET A-1 http://www.etipbioenergy.eu/images/SPM9_Presentations/Day2/14_ETIP%20B%20SPM9_F.%20Muller-Langer_DBFZ.pdf	Later versions clarified this.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23843	33	8	33	10	Strong statements, such as for example the one on lignocellulosic feedstocks for aviation fuels should be backed up by appropriate references. Again, especially for feedstocks such as agricultural residues, a reflection on the local availability and potentials is really important. In reality, it seems often difficult to identify regions which can really supply the amount of sustainable lignocellulosic biomasse needed for a commercially operated facitilty for the production of RJF.	Taken into Account	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
13335	33	17	33	18	…need to undergo AS extensive refining as…	Taken into Account	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
31221	33	30	33	31	EU road transport Diesel norm allows higher shares (even up to 100%). A popular Diesel blend with 33% is used in Germany, called R33.	Noted.	Urs Ruth	Robert Bosch GmbH	Germany
34915	33	31	33	31	Compatibility of HVO should be discussed little bit elaborately	Taken into Account	ANUPAM DEBSARKAR	University	India
23847	34	2	34	2	Wondering about the TRL of Syngas fermentation and FT fuels based on renewables - more like ATJ. Happy to forward additional docs, just mail to stefan.majer@dbfz.de (sorry, not able to add attachments to this review)	Noted.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
31223	34	3	34	4	This is a very important comment: Between the section on biofuels and the one on advanced internal combustion engines a section on synthetic hydrocarbons should be inserted. In the biofuel section the coverage for aviation/shipping with biofuels was limited (not reaching 100%). What is the porposal to achieve 100% decarbonization in these segments in the long run if PtX are excluded? --> PtX fuels will be a fundamental part of the future transport system, as fuels for those carriers where electrification is challenging, impossible, or from a life-cycle-perspective just doesn't make any sense. PtX-fuels will be needed in the long run for those applications that are difficult to electrify. And PtX fuels will also help to decarbonize the remaining fleet, as the ramping up of EVs will be to slow to have globally an all-electric fleet by 2050 or even earlier. Therefore PtX fuels will be needed even though they will be expensive and will require additional amounts of renewable electricity generation. The net-decarbonization of fuels thus is an important additional aspect of decarbonizing transport. This will not replace electrification. It is an additional lever. Please include one additional section on PtX-fuels and highlight the demand for these fuels in the long run. This is important to trigger the industrialization of this technology now. It has very long lead-times and the industrialization needs to start now to have enough quantities available after 2030. Also, there seems to be a strong business interest in this technology and the momentum should be accelerated as this technology will also be needed to decarbonize aviation and shipping.	Taken into account to include PtX in 10.3.4	Urs Ruth	Robert Bosch GmbH	Germany
23849	34	4	34	4	Maybe this study helps as well http://task39.sites.olt.ubc.ca/files/2019/05/Survey-on-Advanced-Fuels-for-Advanced-Engines-IEA_Bioenergy_T39_AFAE_DBFZ.pdf	Taken into account to include Biofuek in 10.3.3 and PtX in 10.3.4	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
47347	34	9	34	11	Efficiencies mentioned are true but misleading because these numbers represent maximum efficiency, not average efficiency. In order to determine GHG emission, average emissions are relevant. And because the efficiency quickly becomes lower as you leave the optimal power/RPM point the average efficiency of a car is closer to 20%, especially if you use real world driving conditions instead of the NEDC.	Taken into account of suggested paper for 10.3.4	Auke Hoekstra	Eindhoven University of Technology	Netherlands

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14085	34	9	34	20	Line 16 should indicate that the fuel economy has decreased in all countries and not increase (based on the figure 10.8 and the paragraph information).	Accepted to use "improve"	Victor Garcia Tapia	International Energy Agency (IEA)	France
31553	34	10	34	11	You may add also real fuel efficiencies here! Please refer to the White Paper of ICCT here and add the empirical values. Mock, P., Tietge, U., Franco, V., German, J., Bandivadekar, A., Ligterink, N.E., Lambrecht, U., Kühlwein, J., Riemersma, I., 2014. From laboratory to road – a 2014 update of official and “real-world” fuel consumption and CO2 values for passenger cars in Europe, ICCT White Paper.	Taken into account of suggested paper for 10.3.4	Patrick Jochem	German Aerospace Center (DLR)	Germany
43589	34	10	34	11	break' should be 'brake'	Accepted	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)
11819	34	12	34	16	There seems to be confusing text here, is average fuel economy INCREASING, or DECREASING? It is stated that average fuel economy has decreased globally between 2005 and 2017, but increased in all countries?	Accepted to use "improve"	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
13337	34	13	34	13	I think 'decreased' should be 'increased'	Accepted to use "improve"	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
31555	34	13	34	13	I suppose that these IEA values again are referring to official NEDC (or similar official driving cycles). I'm more sceptical on these and my check new studies from ICCT on this regard. Again you may also referr to Mock et al. again. Mock, P., Tietge, U., Franco, V., German, J., Bandivadekar, A., Ligterink, N.E., Lambrecht, U., Kühlwein, J., Riemersma, I., 2014. From laboratory to road – a 2014 update of official and “real-world” fuel consumption and CO2 values for passenger cars in Europe, ICCT White Paper	Take into account.We can include this report in the literature considered in the LCA review	Patrick Jochem	German Aerospace Center (DLR)	Germany
34917	34	15	34	15	should be "Selected" in place of "select"	Accepted	ANUPAM DEBSARKAR	University	India
31557	34	19	34	19	Many parts of the world are more used to miles per gallon (MPG) (or even km/liter) you may trnaslate this litres per 100 km value here to MPG.	Accepted to use SI units	Patrick Jochem	German Aerospace Center (DLR)	Germany
2885	34	4	36	10	This section doesn’t sketch out what specific technologies would constitute an advanced internal combustion engine. There are a few options on the table such as Homogeneous Charge Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection among others. Interested to know whether the efficiencies quote in lines 10-11 represent in-use vehicle efficiencies or something else? This could be worth qualifying. If these figures are quoted for laboratory testing, compression ignition engines can reach brake thermal efficiencies of around 55%. Patents are also in development to reach efficiencies of 60% for diesel engines.	Accepted to mention about novel combustion systems in 10.3.4	Nicholas Surawski	University of Technology Sydney	Australia
11771	34	4	36	22	Please consider to explain better why ICE is included, preferably we would rather see a focus on energy input/output, ie potential in the reduction of the use of fossile fuels. ICE will never reach 0 emission, and this should be expained for the readers. It might also be useful to describe that investments to achieve efficiency improvements for ICE makes most sence for some appliances where options to ICE currently are not readily available.	Take into account. Will provide context for including ICE since there are subtantial lock ins that prevent a sudden transition to other technologies difficult.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
6417	34	4			Fuel efficiency improvements is the key solution for mitigating the CO2 emissions. I would transfer them earlier in the text.	Take into account.	Apostolos Petropoulos	International Energy Agency	France
2881	35	1	35	29	Not clear what the data source here is for fuel consumption. Is this data from laboratory-based testing or RDE testing for example?	Taken into account : Will be clarified	Nicholas Surawski	University of Technology Sydney	Australia
13723	35	4	35	15	Efficiency improvements are also discussed in aviation; where should this be discussed? I think this should not be ruled out. For example Rao et al. 2014; Rao, A.G., F. Yin, J.P. van Buijtenen, 2014: A hybrid engine concept for multi-fuel blended wing body. – Aircraft Engin. Aerospace Technol. 86, 483–493, DOI: 10.1108/AEAT-04-2014-0054	Accepted. useful reference	volker Grewe	DLR-Oberpfaffenhofen	Germany
13771	35	4	35	15	A large discussion, e.g. within CleanSky, is also on very efficient concepts like Open Rotors. A climate impact analysis of such a concept (continental flight not intercontinental) came up with a 5% increase in fuel efficiency and a reduction in the climate impact of around 15-20%. (Grewe et al 2017; Grewe, V., Dahlmann, K., Flink, J., Frömming, C., Ghosh, R., Gierens, K., Heller, R., Hendricks, J., Jöckel, P., Kaufmann, S., Kölker, K., Linke, F., Luchkova, T., Lührs, B., van Manen, J., Matthes, S., Minikin, A., Niklaß, M., Plohr, M., Righi, M., Rosanka, S., Schmitt, A., Schumann, U., Terekhov, I., Unterstrasser, S., Vázquez-Navarro, M., Voigt, C., Wicke, K., Yamashita, H., Zahn, A., Ziereis, H., Mitigating the Climate Impact from Aviation: Achievements and Results of the DLR WeCare Project, Aerospace 4(3), 34; doi:10.3390/aerospace4030034, 1-50, 2017.)	Take into account.	volker Grewe	DLR-Oberpfaffenhofen	Germany
14087	35	6	35	6	Figure not well referenced. I understand that it should be 10.9 instead of 1.7.	Accepted	Victor Garcia Tapia	International Energy Agency (IEA)	France
25197	35	6	35	6	Replace "1.7" with "Figure 10.9"	Accepted	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
29321	35	6	35	6	The statement starting as "1.7 shows the efficiency…" should be "Figure 10.9 shows the efficiency…".	Accepted	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
34919	35	6	35	6	"1.7" does not carry any meaning	Accepted	ANUPAM DEBSARKAR	University	India

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31225	35	6	35	10	concerning efficiency gains and related costs (up to 50%, less than 5.000 USD) .. Is there a second source besides National Research Council? Both target values seem to be optimistic, especially as hybridization measures are not yet included for efficiency potential.	Taken into account with more investigation for 10.3.4	Urs Ruth	Robert Bosch GmbH	Germany
47349	35	8	35	10	Increase fuel efficiency 50% for under $5000. I did not read the book mentioned here (the ebook is $99 euro and the paperback $124) but this seems pretty fanciful to me. I would suggest finding more literature, preferably peer reviewed and with input from industry that says this is doable for that increased price because this seems strange. Maybe in an optimal hypothetical situation, and excluding R&D costs, profits and taxes? I can recommend IEA (2017), "The Future of Trucks", IEA, Paris https://www.iea.org/reports/the-future-of-trucks. My only gripe is that they omit the electric truck, which is why I wrote this whitepaper: Hoekstra, A., 2017. Electric trucks: economically and environmentally desirable but misunderstood [WWW Document]. URL https://www.elaad.nl/news/auke-hoekstra-electric-trucks-economically-and-environmentally-desirable-but-misunderstood/ (accessed 3.15.20).	Taken into account of suggested paper for 10.3.4	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47351	35	8	35	15	This paragraph seems to cummulate measures that benefit ICE (what the paragraph should be about) with measures that benefit ALL drivetrains (light lightweighting the chassis). That is confusing to the reader and incorrectly gives the impression that these advances are unique to the ICE. It will also lead to errors in figure 10.12 and 10.13 later on because the conventional car gets a "2050 version" with improvements that would also improve the performance of the other drivetrains that do not get a 2050 version. I would recommend to make a seperate paragraph with efficiency improvements that are not related to drivetrains like lightweighting , aerodynamic shapes and low rolling resistance tires and roads.	Accepted and revised.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
22867	35	13	35	14	"mass reductions can also lead to fuel economy improvements" - but mass has increased over time, tending to offset other efficiency improvements. For example, "The average mass of new cars in the EU ... in 2017 (1,395 kg) (was) about 10% higher than 15 years before" (from https://theicct.org/sites/default/files/publications/ICCT_Pocketbook_2018_Final_20190408.pdf). Also, there is an inconsistency between this sentence and and the first paragraph at p. 39 where the "trend towards bigger and heavier vehicles" is presented as something inevitable, which must rather be offset by other measures	Take into account.I think this has to be discussed in the section about ICE, which is now in the hands of Takashi. In Section 10.4 we are trying to collect LCA/LCC data for different vehicle classes, so we may be able to capture differences in vehicle weights but we will not explicitly discuss it.	Giulio Mattioli	TU Dortmund University	Germany
35805	35	16	35	20	In most developing countries, transition to EV will be marginal in the next couple of decades. Alternative fossil fuels (LPG, CNG etc.) for ICE will contribute to mitigating GHG emissions with some non negligible impact given the size of the fleets in DC. Some countries have developed strategies to use alternative fuels (LPG, CNG) to gasoline and diesel. This dimension and its impact does not seem to be captured in the whole report.	Accepted and revised.	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
42261	35	16	35	21	This statement should be given with evidence, particularly if such fuel types are provided as examples, and disclaimers and differences in the impacts should be mentioned.	Taken into account to mention carbon intensity of fuel in 10.3	Alvin Mejia	Wuppertal Institute	Germany
34443	35	16	35	25	Please add in this section: Sharma and Maréchal, (2019) propose a brilliant alternative to reduce CO2 emissions from the transport sector in capturing CO2, directly on board vehicles. Their CO2 capture system for engine exhaust stream (car, truck, bus, ship, or train) can capture 90% of the emitted CO2, without any energy penalty. This system can be integrated into overall mobility systems (fuel-engine- CO2 -fuel), where captured CO2 can be recycled as conventional liquid or gaseous fuels produced from renewable energy sources..	Taken into account to mention CO2 capture in 10.3.4	Célia Sapart	Université Libre de Bruxelles et Co2 Value Europe	Belgium
34445	35	16	35	25	Considering its growing importance, power-to-fuel technologies should be discussed more clearly in this section. To reach the goal of net zero emissions, fossil fuel-based energy demand could be mainly replaced by renewable electricity (RE) (e.g. DENA, 2017, Ram et al., 2019). However, there are sectors such as aviation, shipping, heavy transportation, energy intensive industries for which hydrocarbons cannot be replaced by electricity easily, or physically not at all (e.g. Fasihi et al., 2017, Hepburn et al., 2019, SDSN &FEEM, 2019). Biofuel production is faced with resource limitations and conflicts with food production and, therefore, offers no sustainable substitute (Koizumi et al., 2015, Tomei et al., 2016). Net zero emissions could be achieved by a defossilization of the energy system, whereby carbon from fossil sources is replaced by that which is created synthetically and sustainably from CO2 with the aid of RE. These CO2-based fuels can be emission neutral and be used in the current fossil fuel-based infrastructure (DENA, 2017, Fasihi et al., 2017, Artz et al., 2019, CONCAWE, 2019). Power to fuel is the concept enabling the production of hydrocarbon fuels (e-fuels) using RE. Two types of fuels can be generated: 1) Synthetic gas (e.g. e-methane) so-called Power-to-Gas and 2) Liquid fuels (e.g. methanol, ethanol), so-called Power-to-Liquid. In both cases, CO2 and green H2 (i.e. hydrogen generated by the electrolysis of water with RE) produce e-fuel (e.g. Breyer et al., 2015, Sternberg and Bardow, 2015, Dimitrou et al., 2015, Fasihi et al., 2017, Anwar et al., 2020). These e-fuels can be stored, transported and use as such or to produce electricity again. Liquid e-fuels are easier (and relatively inexpensive) to store and transport compared to electricity. They can be kept in large-scale stationary storage over extended periods, and mobile storage in vehicle tanks, which can compensate for seasonal supply fluctuations and contribute to enhancing energy security (CONCAWE, 2019). Artz et al., 2019 has shown that the largest reduction in the absolute amount of greenhouse gas emissions could be achieved by coupling of highly concentrated CO2 sources from CO2-emitting sectors with carbon-free hydrogen or electrons from renewable power in this so called “Power-to-fuel” scenarios. Using power-to-fuel to meet the expected remaining fuel demand for aviation in 2050 would require renewable electricity equivalent to some 28% of Europe’s total electricity generation in 2015. However, with today’s technology, synthetic fuels are the only technically viable solution that would allow aviation to exist in a world that avoids catastrophic climate change” (Transport and Environment, 2018)	Taken into account to include PtX in 10.3.4	Célia Sapart	Université Libre de Bruxelles et Co2 Value Europe	Belgium

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
34445	35	16	35	25	The long-term use of carbon based energy carriers in a net zero emissions economy relies upon their production with renewable energy for low-cost, scalable, clean hydrogen production—for example via the electrolysis of water. The estimated potential for the scale of CO2 utilization in fuels varies widely, from 1 to 4.2 Gt CO2 yr−1, reflecting uncertainties in potential market penetration. The high end represents a future in which synthetic fuels have sizeable market shares, due to cost reductions and policy drivers. The low end—which is itself considerable—represents very modest penetration into the methane and fuels markets, but it could also be an overestimate if CO2-derived products do not become cost competitive with alternative clean energy vectors such as hydrogen or ammonia, or with direct sequestration (Grinberg Dana et al., 2016, Byrnolf et al., 2018, Hepburn et al. 2019, Anwar et al., 2020). (DENA, 2017, The potential of electricity-based fuels for low-emission transport in the EU: An expertise by LBST and dena (German Energy Agency/ Ram et al., 2019 EWG&LUT, 2019: Global Energy System Based On 100% Renewable Energy, Energy Watch Group & LUT University./Fasihi et al., 2017, J. of Cleaner Production, 224, 957-980./CONCAWE, 2019: A look into the role of e-fuels in the transport system in Europe (2030–2050) (literature review), CONCAWE./Hepburn et al., 2019: The technological and economic prospects for CO2 utilization and removal, 575, 87-97./SDSN & FEEM, 2019: Roadmap to 2050 - A Manual for Nations to Decarbonize by Mid-Century, Sustainable Development Solutions Network & Fondazione Eni Enrico Mattei./Artz et al., 2019: Sustainable Conversion of Carbon Dioxide: An Integrated Review of Catalysis and Life Cycle, Assessment, Chem. Rev., 118, 2, 434-504./Koizumi et al., 2015, Renewable and Sustainable Energy Reviews, 52, 829-841./Tomei et al., 2016, Land Use Policy, 56, 320-326./Breyer et al., 2015, Energy Procedia, 73, 182-189./ Sternberg and Bardow, 2015, Energy Environ. Sci. 8, 389–400./ Anwar et al., 2020, J. of Env. Manag., 260, 110059/ Dimitrou et al., 2015, Energy Environ. Sci, 8, 1775-1789./Transport and Environment, 2018: How to decarbonize European transport by 2050, Transport and Environment.)	Taken into account to include PtX in 10.3.4	Célia Sapart	Université Libre de Bruxelles et Co2 Value Europe	Belgium
31559	35	20	35	20	You may add at the end of this sentence but before the references: "operated by renweable electricity operation (e.g. wind and solar)"	Taken into account to mention carbon intensity of fuel in 10.3	Patrick Jochem	German Aerospace Center (DLR)	Germany
31227	35	24	35	25	missing: synthetic hydrocarbons produced with (renewable) electricity ... So far only mentioned coal, gas, biomass. --> Please mention the production of synsthetic hydrocarbons through PtX, as this will be the main production method in a carbon-neutral future.	Taken into account to mention carbon intensity of fuel in 10.3	Urs Ruth	Robert Bosch GmbH	Germany
25199	35	25	35	29	Figure 10.9 does not show different production pathways for fuels that can be used in ICE	Noted	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
13725	35	16	36	4	The use of LNG or LH2 in aviation might also be benefitial, especially in combination with kerosene to obtain a) a good volumetric and mass energy density and b) a low climate impact; e.g. Grewe et al. (2017) Grewe, V., Bock, L., Burkhardt, U., Dahlmann, K., Gierens, K., Hüttenhofer, L., Unterstrasser, S., Rao, A.G., Bhat, A., Yin, F., Reichel, T.G., Paschereit, O., Levy, Y., Assessing the climate impact of the AHEAD multi-fuel blended wing body, Met. Z. 26, 711-725, doi:10.1127/metz/2016/0758, 2017.	Take into account.	volker Grewe	DLR-Oberpfaffenhofen	Germany
35807	36	4	36	7	Difficult to read fig 10.9	Noted	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
23851	36	7	36	9	Cf. above mentioned paper/presentation from IAV	Taken into account to include PtX in 10.3.4	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
27029	36	11	36	11	Should this be titled 'Life cycle emissions of land-based transport'? If you read the conclusions of section 10.4.4, it should be. This section has a very heavy focus on life cycle emissions. Is this due to a specific intention to tackle this debate or has the discussion become a bit too long?	Take into account. Section 10.4 will heavily focus on LCA but will also include LCA and the new feasibility table.	Thomas Longden	Australian National University	Australia
27031	36	12	36	17	Some long sentances providing obvious information. I would re-write this to focus on the key issues and not define what land-based transport is.	Take into account. Will check	Thomas Longden	Australian National University	Australia
11773	36	14	36	14	Please consider to replace "Historically" with "Since pre-industrial time"	Take into account.Will confirm what is the appropriate language based on the discussions of the WG	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
35809	36	14	36	14	"Historically" must be explored further. In the US by 1900 almost 1/3 of the cars were EV see for instance history of the electric car https://www.energy.gov/articles/history-electric-car	Take into account.Will confirm what is the appropriate language based on the discussions of the WG	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
47353	36	14	36	14	Maybe not important but historically it started with horses (the first trains used them too) followed by steam trains (~1800-1900) and then electric trains. Electric vehicles where dominant from ~1890-1910 before the internal combustion engine car replaced them.	Accept. We will revise this text	Auke Hoekstra	Eindhoven University of Technology	Netherlands
34921	36		36		Fig-10.9 not legible	Accepted. Agreed.	ANUPAM DEBSARKAR	University	India
42977	36	1	46	8	I think that all the paragraph “10.4 Decarbonization of land-based transport” need to be revised and updated for SOD-Draft taking in consideration the recent Hydrogen Council report: “Path to Hydrogen Competitiveness: A Cost Perspective” [January 2020; available at <https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf >]. In particular, in my opinion new and relevant data regarding FCV TCO are provided in this new report. So, with these new data it will be possible to revise the ICE, BEV and FCV comparison and analysis made in all the paragraph, for SOD-Draft.	Take into account.Section 10.4 will focus on LCA and LCC. We will review the report and include as appropriate.	MARIO VALENTINO ROMERI	Independent consultant	Italy

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
45211	36	11	46	8	The title of this section is "decarbonization of land-based transport" however it only discusses vehicle technology options. It needs to cover the entire avoid-shift-improve approach for both passenger and freight. See for example the Sustainable Mobility for All Global Roadmap of Actions (including background paper 'Green Mobility") http://sum4all.org/global-roadmap-action	Take into account. We may consider changing the title of the sections, but section 10.4 aims to assess the LCA literature about inidiviudal technologies for the transportation sector. We have a section on systemic transitions that covers issues like automation, modal shifts, shared transport, logistic planning, etc.	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
16323	36	11			In Section 10.4 Decarbonization of land-based transport, consider adding a subsection describing global military use of land-based transport and the possibilities for decarbonizing that sector, for the sake of clarity and accuracy.	Accepted and revised.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
47863	36	11			Section 10.4 summarizes the state of technologies very well including recent LCAs on GHG emissions per technology. What seems to be missing is a state of art review of carbon reduction potential as a function of mode/technology. Suggest including quantitative estimates of carbon mitigation potential of various transport interventions (technologies, efficiency, demand reduction); or perhaps include more detailed analysis in the scenario/mode trajectory section to compliment the global scale assessment.	Accepted and revised.	Martino Tran	University of British Columbia	Canada
20735	37	1	37	1	How would informality in transport fit in here?	Accepted and revised.	Chandrima Mukhopadhyay	Summer Winter School, CEPT University	India
25603	37	1	37	1	Some means of transport such as van should be added, as well as modes of transport such as waterways or pipeline (freight transport).	Accepted and revised.	Sabine Limbourg	HEC-Uliege	Belgium
11695	37	1	37	2	why is the figure framed to only show 'motorised' transport? By omitting walking and cycling you miss out on opportunitites on debates on quality urban environment (SDG11), health (sdg3). By saying that reducing emissions from motorised transport is about improving their efficiency and electrification, you miss out on the huge potential of modal shift, i.e. people using public and active transport intead of short car trips. various countries should have stats on "% of trips under 5 km by mode of transport" and similar e.g. https://www.sustrans.org.uk/our-blog/research/all-themes/all/key-walking-and-cycling-statistics-for-the-uk/. This further emphasises the need to frame opportunities for 'green transport options' as societal practices: people don't think in terms of CO2 emissions per km but in terms of their activities 'commuting' 'shopping' - can we frame the chapter so we include opporunities for new social norms to emerge, e.g. working from home? (modelling of pollution and ghg emissions based on social activities are here http://www.claircity.eu/wp-content/uploads/2020/01/D7.4-Final-City-Policy-Package-First-City-REVISED.pdf)	Accepted and revised.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
36161	37	1	37	2	Bicycles are missing in the figure as well as in the entire report. Having a bicycle lane is one of the most easiest ways of reducing commuter emissions in urban areas. E-bikes are making this even more attractive.	Accepted and revised.	Arvind Gangoli Rao	Delft University of Technology	Netherlands
45207	37	1	37	2	Good to have such a figure. However it should be completed with three-wheelers for passenger and light commercial vehicle (four or three wheelers) for freight	Accepted. Will do	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
11821	37	7	37	7	Could you please clearify what is included in "BEV", it says "hybrid" also here? Does "Hybrid" include non plug in, and plug in hybrid?	Accepted. We will clarify in the SOD	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
47355	37	13	37	14	"However, studies examining prospective climate performance of vehicles remain somewhat sparce". This line made me call up a couple of professors and the editor of a paper I know to see if we could come up with a new publication that is submitted latest september 2020. The answer is yes. I hope it can be useful.	Take into account. We will include in the review if it meets the literature cut-off deadlines	Auke Hoekstra	Eindhoven University of Technology	Netherlands
34923	37	15	37	15	should be "Selected" in place of "select"	Accepted. Will fix	ANUPAM DEBSARKAR	University	India
47357	37	15	37	16	I recognize the problem of limited primary data. One of the methods I will use in our paper is to add studies by parties that are closer to the market like BloombergNEF. I have the feeling that the LCA community and the transport community are too far from each other at the moment. Fortunately I have LCA collegues that want to help at the Eindhoven University of Technology as well as the automotive master and contacts in Industry.	Noted. Not sure what to say	Auke Hoekstra	Eindhoven University of Technology	Netherlands
14089	37		37		Which criteria are used for each defined category in figure 10.10 (e.g. what it is included in car load)? Could you please clarify the definitions of the different transports ? It might be useful for you to consult the "Glossary for transport statistics 5th edition" by the International Transport Forum)	Accepted. We plan to update Figure 10.10 and will review the glossary suggested by the reviewer	Victor Garcia Tapia	International Energy Agency (IEA)	France
1699	37	3	41	4	LCA is discussed here, but the analysis of LCA depends on so many factors, so conclusion from the analysis should become very obscure. Of course LCA including whole value-chain is important, but for the clarification, it is better to focus on the Well-To-Wheel analysis to show the general potential of CO2 reduction for the combination of vehicle technology and fuel, then for the specific discussion, such as EV and FCV, you can show the detailed analysis for the full value-chain LCA analysis, but should mention the uncertainty of the analysis.	Accepted. We are releasing a request for data from the LCA community so we can perform a harmonization excersice that would allow for more robut comparison of the different technologies	Shigeki KOBAYASHI	TICJ	Japan
11823	38	1	38	1	very difficult figre to understand. Colours difficult to understand. Please consider to fix or delete.	Accepted. We will be updating all the figures	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
28575	38	1	38	1	Only two vehicle classes for ICEVs, and only one for BEVs and HFCEVs are assessed? There are many studies that provide values for different vehicle segemnts and types. For example, Miotti et al. (DOI: 10.1021/acs.est.6b00177) provide estimates for many real-world vehicles. Wolfram et al. (https://osf.io/2zyv6/) simulate life-cycle emissions for six different powertrains and 4 segments. The estimates of both of these studies could add missing data points to this figure.	Take into account. If enough data is available, i.e. for a statistical analysis, we plan to include more classes	Paul Wolfram	Yale University	United States of America

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31561	38	1	38	1	This is a core figure of this report and will be presented thousend times. I'm very queasy when seeing these figures without intervals of uncertainty. We all know that these comparisons rely on many very crucial assumptions such as CO2 emissions during vehicle production, size of batteries, vehicle mileage, emission factor for electricity, ... Hence I would neve show these comparisons without confidence intervals! You already analysed a very good basis of literature, consequently, it might be easy to show these differences in this figure here. (cf. the figure from Messagie et al., 2014)	Accepted. We plan to implement the uncertainty intervals in the SOD, as well as the assumptions. The latter might perhaps be included in the Appendix.	Patrick Jochem	German Aerospace Center (DLR)	Germany
27035	38	1	38	4	There seems to be an issue with Fig 10.11. What is the first unlabelled bar? The numbers presented don't seem to match those in the text below. I cant see how the numbers at the bottom of the page relate to Fig 10.11. For example, mid-size ICEV has 145-255g CO2 and SUV has 180-370g CO2 in lines 29-31, but these numbers dont match those in Fig 10.11.	Accepted. The legend will be included and the bars expalined in more detail in the text. Numbers in the figure represent the median values, while values in the text are the min and max values from literature. This will become clearer with the uncertainty intervals, and with a more explicit definition.	Thomas Longden	Australian National University	Australia
47359	38	1	38	4	Figure 10.11. CO2eq emissions of battery production are at least 9 grams too high. If I quickly try to reverse engineer (see below) I think 115 kg CO2eq/kWh was used while 80 kg/kWh is a conservative estimate now (see below), much too high in 2020 and probably 2-5x too high (depending on SSP) in 2050. This is really misleading in a negative sense regarding BEVs while people expect the IPCC to be pro low carbon solutions. So this is incorrect and hindering attempts to introduce a low carbon solution. Please update.	Noted. Numbers are coming from a handful of studies, harmonized. In addition, we took the median values. The figure is not supposed to present the best-case scenario but the average values calculated from the most recent peer-reviewed papers	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47361	38	1	38	4	Figure 10.11. What I'm missing is a car that is PRODUCED using low carbon energy. That would slash manufacturing emissions and make the difference with ICEV much clearer. Few people are going to use 10.12 and 10.13 because they are too complicated to read for most so this graph will go everywhere. Isn't it possible to add a midsize ICEV 2050, BEV 2050 and FCEV 2050 produced using low carbon electricity? That would really make clear that BEV and FCEV are the technologies that can create realise great reductions. As indicated above we will publish a paper about this in time for AR6 (so submitted latest September 2019 and published latest April 2020).	Take into account. We are not planning to present future scenarios for a given year, as future impacts are dependent on several factors (chemistry, adoption of renewables, recycling, materials etc.). We could try to harmonize assumption about manufacturing if the data allows.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47363	38	1	38	4	Figure 10.12. Many people don't read carefully and on first glance FCEV now seems to emit less than BEV. If one would add FCEV on coal that would of course be dramatically bad but also nonsensical.	Accepted. We plan to include more energy sources for the production hydrogen and for charging BEVs.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47365	38	1	38	4	I think the manufacturing emissions/vkm malus of BEV should be reduced from 28 to 15 g/vkm. Currently the manufacturing emissions of the BEV are 60 g CO2eq/vkm and those of the ICEV 32 g. Multiplying by 180 000 vkm give a difference of 5040 kg. Adding a conservative 1 tonne for the extra emissions of the ICE drivetrain compared to the BE drivetrain gives 6040 kg due to battery production. Assuming 100 kg CO2eq/kWh (see below) this means a battery of 60.4 kWh (average Tesla Model 3 with 350 km real range: pretty high). I propose taking 80 kg CO2eq/kWh or less (see below) which would mean the battery emits 4832 kg. That is 1208 kg less and assuming 180 000 km that's 7 g/vkm less. Total BEV emissions are now 4760 for chassis and drivetrain and 4832 for the battery for a total of 9592 kg or 53 g/vkm. If you take 250 000 km for the lifetime of the vehicle which I consider to be a better supported number than 180 000 (see below) the ICEV manufacturing emissions would reduce from 32 to 23 and BEV manufacturing emissions from 53 to 38. That's 15 g/vkm more than ICE.	Noted. Numbers are coming from a handful of studies, harmonized. In addition, we took the median values. The figure is not supposed to present the best-case scenario but the average values calculated from the most recent peer-reviewed papers	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47367	38	1	38	4	I would propose taking 250 000 km. I am curious what the 180 000 km lifetime was based on. I have found around 20 sources using an explicit number in the literature but none who gave a solid reasoning about why 150 000 km. Ellingsen 2016 said something along the lines of "150 000 is often given by manufacturers but could be on the conservative side" and then picks 180 000 more or less out of the blue if memory serves. Anyway, what I have done is the following. 1) From the Eurostat database we know the number of vehicles in brackets 0-2yrs, 2-5, 5-10, 10-20, and older than 20 years. 2) From among others ACEA we know cars in Europe are on average 10.8 years old. 3) Fit a curve that satisfies all criteria. 4) Multiply each year on that curve by the average amount of km driven in Europe (from ACEA en Eurostat again) namely 13.202 km. The result is a car lasts on average 255 000 km in Europe. And we also know that within Europe, cars last longer as income in a country goes down. So since Europe is richer than the rest of the world on average is seems reasonable to assume the rest of the world will also use its cars as long as this. This is all specified in a report for the German Bundestag that will be available in the grey literature in April and it will be part of our peer reviewed publication in time for AR6 as mentioned in generic point 2. By the way: the average age of the car on the road that you see is different because cars drive more in their first years but that does not invalidate these results. It just makes them a tad counterintuitive for car lovers. All calculations are available on request of course.	Take into account. ICEVs can reach 250k km of lifetime. However, regarding BEVs and FCEVs, there are no studies supporting theis number, as FC stack and battery packs degradation are still important factors for such a lifetime. To harmonize the results under a common lifetime, we took the lower end of the spectrum, which is given by the predicted lifetime of BEVs and FCEVs.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47907	38	1	38	28	This section and Figure 10.11 provide point estimates for things that the text points out are highly variable and come from a range of sources making different assumptions. If possible, some idea of ranges reflecting uncertainty or different assumptions would be helpful. At a minimum, better define your vehicles - what is the assumed fuel efficiency of these vehicles that relate to the in-use GHG emissions? The FCV looks like it is not much more efficient than the ICE - is that because the ICE is a hybrid? Things like that.	Accepeted. We plan to implement the uncertainty intervals in the SOD, as well as the assumptions. The latter might perhaps be included in the Appendix.	Lewis Fulton	University of California, Davis	United States of America

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
23853	38	2	38	2	Fig. needs some more explaination. What is about the light red bars (GHG related to vehicle production (incl. recycling etc.?)? Why these options have been assessed and not other renewable fuels for ICEV for instance? What is the method for calculating the GHG emissions? How do these figures connect to the GHG emission factors for the fuels mentioned before?	Accepted. The legend will be included and the bars expalined in more detail in the text. Numbers in the figure represent the median values, while values in the text are the min and max values from literature. This will become clearer with the uncertainty intervals, and with a more explicit definition. We plan to include more energy sources for the production hydrogen and for charging BEVs.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
31229	38	2	38	2	Figure 10.11 (and following text) does not give a balanced view - missing information about battery size (BEV) or FCEV parameters (engine power & tank size), fuel/electricity consumption (state for all technologies). --> An accompanying table would be very helpful to provide clarity and transparency. - BEV: SUV or long-range vehicles should also be considered (100 - 180 kWh battery), SUV also for FC-EV. Show two vehicle types for each drive train technology: midsize car and SUV. - BEV vehicle production emissions are only shown with "global average" electricity CO2 foot print. Should be differentiated by kind of power generation also for the vehicle production! (e.g. battery production with electricity from coal or from wind); at least show the max/min range, better give all choices of electricity production as you do for the use-phase. - Future scenarios of renewable fuel share for ICE are not considered but must be shown as they are for BEV and FCEV, i.e. state status today and give possible green scenario options, such as PtX-fuels and also biofuels (with a footnote that availability will be limited in many regions) - hybrid and especially plugin-hybrid or range-extender-concepts should also be presented (again with the options of fossil fuels and renewable / PtX fuels, and for two vehicle types). LCA especially for BEV varies strongly for different vehicle segments and use cases, mainly due to range expectation and therefore battery size. This is not reflected here and should be shown by showing two vehicle types as mentioned above.	Accepted. The assumptions will be presented in the SOD, either in the main text or in the Appendix. If data is available we also plan to include separate bars for SUVs. In addition, we will include the uncertainty intervals. More energy carriers are planned for inclusion, likewise PHEVs and HEVs.	Urs Ruth	Robert Bosch GmbH	Germany
28005	38	5	38	6	IPCC states, "Figure 10.11 presents the life cycle emissions and mitigation costs for selected powertrain technologies and fuel chain combinations for light duty vehicles." This figure and the discussion are misleading because they ignore entirely (a) the air pollution emissions from the three technologies, (b) the intake fraction of the air pollution from the three technologies, and (c) the cost of the air pollution intake among the three technologies. Such an analysis would wipe ICE vehicles off the chart. Even if the air pollution emissions from ICE vehicles and BEVs powered by coal were the same, the intake fraction of vehicle exhaust is 15-30 times that of power plant exhaust (Holnicki et al., Intra-urban variability of the intake fraction from multiple emission sources, Atmospheric Pollution Research, 9, 1184-1193, 2018), so BEVs and FCEVs always reduce air pollution mortality, whereas ICEs always increase air pollution mortality. Given that the cost of air pollution mortality exceeds that of climate change today and in 2050 (although it becomes close in 2050 - Jacobson, M.Z., M.A. Delucchi, M.A. Cameron, S.J. Coughlin, C. Hay, I.P. Manogaran, Y. Shu, and A.-K. von Krauland, Impacts of Green New Deal energy plans on grid stability, costs, jobs, health, and climate in 143 countries, One Earth, 1, 449-463, doi:10.1016/j.oneear.2019.12.003, 2019), ignoring the air pollution cost of ICEs versus BEVs and HFCVs should be corrected.	Take into account. A small discussion on air pollution might be included in the main text. However, as the issue is rather complex, it would need a full chapter to present an analysis that cannot be misleading or misunderstood. The target of this section is presenting the findings regarding the GHG burdens of LDVs, regardless of trade-offs and co-benefits. The co-benefits and trade-offs will however be included in the feasibility table.	Mark Jacobson	Stanford University	United States of America
42265	38	8	38	11	This sentence may be rewritten in a way not to imply justification towards the shift to larger personal vehicles.	Accepted. We can reformulate the sentence	Alvin Mejia	Wuppertal Institute	Germany
42263	38	13	38	20	Another example for real world vs lab testing energy efficiency values for vehicles : https://theicct.org/news/real-world-vehicle-fuel-consumption-gap-europe-stabilizing	Noted. implies using RDE literature/values, which in turn would imply "mixing and matching"; we would have to use 'real world' fuel efficiency, then use that to back calculate the supply chain emissions: out of scope	Alvin Mejia	Wuppertal Institute	Germany
28577	38	15	38	20	Much has changed! There are many recent examples that depoly real-world emission factors, e.g.: Wu, 2019, https://doi.org/10.1016/j.apenergy.2019.113923, Ke, 2017, http://dx.doi.org/10.1016/j.apenergy.2016.12.011; Qi, 2018, 10.1016/j.procs.2018.04.176; Wang, 2015, http://dx.doi.org/10.1016/j.apenergy.2015.05.057; Wu, 2017, http://dx.doi.org/10.1016/j.scitotenv.2016.09.040; Yuan, 2017, https://doi.org/10.1016/j.energy.2017.11.134	Take into account. We'll add those to the review if possible (i.e., do not require novel analysis from our side to implement) Note that some of the suggested literature might not be LCA studies and therefore difficult to incorporate	Paul Wolfram	Yale University	United States of America
26321	38	15	38	22	Somewhere around these sentence, or elsewhere if more appropriate, the authors could provide some further account on the discrepancy between test cycle emissions and on-road emissions, a persisting issue that culminated as the emission scandal in the autoindustry during this AR6 cycle. The scandal was about NOx, not about CO2, so air pollution and its health impact is primarily important (Barret et al., 2015, 10.1088/1748-9326/10/11/114005; Chossière et al. 2017, 10.1088/1748-9326/aa5987), but climate impact is also relevant because NOx influences climate (Tanaka et al., 2018, 10.1088/1748-9326/aab18c). This scandal might have influenced the composition of the powertrain by forcing the autoindustry to move away from diesel-powered engines (at least in the US and the Europe). Furthermore, more generally, the role of non-CO2 is not explicit thoughout this part because data are reported just in CO2-eq term. I think some discussion on non-CO2 emissions, together with vehicle emission standards, would be useful just as done for the aviation and shipping sectors (pages 47-48, 50-51, and 54). This is especially so if emissions from diesel-powered vehicles are discussed (although I feel I am looking backward with this statement, given the more forward-looking discussion on HEVs, PHEVs, FCEVs, etc. in the current section 10.4.1).	Accepted. Try to incorporate a sentence about this	Tanaka Katsumasa	Laboratoire des Sciences du Climat et de l'Environnement (LSCE), CEA, FRANCE; National Institute for Environmental Studies (NIES), JAPAN	France

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31563	38	16	38	19	Again you may consider the insights by Mock et al here. Mock, P., Tietge, U., Franco, V., German, J., Bandivadekar, A., Ligterink, N.E., Lambrecht, U., Kühlwein, J., Riemersma, I., 2014. From laboratory to road – a 2014 update of official and "real-world" fuel consumption and CO2 values for passenger cars in Europe, ICCT White Paper	Take into account. Consider this, with possible incorporation of the data in the figure and the numbers in the appendix. In addition, rephrase sentence where we highlight difference between NEDC and WLTP.	Patrick Jochem	German Aerospace Center (DLR)	Germany
28579	38	21	38	22	There should be some quantifications of these underestimations. For example see the papers above. Also, Tietge et al. (https://theicct.org/sites/default/files/publications/Lab-to-road-intl_ICCT-white-paper_06112017_vF.pdf) provide "gaps" for several countries.	Take into account. Consider this, with possible incorporation of the data in the figure and the numbers in the appendix. In addition, rephrase sentence where we highlight difference between NEDC and WLTP.	Paul Wolfram	Yale University	United States of America
23855	38	22	38	28	Referring to the references years this seems to be not related to WLTC? Moreover having some related tail pipe CO2 targets (e.g. according EU CO2 regulation and others) might be helpful in order to set benchmarks.	Take into account. However, could be challenging to provide an adequate global/regional overview…and summarizes succinctly e.g., segment/mass differences of these…	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
14091	38		38		Could you please clarify the definition between SUV and Midsize car ? Please see comment 19	Accepted. We can clarify the differences between SUVs and mid-sized vehicles	Victor Garcia Tapia	International Energy Agency (IEA)	France
23857	38		38		Figure 10.11: Please add a legend.	Accepted. This is planned for the SOD	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
27033	38	5	41	4	A very long discussion of life-cycle emissions. An improvement/extension/re-design of Fig.10.11 would really get to the heart of the issue. Why is there such a large focus on this issue? Surely, this section needs to be re-organised so that the issues are dealt with succinctly. Interesting information, but a bit hard to read and absorb in its current form. Needs to be broken down by issue or vehicle type (with sub-headings) to make it easier to read/follow.	Take into account. Hopefully, in the SOD the text will complement the figure and we will be able to present all the information in an orderly manner.	Thomas Longden	Australian National University	Australia
6419	38	1			Labels from the figure are missing	Accepted. This is planned for the SOD	Apostolos Petropoulos	International Energy Agency	France
47865	38	5			The current figure 10.11 doe not have mitigation costs contrary to this sentence? Perhaps in the next iteration of the figure?	Accepted. We plan to include mitigation costs in the SOD	Martino Tran	University of British Columbia	Canada
46951	39	1	39	6	It would be helpful here (and/ or in sections on legislation/ regulations) to refer to the EU fleet-wide average emission targets. It may be that relevant peer reviewed articles could be referenced to demonstrate any impacts, although it may be too early to determine how successful the 95g CO2/km will be.	Take into account. We can cross-reference with the energy chapter, regarding the first point. We can attempt to address the last point raised by the reviewer, but it might be very challening to do so in a detailed manner.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
22869	39	1	39	11	We do not know enough about the drivers of SUV sales growth - it would be worth highligting this as a gap / direction for future research - see Antal, M., Mattioli, G., & Rattle, I. (2020). Let's focus more on negative trends: A comment on the transitions research agenda. Environmental Innovation and Societal Transitions.	Take into account. We can consider this, if we find literature supporting this point	Giulio Mattioli	TU Dortmund University	Germany
36163	39	1	39	11	The gains made in the efficiency of engine is being offset by the increased mass of SUVs and therefore the average fuel consumption of cars has not changed over the last few years. The authors seem to undermine this issue a bit.	Take into account. Might be challenging to implement this; some literature exists, but not SUV specifically. We will review the data and include if possible.	Arvind Gangoli Rao	Delft University of Technology	Netherlands
28581	39	6	39	8	This sentence is basically the same as the one on lines 1-4.	Accepted. Good point. We will fix that.	Paul Wolfram	Yale University	United States of America
31565	39	6	39	11	This section is very negative (and personally I agree with this). However, some colleagues from the automotive industry may argue that the SUV also became smaller during the last years. Hence we shouldn't mix here these arguments: (1) cars weight increased (which is uncontroversial) and (2) the share of SUV increased substantially (again uncontroversal) but at the same time the SUV became smaller and hance the average weight of sold SUV declined significantls and a shift from a large limusine to a (small) SUV may even lead to a decreasing average vehicle weight. You may seperate these two arguments in this section.	Take into account. We can reformulate to make a tighter argument, perhaps taking into consideration the comparatively more powerful engines and the less aerodynamic form of SUVs compared to non-SUVs belonging to the same segment.	Patrick Jochem	German Aerospace Center (DLR)	Germany
11473	39	8	39	10	"However, the trend towards bigger and heavier vehicles, with consequently higher use phase emissions, can be offset by improvements in powertrain design, fuel efficiency, light weighting and aerodynamics" - However this statement does not reflect the decarbonisation ambition of the transport sector.	Accepted. Rephrase sentence stating that SUVs market share uptake collides with the decarbonisation ambitions of the transport sector	Sudhir Gota	Independent Consultant/Researcher	India
47867	39	8	39	11	Is there data on how much end-use emissions for SUVs/trucks can be offset with engine efficiency, vehicle design, and light weighting?	Take into account. Might be challenging to implement this; some literature exists, but not SUV specifically.	Martino Tran	University of British Columbia	Canada
11475	39	10	39	11	"Alternative fuels such as those 11 described in 10.3.7 may also provide some mitigation potential for ICEVs." - There is no 10.3.7 section	Accepted. We will fix this and refer to the correct section (biofuels - 10.3.3).	Sudhir Gota	Independent Consultant/Researcher	India
11477	39	10	39	11	"Currently, BEVs have higher manufacturing emissions than equivalently sized ICEVs, with 7 – 16 t CO2-eq/vkm against approximately 3.5 - 7 t CO2 -eq/vkm of their mid-sized fossil -fuelled counterparts" - Could you quote the source?	Take into account. Numbers are coming from a handful of studies, harmonized. The values presented in the text represent the min and max values presented the most recent peer-reviewed papers cited at the beginning of the section. On the other hand, the figure at the moment presents the median values.	Sudhir Gota	Independent Consultant/Researcher	India

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
47869	39	12	39	20	Are there challenges with commercially available light weight materials meeting safety/collision standards? If not, perhaps something to highlight at end of paragraph along with recycling challenges.	Noted. Not really, as for example F- and S-segment vehicles have a larger share of lightweight materials, and these materials are approved for vehicle applications.	Martino Tran	University of British Columbia	Canada
28583	39	15	39	18	Generally, this is true. However, many different factors influence the net effects of lightweighting, most prominently vehicle segment and carbon intensity of energy supply. For example, it has recently been shown that lightweighting smaller cars, e.g. micro or passenger cars, can increase overall life cycle emissions, because the increase in material-related emissions outweighs the fuel economy gains. Conversely, under low-carbon energy supply, lightweighting can reduce both material-related emissions as well as emissions of the energy chain (see here: https://osf.io/2zyv6/). The paper also evaluates other material efficiency measures, such as recycling and remanufacturing, and farther downsizing and more intensive use, all aspects that may need to be addressed in this section.	Take into account. We will look into it. At a first glance, the argument of using low-carbon electricity for manufacturing lightweight materials would also apply to conventional materials	Paul Wolfram	Yale University	United States of America
22871	39	21	39	39	What about the issue of increased vehicle weight because of batteries?	Accepted. We can add that in the BEV paragraph	Giulio Mattioli	TU Dortmund University	Germany
28585	39	23	39	25	The proper technical term 'utility factor' may be established here (https://www.sae.org/standards/content/j2841_200903/)	Accepted. The word utility factor may be not immediately recognizable by policy makers not very familiar with the topic. We can add it, introducing its meaning in this context.	Paul Wolfram	Yale University	United States of America
28587	39	25	39	28	ICEV and PHEV production emissions similar? If that claim is made it should be explained a bit why, e.g. small battery; can vary though.	Accepted. Good point, we can expand that and describe why this is the case.	Paul Wolfram	Yale University	United States of America
31567	39	28	39	28	Again, I'm missing references here and you may add Plötz et al. 2017 here. Plötz, P.; Funke, S.; Jochem, P.; Wietschel, M. (2017): CO2 Mitigation Potential of Plug-in Hybrid Electric Vehicles larger than expected, Scientific Reports 7: 16493, doi: 10.1038/s41598-017-16684-9.	Take into account. We will consider that	Patrick Jochem	German Aerospace Center (DLR)	Germany
31569	39	28	39	28	You may add at the end of this sentence: "Also compared to BEV, PHEV may have advantages in GHG mitigation because they electrify the same annual mileage with a smaller battery and consequently with a lowe environmental impact during the vehicle production phase (Plötz et al., 2017)." Plötz, P.; Funke, S.; Jochem, P.; Wietschel, M. (2017): CO2 Mitigation Potential of Plug-in Hybrid Electric Vehicles larger than expected, Scientific Reports 7: 16493, doi: 10.1038/s41598-017-16684-9.	Take into account. We will consider that	Patrick Jochem	German Aerospace Center (DLR)	Germany
11451	39	28	39	29	Contents of sentence "Current HEVs may help reducing the emissions of ICEVs of about 9-20%" is not accurete. Accoridng to the table 1 of "https://www.osti.gov/servlets/purl/1376462,"Fuel consumption sensitivity of conventional and hybrid electric light duty gasoline vehicles to drive style," Hev improves more than 50% in some cases. According to the current catalogue fuel economy figures of some Toyota vehicle, it would be about 30 -40 % improvement (https://www.toyota.com/camryhybrid/). So HEV is more effective and important than present description of this sentence to reduce stock of CO2 in the atmosphere from transport sector, as HEV has much wider market share than ZEVs. Mid to short term CO2 saving technology should be given more focus as such technology can contribute to reduce cumulative CO2 emission from transport sector.	Take into account. We will consider that	TAKAO AIBA	Japan Automobile Manufacturers Association / Toyota	Japan
28589	39	28	39	29	Perhaps mention that, due to carbon-intensive electricity grids, HEVs currently have the biggest mitigation potential in areas like India, Australia, China and similar carbon-intensive regions (e.g. http://dx.doi.org/10.1016/j.apenergy.2017.08.219).	Take into account. however, the issue of air pollution in densily populated cities may also plays a role in technology adoption.	Paul Wolfram	Yale University	United States of America
31287	39	28	39	39	Deeper examination of HEV's CO2 reduction potential is needed. Vehicle electrification offers the greatest opportunity for decarbonization of transport, and HEVs are the most sold class of electric vehicles to date. On the other hand, it is estimated that current HEVs reduce the emissions of ICEVs of about 9-20% in FOD (P10-39 28-29). However, Figure 3 in Reference 1, which FOD refers to, shows that life cycle GHG emissions per km for HEVs are on average 32% lower than that of ICEVs in the urban counties and 15% lower than that of ICEVs in the rural counties. (In this study, HEVs production emissions are comparable to the ICEVs production emissions.) As shown in Figure 1 in Reference 1, fuel consumption of electric vehicles greatly depends on the ambient temperature than that of ICEVs, therefore fuel consumption varies greatly by region. For example, BEVs and PHEVs have higher temperature sensitivity for fuel consumption than HEVs, then the life cycle GHG emissions of these vehicles are worse than that of ICEV and HEV in cold region such as Forest, WI. Contrastively, the life cycle GHG emissions of HEVs are about 9% lower than that of ICEV even in such cold regions, this study means it is necessary to consider the temperature dependence in the evaluation of electric vehicles. On the other hand, the CO2 reduction effect of HEVs is about 40% in Los Angeles, CA. In this way, HEVs are relatively effective in reducing the life cycle GHG emissions in urban counties and large-scale economy region. Furthermore, as described in page 7 and 15 in Reference 2, HEVs are already in the widely spread stage, and considered to be effective as a short to medium term CO2 reduction technology from the viewpoint of cumulative CO2 emissions that have significant environmental impact. As shown in Table 1 and Figure 4 in Reference 3, fuel consumption of HEVs varies greatly depending on the type of powertrain (Power-split transmission with 2 motors, 4-speed transmission with 1 motor, etc.). It is necessary to evaluate the fuel efficiency of HEVs with careful consideration of such differences in powertrains. I would expect these points to be taken into account in Chapter 10 toward SOD. Reference 1: Wu, D., Guo, F., Field, F. R., De Kleine, R. D., Kim, H. C., Wallington, T. J. and Kirchain, R. E. (2019). Regional Heterogeneity in the Emissions Benefits of Electrified and Lightweighted Light-Duty Vehicles. Environmental Science and Technology, 53(18), 10560–10570. https://doi.org/10.1021/acs.est.9b00648 Reference 2: Aiba, T. (2019) Roundtable A: Financing innovative technologies ～From an automotive company's perspective～, G20 Global Summit on Financing Energy Efficiency, Innovative and Clean Technologies, https://ipeec.org/upload/publication_related_language/pdf/1311.pdf Reference 3: Thomas, J., Huff, S., West, B. and Chambon, P.(2017). Fuel Consumption Sensitivity of Conventional and Hybrid Electric Light-Duty Gasoline Vehicles to Driving Style. SAE Int. J. Fuels Lubr. 10(3). https://doi.org/10.4271/2017-01-9379.	Accepted. These four points are fair enough. For point 1, the trends are an artifact of the papers reviewed in the FOD, and present a median value among the revewed papers. This will hopefully change for the SOD, where more literature will be included in the statistical analysis. Points 2 to 4 will hopefully be satisfactorily incorporated in the SOD.	Eiichi Ono	Toyota Technological Institute	Japan

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
28591	39	33	39	34	Not sure I understand this sentence.	Accepted. We can reword it.	Paul Wolfram	Yale University	United States of America
31231	39	34	39	35	The statement: "Because HEVs cannot harness low-carbon energy carriers, they offer limited mitigation opportunities" is incorrect! The additional electric powertrain is an efficiency improvement and is independent of the fuel used. It can be applied to an ICE using CNG, LNG, H2 (as ICE), biofuel, synthetic fuel .... Especially through the option of using fully decarbonized PtX fuels a HEV can also harness low-carbon energy carriers.	Noted. This is technically true, but it seems unlikely that these low carbon energy carriers would in fact be used in an HEV to any significant degree.	Urs Ruth	Robert Bosch GmbH	Germany
14093	39	40	39	41	Are the units of manufacturing emissions correct ? Shouldn't it be emissions by vehicle produced instead of vkm ?	Accepted. Yes, that is a mistake. We will fix that.	Victor Garcia Tapia	International Energy Agency (IEA)	France
17975	39	40	39	41	Please check unit of measure, it should be grams, not tons of CO2eq per vkm, unless it's tons per vehicle and not per veh-km	Accepted. Yes, that is a mistake. We will fix that.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
47369	39	40	39	41	I think emissions should be lowered from 100 kg CO2eq/kWh to at most 80 kg and probably less by 2022. On page 39 line 40 it is claimed that manufacturing a BEV is assumed to cost 7-16t CO2eq and an ICEV 3.5-7. Assuming 1 tonne difference in drivetrain manufacturing emissions between ICE and BE, the battery production emits between 4.5 (= 7 - 3.5 +1) and 10 (= 16 - 9 + 1) tonnes of CO2eq. Assuming the largest battery is 100 kWh the CO2 intensity is 100 kg CO2eq/kWh (10 tonnes / 100 kWh). However, 100 kg CO2eq/kWh is outdated. The oft quoted study of Romare & Dahllöf from 2017 (Romare, M. & Dahllöf, L. The Life Cycle Energy Consumption and Greenhouse Gas Emissions from Lithium-Ion Batteries. 58 (2017)) had an mean of 125 kg CO2eq/kWh but was updated in 2019 (Emilsson, E. & Dahllöf, L. Lithium-Ion Vehicle Battery Production. 47 (2019).) and the new mean was 85 kg CO2eq/kWh. According to Hao 2017 it is 104 kg in China (and according to For China it could indeed be 104 (Hao, H., Mu, Z., Jiang, S., Liu, Z. & Zhao, F. GHG Emissions from the Production of Lithium-Ion Batteries for Electric Vehicles in China. Sustainability 9, 504 (2017)) and according to Yin 2019 (using GREET) it is 111 (Yin, R., Hu, S. & Yang, Y. Life cycle inventories of the commonly used materials for lithium-ion batteries in China. Journal of Cleaner Production 227, 960–971 (2019)). However Yin claims NCA in China (NCA is used in Tesla cars) emits 82 kg in China. And not all batteries are produced in China. Yin estimates that manufacturing in the US would be 58 kg for NCM and 42 kg for NCA. Melin 2019 pegs it at 73 kg on average and lower in Europe (Melin, H. E. Analysis of the climate impact of lithium-ion batteries and how to measure it, Transport & Environment, 17 (2019)). James Frith 2019 estimates 20-80 kg with the median around 35 kg but excluding mining (James Frith. Lithium-Ion Battery Manufacturing Emissions, BloombergNEF. (2019)). We have reason to believe the biggest battery manufacturer is now below 65 kg and we thing we can include this information in the publication we will submit in to the peer reviewd literature in time for the AR6 deadline.	Take into account. We take into consideration the point made by the reviewer, and we will review the papers suggested. However, the studies suggested are only assessing the production impacts of LIBs, while in our first round of reviewed papers we mainly focused on studies assessing full vehicles, and not each component separately. At the moment, the values presented are harmonized across several studies published between 2015-2020. Therefore, the ranges are above the current state-of-the-art impacts, as there is a clear temporal discrepancy between values reported in the literature and current impacts in the industry, as the latter is characterized by a fast-paced development. We believe that using the median values (as opposed to the mean) illustrates in Fig. 10.11 help avoiding the bias of the temporal discrepancy in the literature and the current industrial status.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
11825	39	43	39	43	on land-scale yes, but manufacturing plants often have high degree of renewable energy input.Please clarify if possible.	Noted. The sentence that the reviewer is refering to is addressing the current day production, which is largely using carbon-intensive electricity. There are of course many manufacturers planning to harness low carbon electricity but these currently do not represent the biggest battery manufacturers	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
42065	39	40	41	19	BEV manufacturing have a higher emission when compared with ICEV. This is due to the manufacturing of the battery cells, bit also to the manufacturing of the substantial power electronics interface devoted for battery charging and motor operation. The consequences of disposal of BEV´s should be also assessed, for the sake of the most complete picture.	Take into account. The disposal of BEVs is something we can expand on qualitatively. However, due to different LCA assumption for the EOL in the literature, it might be difficult to incorporate it in the figure.	Francisco Javier Hurtado Albir	European Patent Office	Germany
6421	39	40			The split of the battery component is necessary for the discussion	Accepted. We were planning to split the battery in the next phase.	Apostolos Petropoulos	International Energy Agency	France
47371	40	3	40	3	I must say I have problems reverse engineering 355 g CO2eq/vkm. Coal emits around 1 kg/kWh. An electric vehicle uses around 0.2 kWh/km including charging losses. So that makes 200 gr/km. This is simplistic but it's usually pretty close and I see it was also used in the graph on page 38. I have just explained that manufacturing should be 38 g/vkm but even if it was 80 g/vkm you would still be much lower. Could it be this is just some outdated value that slipped in?	Accepted. Numbers are coming from a handful of harmonized studies (for the period 2015-2020), and in the text we present both minimum and maximum values found in such studies. This will be made more clear once the uncertainty bars are added.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47373	40	3	40	3	Here I would add: "However, cars sold in 2020, driving on the average EU electricity mix over their lifetime (based on current policies and extrapolation of the trend of the past ten years) already reduce carbon emissions by over 50%." This from my short Joule article Hoekstra, A., 2019. The Underestimated Potential of Battery Electric Vehicles to Reduce Emissions. Joule 3, 1412–1414. https://doi.org/10.1016/j.joule.2019.06.002 but to be corroberated by a longer article featuring a broad group of authors by September 2020 (see remark 2 above).	Take into account. We will consider the article suggested by the reviewer	Auke Hoekstra	Eindhoven University of Technology	Netherlands
22873	40	6	40	8	A large share of pollution is due to brake wear, tyre wear and road surface wear - these would not be reduced by Evs - it is important to acknowledge this.	Accepted. Fair point, we will try to briefly include the matter in the text	Giulio Mattioli	TU Dortmund University	Germany
2883	40	6	40	9	Yes, BEVs eliminate tailpipe emissions but the issue of non-exhaust particulate matter remains.	Accepted. Fair point, we will try to briefly include the matter in the text	Nicholas Surawski	University of Technology Sydney	Australia
23859	40	6	40	9	What is about significant sources of fine dust (above all from tyre and brake dust) that occur independently of the vehicle type?	Accepted. Fair point, we will try to briefly include the matter in the text	Stefan Majer	German Biomass Research Centre - DBFZ	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11453	40	20	40	35	According to the report of IEA "The Future of hydrogen" https://www.iea.org/reports/the-future-of-hydrogen, FCEV seems to have a potential to be more cost competitive in terms of total lifecycle cost over BEVs in the future. This section should consider such potential of FCEV though there are a lot of technical challenges are remaining.	Accepted. We aim to qualitatively discuss future cost trajectories for all the technologies, in the SOD, based on the current knowledge and R&D challenges. It may, however, be challenging to quantify costs and emissions of future technologies.	TAKAO AIBA	Japan Automobile Manufacturers Association / Toyota	Japan
31289	40	20	40	35	Deeper examination of FCEV's CO2 reduction potential is needed. In FOD, CO2 emission at FCEV production is about 2 times that of ICEV (P10-38 Figure 10.11), and CO2 emission at H2 production by methane reforming is 130g CO2/km (P10-4 L24-26). These cause FCEV's life cycle CO2 reduction effect is almost zero. However, in Reference 1, even if the CO2 emissions at FCHV production is estimated 1.5 times that of ICEV (P67 Table 4.2) and the CO2 emissions at H2 production is estimated at 200 g CO2/mile (about 125 g CO2/km) which is equivalent to FOD. It is shown that FCEV' s life cycle CO2 emission is 27% lower than that of ICEV and equivalent to HEV. (In reference 3, 180,000mile is used for lifetime driving distance (P67 Table 4.2) and 180,000 km is used in FOD (P67 Table 4.2). But FCEV's life cycle CO2 emission is still calculated 22% lower than that of ICEV when 180,000 km is applied.) Regarding FCEV's CO2 reduction potential, we need more careful consideration about CO2 emission at vehicle production, mileage and H2 consumption during driving. CO2 emissions during H2 production is significantly different by its method like alternative fuel for ICEV, (It is described in FOD(P10-35 16-20, P10-36 1-4, Figure 10.9) for alternative fuel and reviewed in reference 2 for H2; E4tech report in April 2019). Thus, FCEV has the potential to further reduce CO2 emissions over life cycle by using H2 from renewable energy. And we need to consider CO2 emission at H2 production and also its cost since both depend on countries and regions (as described in FOD (P10-35 16-20, P10-36 1-4, Figure 10.9)). I would expect these points to be taken into account in Chapter 10 toward SOD. Reference 1: MIT Energy Initiative (2019). INSITES INTO FUTURE MOBILITY - A report from the Mobility of the Future study -. http://energy.mit.edu/publication/insights-into-future-mobility/ Reference 2: E4tech (UK) Ltd. (2019). H2 EMISSION POTENTIAL LITERATURE REVIEW. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/798243/H2_Emission_Potential_Report_BEIS_E4tech.pdf	Take into account. Regarding the first point, the difference in our results can be justified by the harmonization of several studies taken into account. The difference in production emissions between the source cited by the reviewer and our median value already justifies the difference in the total impacts. With more studies currently under our review, we expect to approach the trends presented by the reviewer. Regarding the H2 production pathway, we aim to include this point, describing how low-carbon energy carriers can be beneficial for the overall lifecycle emissions of the technology. Furthermore, costs will be analyzed for the SOD.	Eiichi Ono	Toyota Technological Institute	Japan
14095	40	21	40	21	Are the units of manufacturing emissions correct ? Shouldn't it be emissions by vehicle produced instead of vkm ?	Accepted. Yes, that is a mistake. We will fix that.	Victor Garcia Tapia	International Energy Agency (IEA)	France
17977	40	21	40	21	Please check unit of measure, it should be grams, not tons of CO2eq per vkm, unless it's tons per vehicle and not per veh-km	Accepted. Yes, that is a mistake. We will fix that.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
28593	40	24	40	26	Source?	Accepted. We will add a reference to that sentence. (At the moment value based on a handful of studies reviewed).	Paul Wolfram	Yale University	United States of America
11479	40	41	40	43	" Life cycle emissions intensity for two -wheelers is also generally lower than LDVs on a vehicle-kilometer basis, however, generally have less carrying capabilities than LDVs, so this may change on a passenger -kilometer basis." -However, based on current occupancy values on an average across cities and countries, this is not true.	Accepted. Modify this sentence to acknowledge that generally LDVs have low occupancy rates.	Sudhir Gota	Independent Consultant/Researcher	India
22875	40	41	40	43	I don't think that would change that much on a passenger-km basis as the occupancy of four-wheelers is typically very low	Accepted. Modify this sentence to acknowledge that generally LDVs have low occupancy rates.	Giulio Mattioli	TU Dortmund University	Germany
42267	40	41	40	43	This many not necessarily be accurate. It should be mentioend that the average occupancies for cars and 2wheelers may not necessarily deviate significantly, particularly for certain types of trips (e.g. car commuting trips in EU are 1.1-1.2 pax / vehicle only) https://www.eea.europa.eu/publications/ENVISSUENo12/page029.html	Accepted. Modify this sentence to acknowledge that generally LDVs have low occupancy rates.	Alvin Mejia	Wuppertal Institute	Germany
45181	40	41	40	43	Lifecycle emissions of electric two-wheelers are substantially lower compared to petrol-fuelled motorcycles, even for a coal-based grid. This is an often overlooked points and needs to be quantified (see for example IEA EV Outlook 2018). Indeed, over 80% of the 29 million tonnes of CO2 savings in 2017 by all types of electric vehicles globally are due to e-bikes in China. The point on the occupancy rate /carrying capacity of two-wheelers compared to cars is hardly relevant (outcomes are similar)	Take into account. Although a comparison between motorbikes and e-bikes is somewhat disengenuous. However, a more comprehensive data collection on LCAs of 2-wheelers is planned, if data is available. This will also facilitate a deper discussion in the text.	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
31233	40	46	40	47	like for BEV also ICEV, HEV and PHEV have further GHG reduction potentials: using low-carbon fuels. For BEV the reduction potential is also mainly driven by the change of the energy carrier: switching from carbon intensive electricity to low carbon electricity. Similar physics and logic applies to other technologies, i.e. switching from fossil fuels (high carbon intesity) to biofuels (where available) or carbon neutral PtX fuels (if the market pays for them).	Accepted. We agree with the first point. In addition, biofuels will be added. Regarding low-carbon combustion fuels, such as methane or hydrogen or ammonia, does not seem like a viable development pathway, compared to BEVs, FCEVs and conventional PHEVs.	Urs Ruth	Robert Bosch GmbH	Germany
46953	40	48	41	4	It would be helpful here to cross-reference sections of the report on the energy sector and its likely progress on decarbonisation in different markets/ geographies. The issue of how electricity is generated is an easy stick to hit the hybrid/ electric vehicle market with, especially in the short term. But as mentioned later in the report (pg. 61 lines 41 - 42) transport is one of the most difficult sectors to decarbonise. Progress in other sectors will therefore be critical, and cross-referencing to how and where this is achievable, deliverable and feasible would add value.	Accepted. We can cross-reference with the energy chapter, regarding the first point. We can attempt to address the last point raised by the reviewer, but it might be very challening to do so in a detailed manner.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
35811	41	7	7	41	"Historically, buses have been powered with diesel fuel". Please check if this is historically true. From a visit to the museum of transport in the UK, I have the filling electric buses were introduced before. I don't have any ref however.	Accepted. We will correct the statement. We meant to say that for the last 70 years (at least) diesel has been the primary fuel used for buses	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
35813	41	12	21	41	Although Africa is behind there is a recent trend to develop metros and tramways in Africa for instance Nort Africa, Ethiopia, Nigeria and very likely quite a few other cities	Take into account. We will review this trend, but more details about adoption of the different technologies will be the focus of the scenarios section	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
31571	41	4	41	4	There is this synergy between the energy transition and the electrification of vehicles which you may emphasise more strongly here by adding after this sentence: "Hence, a successfull energy transition in the power sector helps these technologies to mitigate GHG emissions and vice versa EV may helpt to accelerate the energy transition in the power sector by providing high load flexibilities and help to integrate more electricity generation by renewable energie sources such as wind and solar (cf. Chapter 6).	Take into account. This is a good point. We will consider that.	Patrick Jochem	German Aerospace Center (DLR)	Germany
42269	41	5	41	30	Transit-related improvements that encompasses dimensions aside from drivetrain systems should be discussed (e.g. how electrification, combined with digital technologies are being combined to provide system wide high quality mobility services in order to encourage modal shifting). I would actually suggest bringing a balance between the "avoid, shift, improve" strategies in each of the sub-sections, which currently primarily focuses on technology improvements.	Accepted and revised.	Alvin Mejia	Wuppertal Institute	Germany
47375	41	6	41	11	This gives the impression that a range of technologies for busses is in development. This is not correct from what I see. I see very little biofuels while natural gas is on the way out. In the Netherlands and China electric is basically replacing diesel at breakneck speed without competition to speak of from other low carbon options and from what I see from other countries they are also going for this. Of course there are a few hydrogen pilots but only with very large EU subsidies and only in small numbers.	Section 10.4 aims to characterize the LC emissions of the different technolgoies available. Section 10.7, which relies on IAP and transport models, will focus on evaluating deployment scenarios	Auke Hoekstra	Eindhoven University of Technology	Netherlands
23861	41	10	41	10	I wonder why Biomethane as renewable alternative to CNG is not mentioned here.	Accepted. We will include in the SOD as data permits	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
18203	41	12	41	14	Please modify to: „Passenger light and heavy rail is another alternative mode of passenger transport that could support decarbonization of land-based passenger mobility consistent with strong climate mitigation targets. Rail systems can provide urban services (metro or tramway systems, mostly as light rail), as well as longer distance transport (heavy rail) (UITP, 2019).“ UITP, 2019: Light Rail and Tram – the European Outlook. UITP, November 2019 UITP, 2019: The Global Tram and Light Rail Landscape. UITP, October 2019	Accepted.	Manfred Treber	Germanwatch	Germany
2657	41	20	41	21	Trains: followed. However this passage recognizes that energy issues and decarbonation potential are present in the train sector. Why then electricity? What about low carbon hydrogen? Germany is apparently betting on hydrogen for trains. It is suggested that train transportation be indicated as an issue that deserves further attention and maybe an issue suffering a gap of knowledge.	Accepted. We would like to include hydrogen for trains but we need to have data about it. Hopefully, we will be able to include when we get data from the community	Philippe Waldteufel	CNRS/IPSL/LATMOS	France
34925	41	23	41	25	If possible, to be supported by relevant data	Accepted. Add the following citations: Ercan et al (2015), Tong et al (2017)	ANUPAM DEBSARKAR	University	India
17979	41	25	41	25	Life cycle costs of e-buses is a fast changing topic. I would refrain from writing it in this IPCC report that CNG buses are cheaper on that metric. Better to focus on the more stable and predictable air quality and GHGs indices.	Accepted. This comment also relates to costs and potentials, which we are still trying to figure out.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
29205	41	29	41	30	Lifecycle analyses generally are a good idea but also rather tricky. And in a 1.5-2.0 ° C world they become even more tricky because all sectors have to go to zero. What lifecycle analysis often does is look back at the total emissions involved in a certain amount of transportation by rail (or any other mode). Emissions involved in building trains adds generally a couple of pe cents to the operational emissions 9if these are still based on electricity from coal-powered plants. The main contribution comes from building the infrastructure and then steel and concrete cement involved with that. That may add anywhere between 10% to more than triple the emissions. However, the main parameter here is the use of the line. On highly used lines, the building emissions are divided over many more seatkms. Therefore, lifecycle is only relevant for plans of new infrastructure. Current rail infrastructure is running in many places at close to its maximum capacity, but in many other places it is not. So every 100-150 passengers deciding to not fly but take a train in a country with (almost) zero-emissions rail operation (Sweden, Switzerland, Austria, Parts of Germany, The Netherlands, Norway, most of France) will reduce the emissions of the avoided airplane flight by almost 100%. Only in case of planned infrastructure building, may apply lifecycle emissions, but those need to be based on an assumption with respect to the effect of UNFCCC Paris agreement and NDC policies. This is important because for instance the steel industry is already in the process of reducing its emission by between 30% (HIsarna at Tata Steel https://www.tatasteeleurope.com/en/sustainability/hisarna) to almost 100% (Swedish steel industry, https://mb.cision.com/Main/980/2961494/1141285.pdf), while also in cement and concrete production now steps are being considered to reduce emissions (e.g. https://www.euractiv.com/section/energy/news/worlds-first-zero-emission-cement-plant-takes-shape-in-norway/). More general opportunities given by Bataille (2020). Furthermore, care should be taken to assume reasonable volumes using the new infrastructure, based on integrated measures to promote such a shift from air and car travel and a more difficult to assess, socio-cultural factor that may further shift air and car to rail (e.g. flight shame). An undifferentiated LCA might give the impression that rail is no solution, while railways and public transport companies are well-ahead of car and aviation in realizing zero-emission transport. Bataille, C. (2020). Low and zero emissions in the steel and cement industries: Barriers, technologies and policies. Paris: Lifecycle analyses generally are a good idea but also rather tricky. And in a 1.5-2.0 ° C world they become even more tricky because all sectors have to go to zero. What lifecycle analysis often does is look back at the total emissions involved in a certain amount of transportation by rail (or any other mode). Emissions involved in building trains adds generally a couple of pe cents to the operational emissions 9if these are still based on electricity from coal-powered plants.	Later versions clarified this.	Paul Peeters	Breda University of applied sciences	Netherlands
29205	41	29	41	30	The main contribution comes from building the infrastructure and then steel and concrete cement involved with that. That may add anywhere between 10% to more than triple the emissions. However, the main parameter here is the use of the line. On highly used lines, the building emissions are divided over many more seatkms. Therefore, lifecycle is only relevant for plans of new infrastructure. Current rail infrastructure is running in many places at close to its maximum capacity, but in many other places it is not. So every 100-150 passengers deciding to not fly but take a train in a country with (almost) zero-emissions rail operation (Sweden, Switzerland, Austria, Parts of Germany, The Netherlands, Norway, most of France) will reduce the emissions of the avoided airplane flight by almost 100%. Only in case of planned infrastructure building, may apply lifecycle emissions, but those need to be based on an assumption with respect to the effect of UNFCCC Paris agreement and NDC policies. This is important because for instance the steel industry is already in the process of reducing its emission by between 30% (HIsarna at Tata Steel https://www.tatasteeleurope.com/en/sustainability/hisarna) to almost 100% (Swedish steel industry, https://mb.cision.com/Main/980/2961494/1141285.pdf), while also in cement and concrete production now steps are being considered to reduce emissions (e.g. https://www.euractiv.com/section/energy/news/worlds-first-zero-emission-cement-plant-takes-shape-in-norway/). More general opportunities given by Bataille (2020). Furthermore, care should be taken to assume reasonable volumes using the new infrastructure, based on integrated measures to promote such a shift from air and car travel and a more difficult to assess, socio-cultural factor that may further shift air and car to rail (e.g. flight shame). An undifferentiated LCA might give the impression that rail is no solution, while railways and public transport companies are well-ahead of car and aviation in realizing zero-emission transport. Bataille, C. (2020). Low and zero emissions in the steel and cement industries: Barriers, technologies and policies. Paris:	Later versions clarified this.	Paul Peeters	Breda University of applied sciences	Netherlands
34927	41	37	41	38	If possible, to be supported by relevant data	Later versions clarified this.	ANUPAM DEBSARKAR	University	India
27037	41	38	41	41	What about changes to freight distribution networks? Electrifying smaller vehicles for the last part of the journey into town-centres and cities is much more feasible in the short-term than electrifying large freight. When is the wide-spread electrification of freight expected? This paper has it occuring at the latter part of the century - https://doi.org/10.1016/j.trd.2016.10.007	Accepted and revised.	Thomas Longden	Australian National University	Australia
31235	41	40	41	40	additionally to biofuels: synthetic carbonhydrocarbons (based on renewable electricity)	Take into account. We are trying to include synthetic hydrocarbons and hope we will be able to get data from the community	Urs Ruth	Robert Bosch GmbH	Germany
42271	41	31	43	7	Similarly, this section should be more encompassing, and not just focused on drivetrains and fuels.	Accepted and revised.	Alvin Mejia	Wuppertal Institute	Germany
22877	41	5			This sub-section is very short as compared to the others, and it would benefit from being expanded. For a recent study on the economic aspects of this see Tirachini, A., & Antoniou, C. (2020). The economics of automated public transport: Effects on operator cost, travel time, fare and subsidy. Economics of Transportation, 21, 100151.	Accepted. We will expand as needed in the SOD	Giulio Mattioli	TU Dortmund University	Germany
6423	41	36			There are some recent finding that CNG engines are not declining a lot the pollutant emissions	Noted. The plan is to inclde a discussion about co-benefits from the different technologies, in which we will discuss the impact on local air pollutants.	Apostolos Petropoulos	International Energy Agency	France

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
47871	41				For recent analysis on carbon/energy reduction potential of Hydrogen-EV for freight transport see: Talebian, H., Herrera, O., Tran, M., Merida, W. (2018) Electrification of Road Freight Transport: Policy Implications in British Columbia, Energy Policy 115: 109 – 118. Talebian, H., Herrera, O., Tran, M., Merida, W. (2018) Potential for hydrogen as a transportation fuel in British Columbia: Resource assessment and GHG emissions analysis. Transportation Research Board 97th Annual Meeting, Issue 18-03352.	Accepted. We will include the life cycle estimates from these studies in the SOD	Martino Tran	University of British Columbia	Canada
47909	42	3	42	35	This section and Table 10.12 and 10.13 for trucks do attempt to show ranges of values based on different studies, and I admit that now my comment shifts - this is a mess. You cannot draw any real conclusions about different technologies from these tables, the data are all over the place. Somehow this IPCC report has to help us narrow down the ranges and give us apples-apples comparisons. I don't believe that FCVs will ever have more GHG emissions than diesel trucks, for example. Why not a table with some simple calculations on the emissions given average efficiency, fuel carbon content, and upstream emissions? You could show that and then show how some of these vary because of specific assumptions made in reports. I realize this is a tough job and you are onyl supposed to draw on literature, but right now Tables 10-12/13 just create confusion, not clarity. And a last point, since I am not sure where else to put it - the report neds to give us some real guiadance one whether we should do BEV or FCV (or something else) for various types of vehicles. We are running out of time and need to make some global choices, and this report needs to help with this. Basically, should we go all in on BEVs and PHEVS and stop working on FCVs? Or should we keep hedging our bets? Where can we be confident that FCVs are a winner, to build on? That kind of discussion would be great to see.	Accepted. Agreed - can't conclude much the way the data is currently presented. Will conduct a harmonization of the different trucking fuel options. Some guidance on whether to go all in on BEV vs FCV, etc. will naturally arise from the harmonization and the resulting ranges. A complete answer to the question of the style "should go all in on BEVs and stop working on FCVs" would require substantial technology forecasting that is beyond our scope. Can add some brief discussion, however, of the conditions required for one technology to be the "winner".	Lewis Fulton	University of California, Davis	United States of America
31573	42	7	42	11	You may also add Plötz et al. 2019. Plötz, P.; Gnann, T.; Jochem, P.; Kaschub, T.; Yilmaz, Ü. (2019): Impact of Trolley Trucks on the European Electricity System and CO2 Emissions, Energy Policy 130, 32-40, doi: 10.1016/j.enpol.2019.03.042.	Accepted. Will add.	Patrick Jochem	German Aerospace Center (DLR)	Germany
47377	42	22	42	23	"None of the values reported in the figure have been harmonized for consistency in assumptions." This is about figure 10.12. I assume this will be done later and I would be willing to help. I think it is really imporant that we get figure 10.11, 10.12 and 10.13 right. And it might seem I have a pro BEV bias but that's not the case I think. I think it is the inherent time-lag in scientific literature combined withe the rapid developments in BEV that are the explanation here. And anyway I love getting such complex sums right and am always willing to learn from others. AR6 should be a really good document imho.	Noted. The plan is to perform a harmonization of the LCA literature based on data provided by the community	Auke Hoekstra	Eindhoven University of Technology	Netherlands
11775	42	24	42	24	Should read "10.13", not "10.12"	Accepted. Ok	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
28595	43	1	43	1	Why is "Conventional diesel 2050" THAT low? This probably needs more data points or some explanation or both.	Accepted. Agreed; this will be clarified in the harmonization exercise.	Paul Wolfram	Yale University	United States of America
9607	43	1	43	3	The panel on heavy-duty trucks should contain ethanol (ED95) for trucks. The company Scania (or CleanFlame Engines) should be able to assist with data.	Accepted. Will look for peer reviewed studies. If unavailable, can mention the fuel option and state lack of LCA data	Jesper Kløverpris	Novozymes	Denmark
45175	43	1	43	3	The first hydrogen fuel cell train was operational since Sept2018 (Coradia iLint trains for a 100km route in northern Germany) and is going to be tested in the Netherlands. This is a major development. If there were any life cycle GHG emissions data please include.	Accepted. Ok	Cheah Singfoong	Independent consultant, formerly more than 10 years with the National Renewable Energy Laboratory, USA	United States of America
23863	43	2	43	2	Please add a simplified legend to the figure. Is this including vehicle manufactring / recycling or not? Is FT diesel based on renewable feedstocks? Why e-fuels / PTx fuels (power-to-x-fuels) have been not considered?	Take into account This has been described on page 10, line 9 and line 25.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
47379	43		43		Figure 10.12 about the LCA GHG emissions for land based freight. The figure contains conventional diesel 2050 and I know these studies: they are very optimistic. Why not BEV 2050? This is why I work so hard on BEVs: because the combination of low carbon electricity and BEVs could really lower emissions. Also I would like to point out that HEV Diesel probably did not include ILUC effects. Harmonising all these studies so that the base assumptions about lifetime and energy use of the vehicle etc are the same would be a lot of work but I would learn something and I can ask help from 2 PhD students from the NEON project. As it stands it's just a summary of all articles found without clarity on who said what and why.	Accepted. Will undertake a harmonization, and will ensure there is a BEV + low carbon electricity scenario within it	Auke Hoekstra	Eindhoven University of Technology	Netherlands
31245	43	1	44	1	Explain the meaning of different color shadings and of the black squares in the diagrams.	Take into account. This has been described on page 10, line 9 and line 25.	Urs Ruth	Robert Bosch GmbH	Germany
6425	43	2			Labels from the figure are missing	Take into account. This has been described on page 10, line 9 and line 25.	Apostolos Petropoulos	International Energy Agency	France
31237	44	4	44	4	Figure 10.13 does not provide a neutral overview (most likely also the figures before). Studies considered seem to use completely different assumptions for the energy source. Heavy duty truck "fuel cell gaseous" reflectst 2 scenario: H2 from low-carbon source and higher (SMR??) whereas for liquid H2 only a high-carbon source is stated. FT-Diesel, DME, etc. are produced from which source? Electricity based (eFuel with which electricty mix?) or from gas/coal ?? This is very misleading. FT-Diesel should be replaced by PtX-Diesel with low carbon intensity electricity derived from renewables.	Accepted. Will conduct a harmonization of the different fuel options to ensure consistent assumptions	Urs Ruth	Robert Bosch GmbH	Germany
23865	45	1	45	1	Recommendation to also highlight that electric mobility will not be able to solve this on its own, and renewable transport fuels (esp. for existing fleets) will help to bridge the gap between GHG emission reduction targets and the prospected emission reductions. Cf. also IEA/EC study mentioned above	Accepted and revised.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31291	45	1	45	44	Consideration of CO2 reduction measures based on regional characteristics is required. CO2 reduction effect varies greatly depending on the combination of the powertrain type of the vehicle and the CO2 emissions at fuel (gasoline, diesel, biomass, electricity and hydrogen) production. It is shown in Reference 1 (P90 Figure 4.22, 4.23) that ownership cost, which is summation of vehicle purchase cost and fuel cost, varies depending on the vehicle price, gasoline price, and electricity price. It is concluded that the optimal solution differs depending on county and region. Furthermore, consideration for end of life recycling cost becomes more important. And it is shown in Reference1 (P49 Figure 14) that the price potential of H2 from renewable energy (which has same trend of renewable electricity price) varies greatly depending on the region. Therefore, when we evaluate vehicle powertrain types, detailed analysis of CO2 emissions at fuel production (including transportation and storage from a well-to-tank point of view) is required considering with characteristics of each country and region. I would expect these points to be taken into account in Chapter 10 toward SOD. Reference 1: IEA (2019). The Future of Hydrogen. https://www.iea.org/reports/the-future-of-hydrogen	Noted. Section 10.4 is not spatially explicit as we are attempting to summarize the life cycle GHG emissions for individual technology options. Through a harmonization effort, we will attempt to remove geographic-specific biases in the values. A discussion about spatially-explicit emissions and costs will be included in the scenarios section.	Eiichi Ono	Toyota Technological Institute	Japan
36169	45	1	45	44	Bicycle and E-bikes have not been looked into at all. Increasing number of cities are considering to buit bicycle lanes in order to ease traffic and also to promote eco-friendly image. Construction of a bicycle lane is one of the best and cheapest options to reduce emissions from road traffic.	We can include e-bikes in section 10.4. Discussions about biking infrastructure will be included in the section about systemic transitions	Arvind Gangoli Rao	Delft University of Technology	Netherlands
11169	45	2	45	44	I lack an assessment of the behavioral changes that follow from technological changes. The review in 10.4 is just a technological review. But a change in technology also means a change in driving costs, people's interest in cars and their environmental concerns about driving. One study that look at this and surveys some of the literature is: Kverndokk, S., E. Figenbaum and J. Hovi (2020): Would my driving pattern change if my neighbor were to buy an emission-free car?, Resource and Energy Economics, Volume 60, in progress (May 2020)	Accepted and revised.	Snorre Kverndokk	Frisch Centre	Norway
35815	45	4	45	5	To be accurate fig 10.14 should show that LPG can be obtained in the oil fiels just by a separation without refining. The former is also an important source of LPG supply. A rough estimate is that more than 50% comes from oil fiels and of course the reste from refineries. This may have an impact on some small oil producing countries without refineries.	Take into account. I will need to review the data to confirm this statement.	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
31239	45	6	45	7	this is a quite general statement and does not reflect different segments or regional operation .. at least for the next decade. "Of the available technologies and fuels, vehicle electrification offered the greatest opportunity for decarbonization of personal passenger transport provided that they are operated in a low carbon electricty mix. "	Take into account. We can confirm this statement using the results from the IAM and transport models and will update as needed	Urs Ruth	Robert Bosch GmbH	Germany
47383	45	8	45	12	"IAMs show the market share of BEVs growing in the most ambitious climate stabilization scenario's." I've been predicting EV uptake with some success in the past 10 years and I've made endless sticker price and TCO calculations and I can say that this phrase is beyond conservative. It's completely unrealistic. In 2025-2030 you will walk into a showroom and you will be able to choose between a BEV with a 450km range that drives super-sporty and an ICEV that's a bit more expensive. You will know that the running costs of the BEV will be about half or less. Why you would assume that most people will still buy the ICEV unless we have the "most ambitious climate stabilization scenarios" is beyond me. Saying most people will still buy ICEV in 2030 unless we have strong climate policies is like saying that most peopole will still buy incandescent light bulbs in 2021 unless we have strong climate policies. Yes we need charging infrastructure but that will follow when the demand is there. We need to use capitalism to our advantages if we find we can do so now and then.	Take into account. This sounds like an opinion of the reviewer. We can only rely on the information available in the literature. We will need to carefully draft a response to this comment.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
23867	45	16	45	18	"Natural gas-based fuels could also provide some carbon benefits relative to diesel-powered buses, but these technologies will not lead to deep decarbonization of the bus fleets.": Positive GHG impacts can been seen in case renewable methane (e.g. bio-CNG, Bio-LNG) is applied.	Accepted. We need to include renewable methane	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
28597	45	16	45	18	Has the risk of methane leakage been mentioned already (https://doi.org/10.1016/j.apenergy.2019.03.196)?	Accepted. We should add a mention about methane leakaga when we discuss natural gas based fuel. Hopefully we can include a methane leakaga rate in the harmonization process.	Paul Wolfram	Yale University	United States of America
27039	45	19	45	22	This discussion of electrifying medium and heavy-duty freight should include a discussion of when these vehicles may become viable. As mentioned above, this paper has the electrification of freight occuring at the latter part of the century - have battery costs come down so much? - https://doi.org/10.1016/j.trd.2016.10.007	Accepted. Will include a comment about current viability. Beyond scope of the chapter to project a specific viability timeframe.	Thomas Longden	Australian National University	Australia
47385	45	19	45	28	By now it will be clear that I think heavy BEV trucks will find rapid adoption after 2025. See remarks above and the peer reviewed paper we will submit within the AR6 timeline.	Accepted. Will cite the paper when published. This will also help address the viability comment in row 29	Auke Hoekstra	Eindhoven University of Technology	Netherlands
36165	45	21	45	21	"associated" and not "associate"	Accepted. Ok	Arvind Gangoli Rao	Delft University of Technology	Netherlands

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31293	45	40	45	44	Comprehensive analysis is required taking into account the costs for CO2 reduction. Life cycle CO2 emissions (180,000km driving distance) depending on the combination of powertrain type and fuel are shown in FOD (P10-38 Figure 10.11). BEV (170g-CO2/km) is estimated 15% less than that of ICEV (200g-CO2/km). But CO2 reduction cost is not mentioned in FOD. In Reference 1 Figure 4.18, ownership cost; which is summation of vehicle purchase cost and fuel costs, is discussed in case of 150,000 mile driving distance. BEV (0.51$/km) is estimated 12% higher than that of ICEV (0.46$/km). On the other hand, BEV (199g-CO2/km) is estimated 46% less than that of ICEV (370g-CO2/km) in terms of lifecycle CO2 emissions (shown in Figure 4.6). This trend is same when we calculate 180,000km driving distance which is used in FOD, as the ownership cost of BEV (0.50$/km) is estimated 16% higher than that of ICEV (0.43$/km) and lifecycle CO2 emissions of BEV (152g-CO2/km) is estimated 39% less than that of ICEV (248g-CO2/km). The difference about the lifecycle CO2 emissions between FOD and Reference 1 is supposed to be from the difference of vehicle size, driving conditions and so on. But when we compare BEV and ICEV, it is necessary to consider the balance between amount of lifecycle CO2 reduction and increase of ownership cost since there is a trade-off between them. Ownership costs are affected by driving distance, vehicle prices, fuel prices and subsidies, then comprehensive discussion considering all the aspects, is required taking into account the costs for CO2 reduction. In order to achieve both CO2 reduction target and sustainable economic development, a well-balanced policy that takes into account the costs required for CO2 reduction is necessary. I would expect these points to be taken into account in Chapter 10 toward SOD. Reference 1: MIT Energy Initiative (2019). INSITES INTO FUTURE MOBILITY - A report from the Mobility of the Future study -. http://energy.mit.edu/publication/insights-into-future-mobility/	Take into account. In the SOD we aim to discuss and illustrate with a figure the lifecycle cost for the different LDV technologies, which in turn means that we also will discuss the points made by the reviewer, if all the reviewed papers will support those conclusions. The approach described by the reviewer is the same we were planning to take to calculate the mitigation cost of the technologies. We will also discuss the aspects affecting cost as the reviewer suggests.	Eiichi Ono	Toyota Technological Institute	Japan
11171	45	1	59	18	Both sections 10.5 and 10.6 are summarized with a Synthesis that is basically an emissions scenario. However, this is not done in section 10.4. The sections should be summarized in the same way.	Take into account. We need to think about how to structure sectiosn 10.4, 5 and 6 so they are somewhat consistent.	Snorre Kverndokk	Frisch Centre	Norway
31253	45	1			It should be mentioned that for propper governance it will be important to monitor the real driving CO2 emissions of the vehicles. In the past, the discrepancy between catalogue consumption and real driving consumption has tremendously increased, and also the introduction of WLTP will not stop this discrepancy. In addtion, by market introduction of PHEVs the catalogue values for these vehicles are extremely low, while real driving emissions are very high. As was done for e.g. NOx and PM emissions (moving from test cycle emissions ot real driving emissions) should also be done for CO2 emissions (i.e. fuel consumption). This appears to be no more than a byrocratic act, but, in fact it is crucial to prevent the car market developing into a non-useful direction!	Take into account. We can only rely on what is available in the literature. In so far as the LCA studies make assumptions about driving conditions, our values will include them.	Urs Ruth	Robert Bosch GmbH	Germany
23869	46	3	46	3	GHG mitigation costs? Why for 2015 and not for 2018/19? Will all values be normalised to on reference year?	Accepted. We are still working out how to deal with mitigation costs.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
36167	46	3	46	4	bars for several vehicle types are missing in the top left figure	Take into account. This figure was meant to be a placeholder only, and will be expanded with further data (including technology types) in the SOD	Arvind Gangoli Rao	Delft University of Technology	Netherlands
47387	46	3	46	4	Would love to provide the 2030 data in this table. Would also like to add heavy trucks. This is also important for the table in chapter 12 that Kornelis Blok will fill with climate mitigation potentials 2030 for (among others) electric LDVs and electric HDVs.	Accepted. Will aim to mirror the LDV presentation in the HDV figure	Auke Hoekstra	Eindhoven University of Technology	Netherlands
9609	46	5	46	8	It is suggested to also draw a line from the box with 'Biogas, alcohol-based fuels' to the Fischer-Tropsch box (right beneath) because biogas production and alcohol fermentation can also deliver captured CO2 for production of synthetic hydrocarbons.	Take into account. We will consider doing so	Jesper Kløverpris	Novozymes	Denmark
23871	46	6	46	6	Many relevant options are not included here (e.g. HVO/HEFA, Gasoline from MTG, DME, OME, e-fuels/PTx-fuels or SynBioPTx fuels). Cf. for instance here http://www.etipbioenergy.eu/images/AllBiofuelFactsheets2016.pdf	Take into account. We could expand the figure as needed	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
34929	47	7	47	7	use of the word "yet" made twice unnecessarilly	editorial - noted	ANUPAM DEBSARKAR	University	India
28007	47	13	47	38	The most detailed paper on aircraft CO2 emissions is Wilkerson, J.T., M.Z. Jacobson, A. Malwitz, S. Balasubramanian, R. Wayson, G. Fleming, A.D. Naiman, and S.K. Lele, Analysis of emission data from global commercial aviation: 2004 and 2006, Atmos. Chem. Phys., 10, 6391-6408, 2010. Please include.	Noted. Predates literature assessment and the model is included from ICAO	Mark Jacobson	Stanford University	United States of America
14097	47	15	47	15	Section XX ?	editorial - noted	Victor Garcia Tapia	International Energy Agency (IEA)	France
29323	47	15	47	15	Correct the reference "(see section xx).	editorial - noted	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
39229	47	18	47	21	The discussion of the ICAO emission inventories would benefit from a reference to those publications or that data.	Accepted	Steven Baughcum	Boeing Company	United States of America

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36563	47	21	47	21	“ICAO addresses on”, not “focus on”? Domestic aviation should be regulated by national jurisdiction.	Accepted	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
14099	47	23	47	25	I suggest to reference directly the specific IEA database (IEA (2019), "CO2 Emissions from Fuel Combustion 2019", IEA, Paris https://www.iea.org/reports/co2-emissions-from-fuel-combustion-2019)	Accepted	Victor Garcia Tapia	International Energy Agency (IEA)	France
34311	47	26	47	31	Suggestion, mention here IAE statistics in addition to various National agencies in particular for respective types of fuels	Accepted	Antoine BONDUELLE	Climate Action Network France	France
41269	47	26	47	31	This para contains very important info - not only for this chapter but also for other chapters in WGIII. Thus, I hope this can be highlighted in the ES of Ch10, and in TS and SPM. In addition to explaining role of aviation (and shipping) in NDCs and PA, the reports should also be sure to adress the implications of this.	Accepted	Jan Fuglestvedt	CICERO	Norway
36489	47	28	47	31	What does "(unlike)" means? Please describe precisely. Article 2.2 of Kyoto Protocol mentions how to deal emission from aviation and maritime clearly.	Accepted	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
18205	47	32	47	32	In 2018, emissions of CO2 from global aviation were just over 1 Gt of CO2" 1. What is the source ? 2. The report should remind that CO2 emissions related to the production, refining and distribution of jet fuel (+ 20%, ie 0.2 Gt) are not included.	Noted	Manfred Treber	Germanwatch	Germany
34313	47	32	47	32	Figures are not sourced, and does not mention upstream emissions in transport and refineries to be included in National inventories.	Noted	Antoine BONDUELLE	Climate Action Network France	France
31241	47	32	47	34	for a better understanding, the increase in transport capacity in the corresponding periods should also be stated here	Accepted, add data	Urs Ruth	Robert Bosch GmbH	Germany
38049	47	33	47	34	Over the period 2010-2018, a sharper increase of 27% in total in the global CO2 emissions has been observed. The question is what would be the reason behind? Would this trend remain in the future?	Noted: add qualification of increase in demand	FEIJIA YIN	Delft University of Technology	Netherlands
11777	47	34	47	35	Please clearify that it is 65 % of emissions from aviation like this:"International emissions of aviation are calculated by ICAO to be 65 % of global emissions from aviation..."	Accepted	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
25201	47	34	47	36	International emissions of aviation cannot be 65% of global emissions. Please correct this statement	Accepted	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
34931	47	34	47	38	parity of the information may be verified	Noted. Unclear	ANUPAM DEBSARKAR	University	India
18207	47	36	47	37	Current (2018) total CO2 emissions from aviation represent approximately 2.4% of total anthropogenic emissions of CO2" The report should remind that CO2 emissions related to the production, refining and distribution of jet fuel are not included, and that, when included, aviation is responsible for 2.8% of total anthropogenic emissions of CO2.	Rejected, this confuses the discrimination of sectors in the report	Manfred Treber	Germanwatch	Germany
34315	47	36	47	37	The figure should be 2,8 with upstream included	Rejected, this confuses the discrimination of sectors in the report	Antoine BONDUELLE	Climate Action Network France	France
18209	47	40	47	43	1. What is the definition of "climate forcing" ? Is it RF, or ERF like in page 10-48 lines 1-7 ? 2. How can the forcing of aviation, with a total of 98 mW/m2 in 2018, represent only 3 % of total anthropogenic RF, when it had been assessed to be 4,9% for only 78 mW/m2 in 2005 ?	Noted; this is made clear in the new (as yet unpublished) paper	Manfred Treber	Germanwatch	Germany
34317	47	40	47	43	Is this "in addition" of carbon emissions this should be explicit. Is it a RF or a ERF (see page 10-48 lines 1-7)?. If not, how can the forcing of aviation, with a total of 98 mW/m2 in 2018, represent only 3 % of total anthropogenic RF, when the figure was 4,9% for 78 mW/m2 in 2005?	Noted; this is made clear in the new (as yet unpublished) paper	Antoine BONDUELLE	Climate Action Network France	France
34769	47	43	47	43	delete "," after NOx	Noted: add reference when accepted for publications	Rudra Shrestha	Tyndall center for climate change research, The University of Manchester	United Kingdom (of Great Britain and Northern Ireland)
38063	47	43	47	43	The reference, Lee et al, 2020, could not be found in the reference list.	Noted: add reference when accepted for publications	FEIJIA YIN	Delft University of Technology	Netherlands
24077	47	13	48	25	In section 10.5.1 and 10.5.2 there is a lack of clear presentation of the total climate impact of aviation today (CO2 + non-CO2). Is is said that CO2 emissions from aviation represents 2.4% of total CO2 emissions (p.47 line 37). In order to avoid wrong understanding (many people still think that aviation only counts for 2% of total climate impact of human activities today), the sentence should be completed to state clearly that this represents only a part of total climate impact of aviation (approx. the half). For examle the sentence would become (bold is added) : "Current (2018) total CO2 emissions from aviation represent approximately 2.4% of total anthropogenic emissions of CO2, including land use change, on an annual basis (...). These emissions represent only part (approximately half) of the total climate impact of aviation, because non-CO2 effects of aviation are of comparable magnitude with CO2 effects (see section 10.5.2)." Maybe a table could bring some clarity on the different climate impacts of aviation, as it is stated that " The net warming from aviation’s non-CO2 SLCFs is ~64% of aviation’s total warming" (p.48 line 19)	Noted: good idea	Noé Lecocq	Inter-Environnement Wallonie	Belgium
13495	47	39	48	25	The effect of aviation is assessed in WG1 chapter 6 (section 6.5 of the SOD) with a low level of confidence, please refer to WG1 and homogeneize the values as well as their range of uncertainties.	Noted, will make efforts to coordinate with WG1	Sophie Szopa	Commissariat à l'Energie Atomique et aux Energies Alternatives	France
27541	47	39	48	25	For the climate effects of aircraft, this section should refer to WG1, and ensure consistency through the WG reports. For instance WG 1chapter 7 covers the radiative forcing from contrails.	Noted, will make efforts to coordinate with WG1	William Collins	University of Reading	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
39231	47	39	48	25	The draft WG1 report appears to conclude that these effects are still very uncertain and there is low confidence in net RF effects. This section does not discuss uncertainties and cites the unpublished Lee et al paper multiple times. It would seem reasonable to expect this chapter to be consistent with the conclusions of the WGI and focus the discussion on possible mitigation options.	Noted, will make efforts to coordinate with WG1	Steven Baughcum	Boeing Company	United States of America
41271	47	39	48	25	Secion 10.5.2. is very useful. It addresses one of the main uncertainties in our understanding of aviation and CC; with implicatations for climate footprint calculators, how role of aviation is perceived etc. I suggest some cooridnation with WGI here; especially ch6 on SLCF.	Noted, will make efforts to coordinate with WG1	Jan Fuglestvedt	CICERO	Norway
43591	47	40	48	7	the RF attributed to NOx of 18 mW/m2has been challenged by Grewe et al who have identified two methodological flaws underlying previous work and have proposed a value for the NOx contribution in 2005 of 26.7 mW/m2, putting it very close to the CO2 contribution (Grewe et al 2019 Environ. Res. Lett. 14 121003). This increase in its magnitutude	Noted. Rejected - this is one paper inconsistent with other literature	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)
13795	47	1	53	27	This is a general comment for the aviation part. Details are added individually, however, I think it is important to note my concerns in a compromised manner for the whole section. The whole part is written in an extremely conservative way and states that non-CO2 effects are poorly understood and gives by this the impression that one cannot deal with non-CO2 effects in a proper manner. a) I do not think that this is reflecting the current status in literature, which is also indicated that a hugh amount of work on the impact of non-CO2 effects for both aircraft design and operations is missing. (Details are given in other comments) b) the statements are even not in agreement with the last assessment by Lee et al. (2009, 2010), who state, e.g., that the NOx effects are rates as medium to low, and in the last 10 years the understanding has been enhanced significantly. And the understanding with respect to contrail-cirrus has been estimated by IPCC (2013; Fig. TS-6) to be medium to low. And also there a better understanding has been achieved.	Accepted. Agree much literature; disagree that confidence has increased - in both cases of NOx and contrail cirrus, uncertainties have increased with increased knowledge. A good example of this is efficacy. Also, WG1 independently attaches a 'low' level of confidence to aviation non-CO2 effects	volker Grewe	DLR-Oberpfaffenhofen	Germany
13797	47	1	53	27	This is a general comment for the aviation part: Instead of having a discouraging attitude in the description of non-CO2 effects (see also other comment), I would prefer to have a proper discussion of how uncertainties in the non-CO2 effects can be taken into account to establish a risk analysis. I think it is extremly important to develop a mechanism with which aviation non-CO2 effects can be addressed in a proper manner, e.g. to guide aircraft industries, aircraft operators and as well as governments and policy makers. Examples are given in Dahlmann, K., Grewe, V., Frömming, C., Burkhardt, U., Can we reliably assess climate mitigation options for air traffic scenarios despite large uncertainties in atmospheric processes?, Trans. Res. Part D, 46, 40-55, doi:10.1016/j.trd.2016.03.006, 2016. Grewe, V., Matthes, S., Frömming, C., Brinkop, S., Jöckel, P., Gierens, K., Champougny, T., Fuglestvedt, J., Haslerud, A., Irvine, E., Shine, K., Climate-optimized air traffic routing for trans-Atlantic flights. Environm. Res. Lett. 12(3), 034003, DOI: 10.1088/1748-9326/aa5ba0, 2017. Grewe, V. , Matthes, S., Dahlmann, K., Gollnick, V., Niklaß, M., Linke, F., Kindler, K., Climate impact evaluation of future green aircraft technologies, Greener Aviation, 2016.	Accepted principle of inclusion of literature discussing this approach.	volker Grewe	DLR-Oberpfaffenhofen	Germany
29207	47	1	53	27	The challenge for aviation is to decarbonize the coming three decades. Current policies are inadequate to do so. CORSIA only shifts (part of) the reduction into other sectors and has a goal of keeping emission equal. Biofuels fail because these can at best (but generally perform worse) remove 80% of the lifecycle CO2 thus keeping emissions at best at current levels. More efficiency is outpaced by growth and cannot deliver zero-emissions (as already rightly observed in the current chapter 10 text). Operational measures will have a much stronger rebound effect as carbon taxes do (Evans & Schäfer, 2013) because most operational measures have a high political cost, but not a high operational cost, meaning that most of the savings of detours, inefficient flight-paths and speed-schedules directly reduce the cost of flying with say a substantial part of flying cost, thus increasing demand by about the same share. It does not reduce emissions substantially, but it does increase traffic. There is very little research on this, but Evans and Schäfer (2013) found a rebound of a fuel consumption reduction of 0.23% per % fuel efficiency improvement. As fuel cost are between 20 and 30% of all operational costs, this means that one per cent operational cost reduction would have a rebound of 100% minus the cost of operational efficiency improvement/operational efficiency improvement. Evans, A., & Schäfer, A. (2013). The rebound effect in the aviation sector. Energy Economics, 36, 158-165. doi:https://doi.org/10.1016/j.eneco.2012.12.005	Accepted. Agree. Noted, add literature and overall prognosis of CO2 emission reductions.	Paul Peeters	Breda University of applied sciences	Netherlands

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29209	47	1	53	27	The technical solution to have a scenario that combines some growth and zero-emissions by 2100 (almost zero by 2050) is the combination of mandated mixing of synthetic fuels (e-fuels based on PtL) to have a short-term reduction and fuel-cell-electric aircraft for the long-term effect and to avoid the large amounts of renewable energy required for e-fuels. I have developed such scenarios (Peeters, 2019) based on then GTTMdyn model (Peeters, 2013). Also, I published some intermediate results (Gössling & Peeters, 2015), but the new scenarios I presented only at some conferences. I am happy to provide some well-referenced text based on current writing of a paper for Nature Climate Change. Gössling, S., & Peeters, P. M. (2015). Assessing tourism's global environmental impact 1900–2050. Journal of Sustainable Tourism, 23(5), 639-659. doi:10.1080/09669582.2015.1008500 Peeters, P. M. (2013). Developing a long-term global tourism transport model using a behavioural approach: implications for sustainable tourism policy making. Journal of Sustainable Tourism, 21(7), 1049–1069. Peeters, P. M. (2019). Towards zero emissions aviation. 'Clever and Sustainable' at the global level. Paper presented at the ATRS 23rd World Conference, Amsterdam.	Noted: accept much of the argument but await a peer-reviewed paper.	Paul Peeters	Breda University of applied sciences	Netherlands
39225	47	1	53	27	Section 10.5 on the Decarbonization of aviation seems to spend a disproportionate amount of the discussion on the non-CO2 effects of aviation. While these are important, the draft WGI report spends less time and seems to conclude that significant uncertainties remain for those effects. It should also be noted that other sectors also have non-CO2 contributions to RF. In the scope of this section, the authors might spend more time on the discussions of options to reduce CO2.	Accepted. Agree, but others are hard to please and demand much on non-CO2 effects.Will corss reference WG1 and add reference to other sectors on non-CO2 SLCF	Steven Baughcum	Boeing Company	United States of America
39227	47	1	53	27	Many of the publications cited in the text are not included in the refernce list. There is enough information to find some using google scholar but not all and some appear to be papers not yet in press. Ohers appear to be grey literature for which a more complete citation or URL link is needed.	Accepted. Will clear up.	Steven Baughcum	Boeing Company	United States of America
16325	47	1			In Section 10.5 Decarbonization of aviation, consider adding a subsection describing global military use of aviation and rocketry and the possibilities for decarbonizing that sector, for the sake of clarity and accuracy.	Accepted. Add comment on military usage of fuel.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
22879	47	1			A key missing reference from framing the discussion in this section is: Peeters, P., Higham, J., Kutzner, D., Cohen, S., & Gössling, S. (2016). Are technology myths stalling aviation climate policy?. Transportation Research Part D: Transport and Environment, 44, 30-42.	Accepted, add reference	Giulio Mattioli	TU Dortmund University	Germany
22881	47	1			A key message from the literature on the decarbonisation of aviation is that technological measures will not on their own reduce emissions at the required scale and speed, and that some form of demand-management is required. I don't see this important point being given the adequate importance in this section. REFERENCES: Bows-Larkin, A. (2014). All adrift: aviation, shipping, and climate change policy. Climate Policy, 15(6), 681-702; Bows-Larkin, A., Mander, S. L., Traut, M. B., Anderson, K. L., & Wood, F. R. (2016). Aviation and Climate Change–The Continuing Challenge. Encyclopedia of Aerospace Engineering; Peeters, P., Higham, J., Kutzner, D., Cohen, S. & Gössling, S. (2016). Are technology myths stalling aviation climate policy? Transportation Research Part D: Transport and Environment, 44, 30-42; Schäfer, A. W., & Waitz, I. A. (2014). Air transportation and the environment. Transport Policy, 34, 1-4; Scott, D., Hall, C. M., & Gössling, S. (2016). A review of the IPCC Fifth Assessment and implications for tourism seector climate resilience and decarbonisation. Journal of Sustainable Tourism, 24(1), 8-30; Dubois, G., Peeters, P., Ceron, J.-P., & Gössling, S. (2011). The future mobility of the world population: Emission growth versus climate policy. Transportation Research Part A, 45, 1031-1042;	Accepted, add references to demand management	Giulio Mattioli	TU Dortmund University	Germany
6427	47	4			The legacy of aircrafts I don't expect to be so high	Noted. Unclear	Apostolos Petropoulos	International Energy Agency	France
22883	47	39			There are studies that have quantified how much taking into account of SRLs increases the share of transport-related emissions that are due to aviation - see e.g.: Aamaas, B., & Peters, G. P. (2017). The climate impact of Norwegians' travel behavior. Travel Behaviour and Society, 6, 10-18; Aamaas, B., Borken-Kleefeld, J., & Peters, G. P. (2013). The climate impact of travel behavior: A German case study with illustrative mitigation options. Environmental Science & Policy, 33, 273-282; Reichert, A., Holz-Rau, C., & Scheiner, J. (2016). GHG emissions in daily travel and long-distance travel in Germany–Social and spatial correlates. Transportation Research Part D: Transport and Environment, 49, 25-43.	Noted. Unclear - 'SRL'	Giulio Mattioli	TU Dortmund University	Germany
34771	48	1	48	7	Interactions between natural cirrus and contrail are not well documented. Contrail formed within an existing cirrus cloud alters microphysical and optical properties of cirrus cloud and vice versa. Contrail regulates nucleation processes if cirrus forms surrounding the pre-existing contrail. Embedded contrail in background cirrus compets for available water vapour. The properties of linear contrail changes considerably when transforming to contrail cirrus. Further, location of contrail formation is also important whether it is below, in or above existing cirrus. This complex microphysical and optical processes need to be addressd in order to imporve our understanding the impacts of aviation on climate change.	Accepted. Agree but unclear as to the request. Add Tesche contrail/natural cirrus reference	Rudra Shrestha	Tyndall center for climate change research, The University of Manchester	United Kingdom (of Great Britain and Northern Ireland)
13825	48	3	48	7	There is a critical discussion on the climate impact of aviation NOx emissions (Grewe et al. 2019). While there is agreement on the physical and chemical processes Grewe et al (2019) argued that two methodological flaws are inherent to most previous climate impact estimates of aviation NOx emissions. They revised the aviation NOx emissions for 2005 to 26.6 mW/m2 and taking the fuel use increase between 2005 and 2018 into account (+85%) the NOx-RF can be estimated to be around 50 mW/m2. Grewe, V., Matthes, S., Dahlmann, K., The contribution of aviation NOx emissions to climate change: Are we ignoring methodological flaws?, Env. Res. Lett., DOI: 10.1088/1748-9326/ab5dd7, 2019.	Accepted. Agree. Mention referece in terms of methodological differences present in the literature	volker Grewe	DLR-Oberpfaffenhofen	Germany
18211	48	6	48	6	which together results in a net NOx ERF of ~18 mW/m2 (Lee et al., 2020)." According to Grewe et al 2019 (https://iopscience.iop.org/article/10.1088/1748-9326/ab5dd7/meta), the contribution of aviation NOx emissions to climate change would be 26.7 mW/m2.	Noted; this is made clear in the new (as yet unpublished) paper	Manfred Treber	Germanwatch	Germany
34319	48	6	48	6	"which together results in a net NOx ERF of ~18 mW/m2 (Lee et al., 2020)." This figure differs from Grewe et al 2019 (https://iopscience.iop.org/article/10.1088/1748-9326/ab5dd7/meta), the contribution of aviation NOx emissions to climate change would be 26.7 mW/m2.	Rejected. Verbatim repetition of previous point	Antoine BONDUELLE	Climate Action Network France	France

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13727	48	17	48	17	Depending on the initial condtions of the emissions Righi et al (2013) pointed out that also positive or not significant effects are calculated. Hence the sentence should be adapted, e.g. "resulting potentially in a net …"	Take into account. Check - I think this is wrong	volker Grewe	DLR-Oberpfaffenhofen	Germany
34321	48	19	48	25	This caveat is welcome, but it is common with all other non-CO2 emissions.	Noted but this is what is said	Antoine BONDUELLE	Climate Action Network France	France
34323	48	20	48	21	"involving trade-off with CO2" is true only for operational policies for airports and airlines, but is misleading for policy impacting the growth of aviation such as mode shifting, improving filling ratios or taxing social costs of pollutants. In the context of this IPCC report, these are more important and should be mentioned.	Rejected: it is very clear what is being discussed here. Other policies are mentioned elsewhere.	Antoine BONDUELLE	Climate Action Network France	France
13731	48	24	48	25	There is substantial literature prior to Skowron et al. on the impact of background emissions on the ozone response from aviation NOx emissions, e.g. reported by Isaksen et al. (2001), Grewe (2007), Grewe et al. (2002) and Grewe et al (1999). The comparison of the reduced ozone production efficiency due to avaiation NOx emissions between the OsloCTM and the ECHAM/CHEM model nicely showed an agreement of roughly 30% between 1990s and 2050s caused by the changed background emissions in 2050 compared to 1990. Of course the paper by Skowron et al shows very valuable and detailed results. However the text here suggests that this dependency of the aviation ozone impact from the background NOx emissions is a new finding, while its actually well documented in literature. So I suggest to at least refer to the Isaksen et al. 2001 and Grewe et al. 1999 paper here in addition to indicate that this statement is robust over the time. For references please have a look at the references in Lee et al. (2010).	Accepted, add supportive references	volker Grewe	DLR-Oberpfaffenhofen	Germany
13733	48	24	48	25	The last part of the sentence "and mitigation potential" should be elaborated in more detail. As it stands there is the possibility to understand that mitigation potentials can only be estimated by addressing also future changes in the background emissions. While it may be correct for mitigation options which start in the far future, such as new aircraft designs, near future mitigation options, e.g. climate reduced operations, are effective in the current atmosphere and hence short-lived forcers ecperience the current background and a far future change in the atmospheric background is not necessary to be addressed.	Accepted	volker Grewe	DLR-Oberpfaffenhofen	Germany
13735	48	24	48	25	While it is true that the ozone changes resulting from NOx changes, e.g., induced by mitigation options, are dependent on the background concentrations and background emissions, the changes in the contribution of NOx emissions to the ozone concentration is largely independent from the background (Grewe et al 2012, Mertens et al., 2018). The reason is simply that the atmospheric chemistry is non-linear and changes in one sector, here aviation, lead to changes in the ozone productivity, which in turn lead to changes in the contribution of NOx emissions to ozone from other sectors, whithout having changed their emissions. Hence this statement contradicts with findings by Grewe et al and Mertens et al. Instead I suggest to replace "and mitigation options" with "however, the assessment of mitigation potentials can be assessed in a more robust way by using contribution methods (Grewe et al. 2012 and Mertens et al. 2018). Mertens, M., Grewe, V., Rieger, V.S., Jöckel, P., Revisiting the contribution of land transport and shipping emissions to tropospheric ozone, Atmos. Chem. Phys., 18, 5567-5588, https://doi.org/10.5194/acp-18-5567-2018, 2018. Grewe, V., Dahlmann, K., Matthes, S., Steinbrecht, W., Attributing ozone to NOx emissions: Implications for climate mitigation measures, Atmos. Environm., 59, DOI: 10.1016/j.atmosenv.2012.05.002, 102-107, 2012.	Rejected: this is a flawed argument that only addresses half of the impact through ozone. The most important variable and non-linear part is the response of CH4 reductions to NOx emissions.	volker Grewe	DLR-Oberpfaffenhofen	Germany
26323	48	25	48	25	Skowron et al. (2020) is missing in the reference list.	Accepted, added reference	Tanaka Katsumasa	Laboratoire des Sciences du Climat et de l'Environnement (LSCE), CEA, FRANCE; National Institute for Environmental Studies (NIES), JAPAN	France
38051	48	28	48	37	The development trend of engine technology towards high pressure ratio, hence high operating temperature, and high bypass ratio, is mainly driven by the reduction of fuel burn (hence CO2 emissions) via high cycle efficiency. The reduction of NOx are mainly achieved by advanced combustion technology, which is sort of missing in the current version report. It would be helpful to review the improvements in engine combustion technology, and how the tradeoffs between aviation CO2 and NOx have involve with respect to these technological development trend.	Accepted	FEIJIA YIN	Delft University of Technology	Netherlands
29325	48	29	48	30	Please check correctly the provided ratio of CO2 emmision to the fuel combusted. Seems wrong.	Rejected: checked - this is correct	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
36491	48	29	48	30	Carbon emission factor of jet fuel vary country to country and 3.16kgCO2/kg fuel is thought to be a standardized value so source should be referred here. ICAO use 3.16kg for jet-A and 3.14kg for jet-B for the calculation.	Take into account.	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
34933	48	31	48	31	manufacturers' in place of manufacturers	Accepted	ANUPAM DEBSARKAR	University	India
11781	48	32	48	32	Please rephares into two sentences and include the word "therefore" like this: ".. direct operating costs, i.e. fuel burn. Therefore much investment has gone into…"	Accepted	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
34325	48	32	48	32	fuel burn. So much (?)	Accepted	Antoine BONDUELLE	Climate Action Network France	France
36149	48	32	48	32	The sentence is incomplete. There should be a comma or a full stop after fuel burn	Accepted	Arvind Gangoli Rao	Delft University of Technology	Netherlands
25605	48	32	48	33	Operational efficiency can also reduce fuel consumption, e.g., optimal loading results in lower fuel consumption.	Accepted	Sabine Limbourg	HEC-Uliege	Belgium
11783	48	33	48	33	Capital T: "…fuel burn per km. There…"	Accepted	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11785	48	34	48	34	Misspelled engine	Accepted	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
14101	48	34	48	34	Typo in the first word	Accepted	Victor Garcia Tapia	International Energy Agency (IEA)	France
17981	48	34	48	34	Typo: "engine"	Accepted	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
34935	48	34	48	34	engine- spelling mistake	Accepted	ANUPAM DEBSARKAR	University	India
13339	48	44	48	44	...which IS short of...'	Accepted	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
36151	48	44	48	44	The sentence should be "which is short of ICAO"	Accepted	Arvind Gangoli Rao	Delft University of Technology	Netherlands
36153	48	23	49	23	there should be a comma after 14	Noted. Unclear	Arvind Gangoli Rao	Delft University of Technology	Netherlands
13743	48	26	49	44	The Section 10.5.3 nicely gives an overview on different mitigation options in the area of aviation. I think It would be helpful to have a short introductory paragraph that highlights the principle differences between the studies. One important part is that most are concentrating on CO2 only, hence addressing fuel consuption and fuel efficiency. Others are addressing the total climate impact. Mitigation options are taking the aspects of aircraft technologies, operations, and economical measures into account. It is important to note that all these options have different characteristics with respect to eco-efficiency (climate impact reduction per change in operating costs), climate impacts, operating costs, investment costs and time of implementation. Grewe an Linke (2017) gave an overview of published work on mitigation options which address the total climate impact, hence CO2 and non-CO2-effects. Their Figure 2 of their paper gives a qualitative estimate on the importance of the different mitigation options. I think this aspect is important, since in the area of aviation time scale is very important. The life cycle of one aircraft is around 30 years and the life cycle of an aircraft generation might be more than 50 years. Hence implementing any mitigation option with respect to major technology options takes a) a very long time b) the estimate of the potential should be robust to save investments. Grewe, V., and Linke, F., Eco-efficiency in aviation, Met. Z. 26, 689 - 696, doi:10.1127/metz/2017/, 2017.	Accepted. Agree, made clear options between CO2 and non-CO2	volker Grewe	DLR-Oberpfaffenhofen	Germany
13737	48	29	49	5	This section is focussing on efficiency imrovements hence reduction in CO2. It cant be complete, however, other more radical concepts, such blended wing bodies should be mentioned here (e.g. Rao et al 2014 see above) Rao, A.G., F. Yin, J.P. van Buijtenen, 2014: A hybrid engine concept for multi-fuel blended wing body. – Aircraft Engin. Aerospace Technol. 86, 483–493, DOI: 10.1108/AEAT-04-2014-0054	Accepted, add reference	volker Grewe	DLR-Oberpfaffenhofen	Germany
13739	48	29	49	5	This section focusses on efficiency improvements and hence CO2 reductions. However, this is an IPCC report and we are looking at the climate impact and as it was stated above most of the effects are caused by non-CO2 effects. So I think this is an important discussion which is missing here. I would like to see this part split into two paragraphs. One on CO2 emission reduction (or fuel efficiency increase), only, and a second one on mitigation options, which are referring to the reduction of the total climate impact and hence a sum of basically CO2, NOx and contrails. For example, the study by Dahlmann et al. (2016) clearly showed that a total reduction of the climate impact by around 42% can be achieved by flying lower and slower. This refers to a current aircraft and hence increases the CO2 emission by around 10% due to the increased drag at lower flight altitudes. However, the non-CO2 effects are overproportionally reduced and hence reduces the climate impact even on a 100 year time horizon. The important part is that adapting the aircraft design to this new cruise altitude leads to a significant reduction in the climate impact by still 32%, however at no changes in the CO2 emissions. This is an important finding which should be addressed here. Since the mitigation potential of new aircraft concepts have to take into account all climate effects of aviation and not only CO2. Dahlmann, K., Koch, A., Linke, F., Lührs, B., Grewe, V., Otten, T., Seider, D., Gollnick, V., Schumann, U., Climate-Compatible Air Transport System - Climate Impact Mitigation Potential for Actual and Future Aircraft Aerospace 3, 38; doi:10.3390/aerospace3040038, 2016.	Accepted, split up	volker Grewe	DLR-Oberpfaffenhofen	Germany
13741	48	29	49	5	A strut-braced wing aircraft (SBW) propelled with an open rotor has been proposed as an alternative for current fixed wing aircraft resulting in an efficiency improvement of around 5%, but an overall climate impact reduction of more than 15% due to the large reduction in the contribution of aviaiton NOx emissions to climate (Grewe et al, 2017) Grewe, V., Dahlmann, K., Flink, J., Frömming, C., Ghosh, R., Gierens, K., Heller, R., Hendricks, J., Jöckel, P., Kaufmann, S., Kölker, K., Linke, F., Luchkova, T., Lührs, B., van Manen, J., Matthes, S., Minikin, A., Niklaß, M., Plohr, M., Righi, M., Rosanka, S., Schmitt, A., Schumann, U., Terekhov, I., Unterstrasser, S., Vázquez-Navarro, M., Voigt, C., Wicke, K., Yamashita, H., Zahn, A., Ziereis, H., Mitigating the Climate Impact from Aviation: Achievements and Results of the DLR WeCare Project, Aerospace 4(3), 34; doi:10.3390/aerospace4030034, 1-50, 2017.	Accepted, add reference	volker Grewe	DLR-Oberpfaffenhofen	Germany

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13773	48	29	49	5	Please include a discussion that flying lower and slower with a revised aircraft design leads to a total climate impact reduction at no additional CO2 emission (fuel burn). For example, the study by Dahlmann et al. (2016) clearly showed that a total reduction of the climate impact by around 40% (42% in that study) can be achieved by flying lower and slower. This refers to a current aircraft and hence increases the CO2 emission by around 10% due to the increased drag at lower flight altitudes. However, the non-CO2 effects are overproportionally reduced and hence reduces the climate impact even on a 100 year time horizon. The important part is that adapting the aircraft design to this new cruise altitude leads to a significant reduction in the climate impact by still around 30% (32% in that study), however at no changes in the CO2 emissions. This is an important finding which should be addressed here. Since the mitigation potential of new aircraft concepts have to take into account all climate effects of aviation and not only CO2. Dahlmann, K., Koch, A., Linke, F., Lührs, B., Grewe, V., Otten, T., Seider, D., Gollnick, V., Schumann, U., Climate-Compatible Air Transport System - Climate Impact Mitigation Potential for Actual and Future Aircraft Aerospace 3, 38; doi:10.3390/aerospace3040038, 2016.	Accepted, add reference	volker Grewe	DLR-Oberpfaffenhofen	Germany
39233	48	38	49	5	It appears that the Cumpsty paper cited is an ICAO report now available for purchase. While these may be a useful reference, the author's should consider other papers in the European, American, and Asian engineering literature in this section. The discussion of formation flying might better fit into the operational improvements discussion since it would require aircraft from different locations synchronizing their flights into close formations. It is probably worthwhile to note that the 8% reduction is probably for the single flight, not a system wide improvement.	Accepted. Good point on 8%	Steven Baughcum	Boeing Company	United States of America
28009	48	39	49	25	The only two papers that quantify the impacts of short-lived climate forcers and contrails by tracking the emissions of each of 30 million+ commercial flights worldwide per year on global climate are Jacobson, M.Z., J.T. Wilkerson, S. Balasubramanian, W.W. Cooper, Jr., and N. Mohleji, The effects of rerouting aircraft around the Arctic Circle on Arctic and global climate, Climatic Change, 115, 709-724, doi:10.1007/s10584-012-0462-0, 2012; Jacobson, M.Z., J.T. Wilkerson, A.D. Naiman, and S.K. Lele, The effects of aircraft on climate and pollution. Part II: 20-year impacts of exhaust from all commercial aircraft worldwide treated individually at the subgrid scale, Faraday Discussions, 165, 369-382, doi:10.1039/C3FD00034F, 2013. Please use results from these studies and clarify that the other studies cited do not track the emissions or plumes from each flight worldwide.	Noted	Mark Jacobson	Stanford University	United States of America
24079	48	26	51	44	Section 10.5.3 should include a specific paragraph on changes in consumption patterns for aviation as a mean for mitigation (not only market based) : how practices are evolving in some businesses regarding air travel consumption in order to lower it, how academics increasingly adopt new code of conduct in order to reduce air travel, how the social norm is evolving in cases like Sweden (flygskam - see e.g. https://en.reset.org/blog/flygskam-flying-shame-movement-thats-taking-over-sweden-12112018), how some decision makers are studying the ban of short air trips when there is a good alternative (by train for example - see : https://www.connexionfrance.com/French-news/mps-in-france-propose-ban-on-internal-short-haul-flights-to-cut-co2-emissions), etc.	Rejected.foundno literature on this despite having looked hard.	Noé Lecocq	Inter-Environnement Wallonie	Belgium
38053	48	28			In the section of “Technology options”, it is not clear if the focus is on incremental technologies or disruptive technologies or both. For incremental improvements, the inclusion of the “formation flying” is a bit confusing. Furthermore, this is an operational measure, perhaps should be included in a different section. Nevertheless, if the intention is to also review the disruptive options, then there are earlier and ongoing research on various unconventional aircraft designs, e.g., BWB, Flying V, etc., which are currently missing in this section. Though the TRL of these new concepts are low, they have a large potential to substantially reduce the fuel burn and to enable the usage of zero-C fuels, which is impossible in the conventional airframe. Hence it might be worth of looking at this designs and their potentials.	Accepted and restructure	FEIJIA YIN	Delft University of Technology	Netherlands
43593	48	38			It is well understood in the civil aircraft design community that today's civil aircraft are not designed to minimise fuel burn and climate impact but to maximise airline profitability. Redesigning aircraft to fly slower, lower and with a maximum design range around 4,000km would considerably reduce climate impact from NOx and fuel burn per tonne km but at today's fuel and carbon prices would be commercially unacceptable to the airline industry. Only regulation or a very substantial increase in carbon/fuel price would induce a significant move in the climate friendly direction (refs. Poll, D.I.A. On the effect of stage length on the efficiency of air transport, Aeronaut J, May 2011, 115, 1167, pp 273-283; Henderson, R.P., Martins, J.R.R.A. and Perez, R.E. Aircraft Conceptual Design for Optimal Environmental Performance, Aeronaut J. January 2012, 116, 1175, pp 1-2;. Dallara, E.S. and Kroo, I.M. Aircraft Design for Reduced Climate Impact, AIAA Paper 2011-265; Dallara, E.S., Kroo, I.M. and Waitz, I.A. Metric for Comparing Lifetime Average Climate Impact of Aircraft, AIAA Journal, August 2100, vol 49, issue 8, pp 1600-1613.	Accepted and add point	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)
13729	49	19	48	19	Note that with Grewe et al 2019, the percentage should be higher, e.g. around 75%. Grewe, V., Matthes, S., Dahlmann, K., The contribution of aviation NOx emissions to climate change: Are we ignoring methodological flaws?, Env. Res. Lett., DOI: 10.1088/1748-9326/ab5dd7, 2019.	Noted. Unclear	volker Grewe	DLR-Oberpfaffenhofen	Germany
34327	49	1	49	2	"formation flying" is "challenging" but not so radical. This paragraph should mention action on demand for air transport.	Accept, add demand references/mitigation	Antoine BONDUELLE	Climate Action Network France	France

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29211	49	1	49	5	The description of opportunities for radical technology seem to miss the most promising option . The problem here seems that the most viable option – fuel-cell-electric, is ignored, while much attention now goes to battery-electric aircraft., these latter will not be possible at all, unless some, currently unknown in terms of materials used, chemical processes required, etc. Even though Alonso et al. (2018) mention fuel-cell solutions, they did not capture kit very well developments. Large size aircraft were possible with existing technology in 2000 (Peeters, 2000), except for the engines and power-chain weight was still an issue nine years later (Snyder et al., 2009). However, weight of fuel cells is largely compensated by the very low weight of hydrogen as energy source and the overall higher energy efficiency of the electric power-system. Therefore, even with current technology it has become a viable preliminary design for a 19-seats 1000 km range aircraft has been delivered by (Delgado Gosálvez et al., 2018). Though demonstrator aircraft flew already two decades ago, a new startup ZeroAvia (Osborne, 2019), is now taking the challenge seriously. Others discussing this solution are Bradley and Droney (2012); Kadyk, Schenkendorf, Hawner, Yildiz, and Römer (2019). The main advantage is that a hydrogen fuel-cell-aircraft has zero emissions when the hydrogen is produced with renewables . No other technique, batteries, hybrids, current jets can achieve this. Of course developing such aircraft until a full fleet replacement does take up to 2100, but the goal can only be achieved when all aircraft development investments are directed from now on into this direction. I have developed such scenarios (Peeters, 2019) based on then GTTMdyn model (Peeters, 2013). Also, I published some intermediate results (Gössling & Peeters, 2015), but the new scenarios I presented only at some conferences. I am happy to provide some well-referenced text based on current writing of a paper for Nature Climate Change .(Bataille, 2020) Alonso, J., Catalano, F., Cumpsty, N., Eyers, C. J., Goutines, M., Grönstedt, T., . . . Zingg, D. (2018). Independent expert integrated technology goals assessment and review for engines and aircraft. 2017 independent expert integrated review panel. DRAFT. Montreal: Bataille, C. (2020). Low and zero emissions in the steel and cement industries: Barriers, technologies and policies. Paris: Bradley, M. K., & Droney, C. K. (2012). Subsonic Ultra Green Aircraft Research Phase II: N+ 4 Advanced Concept Development (NASA/CR–2012-217556). Hampton, Virginia: Delgado Gosálvez, M., van Ham, J., Joosten, S., Juschus, d., Nieuwerth, G., van Pelt, T., . . . Ziere, T. (2018). Green Flying. Final Report. Delft: Gössling, S., & Peeters, P. M. (2015). Assessing tourism's global environmental impact 1900–2050. Journal of Sustainable Tourism , 23(5), 639-659. doi:10.1080/09669582.2015.1008500 Kadyk, T., Schenkendorf, R., Hawner, S., Yildiz, B., & Römer, U. (2019). Design of Fuel Cell Systems for Aviation: Representative Mission Profiles and Sensitivity Analyses. Frontiers in Energy Research, 7(35). doi:10.3389/fenrg.2019.00035 Osborne, T. (2019). Startup Sees Fuel Cell Future For Regional Aviation. Aviation week & Space technology. Peeters, P. M. (2000). Annex I: Designing aircraft for low emissions. Technical basis for the ESCAPE project. (00.4404.17). Delft: Peeters, P. M. (2013). Developing a long-term global tourism transport model using a behavioural approach : implications for sustainable tourism policy making. Journal of Sustainable Tourism , 21(7), 1049–1069. Peeters, P. M. (2019). Towards zero emissions aviation. 'Clever and Sustainable' at the global level. Paper presented at the ATRS 23rd World Conference, Amsterdam.	Take into account.	Paul Peeters	Breda University of applied sciences	Netherlands
34329	49	1	49	5	Why no mention of electrification of auxiliaries and ground traction, nor distributed electric motorization ?	Accept and add point	Antoine BONDUELLE	Climate Action Network France	France
43595	49	1	49	17	It is worth noting, both in the context of formation flying and in the general area of improving navigation efficiency, that in February 2019 the US company Aireon launched its satcom datalink relay network to the Iridium 66-satellite constellation, to enable ATM surveillance of ADS-B equipped aircraft "anywhere on earth"	Rejected. No reference as to how this will improve environmental efficiency	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)
25607	49	6	49	17	Many airline companies have adopted hub-and-spoke networks to reduce their operating costs. This might involve longer travelling distances.	Accept and add point	Sabine Limbourg	HEC-Uliege	Belgium
39237	49	6	49	17	It would be usefule to expand this discussion to note that improved weather forecasts which would enable more efficient planning to better atnticipate heads winds, tail winds, turbulence, convenctive activity, etc. enroute would allow more efficient flights and mititgate for carrying additional fuel for "what ifs". Improvements on aircraft avionics (position location, sensing of other aircraft, etc.) can also lead to reductions in spacing between aircraft and thus enabling more optimum routings for more aircraft.	Take into account.	Steven Baughcum	Boeing Company	United States of America
42273	49	6	49	17	It might be useful to mention the different strategies such as pushback holding, de-rated take-offs, taxi delay avoidance, towouts, queue management. Ashok, A., Balakrishnan, H., & Barrett, S. (2017) Reducing the air quality and CO Transportation Research Part D 54 (2017) 287– King, D., & Waitz, I.A., (2005). Assessment of the effects of operational procedures and derated thrust.	Accept and add point	Alvin Mejia	Wuppertal Institute	Germany
13745	49	7	49	9	This sentence reads a little bit like a contradiction. Either aircraft fly along great circles or wind optimal. Those are two different situations, which have been widely analysed. (see for example Yamashita et al. 2016, 2019). Yamashita, H., Grewe, V., Jöckel, P., Linke, F., Schaefer, M., and Sasaki, D.: Air traffic simulation in chemistry-climate model EMAC 2.41: AirTraf 1.0, Geosci. Model Dev., 9, 3363-3392, doi:10.5194/gmd-9-3363-2016, 2016. Yamashita, H., Yin, F., Grewe, V., Jöckel, P., Matthes, S., Kern, B., Dahlmann, K., and Frömming, C. Various aircraft routing options for air traffic simulation in the chemistry-climate model EMAC 2.53: AirTraf 2.0, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2019-331, in review, 2019.	Accepted. Change sentence structure. References are irrevlevant to the point of long-established navigational practices.	volker Grewe	DLR-Oberpfaffenhofen	Germany
13747	49	7	49	9	Aircraft are currently routed in a way to minimise both operating costs and flight time. For example the ATC costs lead to detours with additional fuel use and therefore operational inefficiencies (e.g. Lindner et a.) Lindner, Martin & Förster, Stanley & Rosenow, Judith. (2016). Ecological Impact Of Air Traffic Control En-Route Charging Zones From Multi Criteria Optimized Flight Paths. In 2012 it was estimated (Boing ans CANSO, 2012) that operational inefficiencies are around 6 to 8%, which is significant. https://www.ainonline.com/sites/default/files/pdf/boeingcanso.pdf	Accepted Add point on minimizing costs	volker Grewe	DLR-Oberpfaffenhofen	Germany

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29213	49	7	49	17	Rebounds might be up to 100% for operational measures because the operational costs reduce almost proportionally to the operational efficiency gains. The point is that direct operational costs depend very much on the flight time and distance. Maintenance is a function of flight hours, flight attendant and pilot cost go by flight hours, fuel cost is a function of flight hours a ns is depreciation (Padilla, 1996). Therefore, a shorter route will always significantly reduce direct operational. Cost, which, in ten current price-market, will lead to lower prices and higher demand. Padilla, C. E. (1996). Optimizing Jet transport efficiency; Performance, operations, & economics. New york: McGraw-Hill.	Take into account. Check	Paul Peeters	Breda University of applied sciences	Netherlands
34331	49	16	49	16	en-route ?	Accepted and restructure	Antoine BONDUELLE	Climate Action Network France	France
23873	49	19	49	19	"bio-based 'sustainable alternative fuels'": And also FT-SPK based on PTL	Later versions clarified this.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
23875	49	28	49	29	"five different types of sustainable aviation fuels with maximum blends ranging from 50% to 10%": To be checked: cf. also here for instance https://www.gti.energy/wp-content/uploads/2019/10/47-tcbiomass2019-Presentation-Steve-Csonka.pdf	Later versions clarified this.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
18225	49	35	49	37	the primary one being the current cost of fossil fuel vs SAF production (SAF is currently around three times the price of kerosene, Hari et al., 2015), which is a constraint on commercial development and viability." There is another issue around cost, it's the cost per ton of CO2e reduced, which is quite high (200 to 500 €) According to the International Council for Clean Transportation (ICCT) "the most cost effective fuel for carbon abatement in the near term is used cooking oil–derived HEFA at approximately €200 per tonne of CO2 equivalents (CO2e) reduced; however, waste fats and oils are already widely used by the road sector and therefore their supply may be limited. The next most effective options are the gasification of municipal solid waste and lignocellulosic feedstocks, which have a cost of approximately €400 to €500 per tonne of CO2e reduced." It would therefore be important to also mention that new generation jetfuels pathways and productions highly depend on carbon pricing policies and in particular on the price targets that some countries have set (like "valeur tutélaire du carbone" in France). The cost of supporting alternative jet fuels in the European Union, Pavlenko et al (2019), ICCT https://theicct.org/publications/cost-supporting-alternative-jet-fuels-european-union (peer-reviewed sources of the analysis may be obtained from the ICCT)	Later versions clarified this.	Manfred Treber	Germanwatch	Germany
34345	49	35	49	37	"the primary one being the current cost of fossil fuel vs SAF production (SAF is currently around three times the price of kerosene, Hari et al., 2015), which is a constraint on commercial development and viability." Costs of biofuels is not the only point to mention, but also the cost per ton of CO2e reduced, which is quite high (200 to 500 €/ton) According to the International Council for Clean Transportation (ICCT) "the most cost effective fuel for carbon abatement in the near term is used cooking oil–derived HEFA at approximately €200 per tonne of CO2 equivalents (CO2e) reduced; however, waste fats and oils are already widely used by the road sector and therefore their supply may be limited. The next most effective options are the gasification of municipal solid waste and lignocellulosic feedstocks, which have a cost of approximately €400 to €500 per tonne of CO2e reduced." The new generation jetfuels pathways and productions highly depend on carbon pricing policies and in particular on the price targets that some countries have set with a reference cost of carbon ("valeur tutélaire du carbone" in France). This mention is lacking int he two pages and is needed to be policy relevant and not only technical. Source: The cost of supporting alternative jet fuels in the European Union, Pavlenko et al (2019), ICCT https://theicct.org/publications/cost-supporting-alternative-jet-fuels-european-union (peer-reviewed sources of the analysis may be obtained from the ICCT)	Later versions clarified this.	Antoine BONDUELLE	Climate Action Network France	France
36513	49	35	49	37	Please refer the IEA's analysis about price competitiveness too. Fig.3.8, "Break-even crude oil prices for different aviation biofuel production pathways' at Renewable 2018 is a useful analysis.	Accepted, add reference	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
27863	49	43	49	44	The estimation on the GHG emissions recution by SAF presented here is too conservative. "Biofuels for aviation: technology brief" (IRENA, 2017) presents the emission reduction potential ranging from 50 to 95% (page 3), and "decarbonisation road-map: a path to net zero - a plan to decarbonise UK aviation" (Sustainable Aviation) states that SAF offer at least 70% lifecycle reduction in carbon emissions compared to current fossil fuels. This is also inconsitent with the descprition in page 56 (line 19-20) of this chapter.	Take into account.	Toshimasa Masuyama	International Renewable Energy Agency	Germany
18223	49	18	50	7	The report doesn't highlight the problematic carbon balance effects of widespread use of biofuels. The very principle of carbon neutrality of biofuels is questionable, as shown by the following publications : Haberl H, et al. (2012) Correcting a fundamental error in greenhouse gas accounting related to bioenergy. Energy Policy 5:18–23.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3617913/ DeCicco, J.M., Liu, D.Y., Heo, J. et al., Carbon balance effects of U.S. biofuel production and use. Climatic Change 138, 667–680 (2016) https://link.springer.com/article/10.1007/s10584-016-1764-4 Mary S. Booth 2018, Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy, Environ. Res. Lett. 13 035001 (2018) https://iopscience.iop.org/article/10.1088/1748-9326/aaac88	Later versions clarified this.	Manfred Treber	Germanwatch	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
34343	49	18	50	7	The report doesn't highlight the problematic carbon balance effects of widespread use of biofuels and should at least mention it here. The very principle of carbon neutrality of biofuels is questionable, as shown by the following publications : Haberl H, et al. (2012) Correcting a fundamental error in greenhouse gas accounting related to bioenergy. Energy Policy 45:18–23.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3617913/ DeCicco, J.M., Liu, D.Y., Heo, J. et al., Carbon balance effects of U.S. biofuel production and use. Climatic Change 138, 667–680 (2016). https://link.springer.com/article/10.1007/s10584-016-1764-4 Mary S. Booth 2018, Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy, Environ. Res. Lett. 13 035001 (2018) https://iopscience.iop.org/article/10.1088/1748-9326/aaac88	Later versions clarified this.	Antoine BONDUELLE	Climate Action Network France	France
13751	49	18	50	16	This is an important overview on SAF. The climate impact assessment is done using a state-of-the-art life cycle analysis, which includes, e.g. Bincer and Dincer GWP for emissions. However, it should be made clear that the use of an aircraft includes many more effects such as contrail formation. And we know that the combustion of bio fuels leads to a lower emission of the number of soot particles, which in turn leads to changes of the contrail lifetime and contrail coverage, eventually leading to a reduction in contrail RF (Burkhardt et al. (2018). Hence this affects the LCA I would guess. I do not think that this is a problem, but I suggest to clearly state on what the LCA are based and what effects may come on top, but are currently not included. Burkhardt, U. et al. Mitigating the contrail cirrus climate impact by reducing aircraft, npj climate and atmospheric science, www.nature.com/npjclimatsci	Accepted. Accept, add reference	volker Grewe	DLR-Oberpfaffenhofen	Germany
38055	49	6			The operational improvements includes inflight as well as ground operations. They both contribute to the efficiency improvement hence the reduction of fuel burn. In the current section, only the inflight operations are discussed.	Accepted. Accept and add point	FEIJIA YIN	Delft University of Technology	Netherlands
38057	49	18			In the section on “Fuels”, liquefied natural gas (LNG) is not mentioned at all. LNG has less weight than kerosene. Thought the reduction in CO2 by LNG is not substantial (~25% reduction than kerosene), LNG itself is clean, therefore, enabling ~60% reduction in NOx and particulate emissions. Furthermore, the cost of LNG is lower compared to kerosene. Overall, LNG can be a promising candidate during the energy transition phase, which shouldn’t be overlooked.	Rejected.	FEIJIA YIN	Delft University of Technology	Netherlands
36155	50	17	49	37	There is no mention of LNG (Liquified Natural Gas). LNG is much cheaper and easier to be used than LH2. LNG reduces CO2 emission by 25% as compared to kersene on an energy basis. Methane can be produced by bio sources or by using renewable energy, just like hydrogen.	Rejected.	Arvind Gangoli Rao	Delft University of Technology	Netherlands
39549	50	1	50	1	HVO emergence is expanding the possibility of mitigation by biofuels because it can be exceed blend wall of FAME(7%) and it can be co prodeced with bio-jet fuels. Also folloing figure may be interesting. https://www.iea.org/data-and-statistics/charts/hvo-production-forecast-by-plant-type-2018-2024	Noted	Shunsuke Kawagishi	Mitsubishi Research Institute	Japan
18227	50	1	50	2	Knowing that the life-cycle emissions reductions range between approximately 2% and 70% (p 10-49 lines 43-44), the key indicator is not the penetration, but the CO2e abatement rate (penetration x abatement yield).	Accepted. Accept and add point	Manfred Treber	Germanwatch	Germany
34347	50	1	50	2	As the life-cycle emissions reductions range between approximately 2% and 70% (p 10-49 lines 43-44), the key indicator is not the penetration, but the CO2e abatement rate (penetration x abatement yield).	Rejected. Verbatim repetition of previous point	Antoine BONDUELLE	Climate Action Network France	France
29215	50	3	50	7	I do not see why, now then world has entered a kind of climate crisis, with only a few decades to go to achieve zero-emissions in every sector, the only way to introduce more expensive SAF is by adjusting prices. It seems a much better option to gradually increase SAF mix ratios between now (0.1%) and 2050 (100%). In that case the cost of CO2 is directly internalized and the problem is solved. Waiting until kerosene becomes three to four times more expensive means wasting decades if it will happen at all. Current move towards electric mobility seems already top cause further reductions of oil prices and thus cheaper kerosene. The Dutch government decided on 03-03-2020 to have substantial shares of drop-in fuels to be added mandatory (up to 14% by 2030). See https://www.tweedekamer.nl/kamerstukken/brieven_regering/detail?id=2020Z04159&did=2020D08669 for the decision (Dutch) and a report on which it is based (E4tech (UK) Ltd & studio Gear Up, 2019). E4tech (UK) Ltd, & studio Gear Up. (2019). Study on the potential effectiveness of a renewable energy obligation for aviation in the Netherlands. Final report. London:	Noted	Paul Peeters	Breda University of applied sciences	Netherlands
27865	50	4	50	7	IRENA estimates that the energy transformation scenario in line with the 2 degrees goals requires four-fold increase of modern bioenergy deployment for all sectors (transport, building, industry and power) between 2016 and 2050 with total investment costs amounting to 2 trillion US dollars, approx 60 billion US dollars per year (Global Energy Transformation, IRENA, 2019). IRENA also estimates that the trasnport sector decarbonization, inclusive of road, aviation and shipping, requires five-fold increase of biofuel consupmtion from 130 billion litres in 2016 to 650 billion litres in 2050, with annual investment of 20 billion US dollars (Advanced Biofuels: What holds them back?, IRENA, 2019). Compared to these figures, 22 to 88 billion US dollars of investment for aviation biofuels look too high, and even unrealistic as the worldwide investments for biofuels in 2007, when the investment boom for biofuels reached the climax, just recorded at 26 billion US dollars.	Accepted.	Toshimasa Masuyama	International Renewable Energy Agency	Germany
23877	50	8	50	8	"Other pathways": Hybrid options like PTG-HEFA are also part of the discussion (e.g. https://www.mdpi.com/2076-3417/9/19/4047) and will be realised similarily for instance by SkyNRG (e.g. https://www.ainonline.com/aviation-news/aerospace/2019-11-14/shell-skynrg-collaborate-first-european-saf-plant)	Noted.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
9595	50	8	50	16	Only DAC is mentioned as a source of CO2 for P2X. Several other possible carbon sources exist (e.g. biogas production) with bioethanol production being the commercially most attractive (Global CCS Institute 2019: Bioenergy and carbon capture and storage, available online). In the IEA’s 2-degree scenario, 60% of BECCS is associated with biofuels production (IEA 2017: Technology Roadmap - Delivering Sustainable Bioenergy, available online).	Accepted. Accept and add point	Jesper Kløverpris	Novozymes	Denmark

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
20469	50	8	50	16	power-to-liquds on Fischer-Tropsch basis can be highly beneficial for aviation, since the fossil carbon part in aviation emissions can be fully avoided. Fasihi et al. (https://www.sciencedirect.com/science/article/pii/S1876610216310761 ; https://www.mdpi.com/2071-1050/9/2/306) as show the potential and relative economics and Khalili et al. (https://www.mdpi.com/1996-1073/12/20/3870) showed energy flows efficiencies and discussion, while Ram et al. (http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf) have shown that the respective drop-in fuel transition is possible and affordable.	Accepted. Accept and add point	Christian Breyer	LUT University	Finland
29217	50	8	50	16	You discuss 'synthetic fuels', but in the wider literature the name 'e-fuels' seems more widely used. Also I suggest to add the term power-to-liquids (PtL), the process to produce them.	Accepted (revise)	Paul Peeters	Breda University of applied sciences	Netherlands
29219	50	8	50	16	I feel the option of e-fuels is not covered because it seems the only viable option to make aviation zero-emission before 2050. Biofuels provide at best 80% reductions which under then expected growth means constant emissions until the end of this century, which is not a development that fits the 1.5 and 2.0 ° C emission pathways. Without e-fuels there will be a serious problem with the volume of aviation by 2050. With e-fuels, the ticket prices are likely to in the end about double, assuming e-fuels to be four times as expensive as current fossil kerosene (Schmidt, Batteiger, Roth, Weindorf, & Raksha, 2018), which will slow-down the growth of aviation but not make it negative when the fuel is gradually introduced. Technically, there is no reason to not assume a short-term introduction. The barriers are entirely political and economic. The reason is that fuel certification is not necessary as the e-fuel is based on processes used for biofuels that are already certified, the issues with feedstock do not exist (both concentrated industrial CO2 and atmospheric CO2 are plenty available without competition with nature or agriculture), and all processes are being used at industrial scale for other purposes in the petrochemical industry. Integration of then processes, DAC and finance are the current issues to be solved, where finance seems more a political one (see for instance the Dutch decision to mandate SAF mixing to 14% by 2030, starting gradually in 2023: https://www.tweedekamer.nl/kamerstukken/brieven_regering/detail?id=2020Z04159&did=2020D08669. Schmidt, P., Batteiger, V., Roth, A., Weindorf, W., & Raksha, T. (2018). Power-to-Liquids as Renewable Fuel Option for Aviation: A Review. Chemie Ingenieur Technik, 90(1-2), 127-140. doi:10.1002/cite.201700129	Take into account.Investigate	Paul Peeters	Breda University of applied sciences	Netherlands
29221	50	8	50	16	Another point is that The sentence "No trials have yet been achieved" is incorrect. Examples are: Large project producing small amounts but being scaled-up within two years: https://www.kopernikus-projekte.de/aktuelles?backRef=6&news=Erste_Strom_zu_Kraftstoff_Anlage_in_Betrieb They offer the technology: https://ineratec.de/en/processes/ The required DAC: https://carbonengineering.com/our-technology/ Working on CCR: https://www.skiesmag.com/news/montreal-saf-sustainable-aviation-fuel/ Research in Netherlands: https://www.differ.nl/research/solar-fuels and other e.g. Rotterdam-The Hague Airport and Synkero project. Unfortunately, the aviation industry seems not very aware of all this. Germany: https://www.cleanenergywire.org/news/start-sunfires-e-fuels-can-decarbonise-industries-most-addicted-fossil-fuels Maybe helpful: https://en.wikipedia.org/wiki/Synthetic_fuel as it shows this kinds of fuel being produced six decades ago.	Take into account.Investigate	Paul Peeters	Breda University of applied sciences	Netherlands
29223	50	8	50	16	E-fuels could technically be very quickly on the market if a kind of Manhattan project was started. The main roadblock is economic, but there seems no need to wait for the cost of e-fuels to reduce or those of fossil fuels to rise or tax-subsidies being set in place, as the Dutch government shows by mandating mixing the fuel.	Take into account.Investigate	Paul Peeters	Breda University of applied sciences	Netherlands
34447	50	8	50	16	Considering power to x, especially power to fuel as technologies that are in the infancy level is not right. By driving out the use of fossil kerosene fuel in aviation through carbon pricing and requiring aircraft to switch to synthetic fuels, and advanced biofuels to a very limited extent, the climate impact of flying can be reduced dramatically. Zero emission CO2-based synthetic fuels and very low carbon advanced sustainable biofuels can be produced today and deployed immediately using existing engines and infrastructure.Here are key reference son this subject: Transport and Environment, 2018: How to decarbonize European transport by 2050, Transport and Environment./IEAGHG, 2019a: Putting CO2 to Use – Creating value from emissions, International Energy Agency./Gumber and Gurumoorthy, 2018, Methanol, Chap. 25, 661-675./ Byrnolf et al., 2018, Renewable and Sustainable Energy Reviews, 81/2, 1887-1905./ Schemme et al., 2017, Fuel, 205, 198-221/ Global Alliance Powerfuels, 2019: Powerfuels: Missing Link to a successful global Energy Transition, Global Alliance Powerfuels/CONCAWE, 2019: A look into the role of e-fuels in the transport system in Europe (2030–2050) (literature review), CONCAWE.)	Accepted.	Célia Sapart	Université Libre de Bruxelles et Co2 Value Europe	Belgium
29327	50	12	50	13	Please use correct or use another conversion method in place of "methanol synthesis" since FT technology can still be used to produce methanol. Not unless it is explicitly refereed to the 'direct CO2 conversion to methanol".	Take into account.	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
11827	50	15	50	16	Not clear if the "potential for large life cycle emission reductions" of power-to-liquid is provided that the origin of the CO2 is direct air capture. This could be said more explicitly.	Accepted.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
17983	50	16	50	16	The reference (Schmidth et al 2016) is not reported in the bibliography	Accepted.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
38059	50	17	50	32	The direct replacement of kerosene by LH2 is certainly challenging due to the large volume requirement. Alternatively, one could consider an "energy mix" concept, similarly as hybrid electric concept, but mixing two types of fuels (LH2+kerosene/biofuels) instead. The earlier research (Rao, et al, 2014; Yin et al, 2018; Grewe et al, 2016) showed such an energy mix configuration is able to reduce the emissions and climate impact. The reduction rate is sensitive to the degrees of the hybridization.	Take into account.Investigate	FEIJIA YIN	Delft University of Technology	Netherlands

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
13753	50	17	50	37	Similarily to my comments above a paragraph on the non-CO2 effects from using LH2 should be included. For example Ponater et al. (2006) and Grewe et al. (2017) showed that there is also a potential to reduce the climate impact from non-CO2 effects. Both NOx emissions and the climate impact from contrails might be reduced considerably. Ponater, M., Pechtl, S., Sausen, R., Schumann, U., and Huttig, ¨ G.: Potential of the cryoplane technology to reduce aircraft climate impact: A state-of-the-art assessment, Atmospheric Environment, 40, 6928–6944, doi:10.1016/j.atmosenv.2006.06.036, 2006 Grewe, V., Bock, L., Burkhardt, U., Dahlmann, K., Gierens, K., Hüttenhofer, L., Unterstrasser, S., Rao, A.G., Bhat, A., Yin, F., Reichel, T.G., Paschereit, O., Levy, Y., Assessing the climate impact of the AHEAD multi-fuel blended wing body, Met. Z. 26, 711-725, doi:10.1127/metz/2016/0758, 2017.	Accepted.	volker Grewe	DLR-Oberpfaffenhofen	Germany
13749	50	25	50	25	Please include the Pereria reference.	Take into account. Check references	volker Grewe	DLR-Oberpfaffenhofen	Germany
39235	50	29	50	32	It is difficult to evaluate the asssertion that LH2 is a viable fuel source for commercial aviation since the Klug paper is not included in the reference and can not be found in a quick search of the peer-reviewed literature. A major challenge is that in addition to large quantities of inexpensive environmentally friendly H2, an extensive infrastructure would need to be in place at airports before any flights using a cryoplane could be introduced. This is a huge barrier and would suggest that H2 fueled airplanes would likely only occur after a massive global shift to a hydrogen economy. It's not clear if the papers cited address the issues encountered by the space industry on using cryogenic fuel or the additional challenges for such cryogenic fuels on commercial airplanes in service. Most analyses seem only to focus on the need for a larger fuel storage volumes.	Accepted.	Steven Baughcum	Boeing Company	United States of America
29225	50	30	50	37	I am afraid the real roadblock for hydrogen is that it requires a completely renewed fleet. It cannot be applied as a drop-in fuel. On the other hand, compared to the above challenges, I do not see why adjusting fueling infrastructure on some 3000 airports worldwide could be much of a problem or prohibitive. The other issue is the fact that a jets plus H2 aircraft requires a large amount of space for storing the hydrogen, while not being more efficient than normal jets and still requiring complete re-design of airframes and engines. The hydrogen electric fuel-cell aircraft has a much higher energy efficiency requiring much less hydrogen on board and is thus more feasible.	Accepted.	Paul Peeters	Breda University of applied sciences	Netherlands
13757	50	45	50	45	"extra fuel efficiency"; Probably "extra fuel consumption" or "reduced fuel efficiency"	Accepted.	volker Grewe	DLR-Oberpfaffenhofen	Germany
13775	50	45	50	47	It would be helpful to state whether the issue of complexity is hindering a climate assessment of trade-offs. By reading this sentence, I have the feeling that this might have been suggested. However, the whole climate system is complex and complexity should not be communicated as a limitation for an assessment. I suggest to include a sentence that a risk assessment has to be included in any trade-off study to take into account uncertainties from atmospheric science as well as aircraft/engine design aspects and operations. As Dahlmann et al. (2016) have shown such a risk assessment can be achieved by including a Monte-Carlo Simulation and deriving from that robust answers. Dahlmann, K., Grewe, V., Frömming, C., Burkhardt, U., Can we reliably assess climate mitigation options for air traffic scenarios despite large uncertainties in atmospheric processes?, Trans. Res. Part D, 46, 40-55, doi:10.1016/j.trd.2016.03.006, 2016.	Accepted. Accept and revise but this ignores unknown unknowns, of which we have had recent exampes of in the science	volker Grewe	DLR-Oberpfaffenhofen	Germany
39239	50	38	51	18	It is not clear if this section quite belows in a secction on decarbonizing aviation, particularly since flight routing to avoid contrails may increase CO2 emissions. Improvements in weather forecasting of ice supersaturated reigons would be necessary enable more efficient flight planning if the contrail/CO2 tradeoffs could be done. Aircraft would need to be forecast the flight path (and adiitional fuel) prior to takeoff so that the appropriate amount of fuel was loaded. Carrying extra fuel so that an aircraft could avoid ISS regions if it needed to would entail additional CO2 emissions since fuel burn rates increase with aircraft weight.	Accepted. Agreee and split section into CO2 and non CO2 as other suggested	Steven Baughcum	Boeing Company	United States of America
43605	50	39	51	16	the discussion of trade-offs in mitigating the non-CO2 effects ignores recently published work, is essentially qualitative and consequently, it may be argued, unduly negative. The recent work referred to is the paper by Teoh, Schumann, Majumdar and Stettler (https://dx.doi.org/10,1021/acs.est.9b05608) that evaluated the total energy forcing by contrails and contrail cirrus by traffic over six one-week periods in Japanes air space in 2012-2013. The finding was that 80% of the energy forcing came from only 2% of the traffic and that changing cruise altitude of 1.7% of the flights by plus or minus 2,000ft reduced the contrail energy forcing by 59.3%. The fuel burn penalty for the diverted traffic was 0,27% and the fuel burn penalty for the entire fleet was 0.014%. Including the energy forcing over a 100-year time horizon of the CO2 emiitted from the flights, the effect of the diversion was to reduce the totla contrail plus CO2 energy forcing by 35.6%. The study also assessed the effect of Double Annular Combustors on contrail forcing and concluded that a combination of converting the entire fleet to Double Annular Combustors and adopting the tactical avoidonce method used in the study would reduce the net energy forcing from contrails and CO2 with a 100-year time horizon by 65% and that from contrails alone by 91.8%. Scientists in Germany and the UK believe there is a strong case for puting the findings to the test by organising a prectical trial of the avoidance method under internationlal air traffic management over the North Atlantic.	Noted. This work was not published at the time of writing. Assimilate reference	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)
43603	50	39	51	18	the discussion of trade-offs in mitigating the non-CO2 effects ignores recently published work, is essentially qualitative and consequently, it may be argued, unduly negative. The recent work referred to is the paper by Teoh, Schumann, Majumdar and Stettle (https://dx/doi.org/10.1021/acs.est.9b05608) that evaluates the impact on total energy forcing by contrails and contrail-cirrus of air traffic in Japanese air space over six one week periods in 2012 and 2016. The finding was that 80% of the energy forcing came from only 2% of the flights and that a procedure for changing the cruise altitude of 1.7% of the total flights by plus or minus 2,000ft reduced the total contrail energy forcing	Noted.This work was not published at the time of writing. Assimilate reference	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
13755	50	39	59	39	There is quite a substantial amount of work on aviation non-CO2 effects from NASA (e.g. Sridhar et al.,), TU-Delft (e.g. Yin et al; Hartjes et al.), TU Dresden (Rosenow et al), DLR (Grewe et al., Matthes et al., Schumann et al., ….), and many other academia. I would recommend to delete the word "some" and I think it would be wise to refer to such studies, instead.	Accepted. Accept and add any recent/relevant references	volker Grewe	DLR-Oberpfaffenhofen	Germany
43597	50	18			Although the fuel has a specfic energy in J/kg 3times greater than kerosene, it has a much lower energy density per unit volume	Take into account.	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)
43607	50	39			general remark - this spread sheet is very user unfriendly and switches itself off part way though a passage with the result that I have to type some pieces more than once and some pieces have lost a few words. As I am typing this on a Sunday evening I have opted not to enlist help. I hope what reaches you is useful.	Noted. No response needed	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)
43599	50	44			There has been substantial research in Europe and the USA into low NOx combustors, mainly to address the problem of local air pollution at airports, and in 1995 CFM International introduced its Double Annular Combustor into service on the CFM 56, thereby halving NOx emissions. The increase in RF as now estimated by Grewe et al now suggests that the introduction of a Double Annualr Combustore in place of a Single Annular Combustor would have the same impact on RF as switching to 50/50 biokerosene. There seems to be a strong case for regulators to press for the introduction of Double Annular Combustors, or one with lower NOx emissions, as a standard.	Noted. DACs are almost 'ancient history' and long overtaken by lean burn technologies.	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)
41273	51	2	51	2	I dont think this is the most relevant referene to use here; i.e. Dasøren et al. "Environmental impacts of shipping in 2030 with a particular focus on the Arctic region". Instead I suggest one of the papers from the ATTICA study or WGI AR5 Ch8.	Accepted.	Jan Fuglestvedt	CICERO	Norway
13759	51	2	51	4	I suggest to clarify this sentence in more detail. I think this is an important issue. The sentence suggests that there is some ambiguity in the choice of the climate metric. Grewe and Dahlmann (2015) pointed out that climate metrics cannot be chosen arbitrarily nor are they ambiguous. The choice is the political objective, the political target and not the climate metric per se. The political choice very much defines the climate metric. If we aim at reducing climate warming below a certain global mean threshold, e.g. below 1.5°C in 2100 and later, then the climate metric automatically evolves from that. This is important, because, as Grewe and Dahlmann pointed out, it is not about a choice of the time horizon or metric, it is about the choice of the political target and it allows to make use of short-lived climate forcers to reduce climate impact on a shorter timescale than for CO2. This might be an important issue in reducing an overshoot effects as described in the 1.5°C-IPCC report. Hence a revision might be: "Any emission equivalence calculation always involves a political target, which leads to an adequate choice of an emission scenario, time horizon and climate indicator/metric and the initial political target is a subjective one (Grewe and Dahlmann, 2015)". Grewe, V., and Dahlmann, K.: How ambiguous are climate metrics? And are we prepared to assess and compare the climate impact of new air traffic technologies?, Atmos. Environm. 106, 373-374, doi:10.1016/j.atmosenv.2015.02.039, 2015.	Take into account.	volker Grewe	DLR-Oberpfaffenhofen	Germany
13761	51	4	51	5	Yes, this sentences is true for most applications. However, not necessarily for all, and especially not for aviation. A climate metric has three ingredients: an emission scenario, which might be pulse, sustained, or increasing emissions; a time horizon and a climate indicator/metric such as RF, integrated RF, temperture or averaged temperature. The assessment of a mitigation option has an underlying question. For example "Is the introduction of a new aircraft design reducing the aviation climate impact?" or "Is the introduction of the routing strategy to avoid climate sensitive regions reducing the climate impact from aviation?". Both cases refer to a change in the strategy and an avaition scenario, with increasing transport volume, as predicted, is a reasonable choice for such a overaarching question. Global mean temperature change, but not RF, is an adequate metric with respect to this question. Hence, the underlying question on a change in a strategy, e.g., routing strategy, which is applied on an every day basis, refers to an over the time increasing emission scenarion which then will affect the temperture over a, e.g., 20 year time span (see e.g. Grewe et al. 2014a). For such a scenario the dependency on the time horizon largely vanishes (Grewe et al. 2014b; Grewe et al. 2017; page 6!). This can be even deduced on the back of an envelope (see e.g. appendix of Grewe and Stenke, 2008). Grewe, V., Frömming, C., Matthes, S., Brinkop, S., Ponater, M., Dietmüller, S., Jöckel, P., Garny, H., Dahlmann, K., Tsati, E., Søvde, O. A., Fuglestvedt, J., Berntsen, T. K., Shine, K. P., Irvine, E. A., Champougny, T., and Hullah, P.: Aircraft routing with minimal climate impact: The REACT4C climate cost function modelling approach (V1.0), Geosci. Model Dev. 7, 175-201, doi:10.5194/gmd-7-175-2014, 2014a. Grewe, V., Champougny, T., Matthes, S., Frömming, C., Brinkop, S., Søvde, A.O., Irvine,E.A., Halscheidt, L., Reduction of the air traffic's contribution to climate change: A REACT4C case study, 10.1016/j.atmosenv.2014.05.059, Atmos. Environm. 94, 616-625, 2014b. Grewe, V. and A. Stenke, AirClim: an efficient climate impact assessment tool, Atmospheric Chemistry and Physics, 8, 4621 - 4639, 2008. Grewe, V., Matthes, S., Frömming, C., Brinkop, S., Jöckel, P., Gierens, K., Champougny, T., Fuglestvedt, J., Haslerud, A., Irvine, E., Shine, K., Climate-optimized air traffic routing for trans-Atlantic flights. Environm. Res. Lett. 12(3), 034003, DOI: 10.1088/1748-9326/aa5ba0, 2017. Hence I suggest to rewrite this part e.g. " requiring climate/chemistry model calculations. The uncertainties arising from atmospheric processes may be integrated in response modelling to achieve a robust risk assessment (Dahlmann et al. 2016). The usage of emission equivalency metrics such as the Global Warming Potential (GWP) or Global Temperature change Potential (GTP) (see (Dalsøren et al., 2013) for an overview) requires a thorough consideration of the overall objective. In the case of the introduction of new technologies or routing options, this objective addresses potential to reduce the aviation's climate impact and hence refers to an analysis of a future aviation scenario including this technology or routing option. The overall objective and with this the climate metric is still a subjective choice (Fuglestvedt et al. 2010), however climate metrics which adequately resemble the overall objective are very much confined (Grewe and Dahlmann, 2015) and studies on routing options show that the choice of the climate metric has a limited effect on the equivalence metric, as long as they support the overal objective (Grewe et al. 2014b)."	Reject, incorrect: the statement is true for aviation as well as any other LLGHG vs SLCF	volker Grewe	DLR-Oberpfaffenhofen	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
13763	51	6	51	6	Since the authors state that it is a widely discussed mitigation option, I think it should also refer to e.g. most current papers? Or a series of papers? E.g. by Schumann, Sridhar, Irvine, or recvently by Yin et al. (see references therein) Yin, F., Grewe, V., Frömming, C., Yamashita, H., Impact on flight trajectory characteristics when avoiding the formation of persistent contrails for transatlantic flights, Transportation Research Part D: Transport and Environment, DOI:10.1016/j.trd.2018.09.017, online available, 2018. The Yin et al study is not only thinking theoretically if this could be feasible or not, but actually calculates changes in flight distance, seasonal cycle etc. So the statement "widey discussed opportunity" might be interpreted as a theoretical idea, but it is actually underpinned, in the case of Yin et al., with quite some detailed calcualtions based on a climate model, which includes a air traffic simulator.	Accepted. Add reference	volker Grewe	DLR-Oberpfaffenhofen	Germany
29227	51	6	51	18	There exists a connection between SAF/e-fuels and contrails. In the case of 100% SAF-use, the tradeoff between CO2 and contrails shifts towards reducing contrails more because the CO2 penalty is 50-80% less than with fossil kerosene. In then case of e-fuels from DAC, the CO2-penalty no longer exists and minimum contrails flight becomes an opportunity. Furthermore, when those fuel cell aircraft become reality, the non-CO2 problem will disappear. Even though water vapor can be an issue with respect to contrails and clouds, this will be much less an issue for fuel-cell-electric aircraft as those will likely be most efficient at lower altitudes (7000-8000 m rather than 11000-13000 m), thus flying in less contrail-vulnerable airspace anyway. Furthermore, the vapor from the fuel cells could easily be cooled to water or even ice droplets doing probably even less harm. A research recommendation to these aspects would be useful because, as far as I am aware, nobody has so far studied these connections between non-CO2 and SAF/e-fuels.	Accepted.	Paul Peeters	Breda University of applied sciences	Netherlands
38061	51	6	51	18	In addition to the contrail avoidance, the climate impact from NOx and water vapor can also be reduced by avoiding the atmospheric climate sensitive regions (Søvde et al, 2014; Grewe et al, 2014). The choice of climate metrics and time-horizon would influence the magnitude of benefits by avoiding climate sensitive regions, however, the sign would remain unchanged (Grewe et al, 2014).	Take into account.	FEIJIA YIN	Delft University of Technology	Netherlands
13765	51	11	51	12	I am not quite what the meaning of "theoretical" in this respect means? Most of the other studies mentioned here are also modelling studies. I suggest to rephrase this sentence to avoid confusion. In addition, there was a large project - REACT4C - which investigated in detail the opportunities to reduce the climate impact on north atlantic flights. A model desription (Grewe et al 2014a), a case study (Grewe et al. 2014b) and a summary of the climataological effects (Grewe et al. 2017) are giving a very detailed analysis of the results and i think they are worth mentioning here. The trajectory calcualtion and optimization in order to reduce the total climate impact was done by EUROCONTROL in a very sophisticated manner. I suggest to include a sentence like: "An analysis of north Atlantic flights for 8 different representative weather situation showed the feasibility to reduce their climate impact by 10% with a cost increaseof only 1% (Grewe et al. 2017). A similar ratio was found for European flight (Matthes et al., 2017) based on a case study. Both studies indicate the feasibility to reduce the climate impact from aviation by avoiding climate sensitive regions, especially regions with contrail formation, on a flight-by-flight basis. Grewe, V., Frömming, C., Matthes, S., Brinkop, S., Ponater, M., Dietmüller, S., Jöckel, P., Garny, H., Dahlmann, K., Tsati, E., Søvde, O. A., Fuglestvedt, J., Berntsen, T. K., Shine, K. P., Irvine, E. A., Champougny, T., and Hullah, P.: Aircraft routing with minimal climate impact: The REACT4C climate cost function modelling approach (V1.0), Geosci. Model Dev. 7, 175-201, doi:10.5194/gmd-7-175-2014, 2014a. Grewe, V., Champougny, T., Matthes, S., Frömming, C., Brinkop, S., Søvde, A.O., Irvine,E.A., Halscheidt, L., Reduction of the air traffic's contribution to climate change: A REACT4C case study, 10.1016/j.atmosenv.2014.05.059, Atmos. Environm. 94, 616-625, 2014b. Grewe,, V., Matthes, S., Frömming, C., Brinkop, S., Jöckel, P., Gierens, K., Champougny, T., Fuglestvedt, J., Haslerud, A., Irvine, E., Shine, K., Climate-optimized air traffic routing for trans-Atlantic flights. Environm. Res. Lett. 12(3), 034003, DOI: 10.1088/1748-9326/aa5ba0, 2017.	Take into account.	volker Grewe	DLR-Oberpfaffenhofen	Germany
18213	51	11	51	15	Theoretical approaches in the literature show that avoidance is possible on a flight-by-flight basis (Matthes et al., 2017). In case studies, it has been demonstrated that flight planning according to trajectories with minimal climate impact can substantially (up to 50%) reduce the aircraft net climate impacts despite additional CO 2 emissions (e.g., (Niklaß et al., 2019))." Please consider adding the following references :- Roger Teoh, Ulrich Schumann, Arnab Majumdar, Marc E. J. Stettler, Mitigating the Climate Forcing of Aircraft Contrails by Small-Scale Diversions and Technology Adoption, https://pubs.acs.org/doi/abs/10.1021/acs.est.9b05608 - Greener by design 2018-2019, Atmospheric science (Royal Aeronautical society), https://www.aerosociety.com/media/12007/greener-by-design-report-2018-2019.pdf	Take into account.	Manfred Treber	Germanwatch	Germany
34333	51	11	51	15	"Theoretical approaches in the literature show that avoidance is possible on a flight-by-flight basis (Matthes et al., 2017). In case studies, it has been demonstrated that flight planning according to trajectories with minimal climate impact can substantially (up to 50%) reduce the aircraft net climate impacts despite additional CO 2 emissions (e.g., (Niklaß et al., 2019))." Please consider adding the following references : - Roger Teoh, Ulrich Schumann, Arnab Majumdar, Marc E. J. Stettler, Mitigating the Climate Forcing of Aircraft Contrails by Small-Scale Diversions and Technology Adoption, https://pubs.acs.org/doi/abs/10.1021/acs.est.9b05608 - Greener by design 2018-2019, Atmospheric science (Royal Aeronautical society), https://www.aerosociety.com/media/12007/greener-by-design-report-2018-2019.pdf	Take into account.	Antoine BONDUELLE	Climate Action Network France	France

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13341	51	15	51	15	strange formatting around Niklass reference	Editorial - revised	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
13777	51	15	51	15	I suggest to add a line to adderss hurdles in the implementation of such concepts. E.g. "However, the implementation of such concepts requires enhanced understandings in the area of atmospheric science, analysis of the implications on air traffic flows and macro economic options to enable these concepts (Grewe et al., 2017, Matthes et al. 2017)." Grewe, V., Matthes, S., Frömming, C., Brinkop, S., Jöckel, P., Gierens, K., Champougny, T., Fuglestvedt, J., Haslerud, A., Irvine, E., Shine, K., Climate-optimized air traffic routing for trans-Atlantic flights. Environm. Res. Lett. 12(3), 034003, DOI: 10.1088/1748-9326/aa5ba0, 2017. Matthes, S., Grewe, V., Dahlmann, K., Frömming, C., Irvine, E., Lim, L., Linke, F., Lührs, B., Owen, B., Shine, K., Stromatas, S., Yamashita, H., Yin, F., A concept for multi-dimensional environmental assessment of aircraft trajectories, Aerospace 4(3), 42; doi:10.3390/aerospace4030042, 2017.	Accepted	volker Grewe	DLR-Oberpfaffenhofen	Germany
13767	51	15	51	16	As above: I would argue that the a conclusion depends on the political objective. It make a difference if we try to minimize climate change on a short-term or on a long term. I think this is a communication issue. "The choice of metric" relates to a technical or scientific question and hence addressing science. However, as stated in Fuglestvedt et al (2010) and many others papers, this is more a political and societial choice. And I think it would be helpful to clearly state this. E.g. by revising to "However, such a conclusion of the net benefit or disbenefit depends upon the political objective on how to minimise climate change. This objective very much defines the choice of metric and time horizon (Fuglestvedt et al., 2010; Grewe and Dahlmann, 2015)" Grewe, V., and Dahlmann, K.: How ambiguous are climate metrics? And are we prepared to assess and compare the climate impact of new air traffic technologies?, Atmos. Environm. 106, 373-374, doi:10.1016/j.atmosenv.2015.02.039, 2015.	Accepted and revise	volker Grewe	DLR-Oberpfaffenhofen	Germany
18215	51	15	51	18	However, such a conclusion of the net benefit or disbenefit depends upon the choice of metric and time-horizon applied. As for the above example of technological trade-offs, there is a tendency for additional CO2 to cause a net disbenefit for all metrics when longer time horizons are considered." The simulations made for transatlantic flights and long haul flights overflying Japan show that huge benefits can be cropped at a minimal cost in terms of incremental CO2 emissions. Even if there could be a minor penalty on the longer term, the large short term benefits should be considered as they are needed to delay reaching critical threshold.	Take into account.C	Manfred Treber	Germanwatch	Germany
34335	51	15	51	18	The text suggest a complex trade-off calculation. This is misleading for long distance flights in the context of the 2°C or 1.5°C where benefits always apply. The simulations made for transatlantic flights and long haul flights overflying Japan show that huge benefits can be cropped at a minimal cost in terms of incremental CO2 emissions. This message could be emphasised.	Take into account.C	Antoine BONDUELLE	Climate Action Network France	France
13769	51	16	51	18	As above, this is not necessarily true. It very much depends on what emission scenario and mertric is used. Here the comment from the previous point: A climate metric has three ingredients: an emission scenario, which might be pulse, sustained, or increasing emissions; a time horizon and a climate indicator/metric such as RF, integrated RF, temperture or averaged temperature. The assessment of a mitigation option has an underlying question. For example "Is the introduction of a new aircraft design reducing the aviation climate impact?" or "Is the introduction of the routing strategy to avoid climate sensitive regions reducing the climate impact from aviation?". Both cases refer to a change in the strategy and an avaition scenario, with increasing transport volume, as predicted, is a reasonable choice for such a overaarching question. Global mean temperature change, but not RF, is an adequate metric with respect to this question. Hence, the underlying question on a change in a strategy, e.g., routing strategy, which is applied on an every day basis, refers to an over the time increasing emission scenarion which then will affect the temperture over a, e.g., 20 year time span (see e.g. Grewe et al. 2014a). For such a scenario the dependency on the time horizon largely vanishes (Grewe et al. 2014b; Grewe et al. 2017; page 6!). This can be even deduced on the back of an envelope (see e.g. appendix of Grewe and Stenke, 2008). Grewe, V., Frömming, C., Matthes, S., Brinkop, S., Ponater, M., Dietmüller, S., Jöckel, P., Garny, H., Dahlmann, K., Tsati, E., Søvde, O. A., Fuglestvedt, J., Berntsen, T. K., Shine, K. P., Irvine, E. A., Champougny, T., and Hullah, P.: Aircraft routing with minimal climate impact: The REACT4C climate cost function modelling approach (V1.0), Geosci. Model Dev. 7, 175-201, doi:10.5194/gmd-7-175-2014, 2014a. Grewe, V., Champougny, T., Matthes, S., Frömming, C., Brinkop, S., Søvde, A.O., Irvine,E.A., Halscheidt, L., Reduction of the air traffic's contribution to climate change: A REACT4C case study, 10.1016/j.atmosenv.2014.05.059, Atmos. Environm. 94, 616-625, 2014b. Grewe, V. and A. Stenke, AirClim: an efficient climate impact assessment tool, Atmospheric Chemistry and Physics, 8, 4621 - 4639, 2008. Grewe, V., Matthes, S., Frömming, C., Brinkop, S., Jöckel, P., Gierens, K., Champougny, T., Fuglestvedt, J., Haslerud, A., Irvine, E., Shine, K., Climate-optimized air traffic routing for trans-Atlantic flights. Environm. Res. Lett. 12(3), 034003, DOI: 10.1088/1748-9326/aa5ba0, 2017.	Rejected. Incorrect.	volker Grewe	DLR-Oberpfaffenhofen	Germany
23879	51	19	51	19	"offsetting measure": cf. e.g. also here https://www.biofuelsflightpath.eu/images/final-event-presentations/Nils_Bullerdiek.pdf and DEMO-SPK recommendation paper here https://www.bmvi.de/SharedDocs/DE/Anlage/G/MKS/demo-spk-recommendation-paper.pdf?__blob=publicationFile	Later versions clarified this.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
13779	51	20	51	21	Please clarify why "they have to be introduced": Either because there is a legal act ongoing (forced by some parliaments) or because the climate impact from aviation has to be reduced (sort of forced by IPCC)?	Later versions clarified this.	volker Grewe	DLR-Oberpfaffenhofen	Germany
13781	51	32	51	32	"with with"	editorial - noted	volker Grewe	DLR-Oberpfaffenhofen	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
14103	51	32	51	32	extra "with" in the sentence	editorial - noted	Victor Garcia Tapia	International Energy Agency (IEA)	France
25203	51	32	51	32	Delete "with"	editorial - noted	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
18217	51	32	51	38	This paragraph should mention that Corsia doesn't address the short lived climate forcers.	Accepted. This will be fixed with splitting into CO2 and non-CO2	Manfred Treber	Germanwatch	Germany
34337	51	32	51	38	Add "Corsia doesn't address the short lived climate forcers". Recalling this point is important for policy.	Rejected. Repetition	Antoine BONDUELLE	Climate Action Network France	France
36571	51	37	51	38	Carbon Neutral Growth aims to emission reduction by 2035 and has schedule to determine the post Carbon Neutral Growth in 2032. Schedule is clear, not unclear.	Accepted. Revised wording	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
36565	51	37	51	41	Under CORSIA, emission excess from the baseline, average of emission in 2019 and 2020, should be offset. “Commence in 2020” is not correct.	Accepted. Revised wording	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
13783	51	38	51	38	Please add a line on the climate impact reduction potential by CORSIA. "However, allowing aviation a 5% contribution to the 1.5°C target would result in a passing of this target between 2026 and 2047 (95% range, Grewe et al., to be about to be submitted 2020)."	Rejected - not submitted/published yet	volker Grewe	DLR-Oberpfaffenhofen	Germany
29229	51	39	51	44	Adding to the arguments against CORSIA could be the lack of quality of offsets (2% of all projects is beyond doubt, while 85% is certainly not additional and/or delivering the claimed emissions (Cames et al., 2016). Furthermore, considering this fallacy of offsetting projects to deliver, the global CORSIA project will deliver less emission reductions than the EU ETS that does not suffer such fallacies (Maertens, Grimme, Scheelhaase, & Jung, 2019). Cames, M., Harthan, R. O., Füssler, J. r., Lazarus, M., Lee, C. M., Erickson, P., & Spalding-Fecher, R. (2016). How additional is the Clean Development Mechanism? Analysis of the application of current tools and proposed alternatives (CLIMA.B.3/SERI2013/0026r). Berlin: Maertens, S., Grimme, W., Scheelhaase, J., & Jung, M. (2019). Options to Continue the EU ETS for Aviation in a CORSIA-World. Sustainability, 11(20), 5703.	Take into account.	Paul Peeters	Breda University of applied sciences	Netherlands
18219	51	41	51	41	whereas CORSIA relies on verified offsetting, and exempts some biofuels." The report should precise whether biofuels are 100 % exempted or only partly, according to their actual carbon footprint.	Accepted	Manfred Treber	Germanwatch	Germany
34339	51	41	51	41	"whereas CORSIA relies on verified offsetting, and exempts some biofuels." The report should precise whether biofuels are 100 % exempted or only partly, according to their actual carbon footprint.	Accepted	Antoine BONDUELLE	Climate Action Network France	France
36567	51	41	51	44	“Real reduction is unclear” is very definitive although eligibility criteria for environment integrity is applied to units for offset. “Why” should be explained and what is evidences?	Take into account.	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
29231	52	2	52	16	The discussion about the split-responsibility is indeed important. The current situation is that interests of the international aviation sector are not weighed against any other sector (other transport modes, households, industry, agriculture), which makes it difficult to reduce its emissions. Bringing the responsibility of all international bunkers back into the NDCs would be a very simple to implement and control measure. All relevant information is already measured by UNFCCC (2018). Countries responsible for large amounts of (domestic) aviation fuel may already be more active to change the whole aviation sector. This is for instance the case in Norway, a country with an – unrealistic – electric domestic aviation by 2040 and a heavy program on SAF. So national responsibilities mean national actions being taken. UNFCCC. (2018). GHG data - UNFCCC, Time series - Annex I. Retrieved from http://di.unfccc.int/time_series	Accepted. Agree but allocation has dogged UNFCCC discussions for decades	Paul Peeters	Breda University of applied sciences	Netherlands
42863	52	5	52	9	I strongly disagree with this section as it implies that somehow international aviation and maritime are treated differently to other sectors in the PA when in fact few sectors are explicitly mentioned in the Paris Agreeement (buildings, transport, land use ALL NOT MENTIONED) but the PA clearly covers all anthropogenic emissions. Aviation and maritime emissions should be covered by NDC´s which will ideally include national policy preferences for reducing these emissions in IMO and ICAO.	Rejected. partially incorrect. Expand to show abiguity of PA.	Mark MAJOR	Partnership on Sustainable Low Carbon Transport	Spain
36569	52	9	52	16	It seems to be commitments for domestic aviation under Paris Agreement, not ICAO’s CORSIA. Emission from international aviation and maritime is independently controlled from Paris Agreement. It is better to describe separately.	Rejected. partially incorrect. Expand to show abiguity of PA.	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
37545	52	13	52	16	Odd sentence and also incomplete. The Paris Agreement "is" not a target. It is an international agreement, and its agreement text in its Art 2 refers to a long-term temperature goal (not a target) that is to hold warming well below 2°C and (simultaneously) pursue the 1.5°C limit. So this is one temperature "goal", with reference to two temperature limits. In addition, in its Art 4, it defines a very global emissions goal, which is to peak asap, decline emissions rapidly and reach global zero emissions in line with Art. 2. There is therefore a clear reference to global emissions and in that light this sentence is a mischaracterization of the PA. It seems quite appropriate to me if the authors explain PA Art 4 here, and with reference to the literature, in particular in relation to the "transformational scenario" elsewhere in the chapter	Accepted.	Michiel Schaeffer	Climate Analytics	Netherlands
13785	52	15	52	16	This is a very negative statement. It also could be interpreted in a more positive way. Perhaps one could add: "On the other side	Rejected - we do not propose policy	volker Grewe	DLR-Oberpfaffenhofen	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
29233	52	37	53	43	Regarding the scenarios: may I suggest to create the following set of scenarios: 1.BAU (as it is now, but maybe adding the fact that such a scenario will make it impossible to reach the Paris emissions pathways because aviation will consume all emissions by somewhere between 2060 and 2080. Also in such a scenario, aviation will take about 15% of the global carbon budget of 1000 Gton (2 ° C) or even over 30% of the 1.5 ° C budget (450 Gton) until 2100 (based on Peeters, 2017; Rogelj, Forster, Kriegler, Smith, & Séférian, 2019; Tokarska & Gillett, 2018; van der Ploeg, 2018). 2.A scenario that 'fixes the emission deficit by reduced volume of air travel in a combination of reduced travel distances and modal shifts to electric cars and electric trains/busses (Peeters, 2017). 3.A scenario that aims at nearly zero-emissions by 2050 and zero-emissions by 2100 and a more reasonable share of the carbon budget (whatever that may be for a sector delivering 1-2% directly to the economy; 2-5%??). As nearly zero-emissions can only be reached using mandated e-fuels this should be the first part of the scenario. The second part requires to start development of then fuel-cell aircraft, which may start to enter the short-haul fleet by 2035 and replace the whole fleet by 2100. To contain the budget share, this scenario may still require volume measures with taxes or for instance reduced slot-allocations globally. Peeters, P. M. (2017). Tourism's impact on climate change and its mitigation challenges. How can tourism become 'climatically sustainable'? (PhD), Delft University of Technology, Delft. Rogelj, J., Forster, P. M., Kriegler, E., Smith, C. J., & Séférian, R. (2019). Estimating and tracking the remaining carbon budget for stringent climate targets. Nature, 571(7765), 335-342. doi:10.1038/s41586-019-1368-z Tokarska, K. B., & Gillett, N. P. (2018). Cumulative carbon emissions budgets consistent with 1.5 °C global warming. Nature Climate Change, 8(4), 296-299. doi:10.1038/s41558-018-0118-9 van der Ploeg, F. (2018). The safe carbon budget. Climatic Change, 147(1), 47-59. doi:10.1007/s10584-017-2132-8	Rejected: adopt as per report agreeement	Paul Peeters	Breda University of applied sciences	Netherlands
41275	53	6	53	6	Check if the aviation sector uses this formulation - net-zero CO2. Usually "carbon neutral" is used. The concepts used should be clearly explained.	Accepted. Agree-revise	Jan Fuglestvedt	CICERO	Norway
45091	53	6	53	7	The definition of "transformational scenarios" may also be given earlier in the chapter for land-based transport.	Take into account.	Siir Kilkis	The Scientific and Technological Research Council of Turkey	Turkey
34449	53	6	53	11	Here a discussion about CO2-based alternative fuels is missing: By driving out the use of fossil kerosene fuel in aviation through carbon pricing and requiring aircraft to switch to synthetic fuels, and advanced biofuels to a very limited extent, the climate impact of flying can be reduced dramatically. Zero emission CO2-based synthetic fuels and very low carbon advanced sustainable biofuels can be produced today and deployed immediately using existing engines and infrastructure.Here are key reference son this subject: Transport and Environment, 2018: How to decarbonize European transport by 2050, Transport and Environment./IEAGHG, 2019a: Putting CO2 to Use – Creating value from emissions, International Energy Agency./Gumber and Gurumoorthy, 2018, Methanol, Chap. 25, 661-675./ Byrnolf et al., 2018, Renewable and Sustainable Energy Reviews, 81/2, 1887-1905./ Schemme et al., 2017, Fuel, 205, 198-221/ Global Alliance Powerfuels, 2019: Powerfuels: Missing Link to a successful global Energy Transition, Global Alliance Powerfuels/CONCAWE, 2019: A look into the role of e-fuels in the transport system in Europe (2030–2050) (literature review), CONCAWE.)	Accepted.	Célia Sapart	Université Libre de Bruxelles et Co2 Value Europe	Belgium
36493	53	6	53	11	ICAO consider petro-base lower carbon fuel and IEA WEO 2018 also introduced the same approach. Please see "11.4.4 Enhanced oil recovery using CO2" and Box of "Can CO2-EOR provided carbon-negative oil?". "Net-zero emission" does not mean "phase-out of fossil fuel" (L7). Also "decommissioning of fossil fuel energy system" is not appropriate when net zero emission petro-base fuel is an option (L11). In addition to that, this chapter deals transportation, but "decommissioning" links with other sector, so it is too big option as the option to aviation (general options) It is recommended to delete this.	Rejected.	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
36497	53	6	53	27	At the part of maritime (p56), biofuel is introduced as an option but availability of biofuel is touched, It is recommended stating these analysis here too.	Accepted. Agree	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
20471	53	7	53	27	the transition scenario for aviation in Khalili et al. (https://www.mdpi.com/1996-1073/12/20/3870) and Ram et al. (http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf) quantifies the qualitative discussion in the section and also delivers cost numbers	Take into account.	Christian Breyer	LUT University	Finland
22885	53	14	53	15	"the cost of flying may become considerably higher"... this is the first time cost measures to reduce air travel demand were mentioned in section 10.5. I suggest that the section is revised to make sure that these important measures are discussed more in detail (possibly with a dedicated sub-section)	Accepted.	Giulio Mattioli	TU Dortmund University	Germany
18221	53	15	53	15	zero-C paraffinic fuels" This denomination is somewhat misleading. Should rather use "zero-C synthetic fuels"as above in line 13.	Accepted.	Manfred Treber	Germanwatch	Germany
34341	53	15	53	15	"zero-C paraffinic fuels" This denomination is somewhat misleading. Should rather use "zero-C synthetic fuels"as above in line 13.	Noted.	Antoine BONDUELLE	Climate Action Network France	France

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
13791	53	21	53	27	Please rephrase this sentence. It is true that we do not understand everything, but "poorly understood" is, to my understanding, largely underestimating the available literature. Grewe et al. (2017) showed that the contrail cirrus effect for a higher H2O emission per used energy is leading to a larger region where contrails can form (adapted Schmidt-Appleman criterion) and largely increasing contrail-cirrus coverage and RF, however, the reduced soot emission leads to a shorter lifetime and changed optical properties, which in total reduce the contrail-cirrus RF. Hence the theoretical frame work of the formation criterion is very well understood and not poorly! Grewe, V., Bock, L., Burkhardt, U., Dahlmann, K., Gierens, K., Hüttenhofer, L., Unterstrasser, S., Rao, A.G., Bhat, A., Yin, F., Reichel, T.G., Paschereit, O., Levy, Y., Assessing the climate impact of the AHEAD multi-fuel blended wing body, Met. Z. 26, 711-725, doi:10.1127/metz/2016/0758, 2017.	Rejected. Cross-reference WG1	volker Grewe	DLR-Oberpfaffenhofen	Germany
13793	53	21	53	27	The consequences of changing the emission of the number of particles on the contrail properties are simulated and observed and give a much better understanding than the text suggests. E.g. Bier, A., Burkhardt, U., & Bock, L. (2017) Synoptic control of contrail cirrus life cycles and their modification due to reduced soot number emissions. Journal Geophysical Research: Atmospheres, 122. https://doi.org/ 10.1002/2017JD027011 Bier, A., & Burkhardt, U. (2019). Variability in contrail ice nucleation and its dependence on soot number emissions. Journal of Geophysical Research: Atmospheres, 124. https://doi.org/10.1029/2018JD029155 Burkhardt, U., Bock, L., & Bier, A. (2018). Mitigating the contrail cirrus climate impact by reducing aircraft soot number emissions. npj, Climate and Atmospheric Science, 37, 1–7. https://doi.org/10.1038/s41612-018-0046-4 Tesche, M., Achtert, P., Glantz, P. & Noone, K. J. Aviation effects on already existing cirrus clouds. Nat. Commun. 7, 12016 (2016).	Take into account.	volker Grewe	DLR-Oberpfaffenhofen	Germany
13789	53	22	53	22	Please rephrase this sentence. Emission index is normally defined per kg-fuel. In this respect the EI is 9 kg/kg. However, relating it to the lower heat content of the fuel the value of x2.6 is correct. At least, include in front of the brackets "for the same lower heat value of the fuel"	Take into account.	volker Grewe	DLR-Oberpfaffenhofen	Germany
13787	53	25	53	25	Marquart et al did not investigate contail-cirrus effects, but line shapoed contrails.	Accepted. Agree	volker Grewe	DLR-Oberpfaffenhofen	Germany
13343	53	26	53	27	It is hard to imagine that fuel efficiency will not be a/the major driver for engine technology, even if the fuel is renewable, because aircraft range and cost of operation are driven by efficiency. Engien thermodynamic efficiency is largely controlled by turbine entry temperatures, which are themselves limited by materials and cooling technology. Both of these are likely to increase, and certainly not decrease into the future. Therefore combustion temperatures are unlikely to decrease irrespective of fuel. 'Lean burn' technologies are likely to reduce NOx emissions, however.	Take into account.	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
39241	53	26	53	27	The statement about lower NOx emissions because of lower combustion temperatures is puzzling. Stoichiometric mixtures of hydrogen are hotter than JetA flames. Turbine engine efficiency is determined in part by the turbine inlet temperature so if a different fuel was used, the engine would be resized so that the turbine inlet temperatures would still be high for high efficiency.	Take into account.	Steven Baughcum	Boeing Company	United States of America
35817	53	32	53	32	2012 a bit old. More recent figure??	Taken into account. This figure will be compared to the lastest numbers from the IMO 4th GHG study to be published this year.	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
11083	53	38	53	38	Jalkanen et al. (2014) and Granier et al. (2019) references missing	Taken into account. References added	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
37047	53	28	57	26	The reference has many upto date information relevant for the section. Ocean as a solution to climate change: five opportunities for action Report Washington DC, World resources institute. http//www.oceanpanel.org.climate	Noted. References added.	Joyashree Roy	Asian Institute of Technology, Thailand. Jadavpur University, India	Thailand
47389	53	28	59	18	I would just like to recommend looking at Skysails as an energy saving tool. This company deserves some more recognition in my opinion. (I have no financial or other interest in the company.)	Taken into account. Sails mentioned in list of measures.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
23881	53		59		What about ammonia in the shipping sector?	Noted. Ammonia is already in Section 10.6.4	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
16327	53	28			In Section 10.6 Decarbonization of shipping, consider adding a subsection describing global military use of shipping and the possibilities for decarbonizing that sector, for the sake of clarity and accuracy.	Rejected. There is little / no literature on military use of shipping and its decarbonisation to assess.	Daniel Helman	College of Micronesia-FSM	Micronesia, Federated States of
17985	54	15	54	15	The reference (Smith et al 2014) is not reported in the bibliography	Taken into account. Reference added	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
41277	54	19	54	39	WGI has a separate chater on SLCF. Please coordinate for consistency with authors there. TSUs or bureau members can help.	Taken into account. Reference added	Jan Fuglestvedt	CICERO	Norway

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32541	54	20	54	27	Shipping emits short-lived cooling aerosols (sulfates) and short-lived warming aerosols (black and brown carbon), as well as long-lived CO2. Black carbon adds further warming by reducing albedo of snow and ice when it reaches these surfaces. The goal should be to ensure that reductions of black and brown carbon occur faster than reductions of the cooling sulfates. Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; International Energy Agency (IEA) (2016) WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND AIR POLLUTION; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES; Ramanthan V. & Xu Y. (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Nat'l. Acad. Sci. 107(18):8055–8062.	Noted. Short lived climate forcers are already addressed in Section 10.6.2 and 10.6.3. For more on this, see WG1 Ch 6.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32543	54	20	54	27	More traffic within the Arctic and global climate because increased tourism or shipping will lead to increased pollution, including that of GHGs and SLCPs including black carbon that can further enhance warming in the region that is already warming twice the global average. Declining sea ice is already increasing shipping and tourism within the delicate Arctic region, where increased pollutants—including emissions of black carbon that can decrease the reflectivity of the surface in the region when it lands on snow and ice, which allows greater warming—could further endanger the Arctic, and as such, policies should be developed that will limit and minimize climate impacts in the Arctic. Given the current climate emergency, continued warming in the Arctic will continue to deplete sea ice—to which, if all of the sea ice is lost, it would be like adding an additional trillion tons of CO2 to the atmosphere—and thaw permafrost, which will also amplify warming through its release of stored carbon dioxide and methane; all together, these and other feedbacks will lead to a hothouse Earth. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 ("Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 ("Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region's ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area."); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists' Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595; and Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259, 8254 & 8256, and SI, Table S2.	Noted. Shipping in the Arctic and emissions from GHG and SLCP are addressed in Section 10.6.3. For more on climate feedbacks, see WG1.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32545	54	20	54	27	While not GHGs, black and brown carbon aerosols also are important climate forcers and comes from some similar sources that should be considered part of this discussion. While organic carbon is reflective, the warming effect of black and brown carbon components overall amplify warming. Black carbon is a powerful climate-warming aerosol that directly warms the atmosphere by absorbing solar radiation and indirectly by darkening snow and ice surfaces. Nearly 90% of black carbon emissions come from residential solid fuels, diesel engines, and residential coal; the rest of the emissions come from aviation, shipping, and flaring. Reducing black carbon is especially beneficial for the Arctic because black carbon not only warms the atmosphere but also facilitates additional warming. Once black carbon is deposited on the snow and ice, it reduces the reflectivity (albedo) and absorbs extra solar radiation, which leads to further melting than pristine snow and ice. Since 1890, black carbon has contributed about 0.5–1.4 ºC of warming to the Arctic. Bond T. C., et al. (2013) Bounding the role of black carbon in the climate system: A scientific assessment, J. GEOPHYSICAL RESEARCH–ATMOSPHERES 118(11):5380–5552; Myhre G., et al. (2013) CHAPTER 8: ANTHROPOGENIC AND NATURAL RADIATIVE FORCING, in IPCC (2013) CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Table 8.A.6; Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; International Energy Agency (IEA) (2016) WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND AIR POLLUTION; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES.; Shindell D. & Faluvegi G. (2009) Climate response to regional radiative forcing during the twentieth century, Nature Geoscience 2:294–300; Feng Y., et al. (2013) Brown carbon: a significant atmospheric absorber of solar radiation?, ATMOS. CHEM. PHYSICS 13:8607–8621.	Noted. Short lived climate forcers are already addressed in Section 10.6.2 and 10.6.3. For more on this, see WG1 Ch 6.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
32833	54	20	54	27	More traffic within the Arctic and global climate because increased tourism or shipping will lead to increased pollution, including that of GHGs that can further enhance warming in the region that is already warming twice the global average. Declining sea ice may tempt people to increase shipping and tourism within the delicate Arctic region, where increased pollutants—including emissions of black carbon that can decrease the reflectivity of the surface in the region when it lands on snow and ice, which allows greater warming—could further endanger the Arctic, and as such, policies should be developed that will limit and minimize climate impacts in the Arctic. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 ("Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 ("Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region's ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area."); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Richter-Menge J., et al. (eds.) (2019) ARCTIC REPORT CARD 2019; Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists' Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595.	Noted. Shipping in the Arctic and emissions from GHG and SLCP are addressed in Section 10.6.3. For more on climate feedbacks, see WG1.	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
32835	54	20	54	27	Black carbon is not a greenhouse gas, but it is a powerful climate-warming aerosol that directly warms the atmosphere by absorbing solar radiation and indirectly by darkening snow and ice surfaces. Nearly 90% of black carbon emissions come from residential solid fuels, diesel engines, and residential coal; the rest of the emissions come from aviation, shipping, and flaring. Reducing black carbon is especially beneficial for the Arctic because black carbon not only warms the atmosphere but also facilitates additional warming. Once black carbon is deposited on the snow and ice, it reduces the reflectivity (albedo) and absorbs extra solar radiation, which leads to further melting than pristine snow and ice. Since 1890, black carbon has contributed about 0.5–1.4 ºC of warming to the Arctic. Bond T. C., et al. (2013) Bounding the role of black carbon in the climate system: A scientific assessment, J. GEOPHYSICAL RESEARCH–ATMOSPHERES 118(11):5380–5552; Myhre G., et al. (2013) CHAPTER 8: ANTHROPOGENIC AND NATURAL RADIATIVE FORCING, in IPCC (2013) CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Table 8.A.6; Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; International Energy Agency (IEA) (2016) WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND AIR POLLUTION; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES.; Shindell D. & Faluvegi G. (2009) Climate response to regional radiative forcing during the twentieth century, Nature Geoscience 2:294–300.	Noted. See WG1	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
32547	54	28	54	34	While not GHGs, black and brown carbon aerosols also are important climate forcers and comes from some similar sources that should be considered part of this discussion. While organic carbon is reflective, the warming effect of black and brown carbon components overall amplify warming. Black carbon is a powerful climate-warming aerosol that directly warms the atmosphere by absorbing solar radiation and indirectly by darkening snow and ice surfaces. Nearly 90% of black carbon emissions come from residential solid fuels, diesel engines, and residential coal; the rest of the emissions come from aviation, shipping, and flaring. Reducing black carbon is especially beneficial for the Arctic because black carbon not only warms the atmosphere but also facilitates additional warming. Once black carbon is deposited on the snow and ice, it reduces the reflectivity (albedo) and absorbs extra solar radiation, which leads to further melting than pristine snow and ice. Since 1890, black carbon has contributed about 0.5–1.4 ºC of warming to the Arctic. Bond T. C., et al. (2013) Bounding the role of black carbon in the climate system: A scientific assessment, J. GEOPHYSICAL RESEARCH–ATMOSPHERES 118(11):5380–5552; Myhre G., et al. (2013) CHAPTER 8: ANTHROPOGENIC AND NATURAL RADIATIVE FORCING, in IPCC (2013) CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Table 8.A.6; Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; International Energy Agency (IEA) (2016) WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND AIR POLLUTION; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES.; Shindell D. & Faluvegi G. (2009) Climate response to regional radiative forcing during the twentieth century, Nature Geoscience 2:294–300; Feng Y., et al. (2013) Brown carbon: a significant atmospheric absorber of solar radiation?, ATMOS. CHEM. PHYSICS 13:8607–8621.	Noted. Short lived climate forcers are already addressed in Section 10.6.2 and 10.6.3. For more on this, see WG1 Ch 6.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America

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32837	54	28	54	34	Black carbon is not a greenhouse gas, but it is a powerful climate-warming aerosol that directly warms the atmosphere by absorbing solar radiation and indirectly by darkening snow and ice surfaces. Nearly 90% of black carbon emissions come from residential solid fuels, diesel engines, and residential coal; the rest of the emissions come from aviation, shipping, and flaring. Reducing black carbon is especially beneficial for the Arctic because black carbon not only warms the atmosphere but also facilitates additional warming. Once black carbon is deposited on the snow and ice, it reduces the reflectivity (albedo) and absorbs extra solar radiation, which leads to further melting than pristine snow and ice. Since 1890, black carbon has contributed about 0.5–1.4 ºC of warming to the Arctic. Bond T. C., et al. (2013) Bounding the role of black carbon in the climate system: A scientific assessment, J. GEOPHYSICAL RESEARCH–ATMOSPHERES 118(11):5380–5552; Myhre G., et al. (2013) CHAPTER 8: ANTHROPOGENIC AND NATURAL RADIATIVE FORCING, in IPCC (2013) CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Table 8.A.6; Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; International Energy Agency (IEA) (2016) WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND AIR POLLUTION; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES.; Shindell D. & Faluvegi G. (2009) Climate response to regional radiative forcing during the twentieth century, Nature Geoscience 2:294–300.	Noted. See WG1	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
32549	54	41	55	3	More traffic within the Arctic and global climate because increased tourism or shipping will lead to increased pollution, including that of GHGs and SLCPs including black carbon that can further enhance warming in the region that is already warming twice the global average. Declining sea ice is already increasing shipping and tourism within the delicate Arctic region, where increased pollutants—including emissions of black carbon that can decrease the reflectivity of the surface in the region when it lands on snow and ice, which allows greater warming—could further endanger the Arctic, and as such, policies should be developed that will limit and minimize climate impacts in the Arctic. Given the current climate emergency, continued warming in the Arctic will continue to deplete sea ice—to which, if all of the sea ice is lost, it would be like adding an additional trillion tons of CO2 to the atmosphere—and thaw permafrost, which will also amplify warming through its release of stored carbon dioxide and methane; all together, these and other feedbacks will lead to a hothouse Earth. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 (“Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic.”); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 (“Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region’s ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area.”); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 (“Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow.”); Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT’L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists’ Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595.	Noted. Short lived climate forcers are already addressed in Section 10.6.2 and 10.6.3. For more on this, see WG1 Ch 6.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America

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32839	54	41	55	3	More traffic within the Arctic and global climate because increased tourism or shipping will lead to increased pollution, including that of GHGs that can further enhance warming in the region that is already warming twice the global average. Declining sea ice may tempt people to increase shipping and tourism within the delicate Arctic region, where increased pollutants—including emissions of black carbon that can decrease the reflectivity of the surface in the region when it lands on snow and ice, which allows greater warming—could further endanger the Arctic, and as such, policies should be developed that will limit and minimize climate impacts in the Arctic. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 ("Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 ("Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region's ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area."); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Richter-Menge J., et al. (eds.) (2019) ARCTIC REPORT CARD 2019; Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists' Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595.	Noted. Shipping in the Arctic and emissions from GHG and SLCP are addressed in Section 10.6.3. For more on climate feedbacks, see WG1.	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
6429	54	34			A discussion about new low sulfur gasoil and its impact on other emissions is missing	Taken into account.	Apostolos Petropoulos	International Energy Agency	France
32551	55	4	55	9	Given the current climate emergency, continued warming in the Arctic will continue to deplete sea ice; a recent paper in PNAS calculates that if all of the summer sea ice is lost, it would be like adding an additional trillion tons of CO2 to the atmosphere, which would in turn accelerate the thawing of permafrost, which will further amplify warming through its release of stored carbon dioxide, methane, and N2O; these and other feedbacks risk a hothouse Earth. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 ("Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 ("Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region's ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area."); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists' Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595.	Noted. Shipping in the Arctic and emissions from GHG and SLCP are addressed in Section 10.6.3. For more on climate feedbacks, see WG1.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
32553	55	4	55	9	While not GHGs, black and brown carbon aerosols also are important climate forcers and comes from some similar sources that should be considered part of this discussion. While organic carbon is reflective, the warming effect of black and brown carbon components overall amplify warming. Black carbon is a powerful climate-warming aerosol that directly warms the atmosphere by absorbing solar radiation and indirectly by darkening snow and ice surfaces. Nearly 90% of black carbon emissions come from residential solid fuels, diesel engines, and residential coal; the rest of the emissions come from aviation, shipping, and flaring. Reducing black carbon is especially beneficial for the Arctic because black carbon not only warms the atmosphere but also facilitates additional warming. Once black carbon is deposited on the snow and ice, it reduces the reflectivity (albedo) and absorbs extra solar radiation, which leads to further melting than pristine snow and ice. Since 1890, black carbon has contributed about 0.5–1.4 ºC of warming to the Arctic. Bond T. C., et al. (2013) Bounding the role of black carbon in the climate system: A scientific assessment, J. GEOPHYSICAL RESEARCH–ATMOSPHERES 118(11):5380–5552; Myhre G., et al. (2013) CHAPTER 8: ANTHROPOGENIC AND NATURAL RADIATIVE FORCING, in IPCC (2013) CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Table 8.A.6; Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; International Energy Agency (IEA) (2016) WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND AIR POLLUTION; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES.; Shindell D. & Faluvegi G. (2009) Climate response to regional radiative forcing during the twentieth century, Nature Geoscience 2:294–300; Feng Y., et al. (2013) Brown carbon: a significant atmospheric absorber of solar radiation?, ATMOS. CHEM. PHYSICS 13:8607–8621.	Noted. Short lived climate forcers are already addressed in Section 10.6.2 and 10.6.3. For more on this, see WG1 Ch 6.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32841	55	4	55	9	More traffic within the Arctic and global climate because increased tourism or shipping will lead to increased pollution, including that of GHGs that can further enhance warming in the region that is already warming twice the global average. Declining sea ice may tempt people to increase shipping and tourism within the delicate Arctic region, where increased pollutants—including emissions of black carbon that can decrease the reflectivity of the surface in the region when it lands on snow and ice, which allows greater warming—could further endanger the Arctic, and as such, policies should be developed that will limit and minimize climate impacts in the Arctic. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 (“Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic.”); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 (“Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region’s ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area.”); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 (“Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow.”); Richter-Menge J., et al. (eds.) (2019) ARCTIC REPORT CARD 2019; Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT’L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists’ Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595.	Noted. Shipping in the Arctic and emissions from GHG and SLCP are addressed in Section 10.6.3. For more on climate feedbacks, see WG1.	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
32843	55	4	55	9	Black carbon is not a greenhouse gas, but it is a powerful climate-warming aerosol that directly warms the atmosphere by absorbing solar radiation and indirectly by darkening snow and ice surfaces. Nearly 90% of black carbon emissions come from residential solid fuels, diesel engines, and residential coal; the rest of the emissions come from aviation, shipping, and flaring. Reducing black carbon is especially beneficial for the Arctic because black carbon not only warms the atmosphere but also facilitates additional warming. Once black carbon is deposited on the snow and ice, it reduces the reflectivity (albedo) and absorbs extra solar radiation, which leads to further melting than pristine snow and ice. Since 1890, black carbon has contributed about 0.5–1.4 ºC of warming to the Arctic. Bond T. C., et al. (2013) Bounding the role of black carbon in the climate system: A scientific assessment, J. GEOPHYSICAL RESEARCH–ATMOSPHERES 118(11):5380–5552; Myhre G., et al. (2013) CHAPTER 8: ANTHROPOGENIC AND NATURAL RADIATIVE FORCING, in IPCC (2013) CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Table 8.A.6; Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; International Energy Agency (IEA) (2016) WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND AIR POLLUTION; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES.; Shindell D. & Faluvegi G. (2009) Climate response to regional radiative forcing during the twentieth century, Nature Geoscience 2:294–300.	Noted. See WG1	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
32555	55	10	55	17	More traffic within the Arctic and global climate because increased tourism or shipping will lead to increased pollution, including that of GHGs and SLCPs including black carbon that can further enhance warming in the region that is already warming twice the global average. Declining sea ice is already increasing shipping and tourism within the delicate Arctic region, where increased pollutants—including emissions of black carbon that can decrease the reflectivity of the surface in the region when it lands on snow and ice, which allows greater warming—could further endanger the Arctic, and as such, policies should be developed that will limit and minimize climate impacts in the Arctic. Given the current climate emergency, continued warming in the Arctic will continue to deplete sea ice—to which, if all of the sea ice is lost, it would be like adding an additional trillion tons of CO2 to the atmosphere—and thaw permafrost, which will also amplify warming through its release of stored carbon dioxide and methane; all together, these and other feedbacks will lead to a hothouse Earth. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 ("Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 ("Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region's ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area."); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists' Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595.	Noted. Shipping in the Arctic and emissions from GHG and SLCP are addressed in Section 10.6.3. For more on climate feedbacks, see WG1.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32557	55	10	55	17	While not GHGs, black and brown carbon aerosols also are important climate forcers and comes from some similar sources that should be considered part of this discussion. While organic carbon is reflective, the warming effect of black and brown carbon components overall amplify warming. Black carbon is a powerful climate-warming aerosol that directly warms the atmosphere by absorbing solar radiation and indirectly by darkening snow and ice surfaces. Nearly 90% of black carbon emissions come from residential solid fuels, diesel engines, and residential coal; the rest of the emissions come from aviation, shipping, and flaring. Reducing black carbon is especially beneficial for the Arctic because black carbon not only warms the atmosphere but also facilitates additional warming. Once black carbon is deposited on the snow and ice, it reduces the reflectivity (albedo) and absorbs extra solar radiation, which leads to further melting than pristine snow and ice. Since 1890, black carbon has contributed about 0.5–1.4 ºC of warming to the Arctic. Bond T. C., et al. (2013) Bounding the role of black carbon in the climate system: A scientific assessment, J. GEOPHYSICAL RESEARCH–ATMOSPHERES 118(11):5380–5552; Myhre G., et al. (2013) CHAPTER 8: ANTHROPOGENIC AND NATURAL RADIATIVE FORCING, in IPCC (2013) CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Table 8.A.6; Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; International Energy Agency (IEA) (2016) WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND AIR POLLUTION; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES.; Shindell D. & Faluvegi G. (2009) Climate response to regional radiative forcing during the twentieth century, Nature Geoscience 2:294–300; Feng Y., et al. (2013) Brown carbon: a significant atmospheric absorber of solar radiation?, ATMOS. CHEM. PHYSICS 13:8607–8621.	Noted. Short lived climate forcers are already addressed in Section 10.6.2 and 10.6.3. For more on this, see WG1 Ch 6.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32559	55	10	55	17	The Eastern Pacific Emitted Aerosol Cloud Experiment (E-PEACE) studied the cooling effect of smoke from ships due to their emission's effect on brightening clouds, and found that brighter clouds from smoke produce a cooling effect 2 to 50 times greater than warming effect from carbon emissions from ships. See Russell et al., Eastern Pacific Emitted Aerosol Cloud Experiment, Bulletin of the American Meteorological Society (May 2013): "We use the 15% cloud brightening measured for the smoke on 16 July (Fig. 5) for both tracks to find 2-nK cooling for the cargo ship and 0.4-nK cooling for the smoke—that gives us ratios of cooling to warming (i.e., a cooling efficiency) of ~2 for the cargo ship and ~50 for the smoke generator. Although this is a very simplified calculation, we find that, if half of the open-ocean transit days of a cargo ship result in tracks that are on average 15% brighter than the surrounding clouds and cover 2,500 km2, then cargo ship transit (for consumables only) could be considered "carbon neutral" (in the sense of having no net warming effect) transportation. Further, we find that smoke generators on board smaller ships (that require less than 2% of the fuel per transit mile) could provide a net cooling effect, which could be used to offset some of the warming caused by ship CO2 emissions."	Noted. The effects of ship emissions on shortwave radiation is addressed in Section 10.6.3. More on this in WG1.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America

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32845	55	10	55	17	More traffic within the Arctic and global climate because increased tourism or shipping will lead to increased pollution, including that of GHGs that can further enhance warming in the region that is already warming twice the global average. Declining sea ice may tempt people to increase shipping and tourism within the delicate Arctic region, where increased pollutants—including emissions of black carbon that can decrease the reflectivity of the surface in the region when it lands on snow and ice, which allows greater warming—could further endanger the Arctic, and as such, policies should be developed that will limit and minimize climate impacts in the Arctic. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 ("Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 ("Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region's ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area."); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Richter-Menge J., et al. (eds.) (2019) ARCTIC REPORT CARD 2019; Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists' Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595.	Noted. Shipping in the Arctic and emissions from GHG and SLCP are addressed in Section 10.6.3. For more on climate feedbacks, see WG1.	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
32847	55	10	55	17	Black carbon is not a greenhouse gas, but it is a powerful climate-warming aerosol that directly warms the atmosphere by absorbing solar radiation and indirectly by darkening snow and ice surfaces. Nearly 90% of black carbon emissions come from residential solid fuels, diesel engines, and residential coal; the rest of the emissions come from aviation, shipping, and flaring. Reducing black carbon is especially beneficial for the Arctic because black carbon not only warms the atmosphere but also facilitates additional warming. Once black carbon is deposited on the snow and ice, it reduces the reflectivity (albedo) and absorbs extra solar radiation, which leads to further melting than pristine snow and ice. Since 1890, black carbon has contributed about 0.5–1.4 ºC of warming to the Arctic. Bond T. C., et al. (2013) Bounding the role of black carbon in the climate system: A scientific assessment, J. GEOPHYSICAL RESEARCH–ATMOSPHERES 118(11):5380–5552; Myhre G., et al. (2013) CHAPTER 8: ANTHROPOGENIC AND NATURAL RADIATIVE FORCING, in IPCC (2013) CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Table 8.A.6; Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; International Energy Agency (IEA) (2016) WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND AIR POLLUTION; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES.; Shindell D. & Faluvegi G. (2009) Climate response to regional radiative forcing during the twentieth century, Nature Geoscience 2:294–300.	Noted. See WG1	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
34937	55	16	55	16	"effect" in place of "affect"	Taken into account. Typo corrected.	ANUPAM DEBSARKAR	University	India

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
32561	55	18	55	34	The loss of Arctic summer sea ice to date is allowing more traffic within the Arctic for increased tourism and shipping, which will lead to increased pollution, including from GHGs and SLCPs such as black carbon, which will, in turn, further enhance warming in the region that is already warming twice the global average. Black carbon emissions from shipping add significant forcing while also decreasing the reflectivity of the surface in the region when it lands on snow and ice, which allows greater warming—could further endanger the Arctic. Protecting the Arctic requires policies to minimize climate impacts in the Arctic, including, e.g., limiting shipping to only those using clean energy. Failing to protect the Arctic risks contributing to stronger feedbacks and faster tipping points, risking a Hothouse Earth. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 ("Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 ("Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region's ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area."); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists' Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259, 8254 & 8256, and SI, Table 2S.	Noted. Shipping in the Arctic and emissions from GHG and SLCP are addressed in Section 10.6.3. For more on climate feedbacks, see WG1.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America
32563	55	18	55	34	While not GHGs, black and brown carbon aerosols also are important climate forcers and comes from some similar sources that should be considered part of this discussion. While organic carbon is reflective, the warming effect of black and brown carbon components overall amplify warming. Black carbon is a powerful climate-warming aerosol that directly warms the atmosphere by absorbing solar radiation and indirectly by darkening snow and ice surfaces. Nearly 90% of black carbon emissions come from residential solid fuels, diesel engines, and residential coal; the rest of the emissions come from aviation, shipping, and flaring. Reducing black carbon is especially beneficial for the Arctic because black carbon not only warms the atmosphere but also facilitates additional warming. Once black carbon is deposited on the snow and ice, it reduces the reflectivity (albedo) and absorbs extra solar radiation, which leads to further melting than pristine snow and ice. Since 1890, black carbon has contributed about 0.5–1.4 ºC of warming to the Arctic. Bond T. C., et al. (2013) Bounding the role of black carbon in the climate system: A scientific assessment, J. GEOPHYSICAL RESEARCH–ATMOSPHERES 118(11):5380–5552; Myhre G., et al. (2013) CHAPTER 8: ANTHROPOGENIC AND NATURAL RADIATIVE FORCING, in IPCC (2013) CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Table 8.A.6; Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; International Energy Agency (IEA) (2016) WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND AIR POLLUTION; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES.; Shindell D. & Faluvegi G. (2009) Climate response to regional radiative forcing during the twentieth century, Nature Geoscience 2:294–300; Feng Y., et al. (2013) Brown carbon: a significant atmospheric absorber of solar radiation?, ATMOS. CHEM. PHYSICS 13:8607–8621.	Noted. Short lived climate forcers are already addressed in Section 10.6.2 and 10.6.3. For more on this, see WG1 Ch 6.	Durwood Zaelke	Institute for Governance & Sustainable Development	United States of America

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
32849	55	18	55	34	More traffic within the Arctic and global climate because increased tourism or shipping will lead to increased pollution, including that of GHGs that can further enhance warming in the region that is already warming twice the global average. Declining sea ice may tempt people to increase shipping and tourism within the delicate Arctic region, where increased pollutants—including emissions of black carbon that can decrease the reflectivity of the surface in the region when it lands on snow and ice, which allows greater warming—could further endanger the Arctic, and as such, policies should be developed that will limit and minimize climate impacts in the Arctic. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 ("Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 ("Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region's ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area."); Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Richter-Menge J., et al. (eds.) (2019) ARCTIC REPORT CARD 2019; Pistone K., et al. (2019) Radiative Heating of an Ice-Free Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 46(13):7474–7480; Schaefer K., et al. (2014) The Impact of the Permafrost Carbon Feedback on Global Climate, Environmental Research Letters 9:1–9; Steffen W., et al. (2018) Trajectories of the Earth System in the Anthropocene, PROC. NAT'L. ACAD. SCI. 115(33):8252–8259; Ripple W. J., et al. (2019) World Scientists' Warning of a Climate Emergency, BIOSCIENCE biz088:1–5; Lenton T. M., et al. (2019) Climate tipping points—too risky to bet against, NATURE, Comment, 575:592–595.	Noted. Shipping in the Arctic and emissions from GHG and SLCP are addressed in Section 10.6.3. For more on climate feedbacks, see WG1.	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
32851	55	18	55	34	Black carbon is not a greenhouse gas, but it is a powerful climate-warming aerosol that directly warms the atmosphere by absorbing solar radiation and indirectly by darkening snow and ice surfaces. Nearly 90% of black carbon emissions come from residential solid fuels, diesel engines, and residential coal; the rest of the emissions come from aviation, shipping, and flaring. Reducing black carbon is especially beneficial for the Arctic because black carbon not only warms the atmosphere but also facilitates additional warming. Once black carbon is deposited on the snow and ice, it reduces the reflectivity (albedo) and absorbs extra solar radiation, which leads to further melting than pristine snow and ice. Since 1890, black carbon has contributed about 0.5–1.4 ºC of warming to the Arctic. Bond T. C., et al. (2013) Bounding the role of black carbon in the climate system: A scientific assessment, J. GEOPHYSICAL RESEARCH–ATMOSPHERES 118(11):5380–5552; Myhre G., et al. (2013) CHAPTER 8: ANTHROPOGENIC AND NATURAL RADIATIVE FORCING, in IPCC (2013) CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Table 8.A.6; Qian Y., et al. (2014) Light-absorbing Particles in Snow and Ice: Measurement and Modeling of Climatic and Hydrological impact, ADVANCES IN ATMOSPHERIC SCIENCES 32:64–91; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; International Energy Agency (IEA) (2016) WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND AIR POLLUTION; World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES.; Shindell D. & Faluvegi G. (2009) Climate response to regional radiative forcing during the twentieth century, Nature Geoscience 2:294–300.	Noted. See WG1	Kristin Campbell	Institute for Governance & Sustainable Development	United States of America
11085	55	22	55	23	There has also been a significant increase in the activity of LNG carriers in the Russian arctic e.g. the building of 15 Arc7 LNG carriers for this trade.	Noted.	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
11089	56	4	56	12	The potential for ammonia should also be mentioned here, including its use as a hydrogen carrier, even though it is mentioned later. This is currently considered to be the best long term option for decarbonisation by the shipping industry – more so than biofuels. (T&E 2018) T&E (2018) Roadmap to decarbonising European shipping https://www.transportenvironment.org/publications/roadmap-decarbonising-european-shipping The use of shore supply electricity in ports should also be discussed here.	Taken into account. Ammonia has been elaborated on in the text.	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
23883	56	10	56	10	"Alternative fuels": cf. also http://task39.sites.olt.ubc.ca/files/2013/05/Marine-biofuel-report-final-Oct-2017.pdf https://www.iea-amf.org/app/webroot/files/file/Annex%20Reports/AMF_Annex_41.pdf and ongoing IEA AMF https://www.iea-amf.org/content/projects/map_projects/56	Noted.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany

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11091	56	19	56	21	This statement is misleading. A combination of e.g. wind propulsion and biofuels is technically feasible , although still in the early stages of development, and could deliver reductions of 90% plus. For some ships, a combination of wind power, using onboard power generation from the propeller, has the technological potential to deliver almost 100% emissions reduction from onboard propulsion and auxiliary power systems. (Köhler, 2019, Köhler 2020a,b). Köhler J. (2019) Transitions pathways to very low emissions shipping: the Matisse-Ship model, in The Royal Institution of Naval Architects, International Conference on Wind Propulsion pp. 83-90, RINA, London. ISBN 978-1-909024-97-7 Köhler J. (2020a) Zero carbon propulsion in shipping - scenarios for the development of hydrogen and wind technologies with the MATISSE-SHIP model Accepted for publication in International Shipbuilding Progress, Hydrogen Special Issue Köhler J. (2020b): Modelling the multi-level perspective: The MATISSE agent-based model. In Enayat Moallemi, F. de Haan (Eds.): Modelling Transitions – Virtues, Vices visions of the future: Routledge: Oxon; New York pp.77-101. ISBN 978-0-367-17406-4	Taken into account. A combination of measures is mentioned.	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
27867	56	22	56	27	Sustainability concerns over bioenergy production are addressed many times in this report, while the potential of sustainable bioenergy is also recognized. Hence, the opportunities and bottlenecks need to be explained in a balanced manner when discussing the role of bioenergy. Nonetheless, this part only highlights bottlenecks for the deployment of on biofuels posed by land use constraints, underestimating their potential as opposed to the results of scientific analysis presented in page 45 of Chapter 6 as well as the scenario discussed in "7.5.5 Bioenergy" under Chapter 7. This part should be removed or reformunated accordingly.	Taken into account. The paragraph has been reformulated.	Toshimasa Masuyama	International Renewable Energy Agency	Germany
9597	56	24	56	27	First of all, the discussion of sustainable biomass available for biofuels would fit better in the biofuels section (10.3.3). Secondly the quoted range (50-100 EJ) seems to be on the low side as compared to the scientific consensus (see e.g. Creutzig et al. 2015: Bioenergy and climate change mitigation: An assessment, GCB Bioenergy 7, 916–944). Thirdly, it is unclear what (SSI, 2019) refers to. It does not appear in the reference list.	Taken into account. Biofuels is mainly discussed in 10.3.3., but also needs mentioning here. The range is updated. And Reference included.	Jesper Kløverpris	Novozymes	Denmark
36495	56	25	56	26	IRENA disclose different number about bioenergy supply by “Global Energy Transformation” It states that bioenergy will increase from 30EJ to 125EJ in 2050 but share of transportation is 22% and 27% respectively. “10EJ in 2018” seems to be overestimated.	Noted.	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
20473	56	3	57	26	alternative fuels, transition options and relative and total sector cost as discussed in Horvath et al. (https://www.sciencedirect.com/science/article/pii/S0196890418302152), Khalili et al. (https://www.mdpi.com/1996-1073/12/20/3870) and Ram et al. (http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf) would be a value add, in particular since renewable power based indirect fuel solutions could be highlighted more	Taken into account. Horvath reference included.	Christian Breyer	LUT University	Finland
11087	56	3			Section 10.6.4 The discussion of medium term reduction technological reduction potentials is very limited. In particular, the potential contribution of wind technologies is hardly mentioned, even though wind assistance projects are already demonstrating considerable reductions in energy demand and relatively low payback times of as little as 4 years (Köhler et al 2017 and Nelissen et al 2016) Köhler J., Nelissen Dagmar, Traut, Michael (2017) Fighting the windbreak, The Naval Architect, May, 26-32. Nelissen Dagmar, Michael Traut, Jonathan Köhler, Wengang Mao, Jasper Faber, Saliha Ahdour (2016) Study on the analysis of market potential and market barriers for wind propulsion technologies for ships, CE Delft, Delft https://www.cedelft.eu/publicatie/study_on_the_analysis_of_market_potentials_and_market_barriers_for_wind_propulsion_technologies_for_ships/1891 ISBN 978-92-79-64629-4 DOI 10.2834/68747	Noted. Sails and kits are according to cited literature most suitable for smaller ship sizes, with little agreement on the size of CO2 reduction potential. Hence the discussion on this remains limited.	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
34451	57	3	57	4	Here a discussion about CO2-based alternative fuels is missing: By driving out the use of fossil kerosene fuel in aviation through carbon pricing and requiring aircraft to switch to synthetic fuels, and advanced biofuels to a very limited extent, the climate impact of flying can be reduced dramatically. Zero emission CO2-based synthetic fuels and very low carbon advanced sustainable biofuels can be produced today and deployed immediately using existing engines and infrastructure.Here are key reference son this subject: Transport and Environment, 2018: How to decarbonize European transport by 2050, Transport and Environment./IEAGHG, 2019a: Putting CO2 to Use – Creating value from emissions, International Energy Agency./Gumber and Gurumoorthy, 2018, Methanol, Chap. 25, 661-675./ Byrnolf et al., 2018, Renewable and Sustainable Energy Reviews, 81/2, 1887-1905./ Schemme et al., 2017, Fuel, 205, 198-221/ Global Alliance Powerfuels, 2019: Powerfuels: Missing Link to a successful global Energy Transition, Global Alliance Powerfuels/CONCAWE, 2019: A look into the role of e-fuels in the transport system in Europe (2030–2050) (literature review), CONCAWE.)	Accepted and revised.	Célia Sapart	Université Libre de Bruxelles et Co2 Value Europe	Belgium
34939	57	7	57	7	"coupled" in place of "couple"	Taken into account	ANUPAM DEBSARKAR	University	India
11093	57	12	57	16	The potential of energy efficiency management and operational measures should at least be mentioned here, in particular the analogy with other industries, where the implementation of energy efficiency policy generated many practical, cost saving possibilities for the halting of wasteful operational practices. Also, ships can experience considerable waiting times for berth or e.g. to enter the Suez canal. The need to assess the potential benefits from improving operational efficiency in these areas should be mentioned.	Taken into account. Though such operationa measures and voyage optimisation has been deemed by literature to have relatively small CO2 emission reduction potential (e.g. Bouman et al. 2017).	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
11095	57	13	57	13	Traut et al. 2018 reference missing.	Taken into account. Reference added	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
17987	57	19	57	20	The two referenceres are missing in the bibliography	Taken into account. References added	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy

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42275	57	27	58	28	The IMO's initial strategy on reducing emissions reduction from ships (2018) should be mentioned : https://unfccc.int/sites/default/files/resource/250_IMO%20submission_Talanoa%20Dialogue_April%202018.pdf	Taken into account. Now mentioned	Alvin Mejia	Wuppertal Institute	Germany
18387	58	16	58	25	A case study can be added here. In China, some policies encourage travel and tourism to promote economic development may hinder changes, such as the policy of high-speed toll free on holidays, which result in increased emissions from cars.	Taken into account. A case study box is added.	Jie Guo	China Academy of Transportation Sciences	China
37549	58	31	58	32	The Paris Agreement goals relevant for mitigation comprise Article 2 and 4 that need to be interpreted in conjunction and are thus more than just a temperature goal (see e.g. Schleussner et al. 2019, Table 1). However, there is only one goal/target within the PA, as this matches most closely to SSP1-1.9. And this observation also sufers from the problem that the model they are based on (IMAGE) has explicit limitations to mitigation options in the shipping sector (no fuel switching, see above comments)	Taken into account. This limitation of IMAGE is noted.	Michiel Schaeffer	Climate Analytics	Netherlands
37547	58	29	59	16	Please refer to an assessment of mitigation options in IAMs for shipping and other sectors. For example, SSP1-1.9 is from the IMAGE model, for which there is no available fuel switching in the shipping sector, hence there is a floor to the total emissions reduced. See https://www.pbl.nl/sites/default/files/downloads/pbl-2020-analysing-international-shipping-and-aviation-emissions-projections_4076.pdf.	Taken into account. This limitation of IAMs is noted.	Michiel Schaeffer	Climate Analytics	Netherlands
27041	59	20	59	23	This introduction is a bit general. Isnt the big issue linking decarbonisation in transport to advances in clean fuels and low carbon electricity? This then leads to a discussion of when and how this will happen. Many IAMs need another sector (electricity) to decarbonise before transport and that has been a finding in previous research. Higher vehicle costs may exist, but decarbonisation occurs via electrification due to cheaper low-carbon electricity not being penalised by a carbon tax - https://doi.org/10.1016/j.energy.2013.08.059 https://doi.org/10.1016/j.enpol.2013.03.008	Accepted. Thanks for the comment. The intent of the paragraph was to transition from the bottom up (LCA) literature on individual technologies to the sectoral scenario literature and then introduce the scenario literature in the subsequent sections. We understand your comment as proposing strengthen the section with respect to the transition interdependencies between the transport and other sectors, in particular the electricity sector. While the broader interdependencies between sectors are dealt with in chapter 3, we do indeed also cover the fuel and electricity decarbonization in subsection “Fuel energy and technology” starting page 10-66 line 22. E.g Line 15-17 in 10-68. “Shifts towards alternative fuels must occur alongside shifts towards clean technologies in other sectors as all of the alternative fuels have upstream impacts. Without considering other sectors, fuel shifts would not yield their full mitigation potentials.». However the interdependency aspects you bring forth, e.g timing can and should indeed be strengthened and we will do so in the reworking of section “Fuel energy and technology”	Thomas Longden	Australian National University	Australia
28599	59	24	59	27	It must be mentioned somewhere that those large-scale models lack the detailed technological descriptions of engineering/LCA models, and have therefore potentially overlooked important emission pathways. Therefore, further research is necessary to complement the present estimates.	Accepted. Thanks for the comment. Indeed the level of detail in engingeering and LCA models can generally be said to be much higher than in many of the large-scale models. We will point out the knowledge gap implications and any policy relvance of that, as characterized by the broader literature, in the revision of this section.	Paul Wolfram	Yale University	United States of America
27043	59	29	59	30	Need to clarify what type of depth and scope that you are refering to. And the time dimension is also a crucial factor. Whether a model runs until 2050 or 2100 will be important and impact on foresight plus the ability to delay deep decarbonisation until post-2050 when a breakthrough in costs may occur.	Accepted. Thanks for your comment. We will revrite the specified paragraph and the subsequent paragraph to better explain the differences between different models.	Thomas Longden	Australian National University	Australia
16445	59	19	68	36	The climate goals used in this section are confusing. We see 1.6C and 1.75C. Can we keep using 1.5C?	Accepted. Thanks for your comment. We interpret you comment as seeking consistency wrt to temperature targets of the different scenarios. We will rework our figures and aligne them with the scenario definitions used in chapter 3.	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
31247	59	19			This is a very important comment: Please make reference in this section to the scenarios IP1 .. IP5 discussed in chapter 3: Please show how quantitative parameters evolve in these scenarios. E.g. in Figures 10.18, 10.19, and especially in Figure 10.20. Also the projections of other key parameters should be mentioned in this section for IP1 .. IP5: e.g. average fuel/electricity consumption, vehicle mass, percentage of shared rides, vehicle miles travelled, passenger transport activity, freight transport activity etc. It really must become transparent what needs to be done in order to reach the climate targets with IP1..IP5, and how this compares to a reference scenario with no or only little climate action.	Accepted. Thanks for taking time to comment on the FDO. With respect to your comment on the IPs, dialouge was undertaken in cross sectoral workgroups to align scenarios presentations across chapters. This is still work in progress and we will continue to engage in this process with the intent of ensuring as well aligned presentations of the scenarios as possible. Towards this end, we plan redo all figures in this section. That would imply that we would be striving to align with the IPs, as you suggest, if those are maintained by CH3. As with respect to you second request, we will revisit what parameters should be presented throughout this section and review how we may improve transparency regarding the mechanisms are deployed by the models to decarbonize the sector. However, this is a) constrained by what data is available from the different model runs that constitute the research frontier and b) our allocated page space to cover this topic. We are currently not in possession of the variables you request for the model runs. In terms of improving data coverage, a section of the IPCC scenario data call is directed as obtaining more transport model data results.	Urs Ruth	Robert Bosch GmbH	Germany
29191	60	5	60	5	At the end of this introductive part of the sub chapter 10.7., this could be good to integrate a sentence around the existing literrature on hybrid-modelling and qualitative-quantitative pathways. One of our paper on the passenger transport has just been accepted in Climate Policy to detail how this hybrid approach could bring a lot to the definition of pathways articulating consistenly demand-side and technological-side solutions and enabling to build comprehensive and policy-relevant pathways. This is a declination for the passenger transport sector of the more general DDP approach presented here: https://doi.org/10.1038/s41558-019-0442-8	Take into account.	Yann BRIAND	Iddri, Sciences Po	France
11173	60	7	60	22	Figure 10.18 needs some more description.	Accepted. Thanks for the comment. We will elaborate the descrioption for the SOD.	Snorre Kverndokk	Frisch Centre	Norway
27045	60	7	60	36	Can you discuss whether the models are optimistic/pessimistic in relation to historical trends? It seems to be a lost opportunity in the discussion of Fig 10.18 and this could be an important finding to be discussed at the beginning of this section.	Accpeted. Sincere thanks for the comment. We will improve the paragraphs in relation to the figure to improve on the bridge from historical data to the scenarios.	Thomas Longden	Australian National University	Australia
28601	60	13	60	16	Constant carbon intensity of what? Transport fuels?	Accepted. Thanks for pointing out that the text was unclear on this point. We will revise the text to make sure the intended message is clear.	Paul Wolfram	Yale University	United States of America
47391	60	16	60	19	Figure 10.18 I don't understand the numbers across the bins and I don't understand how I can see which IAM says what or how different they are.	Accepted. The FOD variant of these figures covers the full set of AR6 model runs compatible with the different temperature bins and identification of individual models would be difficult. However the figure will be updated for the SOD and we will work to increase the transparency.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
11097	60	17	60	18	Figure 10.18 is poorly designed. The y axis should be consistent across the historical and future areas	Accepted. Thanks for pointing this out. This was unintended and will be corrected for the SOD.	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
27047	60	17	60	18	It would be great to see how Fig 10.18 (and 10.19) would differ if they showed a global total and compared it to developed countries and less developed countries. Might be more important for pkm and tkm in Fig 10.19. This was done in AR5 report.	Thanks for the comment. We are targeting to provide some reginal breakdown for some of the variables. Those you propose are indeed highly relevant.	Thomas Longden	Australian National University	Australia
27049	60	17	60	18	Number of models is hard to read and not reported for sectoral models. Refer to AR5 report Fig 8.9 for alternative representation of number of models (i.e. below x-axis). And, is it the case that the number of models and scenarios is lower in the AR6 database compared to AR5? if so, this is disappointing. I had hoped for an increase.	Accepted. Thanks for the comment. We are targeting to provide some reginal breakdown for some of the variables. Those you propose are indeed highly relevant.	Thomas Longden	Australian National University	Australia
35819	60	17	60	18	Interesting figure. Better resolution needed	Noted	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11765	60	32	60	36	Please consider to include more concrete information about why the transport analysis show that transport needs to cut emissions less than other sectors? While the total reduction in 2030 and 2050 should be 40-58% and 95-107% respectively, the transport sector only needs about 0% reduction in 2030 and 22-37 % reduction in 2050? When reading the above sentences in this para it seems that this is due to an artifact of the models used, and therefore we expect that the authors of this chapter describes such modelling artifacts clearly and try to bridge such non-intuitive results. As it is stated now it could potentially send out mixed signals to policy developers and makers.	Accepted. Thanks for the comment. The paragraph in question does indeed aim to clarify how the literature on scenarios deals with emission reductions	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
20475	60	6	61	44	literature overview is too limited. There are zero GHG emission scenarios by 2050, but this is not mentioned in the section; more ambitious ESM results are available, as summarised by Khalili et al. (https://www.mdpi.com/1996-1073/12/20/3870) - see Tab. 27 there, and this is cost effective as shown in Ram et al. (http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf)	Accepted. Thanks for the comment. The AR6 database is per now not complete. We have an open invitation for submission of scenario data here: https://data.ene.iiasa.ac.at/ar6-scenario-submission/#/about Your submission would be much welcommed.	Christian Breyer	LUT University	Finland
22887	60	11			Given recent controversies on the use of the term "BAU" in climate research & reporting, it would be important to briefly clarify how the term is used here / what it means	Accepted. Thanks for the comment. We agree. At the time of writing there is an ongoing process to harmonize how scenarios are presented across the different chapters, including how the scecnarios are defined. This chapter aims to align with this process for the SOD.	Giulio Mattioli	TU Dortmund University	Germany
28603	61	4	61	6	Discuss why that is the case. Is that because the more technical detail a model has, the harder it becomes to for the model to decarbonize? Compare with Edelenbosch et al., http://dx.doi.org/10.1016/j.energy.2017.01.017	Accepted. Thanks for the comment. We will try to explain this better. There reason for this is simply that a model that only covers one sector is not capable of solving for a global emission target. Such an objectve would per se warrant global coveage (across all sectors and regions).	Paul Wolfram	Yale University	United States of America
28605	61	11	61	13	... unless ICEV lifetimes are shortened	Accepted. Thanks for the comment. We will aim to improve the general text in terms of sensitivities to important assumptions where these are also highlighted in the underlying scenario literature.	Paul Wolfram	Yale University	United States of America
45183	61	18	61	19	A link to per capita emissions (which are discussed in the next para line 34-38) can be made, i.e. about 0.5 to 0.25 tonnes per capita for a 2 degree or 1.5 degree scenario respectively	Thanks for the comment. We will work to improve the bridge between the paragraphs in question.	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
27051	61	20	61	38	How IAMs differ between developed and less developed countries may be an interesting comparison to make (especially for comparison to this section).	Accepted. Sincere thanks for the comment. We will work to improve the representation of regional differences for the SOD.	Thomas Longden	Australian National University	Australia
16439	61	22	61	34	For low-carbon scenarios under 2C/1.5C, only Dhar et atl. (2018) is cited, and I cannot find this in references. The authors need to further investigate the literature. For instance, Pan et al. (2018; Decarbonization of China's transportation sector: In light of national mitigation toward the Paris Agreement goals; doi: https://doi.org/10.1016/j.energy.2018.04.144) is the first study on the decarbonization of China's transportation sector in a 1.5C scenario. The conclusion that the 2050 transport emissions in developing countries increase by 35%-83% from 2010 levels is not sufficiently rigorous. It may hold for 2C scenarios. However, Pan et al. (2018) find that China's transport emissions are expected to reduce by 33% in 2050 from 2010 levels in a 1.5C scenario. The authors should make clear which scenarios result in 35%-83% and show the transport mitigation under 2C and 1.5C separately. Also the authors may consider to remark that the mitigation of the transportation sector is more sensitive to scenarios than other sectors such as power generation and industry.	Accepted. We are including a number of other papers from national level assessments and they will be included in the revision.	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
23885	61	26	61	27	"National studies show that transport CO2 emissions are expected to decline significantly": Cf. also the IEA/EC study https://iea-amf.org/content/news/TD-WS (pre-liminary results)	Accepted. The link provided is for a workshop report. We will invite to contribute towards the national studies and also provide published literature for this	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
11779	61	26	61	30	Incomplete sentence? Or please consider to move the references to the end of the sentence	Accepted. Agree with the reviewer. We will move the reference to the end of the sentence.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
28607	61	36	61	38	Somewehere it should be stressed that (more) research is needed that considers LCA emissions within national or global transport decarbonization scenarios	Accepted. We have included the technology wise LCA literature in this chapter in Section 10.3.4. We havent come across any study that considers LCA emission within national scenarios so It would be fine to add this point.	Paul Wolfram	Yale University	United States of America
11763	61	39	61	44	Please consider to include more concrete information about why transport scenario literature suggest that transport sector needs to cut emissions less than other sectors? Just stating this without clear messages on why and how could potentially send mixed signals to policymakers. The statementon spread in results justifies a quantification of the results, and together with the rationale that it is a difficult sector to transform also justifies a need for more information on options that are already available for early implementation.	Accepted. Yes more literature will be included to stregthen the argument with a better explanation of the underlying reasons	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
27053	61	41	61	44	Is it the case that transport is difficult to decarbonise? Or is it the case that it is dependent on decarbonisation of electricity and other fuels? Surely, industrial emissions and heavy freight are diffiicult, but light duty vehicle reductions are dependent on time (due to the cost of batteries and decarbonisation of electricity). Many IAMs need another sector (electricity) to decarbonise before transport and that has been a finding in previous research. There is a case to be optimistic about decarbonisation via electrification even without a carbon tax - studies that I know of that discuss this time dependency include: https://doi.org/10.1016/j.energy.2013.08.059 https://doi.org/10.1016/j.enpol.2013.03.008	Accepted. The time dependency studies mentioned by the reviewer here are 7 years old and in this chapter, we are considering research papers published ranging from year 2014 to year 2020 so we wont be able to refer to these paper suggested by the reviewer. Surge in battery production in the last ten years has led to 85% decline in battery cost so we need to either check latest IAM literature report mode wise or technology wise mitigation potential.	Thomas Longden	Australian National University	Australia
45185	61	43	61	44	"For 2100, the median results suggest cuts down to -80% for a 1.50 trajectory.". Please check whether this is in line with earlier statements in the chapter, and a net-zero emissions shortly after mid-century	It is not clear to which earlier statements the reviewer is referring here. After quick check, "A 'transformational scenario' is one that works towards a target of net-zero CO2 emissions from the aviation sector. This would be driven by active policies that mandated phase-out of fossil fuel usage by 2050" talks about net zero emission in aviation sector by 2050 not complete transport sector.	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
29193	61	45	63	48	There is no elements regarding the detail of the mobility demand and activity. These elements are fundamental if we want to understand the future of the mobility demand beyond the usual aggregates. This could be good to illustrate some existing details distinguishing for example: - the type of mobility needs (for people living in metropolitan and non-metropolitan areas, short distance and long distance, low and rich income, regular constrained and leisure non constrained) help understand and identify mobility needs and suited technological options. - the type of goods for land transport (category of goods/ international classifications, type of trip: for import/export/transit/national, load, distance travelled) help... - ... and so on.	Accepted. We have included detailed mode wise activity and also developing and developed countries mobility demand per capita to capture some elements(distance, different income/ development levels) highlighted by the reviewers. Transport demand in metropolitan and non-metropolitan areas will be considered in the second order draft.	Yann BRIAND	Iddri, Sciences Po	France
47873	61	41			For section 10.7.2 would be helpful to have transport demand disaggregated by region, sector and mode as a chart to help readibility, and highlight different mitigation needs by region, and end-use.	Accepted. It is a good idea to disaggregate demad projections by region. It is already disaggregated by mode (and by sector since this is the transport chapter). Due to the space limitation, we added a few selected regions to highlight the importance of regional differences.	Martino Tran	University of British Columbia	Canada
43661	61	45			A meta-analysis of evolving transport scenarios shows that demand-side/urban solutions are underestimated in IAMs and contribute an additional bit (like 20%) to mitigation: https://www.tandfonline.com/doi/abs/10.1080/01441647.2015.1079277 Also: Integrating urban solutions into IAMs reveals also potential for reaching 2050 goals without relying too much on CCS. https://science.sciencemag.org/content/350/6263/911.short	Accepted. Thanks for pointing out these references. We have included these view points in terms of urban forms, behaviours and smart cities in Section 10.2. The point that IAMs typically underestimate mitigation potentials due to behavioural changes has been acknowledge in Page 63, Line 38-41. We extended this discussion to include urban solutions. This sentence now reads "Tranditionally there is a disconnection between IAM models and bottom-up sectoral or city-based models due to the different scale (both spatial and temporal) and focus (climate mitigation vs. urban pollutions, safety, etc. Creutzig 2016). Some IAM studies have recently begun to explore demand-side solutions to reducing transport demand to achieve very low carbon scenarios through a combination of culture and low-carbon lifestyle (Creutzig et al., 2018); urban development (Creutzig et al. 2015) and increased vehicle occupancy through mobility-as-a service (Grubler et al., 2018);	Felix Creutzig	MCC Berlin	Germany
11483	62	3	62	23	The discussion should provide insights on modal breakdown. Kindly see https://www.climate-chance.org/wp-content/uploads/2019/12/en_c1_complet_def.pdf	Accepted. Transport demand and activity projection by mode is carefully discussed and illustrated in pages 64-65 and Figure 10.20. We added the following sentence "... for the above 2 degrees scenarios, despite significant regional and mode-specific variations discussed in the following sections." to acknowledg the importance of the subject.	Sudhir Gota	Independent Consultant/Researcher	India

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11485	62	3	62	23	The discussion is not consistent in passenger and freight. For passenger demand, no mention is made of historical increase while for freight a range 1975-2015 is considered.	Noted. Thanks for pointing it out. We provided 1975-2015 for freight for a longer perspective, however, a consistent time frame of 2005-2015 comparison is indeed provided for both passenger and freight vehicles. To avoid confusion, we removed the sentence "over the period 1975–2015, road freight activity in India increased by more than 9-fold, 30-fold in China, and 2.5-fold in the US (Mulholland, Teter, Cazzola, McDonald, & Ó Gallachóir, 2018)."	Sudhir Gota	Independent Consultant/Researcher	India
45187	62	5	62	6	Does "vehicles" include two- and three-wheelers?	Editorial. It only includes car use. To be consistent with the data source, we retain the terminology "vehicle."	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
27055	62	13	62	13	Is there a typo in this sentence? A factor of 1.5 and 2.0 in 2050?	Editorial. It was a typo. Thanks for catching it. It should be 1.5 by 2030 and 2.0 by 2050.	Thomas Longden	Australian National University	Australia
14105	62	17	62	19	I think that the percentage for China is not accurate or the text is not consistent with the figures between parentheses. Consider revising the whole sentence because the proportions and figures don't seem plausible.	Noted. The numbers are correct, but it can be confusing since we compared two different historical period: 1975-2015 and 2005-2015. We now removed the period 1975-2015 to reduce unnecessary confusions.	Victor Garcia Tapia	International Energy Agency (IEA)	France
11787	62	18	62	19	"slower" and "faster" are exchanged in this sentence	Editorial. It was a typo. Thanks for catching it. We've switched the order of "slower" and "faster."	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
14107	62	19	62	19	It seems that some information is missing or at least the capital letter after the dot.	Editorial. It was a typo. Thanks for catching it. We've capitalized the "F" for freight.	Victor Garcia Tapia	International Energy Agency (IEA)	France
1701	62	25	62	28	Fig. 10.19: The wide variation of data in 2030 or even in 2010 probably should be mentioned to reduce the unnecessary variation of data, which will be amplified in the projection of long-term. Informing this point to the researcher of scenarios will reduce the variation of scenarios by recognizing that more reliable current data should be used for their analysis.	Rejected. The word "unncessary" is quite subjective. We report the range appeared in peer-review publication without taking a position which scenario output is more "necessary" than the others. Perhaps the reviewer means "likely," which is again impossible for us to judge ex ante. (As the experience of Corona pandemic taught us, nothing is improbable). However, the point that there is a wide range of uncertainty is well taken. We pointed out on Page 63 Line 11 that the wide range of projection is influenced more by model differences than the variations in the scenarios.	Shigeki KOBAYASHI	TICJ	Japan
27057	62	26	62	27	y-axis needs to be labelled. Can you split into developed and less-developed regions? I am interested in whether pkm is catching up in less developed countries or is assumed to folllow some historical relationship. Previous research has looked at the impact of increased pkm when less developed countries start to converge to a global average pkm level (I wonder what type of pkm scenarios have been uploaded to the AR6 database? [i.e. different across regions]) - https://doi.org/10.1016/j.enpol.2014.04.034	Noted. Thanks for the suggestions. We have now added label to the y axis: "Change from 2030 level. 2030=1" The regional results are now added.	Thomas Longden	Australian National University	Australia
28609	62	27	62	27	Is the figure consistent with text? Increasing demand even in 1.5C scenario? Because of the growth in the developing world?	Noted. Yes indeed. The reason is, for example, when CCS is available, then it is possible to achieve 1.5 degree target even with no significant demand reduction.	Paul Wolfram	Yale University	United States of America
16515	62	7			the growh rate for China should be checked	Noted. According to the International Organization of Motor Vehicle Manufacturers, passenger cars increased from 21.3 million in 2005 to 135.8 million in 2015, whereas total vehicle in use (including passenger and commercial vehicles) incrased from 31.6 million in 2005 to 162.8 millions in 2015, a 5.2 times increase.	Lining WANG	Economics and Technology Research Institute, CNPC	China
11767	63	4	63	9	Overlaps with information from the previous page, see page 62 line10-13	Editorial. Thank you for pointing it out. We have deleted the overlaps.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
45189	63	10	63	29	This para does not clearly state what the impact of climate targets is on transport demand for passenger and freight. Please quantify as much as possible, and if this is a gap in knowledge kindly state so	Noted. As we stated on Page 63, lines 20-23, "Under IEA's most ambitious carbon policy, the beyond 2°C scenario, demand for passenger travel remains similar to the reference scenario (around 110 trillion passenger-kms by 2050), while demand for land-based freight transport in 2050 is slightly lower in this scenario (116 trillion ton-km) compared to the reference scenario (130 trillion ton-km). In addition, the demand for passenger and freight under the reference scenario vs. various climate target scenarios are clearly illustrated in Figure 10.19.	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
46955	63	10	63	31	For this and potentially other sections it would aid the reader if key information was tabulated.	Noted. Thank you for the suggestion. Due to the strict space limitation, we are not able to tabluate all the results. We have tried to illusrate the results in figures and state some findings verbally.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
27059	63	32	63	37	Historical pkm/gdp ratios have been very stable - https://doi.org/10.1016/j.enpol.2014.04.034 - so how realistic are these assumed decreases in pkm or even the wide-spread switch to public transit?	Noted. Indeed there is no disput about the historical data (that travel demand has grown steadily with GDP). What is uncertain is what the future might look like in 2030 and 2050. As we observed in 2020, the rather unexpcted COVID19 pendemic has changed everything we thought we knew, including drastic redcutions in travel and energy use. And there are many more examples of how the historical is full of suprises. Our job is to reflect the findings and key arguments in the peer-reviewed publications, and point out, for example, the tendency of following historical trends in IAM models versus more exploratory, trend-breaking sectoral models in formulating mitigation options to reduce transport GHG emissions.	Thomas Longden	Australian National University	Australia
29195	63	40	63	40	These 4 transport-specific case studies have emphasized scenarios with contrasted demand-side solutions (Deep decarbonization pathways project for transport, 2017): https://www.iddri.org/en/publications-and-events/report/pathways-deep-decarbonization-passenger-transport-sector-uk https://www.iddri.org/en/publications-and-events/report/pathways-deep-decarbonization-passenger-transport-sector-japan https://www.iddri.org/en/publications-and-events/report/pathways-deep-decarbonization-passenger-transport-sector-france https://www.iddri.org/en/publications-and-events/report/pathways-deep-decarbonization-passenger-transport-sector-mexico	Rejected. Thank you for the references. Due to the IPCC policy, we try to avoid citing non-peer reviewed publications.	Yann BRIAND	Iddri, Sciences Po	France
46957	63	40	63	41	Mobility-as-a-service is introduced, but without any further information on the definition, what this means, where and how it could be applied, or if it is important.	Editorial. Thanks for the great suggestion.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
46959	63	42	63	42	Disruptive innovation is mentioned, but no further information on what this could contribute or examples.	Editorial. Thanks for the great suggestion.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
27061	63	46	63	48	Interesting observation about activity. Would be great to see the differences across regions in a graphic and an assessment of how this differs to the historical trend would be very interesting.	Accepted. Thanks for the great suggestion. We added regional details to highlight the importance of regional variations both historically and for the projections.	Thomas Longden	Australian National University	Australia
29197	64	1	64	1	Should be "10.7.3. Transport mode trajectories" isn't ?	Rejected. This heading (also "Energy intensity" and "Fuel energy and technology" on the two subsequent pages) are sub-headings of 10.7.2. Fourth-level headings are not numbered.	Yann BRIAND	Iddri, Sciences Po	France
17989	64	3	64	3	Missing reference	Rejected. The reference for "Schafer & Victor, 2000" is at page 10-94, line 46 of the draft. The reference for "Schafer, 2017" is at page 10-95, line 1.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
22889	64	7	64	8	The share of public transport in the UK has dropped also because of the extreme model of 'quantity deregulation' that has been adopted for local public transport outside of London - see e.g.Bayliss, K., & Mattioli, G. (2018). Privatisation, Inequality and Poverty in the UK: Briefing prepared for UN Rapporteur on extreme poverty and human rights. Sustainability Research Institute Papers No. 116.	Accepted. Cited the suggested paper with the text "see for instance," to indicate that it is one of multiple possible causes of difference between the countries mentioned in the example.	Giulio Mattioli	TU Dortmund University	Germany
35821	64	7	64	12	UK is smaller and denser than France however the share of public transport has dramaticllay decreased betweeen 90 and 2016.	Noted. The text reads "in general", implying that there are exceptions to this correlation. The sentence will be revised per comment 45191.	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
45191	64	11	64	12	This statement needs a reference. Also please do not state "countries/cities" as these have very different transport systems	Accepted. Citations will be added. The sentence will be revised to distinguish the parallel, but distinct, correlations at national and city levels.	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
36499	64	12	64	17	What does this calculation mean, whether “transport volume should be reduced to these levels in order to meet the temperature category” or “it will be reduced to these level when various measures at other sectors are taken”? In other words, what does “projection” mean at this context? is demand for carry going to be lower when carbon cost is increased?	Accepted. Changed- (1) the description of IAMs will be expanded or provide a clear pointer to Ch.3 where demand reduction in response to/as a component of mitigation policy is described. CHANGE (2) the figure caption will be expanded to describe "…projections under climate change mitigation scenarios meeting certain temperature targets."	Takashi Hongo	Mitsui & Co. Global Strategic Studies Institute	Japan
47875	64	1			Would be useful to have these mode trajectories disaggregated by region to highlight differences in mitigation strategies and policies between regions and countries i.e. need to focus on LDV in developed countries vs freight in emerging economies.	Noted. Space allocations prohibit a complete discussion of regional- and national-level differences. However, the figures in the second-order draft will be revised to include regional detail where space permits. The complete underlying data are available from the AR6 database.	Martino Tran	University of British Columbia	Canada
31189	64	13			The increase of freight transport activity in the models appears to be far too low. The ITF suggests an increase to 329,000 bn tkm (by 2050) and also IEA has a much stronger increase. In IEA mobility modelling (MoMo) freight transport increases from 2020 to 2050 by a factor of 2.6 in the NPS scenario and by 2.4 in the 30@30 scenario, which is similar to the SDS scenario (~+1.8°C in 2100). For a comparable scenario your graph shows for "Freight All" an increase of barely above 1. Therefore it must be highlighted what assumptions there are in the transport scenarios used, and ideally the scenarios are updated to reflect higher transport activities.	Taken into account. The projections mentioned in the comment are included in the figure in the first-order draft. The light grey (sectoral models / policy scenarios) median reflects the magnitudes of increases reflected in the comments. The updated figure and accompanying text will more clearly describe the distinction between IAM and sectoral projections.	Urs Ruth	Robert Bosch GmbH	Germany
31249	64	15			It is unclear why in the top left panel there are so many scenarios and colors, while in most other panels there is only green or grey, or green and grey. It seems that all panels should show all colors / scenarios!	Accepted. The plot depends on whether IAM and global transport-sectoral models report activitiy for these specific modes. If none do, no data can be shown. For instance, no models with a 2.0–2.5°C category scenario report freight aviation (top middle) separately from all freight (top left). CHANGE: the figure caption will be revised to make clear this dependency on available projections.	Urs Ruth	Robert Bosch GmbH	Germany
11487	65	9	65	15	"trucks gradually become the largest mode used for freight transport" - This statement is definitely not true.Currently road transport only caters for 23% of freight transport demand and discussion indicates that there is nothing substancial between land freight and shipping growth. https://www.climate-chance.org/wp-content/uploads/2019/12/en_c1_complet_def.pdf	Accepted.	Sudhir Gota	Independent Consultant/Researcher	India
45193	65	10	65	10	Improve logistics efficiency, green logistics and streamline supply chains: please clarify how these are related to "mode change". On the other hand, rail and waterways may be added, as well as (electric)bi/tricycles for logistics	Accepted.	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
11469	65	13	65	15	"As the heavy duty truck demand grows the fastest compared to the other modes, trucks gradually become the largest mode used for freight transport" - This statement is definitely not true.Currently road transport only caters for 23% of freight transport demand. https://www.climate-chance.org/wp-content/uploads/2019/12/en_c1_complet_def.pdf	Noted. Duplicate of later comment 11487; see response there.	Sudhir Gota	Independent Consultant/Researcher	India
27063	65	13	65	16	How do IAMs decarbonise heavy freight and aviation? Would be interesting to know how and when this occurs.	Accepted. a sentence or phrase will be added describing how IAMs represent decarbonization of these modes.	Thomas Longden	Australian National University	Australia
11789	65	21	65	21	What is meant by "demand reduction through land use"? Do you mean good spatial planning which encourages the use of transit, bikes and walking instead of using your car?	Accepted. the diction will be updated to clearly distinguish spatial planning from the (agricultural) "land use" changes associated with producing biofuels for transportation, the meaning in other parts of the chapter.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
22891	65	26	65	28	Developed countries focus more on technology options also because of more entrenched car dependence	Accepted. Changed to "In developed countries, where private vehicle ownership is both saturated and entrenched, there is instead a greater focus on e-mobility and fuel economy standards."	Giulio Mattioli	TU Dortmund University	Germany
46961	65	26	65	28	Recent major investment announcements e.g. in UK, indicate major transport infrastructure investment, including highways, are still a key component of the policy mix. Supply is being provided for increasing demand. The point in the report may still stand, but the issue at hand in terms of decarbonising transport, at least in the short term is lost. Throughout the report, including this chapter, it may also be worthwhile revisiting the use of 'developing' and 'developed' countries as a binary distinction when making comparisons.	Accepted.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11489	65	29	65	30	"Driving remains the fastest growing mode for passenger travel giving the significant growth rate in eveloping counties."	Noted. It is unclear what the comment or requested change is here. However, the sentence could be revised. Changed to "In developing countries, scenarios indicate that private vehicle transport will continue to grow most rapidly among passenger modes."	Sudhir Gota	Independent Consultant/Researcher	India
29199	65	35	65	35	Should be "10.7.4. Energy intensity trajectories" isn't ?	Accepted. We will change the section headings to "Energy intensity trajectories" and "Fuel and technology trajectories" for consistency	Yann BRIAND	Iddri, Sciences Po	France
28261	65	36	65	44	Interested to know what the assumptions for electrification are in the models used for the mitiigation scenario. I would expect that if older models are used that electrification numbers are lower than in more recent models	Accepted.	Cornie Huizenga	CESG	Germany
31251	65	36	65	46	Please state the values in terms of liter per 100 km gasoline consumption for ICEs and in kWh power demand for BEVs, and in kg H2 consumption for FCEVs. These values are important to provide orientation and to enable a comparison to todays transport system. Maybe a small table would be beneficial that lists the values for today, 2050, and 2100. And please state what the given MJ/vkm means: is this the mechanical energy needed (i.e. after the engine) or mechanical energy + thermal (for heating) energy or additionally + electrical (for driver assistance and cooling) energy needed? Or is it the fuel energy filled into the tank or electric energy drawn from the grid (in that case future efficiency improvements of the ICE engine would come on top of these energy efficiency improvements stated! Also, by changing vehicles from ICEs to BEVs would "artificially" provide huge eficiency improvements just because of higher efficiencies of the electric motor compared to the ICE. So please specify exactly what is meant.	Accepted. Revisited	Urs Ruth	Robert Bosch GmbH	Germany
45195	65	35	66	2	A technology-policy perspective on fuel economy of vehicles is missing. See for example ICCT publications, which also discuss the "fuel efficiency gap", i.e. difference between type approval and real-world fuel economy. Also would suggest to talk only about MJ/vkm and not mix this with pkm and tkm. Occupancy rate and load factor are very important, but it's an issue of a different nature	Accepted. We will add a fourth key uncertainty in that section that speaks to the gap between regulations and realized real-world efficiency. As for vkm vs pkm and tkm, we have provided both to capture how each changes, as later in the section we discuss how load factors and occupancy rates can drive decarbonization in addition to efficiency. Note that we will also, in addressing another comment, isolate efficiency improvements in ICEs to provide more details on fuel economy.	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
47877	65	35	66	21	Suggest summarize energy intensity data in a graph to improve readibility.	Noted	Martino Tran	University of British Columbia	Canada
20477	65	35	68	17	energy intensity and fuel energy section is not covering the full body of literature. See the fundamental findings in Khalili et al. (https://www.mdpi.com/1996-1073/12/20/3870) - see section 3.3. and 3.4 in this reference, which broadens the view on the options in transport sector transition - this is also well affordable, as shown in Ram et al. (http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf)	Accepted. We have reviewed findings in those papers and already cited them and discussed their findings. However, we do not enumerate marine transport findings from Khalili et al. We will add those results in a sentence.	Christian Breyer	LUT University	Finland
28263	66	3	66	6	What is missing here is increased regulatory pressure. It is clear that in EU and China regulatory pressure is going to make a large difference in the period after 2020 in terms of what type of vehicles will be offered on the market. Increased availbility of diverse range of EVs will also change customer behavior	Accepted. Section 8 of this chapter focuses on policy, so we do not focus on it here. We will, however, create a new sub-section immediately preceding 10.7.3 titled "Modeling limitations". In this section, we will place the last paragraph from the "Energy intensity" section (which applies equally to fuels and technologies). In this new paragraph, we will also add a couple summary sentences on regulation and policy.	Cornie Huizenga	CESG	Germany
34349	66	7	66	13	This paragraph could be balanced with documented successes such as the "BlaBlaCar" platform for long distance shared travel	Accepted. We will add context to this sentence by highlighting that we have observed declining occupancy despite some successful car sharing experiments. We will also add the Schafer and Yeh 2020 reference once published.	Antoine BONDUELLE	Climate Action Network France	France
22893	66	14	66	21	Models can fail to capture unexpected positive breakthroughs, but the same is true for negative trends such as e.g. the rise of SUVs - see e.g. Antal, M., Mattioli, G., & Rattle, I. (2020). Let's focus more on negative trends: A comment on the transitions research agenda. Environmental Innovation and Societal Transitions.	Accepted. We will add two sentences addressing this point. We will shift a citation to group this conversation and delete text from prior section on this same point.	Giulio Mattioli	TU Dortmund University	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
28265	66	19	66	21	I would argue that developments in EV market are not unexpected and that the writing has been on the wall through policies e.g. in EU and China that have been announced several years ago. I am surprised that this chapter hardly pays any attention to policy and regulation as driver of decarbonization	Accepted. Section 8 of this chapter focuses on policy, so we do not focus on it here. We will, however, create a new sub-section immediately preceding 10.7.3 titled "Modeling limitations". In this section, we will place the last paragraph from the "Energy intensity" section (which applies equally to fuels and technologies). In this new paragraph, we will also add a couple summary sentences on regulation and policy.	Cornie Huizenga	CESG	Germany
29201	66	22	66	22	Should be "10.7.5. Fuel energy and technology trajectories" isn't ?	Accepted.	Yann BRIAND	Iddri, Sciences Po	France
11791	66	31	66	32	This figure is difficult to understand. Please make it easier to read	Accepted.	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
28267	66	31	67	5	Figure 10.21 is hard to understand	Accepted.	Cornie Huizenga	CESG	Germany
23887	67	1	67	1	Which more specific options are included in biofuels (e.g. also gaseous biofuels like biomethane) and gas (also renewable gas)? Are e-fuels/PTx fuels adressed which are increasingly discussed as renewable fuel options also on international level? What is about energy demand related to autonomous vehicles, mobility as a service? What is meant with the white shares?	Accepted. The fuel dissagregation will depend on what is reported in the different models. We will attempt to make the figure clear and add appropriate labels (for example, white shares represent the interquantile range).	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
42277	67	3	67	6	The current models also does not account for the interaction of the movements with the transport infrastructure (and its supply)	Take into account.	Alvin Mejia	Wuppertal Institute	Germany
11793	67	4	67	4	"Numbers above each bar..." - but there are no numbers in figure 10.21	Accepted. We will correct	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
47393	67	10	67	10	"Electricity and biofuels increases to 14-18% and 15-16%, respectively." That is a very unbelievable scenario in my opinion. It would mean BEV sales growth would plummet to below 13% per year, even after BEVs are much cheaper than ICEVs. I don't know what's going wrong in the modelling here but something is clearly amiss.	Accepted. We will confirm the scenario data	Auke Hoekstra	Eindhoven University of Technology	Netherlands
23889	67	17	67	17	"In passenger transport": https://iea-amf.org/content/news/TD-WS shows in the scenarios that BEV and FCEV will play not that role as someone expected.	Noted.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
16441	67	17	67	18	Is there any evidence to support hydrogen fuel cell vehicles? How about biofuel vehicles? Please provide references. In Page 68 Line 27-28, "IAMs, GTMs, and national transport models generally indicate electrification will be the dominant driver of decarbonization, followed by biofuels and hydrogen". The two places are inconsistent.	Take into account. Our statements are based on the outputs of the models and the literature. We will confirm all statements once the complete data comes in	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
34453	67	17	67	18	Here a discussion about CO2-based alternative fuels is missing: By driving out the use of fossil kerosene fuel in aviation through carbon pricing and requiring aircraft to switch to synthetic fuels, and advanced biofuels to a very limited extent, the climate impact of flying can be reduced dramatically. Zero emission CO2-based synthetic fuels and very low carbon advanced sustainable biofuels can be produced today and deployed immediately using existing engines and infrastructure.Here are key reference son this subject: Transport and Environment, 2018: How to decarbonize European transport by 2050, Transport and Environment./IEAGHG, 2019a: Putting CO2 to Use – Creating value from emissions, International Energy Agency./Gumber and Gurumoorthy, 2018, Methanol, Chap. 25, 661-675./ Byrnolf et al., 2018, Renewable and Sustainable Energy Reviews, 81/2, 1887-1905./ Schemme et al., 2017, Fuel, 205, 198-221/ Global Alliance Powerfuels, 2019: Powerfuels: Missing Link to a successful global Energy Transition, Global Alliance Powerfuels/CONCAWE, 2019: A look into the role of e-fuels in the transport system in Europe (2030–2050) (literature review), CONCAWE.)	Accepted. We need to check if IAM and bottom-up models consider CO2-based synthetic hydrocarbons	Célia Sapart	Université Libre de Bruxelles et Co2 Value Europe	Belgium
13375	67	17	67	42	The German Aerospace Center (DLR), commisioned by Greenpeace, modelled the development of the passenger car fleet in the EU-28 in terms of required reductions to reach 1.5°C and 2°C targets in 2018. This may be a useful additional source for this paragraph. https://www.greenpeace.de/sites/www.greenpeace.de/files/publications/20180907_gp_eucarfleet_1.5.pdf	Accepted. We will review	Adam Pawloff	Greenpeace	Austria
45197	67	17	67	42	this para deals with model outcomes regarding electrification of passenger vehicles. It would be good to compare this with policy targets to phase-out fossil-fuelled vehicles/cars by 2030-2040 announced by many countries (see e.g. Slocat: https://slocat.net/publications/e-mobility-trends-and-targets/).	Accepted. We can add a discussion	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
23891	67	18	67	19	"Electrifying passenger transport leverages decarbonization efforts in the power sector": Need to be more highlighted as the additional demand on renewable electricity power generation incl. grid nets etc. for transport will be enourmous.	Accepted. We can add a discussion	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
27065	67	18	67	23	Should cite the key studies that find that electrification of LDVs is crucial - both academic and general literature - sectoral models and IAMs. Important statement that should be backed up with citations.	Accepted. Will do	Thomas Longden	Australian National University	Australia
47395	67	26	67	28	"Ghandi and Paltsev forecast that the global stock of 27 vehicles will increase from 1.1 billion vehicles in 105 up to 1.8 billion by 2050, with a growth in 28 electric vehicles from about 1 million vehicles in 2015 up to 500 million in 2050." That's only 14% growth.	Take into account. We can check the paper, but again we will be relying on the data from the models	Auke Hoekstra	Eindhoven University of Technology	Netherlands

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
27067	67	26	67	29	How do these numbers compare with other estimates? IEA has 3.29 million in 2018 https://www.iea.org/reports/global-ev-outlook-2019 The number for 2050 seems feasible, but will need a rapid diffusion that is faster than that forecasted in this paper - https://doi.org/10.1016/j.enpol.2014.04.034 But overall, it seems feasible with strong support and continued cost reductions in batteries.	Take into account. We can check the paper, but again we will be relying on the data from the models	Thomas Longden	Australian National University	Australia
11715	67	27	67	27	What is 105? May be 2015	Accepted. Will correct	Andrey Kolpakov	Institute of Economic Forecasting of the Russian Academy of Sciences	Russian Federation
14109	67	27	67	27	It should be year 2015 instead of 105	Accepted. Will correct	Victor Garcia Tapia	International Energy Agency (IEA)	France
25205	67	27	67	27	Replace "105" with "2015"	Accepted. Will correct	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
27069	67	37	67	40	Unsure of the study that EIA refers to. Not in the reference list. But it has higher natural-gas fuelled LDVs compared to battery vehicles? Is that likely based on recent trends in the last 5 years?	Take into account.	Thomas Longden	Australian National University	Australia
16517	67	27			in 015 changed to in 2015	Accepted. Will change	Lining WANG	Economics and Technology Research Institute, CNPC	China
11491	68	23	65	24	"It accounts for a quarter of global CO2 emissions in 2017 and could grow by nearly 50% by 2050 under BAU" . This is not really a BAU scenario right? Research indicates - If current trends continue unabated, the global transport sector CO2 emissions could increase to 10 to 18 Gt in 2050. See https://link.springer.com/article/10.1007%2Fs12053-018-9671-3	Take into account. These findings are based on a review of the upper-bound “no policy” scenarios from a number of transportation systems/integrated assessment models: MoMo (IEA), EPPA5 (MIT), Roadmap (ICCT), GCAM (PNNL), and MESSAGE (IIASA). Question: should we caveat this is based on our review and that other author’s findings call for significantly higher BAU: •Gota, Sudhir, Cornie Huizenga, Karl Peet, Nikola Medimorec, and Stefan Bakker. "Decarbonising transport to achieve Paris Agreement targets." Energy Efficiency 12, no. 2 (2019): 363-386.	Sudhir Gota	Independent Consultant/Researcher	India
28269	68	21	68	22	Would prefer to see a 2050 target as well. If 2100 is 80%, what would be the 2050 target?	Accepted.	Cornie Huizenga	CESG	Germany
11795	68	25	68	25	Please consider to replace "systems" with "emissions"	Accepted.Thank you, we have implemented this edit	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
25207	68	25	68	25	Delete "Thsese"	Accepted.Thank you, we have implemented this edit	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
27071	68	25	68	25	Should the word 'emissions' appear after systems?	Accepted.Thank you, we have implemented this edit	Thomas Longden	Australian National University	Australia

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
16443	68	25	68	26	Please change "These" to "these". This conclusion could be reinforced. Please refer to Muratori et al. (2017; Role of the Freight Sector in Future Climate Change Mitigation Scenarios; doi: 10.1021/acs.est.6b04515) and Pan et al. (2018; Decarbonization of China's transportation sector: In light of national mitigation toward the Paris Agreement goals; doi: https://doi.org/10.1016/j.energy.2018.04.144) which decompose the contributions of the three factors to transport mitigation in low-carbon scenarios toward 2100. They both show that fuel carbon intensity is responsible for the majority of transport emissions reduction. Perhaps we can highlight "Such these emissions reductions come from addressing transport activity, improving energy intensity (at the technological or system level) and in particular from lowering fuel carbon intensity (Muratori et al., 2017; Pan et al., 2018)".	Noted. Though we will gladly cite additional works, we remain agnostic that carbon intensity is the most important factor in meeting carbon reduction goals without a consensus opinion in the literature. Add: •Muratori, Matteo, Steven J. Smith, Page Kyle, Robert Link, Bryan K. Mignone, and Haroon S. Kheshgi. "Role of the freight sector in future climate change mitigation scenarios." Environmental science & technology 51, no. 6 (2017): 3526-3533. •Pan, Xunzhang, Hailin Wang, Lining Wang, and Wenying Chen. "Decarbonization of China's transportation sector: in light of national mitigation toward the Paris Agreement goals." Energy 155 (2018): 853-864.	Xunzhang Pan	School of Economics and Management, China University of Petroleum, Beijing 102249, China	China
31243	68	27	68	28	"electrification will be the dominant driver of decarbonization, followed by biofuels and hydrogen." This is most likely for road transport, but what about aviation/shipping ... Biofuel potential was stated to be not sufficienct and use of hydrogen is not a blend-in fuel. PtX fuels therefore need to be stated here too.	Accepted. Our statement holds true based on our discussion of the entire transportation sector not just road transport. Nevertheless, the reviewer brings up a valid option which we have added to the list.	Urs Ruth	Robert Bosch GmbH	Germany
27073	68	30	68	33	This doesn't seem too relevant to mention with respect to IAMs. They are not designed for these assessments and whether sectoral models are appropriate for these issues (i.e. blockchain??) is questionable. Note that it is important that there is consistency in the expectations of what should/could be included in scenario modelling. Chapter 3 states: "Due to the difficulties of including non-technological and non-economic representation in IAMs, factors such as social norms, culture, institutions and behavioural change are neglected, with these critical factors having the potential for substantially affecting the rate of the transition (van Sluisveld et al. 2015; Schwanitz 2013). However, capturing the nuances of demand-side measures is not possible within IAMs nor desirable (Mundaca et al. 2019). Indeed, the low-energy demand outcomes of the LED scenario are dependent on alterations to the social arrangements and institutional alignments of the system and thus demands a multidisciplinary approach (Grubler et al. 2018).".	Take into account. This statement should not be construed as a statement against IAMs. As the reviewer points out, there are assessments for which an IAM is not well-suited (from Ch 3). We are providing some qualitative discussion on factors that experts have identified as strong potential influencers on emissions trajectory but not included in the integrated assessment modelling efforts. Nevertheless, we do note the lack of direct connection of blockchain and AI as a standalone (without referencing the earlier description of blockchain). This has been edited to reflect a more directly relevant factor in sharing economies.	Thomas Longden	Australian National University	Australia
27075	68	30	68	33	You may consider IAMs as a blunt tool. But they have their role in projecting what could be achieved by 2100. Increased scenarios on pkm/tkm declines/increases should occur. But suggesting that the integration of issues such as blockchain seems a bit strange and counterintuitive. Except for page 14 lines 16-22, block chain is not mentioned elsewhere in this chapter. It is strange that this is the place where the second mention of it occurs. I am puzzled and have no idea how these lines appeared in a summary of scenarios. Readers can be left to judge how important these scenarios are by themselves and raising these issues here just seems out of place.	Take into account. This statement should not be construed as a statement against IAMs. As the reviewer points out, there are assessments for which an IAM is not well-suited (from Ch 3). We are providing some qualitative discussion on factors that experts have identified as strong potential influencers on emissions trajectory but not included in the integrated assessment modelling efforts. Nevertheless, we do note the lack of direct connection of blockchain and AI as a standalone (without referencing the earlier description of blockchain). This has been edited to reflect a more directly relevant factor in sharing economies.	Thomas Longden	Australian National University	Australia

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
17991	68	32	68	32	Please avoid mentions to unconfirmed and over-hyped technologies. This is particularly relevant for the so-called “blockchain”, which has significant negative externalities in terms of wasteful electricity consumption.	Take into account. This statement should not be construed as a statement against IAMs. As the reviewer points out, there are assessments for which an IAM is not well-suited (from Ch 3). We are providing some qualitative discussion on factors that experts have identified as strong potential influencers on emissions trajectory but not included in the integrated assessment modelling efforts. Nevertheless, we do note the lack of direct connection of blockchain and AI as a standalone (without referencing the earlier description of blockchain). This has been edited to reflect a more directly relevant factor in sharing economies.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
25209	68	38	68	38	Delete "the"	Accepted. Thank you, we have implemented this edit	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
28611	68		68		Some sectoral and integrated models have started to integrate well-to-wheel emission factors in their scenarios, which should probably be considered somewhere in this section (e.g. http://energy.mit.edu/publication/on-the-road-toward-2050/)	Accepted. Easy	Paul Wolfram	Yale University	United States of America
45213	68	37	75	17	The Policy framework for low-carbon transport needs to be expanded: 1) link low-carbon transport back to the SD benefits discussed in 10.1 (and at length in IPCC SR1.5 chapter 5), with the latter often the main drivers (i.e. the top-down climate perspective should be aligned with the bottom-up transport perspective as argued in Bakker et al. (2019) Low-Carbon Quick Wins: Integrating Short-Term Sustainable Transport Options in Climate Policy in Low-Income Countries https://www.mdpi.com/2071-1050/11/16/4369); 2) NDCs can play a role in this, however NDCs need to be enhanced (Gota et al 2016); 3) there should be a stronger role for measurement, reporting and verification, 4) institutional development and capacity development, 5) financing framework (on infrastructure costs, see Leibowicz (2018) https://doi.org/10.1016/j.enpol.2018.04.066	Later versions clarified this.	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
11797	68	25			Delete "Such": "These emission reductions…."	Accepted. Thank you, we have implemented this edit	Maria Malene Kvalevåg	Norwegian Environment Agency	Norway
31263	68	37			The three aspects of "Avoid" (as much transport demand as possible), "Shift" (transport to the most efficient modes, i.e. private to public, air to rail etc.) & "Improve" (the remaining transport demand) should be highlighted more clearly, preferably in its own section, in a box or in some key visual. Quantifications of these aspects should be provided for scenarios IP1 .. IP5. In relation to the potential effectiveness, the document is unbalanced. A lot of text is dedicated to describing different technologies for different modes (improve). However, there is no dedicated section on avoid or shift. In terms of a potential report outcome, the amount of text dedicated to technologies may blur the importance of addressing avoid and shift solutions.	Accepted. Quantification is the next step. Section 10.2 discusses on Avoid/Shift/Improve, including on urban form and behaviour. Chapter 5 discusses the Avoid/Shift/Improve approach in detail. Our approach goes beyond ASI as it is about Transformative change and this is best discussed using Socio-Technical Transitions. However we have not done enough on ASI in the Policy conclusions and this will need to be added.	Urs Ruth	Robert Bosch GmbH	Germany
39321	68	37			Enabling conditions are actually focused on decarbonization / reduced emissions. Consequently, it has to prioritize the use of energy for the transport system as a whole - reduction of the total amount of energy required to transport passengers and freight from A to B. This requires an interdisciplinary approach and is linked to other SDGs and disciplines such as urban and regional planning (spatial planning plays a key role in enabling residence to reach opportunities and facilities of everyday-life within short distance and without depending on the availability of motorized transport facilities	Accepted. Section 10.2 discusses this and we will quantify this in the SOD.	Stephan Tischler	University of Innsbruck	Austria
28271	69	1	69	3	Disagree that busses and trucks are put together. See example of Shenzen where all 11.000 busses are electric and Netherlands where all buses will be electric by 2025	Accepted. Sentence to be amended from: “This is mostly in light duty passenger vehicles but is moving to buses and trucks”. To “This is mostly in light duty passenger vehicles but is rapidly moving to buses and trucks”.	Cornie Huizenga	CESG	Germany
22895	69	4	69	6	Relevant reference: Peeters, P., Higham, J., Kutzner, D., Cohen, S. & Gössling, S. (2016). Are technology myths stalling aviation climate policy? Transportation Research Part D: Transport and Environment, 44, 30-42;	Accepted. Reference to be added.	Giulio Mattioli	TU Dortmund University	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11175	69	7	69	14	You sum up by saying that "Transport systems are also socio-economic not just technologyu systems...", but this literature is mainly ignored in this chapter. It needs a much larger focus in this chapter as emissions is not only due to technology shifts but also to behavioral changes.	Accepted. Section 10.8 has two and half pages on behaviour. Further, Section 10.2 and 10.4 also discusses/ interlinks between urban form and behaviour. However, the whole Chapter will have more on behaviour in a few different places if it can be fitted in.	Snorre Kverndokk	Frisch Centre	Norway
29203	69	14	69	14	Additional sentence at the end of the paragraph: "However, these dimesions are not well integrated in current climate-modelling and -scenario exercises related to the transport decarbonization."	Accepted. This is a whole Chapter point and we will add the sentence with references supporting this strong statement.	Yann BRIAND	Iddri, Sciences Po	France
46963	69	19	69	28	Evaluation evidence on what has worked / is working is key. This can be complex in transport, but evaluation, theory of change, logic mapping etc all have a role to play in informing evidence-based decision making (e.g. see Tavistock Institute and AECOM (2010) Guidance for transport impact evaluations). They can also be used to inform new Business Cases and help validate forecasting and benefit-cost ratio calculations.	Accepted. Sentence has been amended: While the challenge is that climate change is a “wicked problem” wherein considerable uncertainty prevents easy solutions, a related quandary is that complexity necessitates combining evidence-based decision-making with experiential knowledge to ensure solutions are transparent, forward-looking, context-appropriate and validated.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
43087	69	18	71	47	While the temporal dimension is important, this section could benefit from expanding the assessment of policies beyond the feasibility dimension (linked with technological stage). Ex post insights can be structured based on the assessment criteria mentioned in the policy chapter (Chapter 13) which address other dimensions of policy options such as cost effectiveness, distributional equity, transformative potential etc.	Accepted. We will refer to Chapter 13. Policies are there in pages 70 to 72 and will be made more clearer in the next version with clearer policies.	Parth Bhatia	Centre for Policy Research, New Delhi	India
43089	69	18	71	47	A table which categorizes the broad range of policy instruments used in the sector would be a useful addition to this section. For eg., see Table 9.24 in the buildings chapter.	Accepted. Policies are in table 10.8 and others will be added as well as showing that Tools and Strategies are policies	Parth Bhatia	Centre for Policy Research, New Delhi	India
43037	69		71		Adequate financing is also a key condition for the deployment of low carbon experiments in particular in the transport sector regarding the inertias in this sector see for instance Cassen, C., Cotella, G., Toniolo, J., Lombardi, P., Hourcade,, J-C., 2018, Energy Security Scenarios of Future Europe. An evaluation of upscaling pioneer experiences in a low carbon context, Sustainability 2018, 10(3), 848 ; doi:10.3390/su10030848	Accepted. Reference to be added in # 3 of table 10.8	christophe cassen	CNRS-CIRED	France
11099	69	18			section 10.8.2 Policy framework The literature on MLP and transport should be included, as it discusses the feasible pathways for transitions to sustainability in transport e,g, Geels, F., Kemp, R., Dudley, G. and Lyons, G., 2011. Automobility in transition?: A socio-technical analysis of sustainable transport. ISBN 9780415885058; Köhler, J., Turnheim B., Hodson M. (2018) Low carbon transitions pathways in mobility: Applying the MLP in a combined case study and simulation bridging analysis of passenger transport in the Netherlands, Technological Forecasting and Social Change, doi: 10.1016/j.techfore.2018.06.003; Enayat A. Moallemi, Jonathan Köhler, 2019 Coping with uncertainties of sustainability transitions using exploratory modelling: The case of the MATISSE model and the UK's mobility sector, Environmental Innovation and Societal Transitions, https://doi.org/10.1016/j.eist.2019.03.005.	Accepted. References to be added.	Jonathan Köhler	Fraunhofer Institute for Systems and Innovation analysis ISI	Germany
31255	69	18			It should be mentioned that for propper governance it will be important to monitor the real driving CO2 emissions of the vehicles. In the past, the discrepancy between catalogue consumption and real driving consumption has tremendously increased, and also the introduction of WLTP will not stop this discrepancy. In addtion, by market introduction of PHEVs the catalogue values for these vehicles are extremely low, while real driving emissions are very high. As was done for e.g. NOx and PM emissions (moving from test cycle emissions ot real driving emissions) should also be done for CO2 emissions (i.e. fuel consumption). This appears to be no more than a byrocratic act, but, in fact it is crucial to prevent the car market developing into a non-useful direction!	Later versions clarified this.	Urs Ruth	Robert Bosch GmbH	Germany
31257	69	18			Please suggest moving from a TTW regulation to a WTW regulation for CO2. A TTW-regulation does not require any improvements for BEVs, as at least in EU zero carbon electricity is assumed. Furhter it sets false policy incentives for PHEVs with batteries large enough just to complete the test cycle but too small to provide much benefit in real driving conditions. Also, it must be avoided that PHEV batteries are not charged by the user and vehicle operation is by ICE only (or at least mostly).	Accepted and revised.	Urs Ruth	Robert Bosch GmbH	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
47879	69	18			For section 10.8.2 a complimentary approach to this section would be a state of art review on the policy/investment/governance evidence base for decarbonizing transport systems. i.e. governance, policy incentives/taxes for financing public transit modes vs investment in LDV; new governance arrangements/business models (Public Private Partnerships) for transport infrastructure renewal; deployment of mobility as a service, and taxes/incentives for mode shifting and demand reduction (EV subsidies), penalties (fuel taxes, congestion charging, etc.). Additionally, some discussion on transport interactions with land-use planning, building stock particularly in the context of enabling conditions for new interventions such as V2G, V2I, V2H and land-use impacts from public transit investment would be useful. Some cross-referencing with AR6 chapter 8 could be useful.	Accepted. This will be included as part of redoing the Table 10.8 to include the ASI. Will refer to Chapter 8.	Martino Tran	University of British Columbia	Canada
11697	70	2	70	3	fig 10.23 needs to be neater	Accepted. Figure to be updated.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
13345	70	3	70	3	Quality of figure needs improving	Accepted. Figure to be updated.	Fred Witham	Rolls-Royce	United Kingdom (of Great Britain and Northern Ireland)
23893	70	4	70	4	A more simplified figure might be more understandable. Figures on "Fields of action and relevant factors that characterize the non-technical framework concerning fuel and vehicle regulation" like in here http://iea-retd.org/archives/publications/res-t-next	Accepted. Figure to be updated.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
28273	70	9	70	11	Scaling up to macro also influenced by the announced bans on ICE in several countries see http://www.slocat.net/wp-content/uploads/legacy/slocat_transport-and-climate-change-2018-high-res.pdf p. 94 as well as regulatoiry pressure	Accepted. Reference to be added.	Cornie Huizenga	CESG	Germany
11711	70	11	71	1	It makes sense to study the average income of households who bought an electric car. If on uses the income distribution curves for percentile / decile groups, one can estimate what proportion of the population can afford buing EV today, as well as what additional number of households can afford it, depending on the size of the subsidy. At least in megacities.	Accepted and revised.	Andrey Kolpakov	Institute of Economic Forecasting of the Russian Academy of Sciences	Russian Federation
28275	71	13	71	26	Electric busses are well beyond niche	Accepted. Sentence will be modified.	Cornie Huizenga	CESG	Germany
22897	71	27	71	39	This paragraph was not clear to me	Accepted. This para will be mostly moved to Chapter 1.	Giulio Mattioli	TU Dortmund University	Germany
28279	71	41	71	42	Much of the work on electric vehicles has been done by China, so would suggest to nuance the statement that developing economies can nit take lead. Same applies to High Sopeed Rail	Accepted. The statement is very positive about developing countries at the moment but we can modify by adding something on China.	Cornie Huizenga	CESG	Germany
42067	71	6			At this point, the impact of the additional power flows due to the interaction of electricity based vehicles with the powwer network, needs to be recalled. The infrastructure will have to be strengthened and also ist associated control network, if the power systems need to cope qith this additional power flows, and react to them during operation	Thanks. We have included text on SMart Charging and Vehicle to Grod Integration in Section 10.3.1	Francisco Javier Hurtado Albir	European Patent Office	Germany
25211	72	3	72	3	Replace "Table 10.9" with "Table 10.8"	Accepted.Correction done in text.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
34941	72	4	72	4	Table- 10.8 - Title of the table missing	Accepted. Table name to be added.	ANUPAM DEBSARKAR	University	India
42279	72	4	72	4	Categorizing systes based on "vehicles" may not be the best option to present the tools and strategies. Passenger and freight systems might be better categories to use, for example. Using vehicle systems as categories fall short in terms of thinking about "shifting" (e.g. from light vehicles to heavy vehicles in urban passenger transport - cars to buses/trains)	Accepted. Will be redone to enable more on ASI but this approach is necessary to go beyond ASI to transformative change.	Alvin Mejia	Wuppertal Institute	Germany
42281	72	4	72	4	On number 4: There's a need to transform economic assessments for transport projects globally and provide mechanisms for transparency and for reviewing cost factors included in the models.	Accepted. The table 10.8 mentions new assessment approaches with some detail. This will be expanded as part of redoing the Table 10.8 to include the ASI. Transparency will be included in #6 of the table 10.8.	Alvin Mejia	Wuppertal Institute	Germany
28281	72	3	73	1	In Table 10.8 please separate Education from R+D, these are two totally differentr concepts.Overall table is confusing and consists of apples and oranges	Noted. No change to be made, as we follow the approved outline by IPCC.	Cornie Huizenga	CESG	Germany
29331	72	4	73	1	Please include a caption for Table 10.8.	Accepted. Caption will be added.	Nicholas Musyoka	Council for Scientific and Industrial Research (CSIR), South Africa	South Africa
22899	72	4			Table 10.8, second row (Education and R&D), second column (light-vehicle systems): not clear what "behaviour change programs" are referred to here	Accepted. It refers to travel behaviour change programs that can support rapid adoption of EV's. This will be expanded as part of redoing the Table 10.8 to include the ASI.	Giulio Mattioli	TU Dortmund University	Germany
11177	72				Table 10.8: Co-benefits are mentioned in the table but not focused on in the text. Also, I lack a focus om economic instriuments such as taxes and subsidies as well as infrastructure investments in this figure.	Accepted. 'Financing Economic Incentives and Partnerships' row of Table 10.8 mentions taxes and subsidies. This will be expanded as part of redoing the Table 10.8 to include the ASI.	Snorre Kverndokk	Frisch Centre	Norway

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11179	73	2	73	2	The title "What can people do?" is not a good title. This puts the responsibility to reduce emissions on consumers, while what is needed is governmental policies and system changes that makes it possible for consumers to reduce emssions.	Accepted. The Title seems OK to many reviewers and opens up more of the human dimension many have requested to balance technological approach. 'Section 10.8.2: Policy Framework' covers the governmental policies part. Table 10.9 will be expanded on the points being made by the reviewer.	Snorre Kverndokk	Frisch Centre	Norway
2887	73	8	73	22	The following article may be of relevance as an example of different propulsion technologies:	Accepted and revised.	Nicholas Surawski	University of Technology Sydney	Australia
2889	73	8	73	22	H. Xu et al. Flight of an aeroplane with solid-state propulsion. 2018. Nature, Volume 563, pp 532-535.	Accepted and revised.	Nicholas Surawski	University of Technology Sydney	Australia
2891	73	8	73	22	In this work conducted at MIT, the authors developed an aeroplane using electroaerodynamics which is a technology that features no moving parts and without combustion emissions. The propulsion mechanism works by using electrical forces to accelerate ions in a fluid.	Accepted and revised.	Nicholas Surawski	University of Technology Sydney	Australia
28283	73	8	73	22	Sub-section on Creative Foresight is weird and does not add to narrative at all and is certainly not related to title "Wgat people can do".	Accepted. It seems OK. This sub-section was encouraged by Chapter 4 and is a special cross-sectional approach to enable more creative literature. It discusses human creative foresight – in forecasting and innovate transformative systems. We will try to make it a little less 'weird'.	Cornie Huizenga	CESG	Germany
46965	73	15	73	18	There is work, in the UK at least, on the role of backcasting and 'Vision and Validate' approaches to informing transport strategies.	Accepted. Sentences to be amended from:'McPherson et al (2016) have emphasized the important role of positive images about the future instead of dystopian visions that are simply based around the science of climate change and the impossibility of business-usual futures. Transport visions need to be a part of this cultural change as well as the more frequently presented visions of renewable energy'. To 'McPherson et al (2016) have emphasized the important role of positive images about the future instead of dystopian visions that are simply based around the science of climate change and the impossibility of business-usual futures. Backcasting and "vision and validate" approaches can be used to develop future scenarios (Banister & Soria-Lara, 2018; Jones, 2016). Transport visions need to be a part of this cultural change as well as the more frequently presented visions of renewable energy' Jones, PM; (2016) Transport planning: turning the process on its head. From 'predict and provide' to 'vision and validate'. Presented at: Radical Transport Conference, London, United Kingdom. Soria-Lara, J. A., & Banister, D. (2018). Evaluating the impacts of transport backcasting scenarios with multi-criteria analysis. Transportation Research Part A: Policy and Practice, 110, 26-37.	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
22903	73	18	73	22	This sentence was not clear. Also not clear how things like hyperloop or drones help informing "what people can do"	Accepted. Sentence has been amended: There are some emerging technologies (discussed in s10.3.5) like Maglev, Hyperloop, and Drones that are likely to continue the 20 electrification of transport even further (Kasliwal et al., 2019) and which were only recently at the imagination stage.	Giulio Mattioli	TU Dortmund University	Germany
34351	73	19	73	19	The three examples (Maglev, Hyperloop, Drones) can be seen as wild goose chase compared to improvement of mass transit or even economic models for a better use of existing vehicle technology. It can also be seen as a mis-allocation of funds out of social needs. This questioning should appear in the paragraph.	Accepted. Appraisal of such systems will be locally determined. Section under review but imagination generally precedes innovation and all new ideas are subject to cost scrutiny so don't need to add that.	Antoine BONDUELLE	Climate Action Network France	France

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
11713	73	24	73	24	This section may be supplemented. Firstly, there are factors that impede behavior change. For example, in Russia there is a large car-sharing park, including EV sharing. But in order to start using the service, a person must have a driving experience of at least 2 years. In ordert to rent an electric car, one need at least 6 years of driving experience. Thus, new young drivers have to buy a personal car, so as not to wait 2 years. And they get used to using personal car. Behavioural change task is easier if you avoid the formation of habit. Secondly, if the population of developed countries begins to massively switch to electric cars, used ICE cars may be sold to neighboring regions with less wealth. Perhaps some measures should be taken to prevent the spread of old inefficient cars.	Accepted and revised.	Andrey Kolpakov	Institute of Economic Forecasting of the Russian Academy of Sciences	Russian Federation
28285	73	25	73	25	I am puzzled - I would argue that current draft of Chapter 10 has actually argued that there is no signifucant change in behavior - link to Chapter 12 which discusses demand measures is not being made	Accepted. Section 10.8 has two and half pages on behaviour. Furthermore, Section 10.2 and 10.4 also discusses/ interlinks urban form and behaviour. However, the whole Chapter will have more on behaviour and will refer to Chapter 12.	Cornie Huizenga	CESG	Germany
11699	73	27	73	27	no table 10.10 attached? I would be careful with stating that there is 'emering evidence'. There are a lot fo criticisms about nudge theory, i.e. that this is a low cost policy option which puts burden on residents w/o investments in appropriate infra structure e.g. https://itsrio.org/wp-content/uploads/2017/03/Daphnee-Iglesias-.doc-B.pdf	Accepted. Table 10.10 will be Table 10.9 in the text.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
25213	73	27	73	27	Replace "Table 10.10" with "Table 10.9"	Accepted.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
22905	73	33	73	34	Vehicle taxes and congestion charges are (too briefly) mentioned here. Why not fuel taxes? These are commonly considered as an important climate mitigation policy measure - see Ross, M. L., Hazlett, C., & Mahdavi, P. (2017). Global progress and backsliding on gasoline taxes and subsidies. Nature Energy, 2(1), 1-6.	Accepted.	Giulio Mattioli	TU Dortmund University	Germany
11181	73	24	74	34	The focus on policy instruments is weak in this chapter. It should refer to the economic literature in this field and how imperfections can be reduced. One paper on network externalities which is an important externality when it comes to electrification of the car fleet, is for instance Greaker and Midttømme (2016): Network effects and environmental externalities: Do clean technologies suffer from excess inertia?, Journal of Public Economics, Volume 143, November 2016, Pages 27-38. Another paper on the impacts of economic policy instruments is Kverndokk, S., E. Figenbaum and J. Hovi (2020): Would my driving pattern change if my neighbor were to buy an emission-free car?», forthcoming in Resource and Energy Economics, Vol. 60, May 2020.	Accepted.	Snorre Kverndokk	Frisch Centre	Norway
11701	73	24	74	34	I like the argument in this paragraph - this line of thinking should be present across the whole report. New technologies - policies-markets- communities-individuals: they all interact and mutually shape what's possible and desirable!	Accepted. Thank you. This will continue to be reflected in the next version.	Ola Aleksandra Michalec	The University of Bristol	United Kingdom (of Great Britain and Northern Ireland)
28287	73	25	74	35	See in this context A peer reviewed -interactive process resulted in 23 Quick wins in the Transport Sector to address Climate Change and Sustainable Development : http://www.ppmc-transport.org/wp-content/uploads/2016/11/SLoCaT-Quick-Wins-Report-1.pdf	Accepted. We will look at this report.	Cornie Huizenga	CESG	Germany
42283	73	33	74	3	Kindly mention incentives for using more efficient modes in addition to disincentives for private vehicle ownership and use.	Accepted. The whole Chapter in a number of places mentions the benefits of using public transport modes as compared to private vehicle ownership efficient modes on GHG and SDGs. However the 10.8 Policy section is light on ASI interventions and these will include that policy when revised.	Alvin Mejia	Wuppertal Institute	Germany
43091	73	24	75	4	Table 10.9 provides some examples of the kinds of interventions that could be deployed in theory, however the real complexity of this real world policy challenge is perhaps best understood through a detailed case or a box. It could provide some perspective regarding the various governance barriers and enablers associated with designing a successful behavioural intervention.	Accepted. Trying to include case studies in box(s) if enough space.	Parth Bhatia	Centre for Policy Research, New Delhi	India
22901	73	2			Section 10.8.4 is really too short, particularly given the importance of initiatives to induce behavioural change (many of which are excellently reviewed in Chapter 5, which could at least be referred to here). Also it's not clear what the 'creative foresight' subsection has to do with the rest of the rest	Accepted.	Giulio Mattioli	TU Dortmund University	Germany
47881	73	24			For initiatives to induce behavioural change, there's an increasing amount of research on the role of social networks and influence on travel behaviour that would compliment this section, especially in the context of new mobility services and lifestyle change. This research is also cited in Chapter 8. e.g. refs: Axsen, J. et al. (2019) The roles of users in electric, shared and automated mobility transitions. Transp. Res. Part D, 71: 1 – 21. Kim et al (2017) social networks, social influence and activity travel-behaviour: a review of models and empirical findings. Transport Review.	Accepted.	Martino Tran	University of British Columbia	Canada
42285	74	1	74	3	Taking out parking minimums should be mentioned.	Accepted. Will be mentioned in new Policy section.	Alvin Mejia	Wuppertal Institute	Germany
34353	74	3	74	8	Interesting paragraph showing the level of change since AR4 and even AR5. Congratulations.	Accepted. Thank you.	Antoine BONDUELLE	Climate Action Network France	France
6065	74	9	74	10	E.g. Luxemburg now has free public transport within the cities.	Accepted. Will be mentioned.	Andreas Oberheitmann	FOM University of Applied Sciences	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
46967	74	15	74	27	Here and potentially elsewhere more case studies, possibly case study boxes, would be informative for the reader.	Accepted. Trying to include case studies in box(s).	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
17993	74	18	74	20	The two referenceres are missing in the bibliography	Noted	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
46741	74	28	74	28	Please add Mikael Karlsson, Eva Alfredsson & Nils Westling (2020) Climate policy co-benefits: a review, Climate Policy, DOI: 10.1080/14693062.2020.1724070. In general, co-benefits are highlighted in a very limited way in the chapter, which is a bit surprising since transport is a sector where co-benefits are particularly large and well-studied.	Take into account. Co-benefits section under review.	Mikael Karlsson	KTH Royal Institute of Technology	Sweden
46969	74	28	74	34	Whilst this may be true, there need to be case studies showing if and where this has made a difference to investment decisions and the impact this has on carbon emissions. One issue is that encouraging mode shift to active modes/ transit can result in suppressed demand / induced demand on highways; so a joined up approach is needed to mitigate this.	Accepted. Trying to include case studies in box(s).	Jameel Hayat	AECOM	United Kingdom (of Great Britain and Northern Ireland)
23895	74	35	74	35	"SDG impacts": Why this has been not assessed for each of the interventions?	Accepted. This will be included in the Feasibility table – in the next version.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
42287	74	35	74	35	On"free public transport fares" - the behavioral change impact should be large (I don't have the evidence, but intuitively, this should be the case).	Accepted. A point will be added but the Literature is very mixed as time seems to trump cost of fares.	Alvin Mejia	Wuppertal Institute	Germany
45199	74	35	75	1	Please do not ignore pedestrian infrastructure, traffic management (including speed management) and fossil fuel subsidies. In general for behaviour change, "push and pull" strategy is needed (make private vehicle use less attractive, and PT/NMT more attractive)	Noted	Stefan Bakker	GFA Consulting Group GmbH	Netherlands
35823	74	35	75	3	Space management should be added. For instance if new towns do not include facilities (schools etc..) and far from potential working places and public transport, this will contribute to resorting to light duty vehicles. In many developing countries, the trend in terms of space management and transport does not to be positive.	Accepted. Transport and land use are totally intertwined and this is featured in section 10.2. However it is not mentioned in the Policies section and will be added.	SMAIL KHENNAS	Energy and Climate Change Consultant	United Kingdom (of Great Britain and Northern Ireland)
22907	74	9			"Incentives such as free public transport fares can enhance mobility of low income households" - this is important but (how) does it help with climate mitigation? Also the opportunity of making public transport free is very much debated - see e.g.: Carr, C., & Hesse, M. (2020). Mobility policy through the lens of policy mobility: The post-political case of introducing free transit in Luxembourg. Journal of Transport Geography, 83, 102634.	Accepted. A point will be added but the Literature is very mixed as time seems to trump cost of fares.	Giulio Mattioli	TU Dortmund University	Germany
22909	74	10			It's not clear how SDG impacts have / can be assessed? Surely SDGs are multidimensional, and every intervention will have (at least potentially) different impacts on each of them	Accepted. This will be included in the Feasibility table – in the next version.	Giulio Mattioli	TU Dortmund University	Germany
23897	75	19	75	19	Please check. Some reference are mentioned twice.	Accepted. Referencing will be checked.	Stefan Majer	German Biomass Research Centre - DBFZ	Germany
11183	75				Table 10.9: New Transport Infrastructure: Chargers for electric vehicles should be mentioned.	Accepted. Will include the 'electric charging points' in the Table 10.9: New Transport Infrastructure.	Snorre Kverndokk	Frisch Centre	Norway
17995	83	10	83	28	References are listed more than once	Later versions clarified this.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
17997	85	1	85	8	References are listed more than once	Later versions clarified this.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
34767	88	5	88	14	Although there are many citations of Lee et al. 2020, I found missing citation in the bibliography. Further, I am not aware of any published Lee et al. 2020 paper.	Later versions clarified this.	Rudra Shrestha	Tyndall center for climate change research, The University of Manchester	United Kingdom (of Great Britain and Northern Ireland)
17999	91	10	91	17	References are listed more than once	Later versions clarified this.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
18001	91	25	91	36	References are listed more than once	Later versions clarified this.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
18003	95	28	95	31	References are listed more than once	Later versions clarified this.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
18005	97	34	97	39	References are listed more than once	Later versions clarified this.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
18007	98	6	98	11	References are listed more than once	Later versions clarified this.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
18009	98	37	98	43	References are listed more than once	Later versions clarified this.	Luigi Moccia	Consiglio Nazionale delle Ricerche	Italy
959	100	17	100	23	Yet et al., 2017a and Yet et al., 2017b are the one and the same document. Check your referencing.	Later versions clarified this.	Stella Kabiri-Marial	National Agricultural Research Organisation	Uganda
961	101	17	101	28	Sudhir et 2019a, 2019b, 2019 c, 2019 d are one and the same document. Please check you referencing entries.	Later versions clarified this.	Stella Kabiri-Marial	National Agricultural Research Organisation	Uganda

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
4141					I see a good amount of discussion on smart technology and its role in EV transport, but less on how doing so can help to find a space for excess renenewable energy, and the concept of smart local energy systems generally (i.e. a balancing of eletrcicty use, home heating, and EV transport, and electrcity generation). There is a lot of great examples of SLES rolling out in the UK, under the Prospering From the Energy Revolution (PFER) programme.	Later versions clarified this.	Chad Walker	University of Exeter	United Kingdom (of Great Britain and Northern Ireland)
9419					ok chapter 10	Later versions clarified this.	ANNA LAURA PISELLO	DEPARTMENT OF ENGINEERING - UNIVERSITY OF PERUGIA, ITALY	Italy
10549					According to Evs: I agree that EVs will contribute to the decarbonization of LDVs and trucks in the long term, but I think it assumes an optimistic view.I think that it should be stated in the IPCC 6th report that the challenges to the spread of current EVs are existed and that it is premised to solve them. Automotive industries and suppliers have to innovate the technology for EVs, such as cost down of battery, longer drive range, shorter charging time and longer battery life to popularize them. Actually, in China, decreasing subsidies are discouraging popularize EV's(Attached file). Similar events have occurred in Europe (Denmark, England) in the past due to the cut of subsidies. According to the IEA (Global EV Outlook 2018 Page 70 Figure 5.5), in countries with low gasoline prices, such as developing countries, there is no advantage in the total cost of ownership of EVs even at a battery cost of 100 $/kWh. In addition, these countries need to make more efforts to build a charging infrastructure, which is an economic burden. Therefore, innovation is important and prerequisite for the spread of EVs in these countries.	Take into account.	kazuhisa mogi	company	Japan
14053					There are many acronyms that are not explained or explained later on in the chapter. Some examples: ICE, ICT, TAC, LDV, AV, PEV, SSP, AIS, BRTS, RJF	Accepted	Victor Garcia Tapia	International Energy Agency (IEA)	France
22305					The chapter does not provide the context for transport as a mechanism supporting economic activity and our living standards and that transport is not an end in itself. This is an important concept for addressing the contribution the transport sector has in GHG emissions as it means changes in how we choose to live and how our built form and cities function can change the overall demand and the options that can practically be utilised. The absence of this context means that the chapter is overly focused on the decarbonisation of the existing modes and only narrowly considers how modal choices may shift. An obvious example is with the limited coverage the 'shared economy' has being addressed only in 10.2.2.2, yet as such a shift will greatly lower vehicle numbers even if it does increase passenger vehicle kilometres and as such the commentary in 10.4 is flawed given it compares energy vector and technologies in the context of our current vehicle ownership and use profiles. The commentary in 10.2.2.2 also operates in isolation from the commentary in 10.4 in that it assumes vehicle passenger kilometres inherently mean higher emissions where this has occured from modal shift, yet a renewable electrically powered vehicle via battery or hyrdogen has a margin emissions level of 12g CO2/vkm, a level lower than the emissions from many transit modes.	Accept. We will highlight more of this in SOD.	Kym Lennox	climate change equity	Australia
22307					Notwithstanding the point above, transport infrastructure as an enabler is also absent from the chapter. Most obviously with high-speed rail, but also true at the appropriate scales for slower modes of transport, transport infrastructure creates options for changes in land use and urban form that can structurally lower emissions. How well might Shanghai function and what would it's GHG emissions be if it did not have its metro rail network? If Vancouver, Seattle and Portland were linked via high-speed rail, how might the development of those cities and regions differ so as to lower their GHG emssions (both embedded and locked-in as part of their economic activity)? It is quite likely there are no studies to consider these questions. If this is the case, this report should highlight this gap and promote the work.	Accept. These areas are well researched and are in the chapter, but will be more highlighted.	Kym Lennox	climate change equity	Australia
22309					There is too little linkage for the growth of transport and the improvements for the metrics of SDGs. The commentary in 10.7.2 explores the trends for emissions from the sector and its components but does not contextualise this as to how this much of this is due in part to meeting the SDGs. Energy is considered in the context of how energy demand is increasing to provide improvements in the SDGs, why not transport? There would be much to gain in policy development if the pathways were considered in groupings based on a countries' performance in SDGs, the absence of this in the report lessens is capacity to be an agent of change itself.	Later versions clarified this.	Kym Lennox	climate change equity	Australia
25215					Matters in regard to affordability need to be elaborated, as well as the socio-economic aspects of the scenarios presented on mitigation options in the transport sector. Further analysis is needed on finance related issues in transportation in developing countries	Accepted. We will add a box to discuss innovative financing in developing countries based on a case study if enough space.	Eleni Kaditi	Organization of the Petroleum Exporting Countries (OPEC)	Austria
25531					Please take care not to use value-judgement terms such as 'important', 'significant' and also prescriptive terms such as 'need' and must'. Some readers will interpret these statements as policy prescriptive.	Accept.These will be cleaned out.	Sarah Connors	IPCC WGI TSU	France
25565					As a reader who isnt familiar with all the topics being discussed in your chapter, it might help many Exectutive Summaries to include subheadings to cluster the statements by topic or overarching chapter themes.	Accept. Agreed.	Sarah Connors	IPCC WGI TSU	France
29083					The approved outline indicates sectoral chapters include case studies. Useful to consider for SOD	Accept. Yes case studies are next.	Priyadarshi Shukla	Ahmedabad University	India
40343					It would be useful to look for literature in the transport sector that explores alternative socio-economic futures, such as those that aim to reduce the demand for individualised transport, aviation etc.	Accept. These are likely to be more clearly shown in SOD though they are there now.	Linda Schneider	Heinrich Boell Foundation	Germany

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
42853					From a transport mitigation perspective this Chapter has a bias towards technology based "improve" solutions (electic vehicles, low carbon fuels etc. etc.) - where it is estimated that 40-60% (Klimaschutzbeitrag des Verkehrs bis 2050, 2016 https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/texte_56_2016_klimaschutzbeitrag_des_verkehrs_2050_getagged.pdf (English Summary pages 26-50) of reductions will come from avoiding transport (local shops and services) and shifting transport to more efficient modes (e.g. rail freight, cycling and public transport). Avoid and shift measure deserve particular attention due to their relevance to low and middle income countries, contribution to SDG´s and affordability. This imbalance needs to be addressed in this Chapter - so as to align with the broader philosophy of the other Chapters.	Accept. The imbalance will be rectified.	Mark MAJOR	Partnership on Sustainable Low Carbon Transport	Spain
42855					This Chapter should emphasise that (except for long haul passenger aviation) cost effective and efficient low carbon transport solutions exist (public transport, walking and cycling, rail freight) they are just not implemented at scale. Impementing these solutions is largely a question of policy, resources, pricing and governance.	Accepted. This chapter mentions this. We will add text on governance and planning process in Table 10.8.	Mark MAJOR	Partnership on Sustainable Low Carbon Transport	Spain
42857					This Chapter does not address the widespread fuel subsidies (worth trillions of USD/y) (IMF Working Paper, 2019/89 - Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates) that drive up transport emissions.	Accepted.	Mark MAJOR	Partnership on Sustainable Low Carbon Transport	Spain
42859					For completeness and balance Section 10.5 must deal with policies and measures to AVOID and SHIFT air transport (e.g. teleworking, taxes, charges, slot restrictions, rail services).	Accepted. Agree and add point	Mark MAJOR	Partnership on Sustainable Low Carbon Transport	Spain
42861					For completeness and balance Section 10.6 must deal with policies and measures to AVOID maritime transport (e.g. packaging, logistics processes, taxes, charges, 3 D printing).	Noted.	Mark MAJOR	Partnership on Sustainable Low Carbon Transport	Spain
42865					The Chapter does not deal with the fact that international aviation and maritime transport fuels are not yet taxed. Leading to unfair competition between modes and discouraging action. (if I take the train Paris-London instead of flying the fuel is taxed and the emissions increase the UK and French reduction obligations).	Take into account. Check mitigation literature for taxation	Mark MAJOR	Partnership on Sustainable Low Carbon Transport	Spain
42867					More attention is needed to the contribution of supply chain design (sourcing decisions, location of production, logistics facilities, load factors, product design , packaging and distribution) to driving the 41% of transport emissions from freight transport.	Accepted and revised.	Mark MAJOR	Partnership on Sustainable Low Carbon Transport	Spain
42869					The Chapter mises the whole issue of transport pricing which has a strong influence on behaviour e.g. Marginal social cost pricing of transport.	Accepted - text revised - further text provided to emphasise importance of transport pricing, particularly in context of Avs, Evs, shared vehicles	Mark MAJOR	Partnership on Sustainable Low Carbon Transport	Spain
43715					it approximately on a par with CO2 (Grewe et al 2019 Environ Res Lett 14 121003)	Reject: this is one scaled study only. The (as yet unpublished – it's under review still) Lee et al. (20 international authors) assessment compiles a standardized (year, emissions, RF effects) ensemble of about 30 net NOx RF values that include two of the adjustments (they are not "flaws"), resulting in 17.5 mw/m2 (cf 34.3 mW/m2 CO2).	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)
43717					the RF attributed to NOx of 18 mW/m2has been challenged by Grewe et al who have identified two methodological flaws underlying previous work and have proposed a value for the NOx contribution in 2005 of 26.7 mW/m2, putting it very close to the CO2 contrib	Reject: this is one scaled study only. The (as yet unpublished – it's under review still) Lee et al. (20 international authors) assessment compiles a standardized (year, emissions, RF effects) ensemble of about 30 net NOx RF values that include two of the adjustments (they are not "flaws"), resulting in 17.5 mw/m2 (cf 34.3 mW/m2 CO2) for 2018. The so-called "flaws" are well-known adjustments in the assumptions that can be made (that we include and actually go further on than Grewe et al., 2019 to calculate an ERF [cf RF])	John Green	Royal Aeronautical Society	United Kingdom (of Great Britain and Northern Ireland)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
43801					My FIRST critics is that I find 26 occurrences of "renewable" and zero of "nuclear" (except in one refernece). I do not think that this is a serious position. Do you want to discuss climate mitigation or nuclear phasing out? p.15-One may doubt that V2G will be developed in the next ten years, as said in Fig. 10.2(p. 16). In the right of Fig 10.2, why is pumped hydro use peaking in 2005??? p 17-18-Excellent analysis of Li batteries. p. 19, Table 10-3 not very lisible? p. 23. line 9. The cost of 49$/KW for fuel cells seems very speculative. If an estimate is carried out from the Toyota Mira, it seems to be a few hundreds of dollars. Table 10-4 seems to give reasonable values. In Table 10-4, part 2 (p.24), one should include the power plant (PP) to wheel efficiency: <25% with hydrogen. This is more relevant than the "tank to wheel" efficiency. If the debate is to discuss efficiency, the PP to wheel is less than 25%, vs ~70% for batteries. One can calculate that to power 1Gcars (you speak of 1.7Gcars at the end of the draft) with ~14,000km a year, for 200Wh/km, only 2,800TWh electricity are used for BEV and 7,000TWh for hydrogen cars. It seems to me that we should give these estimates, because this power has to be generated in the future mitigitation. P. 38, Fig 10.11 There is a lack of Electricity from nuclear. I think that you should not consider nuclear as an "insult", but as an excellent way of producing electricity without CO2: In the world, nuclear produced 2,700TWh and wind ~1,100TWh in 2019. I think that the figure is not well chosen. Moreover, this figure is reproduced in Table 10.7. I attach another figure, which comes from a high quality paper from M. Messagies: https://www.transportenvironment.org/sites/te/files/publications/TE%20-%20draft%20report%20v04.pdf and which shows the importance of the national PRESENT mixes. You must not dream exclusively on renewables, there are already existing non-emitting power plants!	Accept.nuclear will be included.	Frédéric Livet	CNRS-France	France
47273					I really like the overall chapter but see room for improvement on three fronts that I have done extensive research on. I know it is a bold ask but I would love to become one of the contributing authors on those fronts. I'm relatively new in scientific research but I'm very passionate about this topic and this year a research proposal from me was awarded (https://www.tue.nl/en/news/news-overview/12-12-2019-energy-transition-gets-major-boost-with-multimillion-grant/) so the coming 5 years I may direct 33 PhD that are focussed mainly on electric transportation and renewable electricity. So I'm quickly mainstreaming into the scientific community. You may ask a reference from IPCC authors Kornelis Blok (chapter 12) or Glen Peters (chapter 3).	Accept. Thanks for compliment.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47275					1) The CO2 emissions of battery production are too high which unduly increases BEV emissions. For 2019 (and ultimately 2022 when AR6 is published) one should account for significant reductions that only show up in the most recent literature. For the future much more reductions are expected if production scales up and if renewable energy is used. I've commented on the relevant sections but would love to contribute more. To underscore this point I will turn my Dutch research on the subject into English peer reviewed content with prominent IPCC co-authors and send to a journal within 6 months. A leading journal has already indicated they are willing to publish.	Take into account. We will take into consideration the future publication of the reviewer. Furthermore, with more literature under review, especially the most recent studies, the production emissions of BEVs, FCEVs and PHEVs, will likely decrease. We are, however, reviewing literature published in the past 4 years.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47277					2) Based on recent studies of heavy transport I did with the Rotterdam Port Authority there is large potential for battery electric heavy (semi) trucks. This goes against accepted wisdom in the trucking industry but the calculations are sound and I've received a lot of feedback but nothing that undermines my results. I've commented on the relevant sections but would love to contribute more. To underscore this point I will turn my Dutch research on the subject into English peer reviewed content with prominent IPCC co-authors and send a second article to a journal within 6 months. A leading journal has already indicated they are willing to publish.	Take into account. Will look for this publication when it becomes available.	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47279					3) Discussion of the improving business case (aka total cost of ownership) of electric vehicles. Their current uptake is largely due to an improving business case that makes their adoption possible with limited subsidies. In 2025-2030 they will cost the same to buy and much less to own (even without subsidies) which will drive their adoption in all SSPs. This is especially true for battery electric heavy trucks for which the payback time of the battery is even shorter and for which the battery weight is less of an issue than often suggested. Furthermore they are often empoyed in fleets where diesel can continue to do the very short and very long distances. I've commented on the relevant sections but would love to contribute more. To underscore this point I will turn my Dutch research on the subject into English peer reviewed content with prominent IPCC co-authors and send a third article to a journal within 6 months. A leading journal has already indicated they are willing to publish.	Teke into account. In the SOD we aim to discuss and illustrate with a figure the lifecycle cost for the different LDV technologies, which in turn means that we also will discuss the points made by the reviewer, if all the reviewed papers will support those conclusions.	Auke Hoekstra	Eindhoven University of Technology	Netherlands

Comment ID	From Page	From Line	To Page	To Line	Comment	Response	Reviewer Name	Reviewer Affiliation	Reviewer Country
47333					I propose to add pararaph 10.3.1.4 on the CO2eq emissions of battery electric vehicles. On twitter and in blogs I spend a significant amount of time debunking studies that seemingly prove that electric vehicles emit more CO2 if you look over the entire lifetime. It became so bad that the authorative journal 'Joule' asked met to write a short article showing what all these studies get wrong and what is the right way to calculate BEV emissions. (Hoekstra, A., 2019. The Underestimated Potential of Battery Electric Vehicles to Reduce Emissions. Joule 3, 1412–1414. https://doi.org/10.1016/j.joule.2019.06.002). This pragraph could help clear up these misunderstandings. It could also be the place to discuss in some more detail what the correct CO2 emissions of battery production are (I'm not happy with figure 10.11 on page 38 and the assumptions on page 39 line 40 to name some examples). Most importantly it could look forward to 2050 (since that is also done for ICE vehicles) and look at CO2eq emissions to be expected then. Because what is missing from this chapter is that CO2 emissions from batteries will be reduced strongly in the coming years, due to three things. First, improved battery production efficiency (some sources report a tenfold reduction in energy use since Ellingsen 2014 - a reference in this chapter). Second the use of new chemistries (e.g. avoiding Cobalt and using less material or 'friendlier' material like LiS). Thirdly the use of low carbon energy, not only during driving but also during manufacturing. The last ten years have taught me that only a combination of low carbon electricity and the electric motor has any hope of keeping us below 2C, let alone 1.5C. We will make sure a publication is accepted latest september to adress this paragraph in more depth in time for the AR6 deadline.	Take into account.Section 10.4 will address the differences in life cycle GHG emissions of different fuel/vehicle technologies. I have included the reviewer's information to the list of contact we will contact regarding the request for LCA data	Auke Hoekstra	Eindhoven University of Technology	Netherlands
47381					Figure 10.13 about the LCA GHG emissions for land based freight in literature since 2015. Most of all this generates a lot of questions for me because outcomes seem logically inconsistent with what I know. I would like to see who said what here and why. By harmonizing the assumptions the outcome could become more consistent. E.g. if you use different fuel use between studies or if you use different assumptions about fuel production or different assumptions about electricity mix or... there is so much that's not clear in this figure.	Accepted. These figures will change once we perform harmonization process	Auke Hoekstra	Eindhoven University of Technology	Netherlands
48055					Comment on the chapter outline : there seems to be an overlap and a need for coherency on cities, urban forms, smart cities with chapter 8. The section on "shipping in the Arctic" could seek coordination with WG1 (sea ice projections; SLCF) (especially WGI chapters 3-9 for sea ice projections and chapter 6 for short lived climate forcers).	Take into account.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
48057					Comment on ES : I do not understand the high fraction of emissions from aviation and shipping (is this for CO2 only? Is it the fraction of the increasing trend and not of total emissions?)	Accept and revised.	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France
48059					Comment on chapter, section aviation and maritime transportation : please coordinate with WGI on the full climate footprint of aviation (including non CO2 effects)	Accepted. Agree - cross check	Valérie Masson-Delmotte	CEA, IPSL/LSCE	France